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Hands-on Science

Science Education and Sustainable Development

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Universidade do Minho, Braga, Portugal

Socrates Comenius   Education and Culture   Hands on Science

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FOREWORD

World' sustainable development both in economical and social terms strengthening the democracy and social cohesion in our societies with high levels of human development in respect to the United Nations chart of human rights should be a goal of all countries and of each one of us.

The importance of Science, both the pursuit of knowledge and the search for practical uses of scientific knowledge, is widely recognised at all levels in modern societies. A strong and enlarged scientific literacy is fundamental to the development of science and technology but also to a democratic citizenship.

In most countries it is being registered a striving lack of scientists technicians and science and technology teachers. Driven by this fact science is gaining an increasing importance in school education. Hopefully also recognising the importance of the study and training in Science in the building up of our youngsters' personality and abilities, both professional and social, changes in school curricula are being implemented in most countries being giving science a clearly higher importance.

However the improvement in the levels of quality and effectiveness in school science education can hardly be achieved without and effective change in the way science education is traditionally approached in our schools. The *method* that drives the pursuit of scientific knowledge should be the starting driving and guiding basis of all process of in-school teaching/learning of science. Leading the students to an active volunteer commitment in hands-on experimental activities: observing, analyzing critically, deducing, reasoning, defining, discussing, experimenting…

"making" (learning) science as a scientist do…

On the lines of our successful previous conferences, HSCI2004 in Ljubljana and HSCI2005 in Crete, we organised the 3rd International Conference on "Hands-on Science. Science Education and Sustainable Development" with the aim to promote an open broad exchange of experiences on good practices, syllabus and policy matters, social factors and the learning of science, and other issues related to Science Education and its development… through an enlarged use of hands-on experiments in the classroom. Results from the activities developed during the first three years of the Hands-on Science Network will be reported and discussed and conclusions established

…towards a better Science Education….

The scheduled over three hundred communications in oral and poster format and as science fair presentations will certainly bring new invaluable insights good practice examples and pedagogical tools to be shared and informally discussed in an open and friendly cooperation environment by participants coming from all over the world.

As Chair of the conference and Coordinator of the Hands-on Science network it is my pleasure to welcome you at the University of Minho wishing you a wonderful stay in Portugal!

Braga, July 18, 2006.

Manuel Filipe Pereira da Cunha Martins Costa
Chair

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Three years of activities of the Hands-on Science network. *Towards a better Science Education.*

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Established in October 2003 in the frames of the Comenius 3 action of the Socrates program of the European Commission, the European Network "Hands-on Science" developed since then a vast range of activities towards a better Science Education in European Schools.

Our main goal is the promotion and development of Science Education and scientific literacy in Europe. We aim to generalise innovate and improve Science & Technology teaching at basic vocational training and secondary schools by hands-on experimental practice in the classroom. ***Bringing hands-on active learning of Science into the classroom and into the soul and spirit of the school.***

The network enrols today, as regular or associated members, about two hundreds schools, several universities, national and international associations, governmental bodies, science centres and museums and companies of practically all countries of the European Union and countries candidates to the integration.

About a thousand teachers and educators from kindergarten to high and vocational training schools including special education institutions and well over 20000 pupils are or had been directly and actively involved in our activities.

Several dozens of lectures, countless experimental activities in the classroom, experiments demonstrations plays festivals and science fairs were performed. Training seminars and courses for teachers and pupils had been developed at national and European level. About two hundred pedagogical and scientific papers were published in conference proceedings and journals. Nine books and experiments guides and support texts had been, or will be briefly, published in different languages. Multimedia CDROMs and DVDs were produced as well as eleven websites in different languages. Several press-conferences news and reports were organised disseminating the results of our work in our communities.

Several successful Comenius 1 and Comenius 2 cooperation projects between dozens European schools and other institutions had been promoted in different subjects: robotics, renewable energies, optics, in-service science' teachers training, sociology and European identity, arts and science, and sustainable development. Other types of cooperation resulted also from the two Socrates/Comenius Contact Seminars we organized as part of our two first annual conferences in Ljubljana, Slovenia in 2004 and in Crete in 2005.

Three international workshops were organized annually in Cologne, Malta and Bucharest to discuss issues of utmost importance as the Access of Women to Science, Scientific Literacy the Development of Europe and the Challenges of EU' Enlargement, and the increasing importance of Life Long Learning and Scientific Literacy in Modern Societies.

Two international conferences highly successful were organised in Ljubljana, HSCI'2004 -1st International Conference on "Hands-on Science. Teaching and Learning Science in the XXI Century"- and in Crete, HSCI'2005 -2nd International Conference on "Hands-on Science. Science in changing Education" with 320 participants from 27 countries of the five continents.

With the active contribution of all members and individuals and institutions committed to the improvement of science education, the Hands-on Science network will continue growing and contributing to the sustainable development of our societies… *towards a better future!*

Keyworks. Hands-on Science, Scientific Literacy, Science Education, In-classroom experiments, Science and Society.

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The Hands-on Science Project: Perspectives of an Adventure

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Abstract. Contemporary knowledge conscious societies are dependent for their prosperity and development on Science and Technology literate citizens. The rapid advances in Science and Technology and their quick implementation into applications of every day's use imply that social interaction may contribute very little, if any, towards this Science and Technology Literacy which may be effected only through an effective education. In this context the Science and Technology subjects of the school curricula especially of the schools in compulsory education become a significant parameter having as a primary objective the education of the future citizen and not that of a specialist to the field. The Hands on Science project, based on an initiative of Manuel Filipe Pereira da Cunha Martins Costa of the University of Minho was created within this context as a Comenius 3 project partially financed by the European Commission. In its 3 years of operation has been transformed into a large network with many and significant field activities. It acquired a momentum which has already formed other related activities permitting the continuation of its operation. It has also inspired new initiatives for an effective Science and Technology teaching appropriate for the citizen of a Technology conscious society. The perspectives of some of these initiatives are being explored in this work.

Keywords. Science teaching, School curriculum, Compulsory education.

1. The Hands on Science project.

In all knowledge conscious societies, special attention is paid to the Science and Technology Literacy (STL) of their citizens. Although this is mostly based on welfare arguments, STL is also vital for the survival of democratic societies [1]. The European Union supports STL in various actions, especially within the Education and training directorate (see for example in http://ec.europa.eu/dgs/education_culture/). The **Hands on Science** (H-Sci), a formal project within the framework of SOCRATES – COMENIUS 3 [2] is such a supported action. This project proposal to European Commission was drawn and submitted by Manuel Filipe Pereira da Cunha Martins Costa of the University of Minho. The original consortium extended to ten countries and included ten partners plus an international association with 28 partners and a number of other collaborators as associated partners under the overall coordination of Manuel Filipe Costa. The HSci project addressed students, teachers and other educators, administrators of education and its objectives focus on the promotion of the Hands on attitude for the teaching of Science (see list in [2]).

After its approval, the HSci project began on October 1, 2003 its operation with its 1st meeting of the coordinators held on November 15, 2003 in Malta. In this 1st meeting most of the partners met for the first time although a number of them had also previous experience of working together. Overcoming normal mismatch and divergences, the partners reached a mutual understanding and in the short time elapsed have produced very remarkable outcomes, as may be seen from the (opening) presentation of the coordinator at this Conference [3] or by browsing the project's web site [2], including:

- The project has expanded into a human network covering the whole of Europe. A real virtual community of persons interested in a more effective Science teaching has been formed.
- Material useful to Hands on Science teaching has been produced and made available to interested teachers.
- A significant number of events (Science fairs and Science weeks, training seminars, workshops …) have been organized including three international conferences and three international workshops. In these events the participants had the opportunity to exchange experiences on good practices, syllabus and policy matters, social considerations and other issues related to Hands-on Science. More important they could be involved in face to face discussions establishing links with colleagues from different countries and (school) cultures and enhancing their visions.

2. A brief commentary

In its 3 years of operation, the HSci project has been transformed into a large network with many and significant field activities. These activities and the interaction between the partners, the associated partners and the teachers and other educators, who participated to the workshops and the Conferences, created an expertise valuable to anyone interested in a more effective Science teaching, appropriate for the citizen of a knowledge based society. Some examples, not included directly within the information provided on the projects web site, are:

- **Syllabus.** An update of the school Science syllabus is necessary. A century since relativity of space time and quantum mechanics were introduced, it is about time for them to reach schools [4]. These topics together with statistical physics, elementary particles and cosmology, materials science and solid state physics, radioactivity, - even more traditional topics like (micro) electronics- and other recent developments should form a new syllabus in a coherent and consistent way. The up to now practice (in tertiary education also) to add separate additional chapters after traditional Science has been taught only confusion provokes. New subjects should be included into the syllabus not as an add-on new module but integrated and interrelated with other subjects [5].
- **Experiments.** They are inherent to Science and they should be integrated to Science teaching. In smaller ages experimentation with simple materials has inherent advantages. Self-made equipment helps towards a better understanding of the basic notions of Science [6], [7]. Experimentation should be incorporated smoothly to the teaching activities with the skill of planning an appropriate experiment to test a hypothesis to be an explicit aim. The distinction between observational (e.g. experimental data) and their interpretation (e.g. the corresponding theory) is very important [8].
- **Inquiry and Modelling.** Open type questions and problems are necessary to complex cognitive skill development. They should, however, be accompanied with scientific discipline. Physics (and Science in general) by inquiry is a valuable resource [9].
- **Teaching.** Should incorporate 'Experiments' and 'Inquiry and Modelling', as commented earlier, towards the attainment to create models of the natural phenomenon under study. The creation of models is a very advantageous process, may be used more generally and should constitute an explicit objective of Science teaching [10]. The relation of observations from everyday life to Science teaching [11] coupled to 'what children think' [12] is very advantageous, leads to a better understanding and appreciation of Science and helps towards the development of reasoning (logic) [13].
- **Teacher education.** This is a matter of urgency. Towards this end, valuable resources are polymorphic practice [14], new and flexible methods of training [15] and project based teaching. My experience from Science Teachers' Education and Training shows that Project based teaching results in a better understanding of the basic principles involved especially if the guidance provided is not in the form of (very) detailed instructions but, rather, in the form of appropriate questions for the trainee to research and solve. Used this way to train the Science teacher it may also serve as an example of the teaching method to use with their students.

3. Perspectives

Three years now after the beginning of the HSci project, the financial support from the European Commission ends. The expertise and the momentum gained, however, permit the continuation of the HSci activities. This can be effected in many ways, including:

- Continuance of the HSci initiative as a Human Network of persons interested in Hands on Science Teaching through the creation of a virtual community. There is a world wide interest for this type of activity and a lot of relevant web pages may be found. Application for financial support in order to have (yearly) meetings with face to face discussion is also possible. The European Commission under the SOCRATES program supports thematic networks for 1 to 3 years (see in http://ec.europa.eu/education/programmes/socrates/tnp/index_en.html).
- The yearly organization of the HSci International Conference. This Conference has already got a reputation [16]. It may well continue to operate as long as there are institutions to host it.
- The operation of the Hands on Science project has brought together persons from all over Europe. During the events organized by the project, they had the opportunity to

discuss their interests and form new consortia. Many consortia have been established, some of them formulated as application projects and quite a few have been successful to get financial support. This process may be continued.

- Associations have been established with primary and secondary schools in almost all the European countries. These associations are a valuable resource linking Higher education and schools with a mutual benefit towards a more efficient Science Education.
- On initiatives created within the Hands on Science activities, for example the Comenius seminars within the International Conferences, many schools have formed Comenius 1 and Comenius 2 consortia supported by the European Union. This is a potential which permits the ongoing collaboration by own means (and, of course, by other financial support, e.g. through bilateral intergovernmental agreements).
- The inventory of Hands on Science activities produced permits the organization of official informal in service training of the interested Science teachers. One such training scheme has been described in [15] and is being implemented as the Comenius 2.1 project AESTIT – Affordable and Efficient Science Teacher In-Service Training [17].
- Etc.

In conclusion, the activities of the Hands on Science may continue with many ways open.

4. Acknowledgements

I would like to thank all the colleagues in the Hands on Science Network for their fruitful cooperation. I am also grateful to Athanasia Margetousaki, Miltiadis Tsigris and Simos Anagnostakis from the Laboratory of Science Teaching of The University of Crete for their support. I would like also to express my special thanks Manuel Filipe Costa for his wise coordination of the Hands on Science network and, also for his invitation to make this presentation.

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5. Notes and References

[1] In Democracy the citizens, acting on their own capacities and not as followers of a “gifted leader” (as sheep under the herdsman), are supposed to participate actively to the decisions taken. As these decisions are increasingly dependent upon Science and Technology developments, the active citizen’s participation implies that he (she) not only should be Science and Technology literate but also that he (she) must have cognitive skills permitting decisions on incomplete knowledge, i.e. also in areas he (she) is not an expert. Formation of models develops such skills and is (or should be) an integral part of Science teaching. Otherwise, science will be mixed with religion as in the Dark middle ages or in some places (for example contemporary USA – see http://www.ncseweb.org/ (visited on June 22, 2006) where Science education, especially the theory of evolution became a legal matter competing with religious doctrine). Note: the effective Science and Technology education has been declared by UNESCO “democratic right”, a right to democracy.

[2] http://www.hsci.info/

[3] http://www.hsci.info/hsci2006/index.html

[4] George Kalkanis ‘Which (and How) Science and Technology Education for Future Citizens?’, pp. 199-214 of Vol. II of the proceedings of the University of Cyprus, ‘1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens’, Paralimni-Cyprus 29/4-2/5 2001.

[5] see Miltiadis Tsigris and P. G. Michaelides, ‘*On the feasibility to include contemporary Science concepts in the Primary school curricula – a retrospection into two case studies*’, paper to be presented at the HSci 2006 - 3rd International Conference on Hands-on Science, 4th - 9th September, 2006, Braga, Portugal, proceedings published by University of Minho.

[6] P. G. Michaelides, Tsigris Miltiadis, Science Teaching with Self-made Apparatus, paper presented in the 1st International Conference on Hands on Science: Teaching and Learning Science in the XXI Century, 5-9 July 2004, Ljubljana, Slovenia, proceedings pp.

(http://www.hsci.info/hsci2004/PROCEEDINGS/FinalPapers/040530.pdf).
[7] Miltiadis Tsigris, '*The Didactics of Science through Polymorphic Self-Made Experimental Apparatus of Quantitative Determinations. An alternative proposal for the teaching of Natural Sciences*, in HSci 2005 - 2nd International Conference on Hands on Science: Science in a Changing Education, 13 – 16 July 2005 at The University of Crete campus at Rethimno-Crete, Greece, Proceedings pp 384-386 (http://www.clab.edc.uoc.gr/2nd/).
[8] P. G. Michaelides, "Understanding difficulties in Science observations", oral presentation, 2nd Pan-Hellenic Conference on the Didactics of Science and the introduction of New Technologies in Education, University of Cyprus, Nicosia May 3-5, 2000 , book of abstracts page 26 (in Greek).
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[13] Reasoning in Physics: The Part of Common Sense by Laurence Viennot, KLUWER Academic Publishers.
[14] P. G. Michaelides, "Polymorphic Practice in Science", pp 399-405 of the proceedings of the 1st Pan-Hellenic Conference on the Didactics of Science and the introduction of New Technologies in Education, University of Thessaloniki, Thessaloniki May 29-31, 1998 (in Greek).
[15] P. G. Michaelides, An affordable and efficient in-service training scheme for the Science Teacher, "Sixth International Conference on Computer Based Learning in Science 2003 (CBLIS03), University of Cyprus, Nicosia, Cyprus, 5 - 10 July 2003" proceedings pp. 792-799.
[16] A search for the whole phrase 'Hands on Science International Conference' gave more than 1 million hits most are referring to the 3 International Conferences organized by the participants of this Hands on Science project.
[17] Athanasia Margetousaki, P. G. Michaelides, '*Affordable and Efficient Science Teacher In-Service Training*' paper to be presented at the HSci 2006 - 3rd International Conference on Hands-on Science, 4th - 9th September, 2006, Braga, Portugal, proceedings published by University of Minho.

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Biology

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Hands on Physics and Biology in House of Science

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Abstract. In House of Science physics and biology join forces to explore nature with microscopes, accelerators and particle detectors. The experiments range from the study of chromosomes, genetic effects and the use of DNA sequencing in criminology to the study of particles in the cosmic radiation and from radioactive substances in our environment.

With a Sweeping Electron Microscope (SEM) a particle accelerator is used to explore biological matter demonstrating a new interdisciplinary project in physics and biology.

During the first four years of operation more than 2000 school classes and teacher groups, totalling close to 40000 visitors, made experiments in astronomy, biology and physics in the House of Science laboratories.

Keywords. Biology, DNA, Electron accele-rators, House of Science, Physics

1. House of Science

Stockholm House of Science in Stockholm is a laboratory for Science, entirely devoted to schools [1,2]. The House is situated in an academic environment at Albanova University centre. Researchers, university students and teachers develop exciting and interesting experiments that can not normally be performed at school. The aim is to make modern science accessible to teachers, school classes and individual students and increase the students' interest in today's natural science. During its first four years in operation almost 2000 school classes and more than 40 000 students and several thousands of teachers visited the laboratory.

2. The world of particles

Many of the physics experiments start with a visual inspection of the continuous 40 x 40 cm area cloud chamber (Fig. 1).

Figure 1. High school students studying particles in a Wilson cloud chamber

Several types of otherwise invisible particles can be seen; electrons, muons from the cosmic radiation and alfa particles from the decay of radioactive substances in the surrounding. More detailed studies are performed with particle detectors and ionisation detectors to explore the world of particles, the cosmic radiation and the radiation in our environment.

2.1. Electrons and annihilation processes

The classical e/m experiment is a good way to get familiar with the electron, particle acceleration and the effect on charged particles of electric and magnetic fields. Annihilation of the electron and its antiparticle, the positron, was studied using a positron emitting specimen and the apparatus shown in fig. 2. In the annihilation two photons are simultaneously emitted back to back to preserve linear momentum, each with energy of 511 keV corresponding to the rest mass energy of the particles.

The particles are registered by detectors coupled in coincidence to eliminate background radiation. With the two sets of detectors, the location of the annihilation source, normally hidden under a cover, is determined. By detecting several such coincidences with a large number of detectors the precise location of the source can be pinpointed. This is the idea of the PET camera (Positron Emission Tomography) used in medicine.

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Fig. 2 A simple PET camera. Each pair of movable detectors is coupled in coincidence. During the demonstrations the source is covered

Electron-positron annihilation at the highest energies available were studied using the web based education program Hands on CERN [3,4] based on real data from the DELPHI experiment [5] at the LEP collider at CERN. At high energies particle annihilations give rise to several types of particles - two photon final states are very rare.

2.2 Muons

Muons, seen as diffuse spots in the cloud chamber, are created in the upper atmosphere. According to classical physics it is surprising that muons with a lifetime of around 2 □s, created at altitudes of around 20 km, can make it down to the Earth. Einstein’s special relativity and the description of the time dilation explains this as a prolonged muon lifetime with a factor of about 40. Fig. 1 shows students studying cosmic muons in the cloud chamber, contemplating mysteries that can be explained by special relativity.

2.3 Alpha particles

The highly ionising alpha particles are the most striking particles in the cloud chamber. What are they and where do they come from? This is the starting point of nuclear physics in House of Science. Radioactive substances, changes in the nucleus, the study of exponential decays and the exploration of radon in our surroundings are the main examples of where the observation of alpha particles in the cloud chamber can lead. House of Science is equipped with both stationary and mobile detectors making it possible to determine the radon content in different locations – in schools, cellars or the underground (Fig. 3).

Fig. 3 Preparing the measurement of Radon under ground

3. The DNA molecule

The DNA molecule is a fascinating molecule that carries the information of life in almost every little living cell. Today the DNA information is used for many purposes, such as designing medicines or improving crops. However, some people are concerned about the consequences of improper use of gene manipulated organisms. Therefore it is important that students get a good understanding of DNA and its use, and get a chance to discuss the ethical aspects of using personal DNA.

3.1 Pyrosequencing

With a Pyrosequencing machine the DNA code can be established and used for identification of different species or individuals. This method is now used at House of Science to solve a fictive criminal case.

The visiting students work as criminal investigators_ resembling very much the investigators in real life or in CSI series on TV. The experiment is set in a crime scene where a hair has been found in the victim’s bathroom cabinet. The different suspects are described and the case has to be solved within the next few hours.

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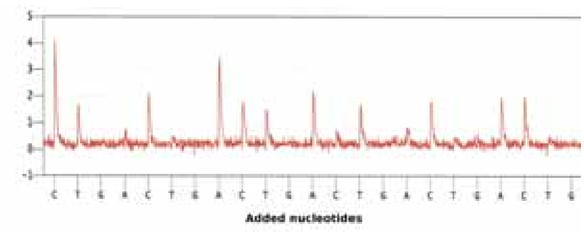

Figure 4. A pyrogram received from hair. The y-axis shows the strength of emitted light

At the end of the experiment a typical pyrogram received by the students determine the first 10 nucleotides on this sequence. In figure 4 a diagram is presented where the sequence C, G, C, A, G, T, A, C, A, A, A, T, A, T, G, T, C has been determined. Comparison with sequences from the suspects shows that the analysed hair originates from the old housemaid. Despite that the technique is rather advanced the procedure consists of steps that are easily comprehended by the students [6].

3.2 Fruit flies

Fruit flies are excellent for genetic studies as it takes only nine days for a new generation of flies to be produced. The effect of the DNA information is manifested when studying the phenotype for different mutations in fruit flies. Breeding experiments are carried out with fruit flies having different eye colour. After nine days the result can be studied under a microscope and it can be determined by the students that the genes responsible of eye colour is located at the chromosomes of gender.

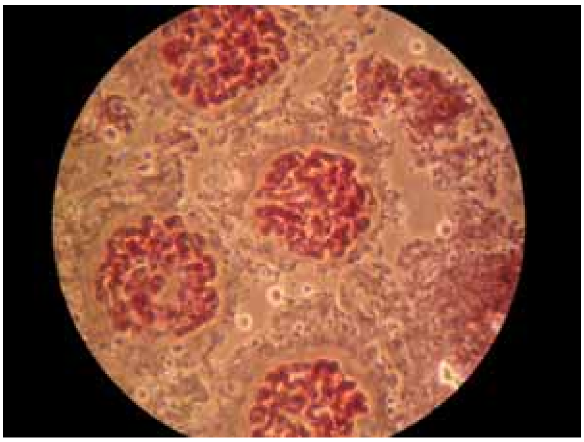

Figure 5. Chromosomes from the salivary gland in a fruit fly

The larvae of the fruit fly are dissected to study the gigantic chromosomes in their salivary glands. As seen in figure 5 the typical darker bands with packed DNA and lighter bands with less packed DNA can easily be studied under a microscope.

4. Interdisciplinary projects

Interdisciplinary projects of biology and physics are implemented for the exploration of living material. Many discoveries of DNA were performed by chemists and physicists at the Cavendish laboratory and elsewhere [6]. In House of Science biology and physics experiments are performed very close to each other, sometimes using the same laboratory.

4.1 SEM (Sweeping Electron Microscope)

The development of sophisticated microscopes, and maybe particularly the use of a particle accelerator, are examples of how physics and biology join forces to explore biological structures. In the basement of House of Science an old SEM is used to depict biological structures. This microscope can provide a magnification of up to 50000 times while keeping a large depth of focus. Once loaded with samples the microscope can be operated by the students themselves. A typical experiment for students often starts with a look into the microscopic world and continues with the theory behind the technique of electron microscopy. Figure 6 shows a photo of a nettle leaf.

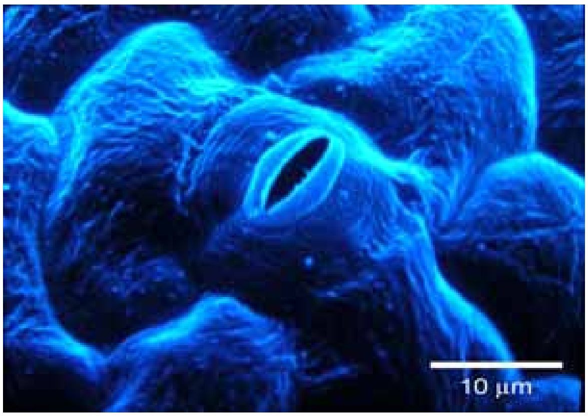

Figure 6. A stoma on the lower epidermis of a nettle leaf

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5. Summary

House of Science is a laboratory close to the university where hands on experiments can be performed by school classes. The experiments complement the basic laboratory experiments performed in school, and give the students a chance to experience the academic environment of a university. Different fields of science, particularly astronomy, biotechnology and physics are demonstrated and several interdisciplinary experiments are being implemented. The laboratory has become very popular in the Stockholm area with the yearly visit of around 700 school class and hundreds of teachers. The House of Science concept can be a model for other universities or academic environments.

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Hands-on Experiments with Bird's Models

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Abstract. It is our believe that hands-on experimental activities, among many other advantages, may be particularly suitable on the teaching of students with low levels of motivations, behavioural or learning disorders or handicaps.

CERCIGUI is an institution working with youngsters with different levels of handicap with special educative needs or in social risk. One of the major problems faced daily by teachers and educators is the extremely low attention span of these students, on average. Costa' opinion was that interdisciplinary hands-on practical activities related to live and nature but off the normal path of their everyday lives, simple yet demanding an active focused commitment of the students could have an effective positive impact on their development. The CERCIGUI' school participated in this project with the aim of approaching its student population to the science through experimental practice.

Several activities related to birds and insects were developed by the students/trainees.

The first step was to perform a research of the different bird's species and flying insects. As result the students selected two species of birds and a flying insect.

The second step was the design and building up of these flying beings in wood models. During these activities the trainees started to recognize and simulate the wings movement analysing its dynamic. Finally the appropriately decorated animals were mounted resulting in appealing and "efficient" mobiles.

During this all process different branches of the Science from physic to zoology were approached promoting the science literacy in this kind of "special" population.

Keywords. Birds, Insects, Science, Models.

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Gravitropism Hands-on Device

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Abstract. It is common belief that plants grow against gravity. Through our device we study geotropism phenomenon, that is the attribute of plants to grow against the effective gravity. The idea is simple; make plants to grow in an accelerating environment, so the resultant of weight and centrifugal force will be the effective gravity for the plant. We expect plants not to grow vertically to the ground but to make an angle.

At last, we propose a didactical approach with specific student objectives that our exercise may fulfil and we describe a worksheet that can be accordingly used for students of the primary school or for students of higher level.

Keywords. Accelerating system, geotropism, plant grow.

1. Introduction

Gravitropism is simply a plant's response to gravity. When a plant, or part of a plant such as the root, grows with gravity, it is called positive gravitropism. When the shoots grow against gravity, it is referred to as negative gravitropism. Plants are accustom to the Earth's 1g pull from a very young age, even before the seedling has grown into the light.

The research of gravity sensing is very exciting right now because the exact mechanism is not known. To better understand gravity sensing it is important to be aware of some of the components. The specialized cells and tissues for sensing gravity are called statocytes. The receptor receives the signal that was sent from the statocytes and then transduces it into physiological information. Sensing ends here, and the signal then moves into the transmission phase.

2. Materials and method

Our device consists of an electric motor which is connected with a rubber band to a round metal disc. The metal disc rotates with an angular velocity of 1rad/s approximately. A piece of steel pipe 1m long, is welded at the centre of the metal disc. As a result, the pipe is rotating at the same speed as the metal disc. At the other end of the steel pipe, we placed vertically an 1.2m long wooden axle (Fig. 1).

At the ends of the axle we hanged two cotton balls which contained lentils seeds with a short thread. The seeds are making circles 24 hours per day.

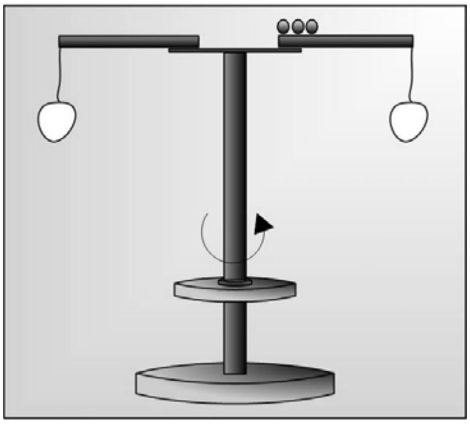

Figure 1. Experimental apparatus

More specifically, we used a power supply which could provide variable voltages $\left(0 \square 12V\right)$ and it could change the setting of the current, thus the sense of rotation in the electric motor.

The electric motor is working with direct current and with maximum input voltage $12V$. The maximum rotation speed is $2,400rpm$. Because of the small size of the motor axle, we cut and fitted a cd-case.

Then we welded a piece of a steel pipe $1m$ long at the centre of a metal disc. The metal disc was fitted in a base which could be rotated through the electric motor.

At the end of the pipe we fitted an horizontal axle where we putted 3 small magnetic balls as counterbalance. We also putted two small cotton balls which contained the seeds.

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3. Educational proposal

According to our method, the didactical approach that is supported by a worksheet should follow five steps: trigger of interest, express of hypotheses, experimentation, express a theory and generalize. This experiment refers directly to the third part of the following method and it can be used for measuring various natural and mathematical quantities such as period, frequency, angle, time, velocity, length.

In order to achieve the accomplishment of the student objectives, it is better for the experiment to consist of two parts; the first one with an experimental setup where the cotton balls with the seeds would be motionless and an experimental setup where the cotton balls with the seeds would be rotated. Thus, it would be feasible to make comparisons between the two different ways of grow.

In the fifth step here students are called to generalize their assumptions, we can put some questions in order to direct them. Particularly, we can ask them:

1. What are some general observations of the typical downward growth of a seed?
2. Is there anything that happens that is different from what you expected?
4. Using the data provided, how fast is the seed growing?
5. Why is it important to know how a seed normally grows?
6. What are some sources of error in this experiment?
7. How does the growth rate of this gravistimulated seed compare to the typical downward growth of a plant? Is it hindered or enhanced?
8. Supposed you see a plant's orientation and that no other reason affects plants grow, can you determine the effective gravity?
9. Can you make any hypothesis about the importance of gravity sensation of a plant in the space?

This exercise may fulfil a large variety of student objectives that can be accordingly applied to the student level. These objectives can be divided into two categories; not only cognitive but also psychomotor.

To be more specific, students (in the cognitive segment) are expected:

- To predict the normal response of a seed when grown down with gravity.
- To predict the response of a seed when it is being rotated.
- To compare the growth patterns of seed that have been rotated to those that are growing down with gravity.
- To compare the growth and angle of orientation of seeds according to angular velocity of the device.
- To identify why it is important for a plant to have gravity sensing.

and in the psychomotor segment are expected:

- To explain why it is important to have a control for an experiment.
- To measure the growth and change in seed angle over time.
- To interpret data generated in tables and graphs.

4. Experimental results

Our experimental results didn't comply fully with our expectations, due to the fact that seeds grew in a small rhythm. According to theory, seeds were supposed to grow parallel to the resultant of their weight and the centripetal force. This means that seeds should not grow vertically to the ground but to make an angle (Fig. 2).

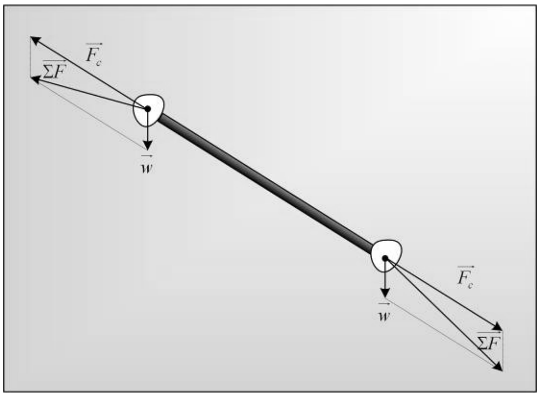

Figure 2. Forces applied at the seeds

Figure 3. The grown seeds

That wasn't what we experimentally noticed. The seeds grew so that shoots appeared to form a small angle with the vertical axis to the ground, but that wasn't too obvious. (Fig. 3).

5. Suggestions

As a future enhancement, we propose an experiment based at the aforesaid, where students can study various factors that determine seeds' grow such as light and orientation. With this they will have to handle more variables and study the importance of each one at the seeds grow.

The required changes in the experimental setup are small, as an electric bulb is needed and a mechanism that turns the vertical axis in various angles (Fig. 4).

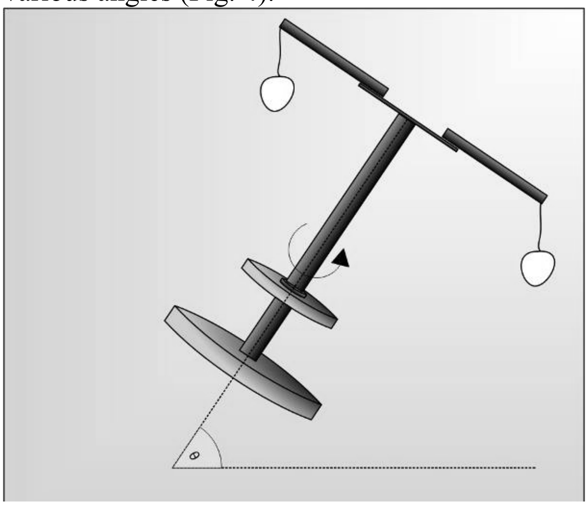

Figure 4. Proposed apparatus

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Young Children's Ideas about the Heart

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Abstract. Young children are often found to hold many ideas about scientific processes which are different from the scientifically accepted version. This paper focuses on primary level children's ideas about the heart. Interviews probed 24 children about the size, position and function of the heart. It was found that many children hold wrong ideas about the heart. They were found to draw the heart as pointed. They had wrong ideas about its size and colour. In many cases, chlidren atrtributed religious functions to the heart, reflecting the strong Catholic influence that still prevails in Malta and how teaching in other areas influences children's ideas in science.

Keywords: Primary science, Alternative frameworks, The heart, Religious influence.

1. Introduction

Much work and research has been undertaken over the years in order to better understand children's ideas about Scientific concepts. Research of this kind has been undertaken both with older children [1,2]as well as those in the elementary years [3-5]. Research has also been undertaken in the areas related to the human body [3,6].

Research into a variety of Science subjects, has shown that children's knowledge about these subjects is characterized by many wrong or limited ideas. It has led teachers and policy-makers to realize that teaching Science is no straightforward task and that in order to teach successfully, one must take these erroneous ideas into consideration when deciding what and how to teach children.

The specific aim of the research is to identify primary children's ideas about the heart; mainly size, position in body and function.

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2. Theoretical Framework

Science educators have given children's ideas different labels. These ideas have been called 'misconceptions' [7], 'alternative frameworks' [1] and 'children's ideas' [5]. These latter labels were preferred as children's ideas were considered to have a degree of logic and seemed perfectly sensible to children [8]. The most commonly-used label in literature is 'alternative frameworks'.

Alternative frameworks share many common features:

Logic and Rationality
Children's alternative frameworks tend to be logical and rational in their own terms, reflecting children's logical and rational thoughts and reasoning processes.

Imprecise use of language
Children tend to be 'imprecise in the language they use to express themselves' [9] (, p38);

Similar ideas are held across different countries
Children have been found to hold similar ideas in various scientific topics even though they are from widely-differing backgrounds [9].

Persistence and resistance to change
Alternative frameworks were also described as being persistent and resistant to change by [6,10,11,12].

They are personal
Children's previously-held knowledge gives a personal meaning to concepts and ideas.

Different reasoning patterns are used in different contexts
Sometimes, children come up with contradicting ideas in explaining the same phenomenon in different contexts [1].

Alternative frameworks are formed before exposure to formal instruction
Children construct their own theories about scientific concepts regardless of whether they have been exposed to any formal instruction about the topic or not. This happens because, as children grow, they struggle to make sense of the world around them. This gives rise to inaccurate or wrong ideas which later on teachers find to be a stumbling block in the learning of scientific knowledge.

Piaget was one of the first to view children's ideas as serious enough to warrant further study. Piaget was a firm believer that children construct their own knowledge and that this knowledge is qualitatively different from that of adults. He showed how a child's reasoning does not remain static but evolves and changes over the years as the child grows.

Piaget's early studies into children's biological knowledge led him to the conclusion that children are actively involved in the construction of their knowledge. He also showed that children younger than 10 years of age tend to answer in terms of intention when asked questions related to physical phenomena, e.g. "Why do children grow?" "Because they want to grow." Or "Why does the sun shine?" "Because it wants to make people warm." This finding is supported by the studies carried out by Caravita *et al* [13] and Caravita and Tonucci [14].

One of the most important studies which took place in the 60's was that undertaken by Gellert [15]. This study has shown that 5 year old children are aware of, on average, three body parts, increasing this to an average of eight by the time they are approximately 9 years old. According to Gellert, while younger children think in terms of what goes in and out of their bodies, older children tend to be more aware of the internal organs making up their bodies. They are also aware that the most important (indispensable) parts of the body are internal organs, generally those found in the trunk, and not external parts such as hair, nose, feet, eyes etc. Gellert's study has shown that very young children tend to view their body as that which is contained in the trunk. The first external body part which children become aware of is the head, followed by the arms and legs. Gellert's study showed that the first internal organ which children become aware of is the heart. Most probably this is because children can hear and feel its beating.

Carey [16] claimed that children do not really understand biological phenomena as 'biological' before the age of 10. They instead confuse biological phenomena with psychological phenomena. This claim brought about a reaction from a number of critics who have sought to show that not only do children hold biological knowledge, but they do so at ages younger than that cited by Carey. Inagaki and

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Hatano [17] found in their reserach that children as young as 6 years of age do possess a biological framework although different from that of older children and adults. Keil [18, 19] has gone as far as to suggest that even at the very young age of 3, children hold a very basic biological framework which is structured around a rudimentary version of the same principles held by adults.

Osborne *et al* [3] argue that children experience a spurt in intellectual development between the ages of 8 and 12. This development brings about an increase in children's interest and curiosity about the body. When children start becoming aware of the composition inside their bodies, they are aware of the heart. They then become aware of other organs, which, however, they perceive as being independent, and separate from one another. It is only later that they conceive these organs as working together through channels which exist between them.

Fraiberg [20] found that up to the age of 9, children viewed their bodies as a hollow skin bag that is all 'stomach' and a place where everything; from blood, to food and also waste, is contained. Very young children were shown by Carey [16] to associate the stomach with breathing, blood, strength and energy. From about 7 years of age, children start to think of the stomach as an organ which breaks or digests food. They are also aware that after being in the stomach, food is transferred somewhere else. Gellert [15] identified the age of 11 when most children had quite a good idea of anatomy and the overall function of the various biological systems.

One of the most significant studies was the Primary SPACE Research Report: Processes of Life [3]. This study provides a very detailed quantitative study about children's ideas about the processes of life. The study consisted of an elicitation phase where various techniques were used in order to elicit children's ideas about biological concepts. Part of the data produced focused on children's knowledge about the heart. This study reproduces some of the findings of the SPACE project.

3. Methodology

Due to the young age of the children with whom the research was carried out, a qualitative approach involving face to face interviews was used. This enabled the researcher to elicit children's ideas and to adapt the questions according the individual children's disposition and rang of ideas held.

The Interview Questions

A set of questions were used in order to elicit children's knowledge and understanding of the functions of the heart. The first two questions sought to establish whether the child possessed at least a basic knowledge of the organ, i.e. whether s/he was familiar with the 'heart' and whether s/he identified it as an organ forming part of the body.

The next two questions sought to identify where the child thought the organ is located in the body. For this purpose, an outline of the body was provided on which the children were asked to draw the organ in question. This exercise also sought to establish other physical characteristics which the children attributed to the heart, such as its size and the shape.

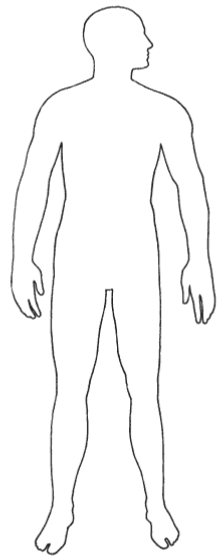

Figure 4: Outline of the human body used

The next question sought to give a clearer understanding of why the child thought that the organ was found in a particular location as opposed to another, i.e. the reason for such knowledge. The next three question tried to establish whether the children thought that the organ has an absolute and universal shape and colour, or whether this varies from person to person. Other questions probed children's knowledge about the contents of the organ; i.e. whether they thought the organ was empty. The rest of the questions elicited children's ideas

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about the function of the heart. The last question; sought to establish the role which common everyday language plays in the construction of children's alternative frameworks about the heart. It aimed to establish whether the use of metaphorical Maltese phrases about the heart and stomach were taken literally by children or whether children identified them as being just a way of expressing oneself in everyday language.

The Sample
This study was carried out with 24 children. The children were aged seven to ten. Four schools were chosen. Six children were chosen at random from each school in order to ensure as wide a range of experiences and abilities as possible.

Data Gathering
Following permission from the local Education authority, the schools were contacted. The aim of the study was explained to the respective Heads of Schools and the anonymity of the children guaranteed. The interviews varied between 20 and 45 minutes, depending on whether the child needed more probing in order to express his/her ideas. The interviews were audio recorded. Notes were taken immediately following the interviews in order to provide a summary of the main points and ideas gathered from the interview

4. Analysis of responses

The heart is found in the chest, slightly off-centre towards the left. It is a muscle which pumps blood around the body through veins and arteries. The average adult person's heart beats between 70 and 80 times per minute until death. Small mammals have a faster heart rate than larger ones, for example, a mouse's heart beats approximately 500 times per minute while that of an elephant beats approximately 30 times per minute. Oxygen from the lungs and energy from food is carried in the blood pumped by the heart. Arteries carry blood rich in oxygen and energy around the body. Waste products are carried away by the blood in the veins. The blood found in veins is dark while the blood found in arteries is bright red. Blood in the veins returns to the heart to be 'recharged'. If the heart stops beating, the body is starved of oxygen and dies quickly. It is sometimes possible to massage a stopped heart back to life. People with heart diseases can be helped by artificial devices. They can also be undergo a heart transplant where they receive a heart from somebody who has just died.

All the children interviewed said that they were familiar with the term heart. All of them also knew that this is an organ which is part of the body. Two children, attending the same school, also specifically mentioned animals; one saying that animals do not have hearts while the other saying that animals, like humans, have hearts. When asked why he thought animals have no heart, the boy stated that animals are not like humans and arrived at the conclusion that they lacked a heart. This child does not seem to be aware of the fact that human beings are also classified as animals. Osborne [3] mentioned the fact that everyday occurrences such as signs in shops saying 'No Animals Allowed' could reinforce a narrow view of the notion of what an animal is. The child who, on the other hand, mentioned that animals also have hearts came to this conclusion through first-hand experience with her pets.

Location of the heart

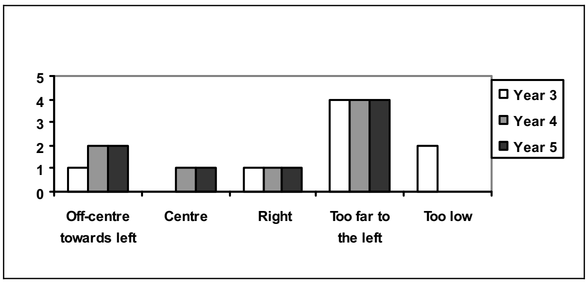

Figure 2: Location of the heart in the chest

All the children knew that the heart is located in the trunk section of the body. Only 5 knew that the heart is located slightly off-centre towards the left side of the chest. 2 children thought it is located exactly in the centre. 12 mistakenly located the heart too far to the left. The number of children mistakenly identifying the heart too far to the left remained consistent across the age groups.

Most of the children interviewed represented the heart on the body outline using the traditional Valentine shape, or a variant of it. Many of the children, who drew the heart as a Valentine shape, mentioned that they had seen pictures of the heart on television and greeting cards. Holy pictures were also often mentioned.

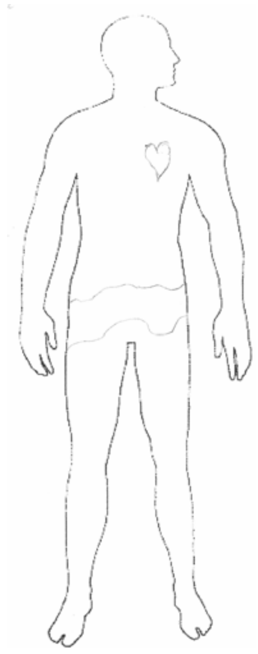

Figure 3: Drawing by Boy – Age 8

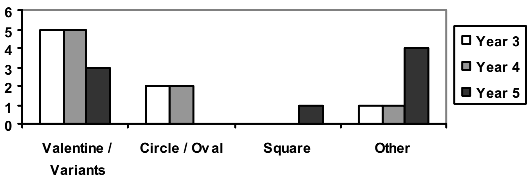

Figure 4: Children's representation of the shape of the heart

Function of the Heart

When asked what they thought can be found inside the heart, the children gave various answers. The table below lists the various responses given by the children as well as the frequency of each response.

Sixteen children mentioned that there is blood inside the heart. Two children mentioned veins, one of whom (Boy – Year 3) said that the veins are there to keep the heart open and supported in order to ensure that there is enough space inside it for the air we breathe. Arteries were never mentioned – presumably due to the fact that in everyday language, the word *'veins'* is used more often than the term 'arteries'. Four children mentioned pipes for various reasons such as for food, blood, or air to pass through.

Table 1: Children's ideas about the contents of the heart

	Frequency of each answer			
Contents of the heart	**Yr 3**	**Yr 4**	**Yr 5**	**Total**
Air (breath)	3	4	2	9
Blood	5	6	5	16
Emotions	0	1	0	1
Energy	0	0	1	1
Food	2	1	1	4
Jesus	0	1	0	1
Pipes	1	2	1	4
Pump	0	0	1	1
Solid mass (flesh)	2	0	2	4
Space	0	1	0	1
Talents	0	0	2	2
Veins	2	0	0	2
Mean of responses per child	1.86	1.86	1.86	

It seems that the children did not improve in their knowledge about the contents of the heart with age. The number of children who mentioned the blood remained quite constant while the number of children associating the heart with Religion, emotions, talents etc increased with age.

Indispensability of the heart

All the children interviewed said that the heart is a vital organ without which we would not be able to live. When asked about the possibility of procuring another heart in the event that one's heart stops functioning as it should, there were eleven children who said that it is possible to acquire another human heart while ten thought that there's nothing one could do. Only two children said that an artificial heart might be possible while one child thought that both a heart transplant and an artificial heart were feasible options. In this case, the awareness of the existence of heart transplants seems to be increasing with age.

Two of the children who mentioned the possibility of a heart transplant were, however, confused as to when the heart could be transferred from one person to another. One child was not sure whether the heart would be taken from a person before or after s/he died, while the other thought that the heart is taken from a person before his/her death.

Many children gave reasons for their thinking that artificial hearts are not possible. They mentioned that artificial hearts *'can't move'*, *'can't beat'*, *'wouldn't allow blood to flow through'*, and that they *'would not be able to function'*.

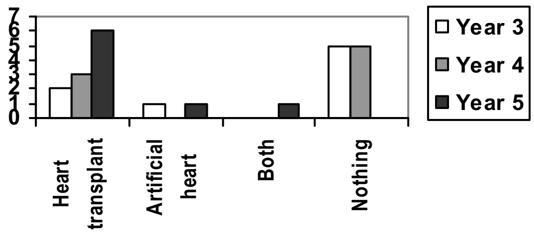

Figure 5: Children's ideas regarding what could be done in the event of malfunctioning of the heart

Two children who thought that artificial hearts are a good idea said that plastic hearts might be possible, but not hearts made of wood or metal. The child who thought that both transplants and artificial hearts are possible said that artificial hearts could be constructed out of metal and then covered with a suitable material such as plastic.

5. Conclusion

The picture emerging from this study does not seem to indicate an increase in children's understanding of the function and role of the heart. In fact, it seems that as age increased, the children are more confused as to the actual function of the heart with many older children attributing Religious and moral functions it. These mistaken ideas seem to arise due to children taking metaphorical and idiomatic expressions about the heart literally. Older children who have been hearing these expressions more often than younger children might have had more time to internalize these expressions and metaphors and to incorporate them into an already-existing alternative framework. Throughout this study, no significant differences were observed between genders or schools.

These results show how important it is to do science at primary level as children possess fragments of knowledge that they pick up from here and there. It is important that children are given the opportunities to learn more about themselves and their biological make-up as from a young age. In the same way that they obtain knowledge from different sources, they can learn much more from the formal educational setting. Although many may question the value of teaching about such concepts at such a young age which may not be of great scientific detail, none the less it is important to help children to start understanding how the human body works.

We are living in a fast changing world with new knowledge and practices generated every day. The science education provided to students should mirror this change. Rather than aiming to cover all the content generated, it makes more sense to aim to develop independent learners who can understand scientific issues and their implications to everyday life. This calls for a radical change in the way that we view science education. It is essential that this change is brought about, and quick, as otherwise we would end up with a future where citizens will not be able to handle appropriately the scientific processes that our scientists have developed. Such great power in ignorant hands would be dangerous to the future of our world. It is thus essential to act now if we want our future generations to enjoy a better quality of life than we have today.

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The Impact of Müller Cell Reactivity During Retinal Degeneration

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Abstract. Age-related macular degeneration and diabetic retinopathy are the most common causes of retinal eye diseases and blindness in the USA. Müller cell reactivity is one common process in all etiologies for various diseases and neuronal loss within the retina. Müller cell reactivity was graded as non-reactive, mildly reactive, moderately reactive, and severely reactive based on the age of the animal and the area of degenerating retina sampled. To test whether the effect is due to a diffusible factor, photoreceptor cells were cultured in conditioned media from reactive and non-reactive Müller cells. In cell-to-cell contact, the Young Central Müller Cells (non-reactive) allowed 23.78% survival; the Young Peripheral (mildly reactive) allowed 50.17% survival; the Old Central (moderately reactive) allowed 3.20% survival; and the Old Peripheral (severely reactive) allowed 3.9% survival. Statistically, these results were extremely significant individually against the control using t-tests ($p \leq 0.001$) and as a whole using the ANOVA test ($p \leq 0.001$). From my data, it appears that a diffusible factor from the reactive Müller cell doesn't play a role in preserving photoreceptor cells during retinal degeneration. However, a cell to cell signaling method does seem involved in this process. The more reactive the Müller cells, the lower the survival of photoreceptor cells in coculture; perhaps due to an increase in the release of cytokines from reactive Müller cells or a decrease in growth factors as Müller cell

reactivity increases. New therapies for retinal diseases could come from the fact that Müller cells potentially harm photoreceptor cell survival.

Keywords. Macular degeneration, Photoreceptor, Muller cells

The Process of Digestion as Chemistry. The Horrible Experiment of Dr. William Beaumont

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Abstract. Occasionally accidents or coincidence may play an important role in the life of many science workers. So it went with the American army doctor William Beaumont in the 19th century. A severe injury caused by an incidental shotgun was enough for the scientist to start experimenting "in vivo" on his patient Alexis St. Martin. Dr. Beaumont worked with great persistence and accuracy and his it was the first comprehensive study of the influence of gastric juices on digestion. There were five or six old theories of stomach digestion: concoction, putrefaction, trituration, fermentation and maceration.

Very much uncertainty existed as to the phenomena occurring during digestion in the stomach, the precise mode of action of the juice, the nature of the juice itself and its action outside the body. On all these points the observations of Beaumont brought clearness and light where there had been previously the greatest obscurity. His somewhat "horrible" experiment can also be regarded as an example of excellent scientific work.

Young people are actually very "food sensitive" and in class room practice topics as healthy food, special diets, low energy drinks, anorexia nervosa …claim a part of the biology lessons. This issue of digestion is also compulsory in most of the biology programmes of the secondary schools in many countries. That is the reason why I have chosen to work out this historical experiment and put it in a broader and more actual context. It will be on the school website and three groups of pupils of the 6th year will continue the hands on part and present it during a European Science Symposium of the European Schools.

Keywords. Digestion, Chemistry, Biology.

2. Structure of the website

2.1 The horrible experiment
2.1.1 Historical view of digestion
2.1.2 The life of William Beaumont
2.1.3 The Alexis St. Martin Experiments
2.1.4 The Beaumont papers
2.2 The importance of Beaumont's work
2.3 Hands-on
2.3.1 Didactical value
2.3.2 Physiology of digestion
2.3.2 Class-experiments
2.3.2.1 Simulations
2.3.2.2 Lab experiments
2.3.2.3 Virtual food analysis and personal diet
2.3.3 Weblinks
2.3.4 Publications

3. Historical view of digestion

Earlier work had been done by a Flemish scientist Van Helmont. His sophisticated studies have been taken down in his book "Oriatrike or Physical Refined", published in 1662. People thought of digestion as a kind of cooking brought about by the heat of the stomach. Van Helmont knew that the proven acidity of stomach fluids were not enough to explain the digestion of meat and he introduced "ferments" responsible for specific action in the digestion process. This was very near our modern concept of an enzyme. From stewing to chymification, fermentation or putrefaction…the view of digestion has been very obscure and open to a lot of guessing.

Later experiments by the Italian Spallanzani also tried to find explain the properties of gastric juiced. He forced animals to swallow tubes of food and made them sick so he could study how the food had changed. He even did the same experiments with himself!

4. The life of Dr. William Beaumont

1785 William Beaumont was born in Lebanon, Connecticut on November 21, 1785.

1811 At age 26, Dr. William Beaumont enlisted as a surgeon's mate in the U.S. Army. He was assigned to the Sixth Infantry

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Regiment in Plattsburgh, New York. Soldiers lived in quite miserable conditions; hospitals were set up in buildings, barns, or even tents. After the war ended, Beaumont left the Army and in June 1815 he began private practice in Plattsburgh, NY, where he met his future wife, Deborah Green Platt.

1819 He re-entered the Army in December 1819, this time as a post surgeon. He was sent to a place near the Canadian border.

1921 In August Beaumont took a leave and travelled to Plattsburgh, where he and Deborah were married.

1826 Beaumont was assigned to Fort Howard, Green Bay. The medical problems he saw included fevers, diarrhoea, dysentery, and rheumatism.

1828 He went to in Wisconsin and stayed four years at Fort Crawford. The biggest medical problem was malaria, caused by mosquitoes and the area's problem of flooding each spring.

1834 Service at his last Army post near St. Louis, Missouri. where Beaumont participated in the new local medical society, which soon became the state medical society.

1853 Dr. Beaumont slipped on an icy step while exiting a patient's home, hitting his head severely. He died on April 25 and was buried in Bellefontaine Cemetery in St. Louis.

5. The Alexis St. Martin Experiment

Fort Mackinac, June 22, 1822, in what is now Michigan: A nineteen-year-old French Canadian trapper, Alexis St. Martin, stands on the threshold of history. Actually, he stands in the American Fur Company store. Suddenly, a shotgun goes off by accident.

The gun was 2½ feet from St. Martin's chest. Duck shot shredded his ribs, lungs, diaphragm, and stomach. The post surgeon, William Beaumont, came on the double. Beaumont sifted out bone fragments, patches of burned clothing -- shredded tissue. Finally he gave the ruined St. Martin 36 hours to live.

But St. Martin rallied. For two years Beaumont tended him. Then he hired him as a handyman. The ghastly wound healed. Well, it almost healed. The breach in St. Martin wouldn't quite close.

Skin healed around a patch of exposed stomach wall. The torn stomach, in turn, formed a kind of mouth. It healed into a valve that opened when St. Martin ate too much.

Beaumont was no backwoods sawbones. He knew the European medical literature. He'd read the heated debate going on about digestion. Doctors couldn't tell if the stomach ground food up, cooked it, or reduced it chemically. One English doctor had finally cried,

Some ... will have it that the stomach is a mill, others that it is a fermenting vat, others again that it is a stew pot.

In 1825 Beaumont realized he'd been handed a remarkable opportunity. He made a deal with St. Martin and began a series of observations. He peered into St. Martin to see what his stomach was doing after different meals. He subjected samples of gastric juices to chemical analysis.

Early in 1826, St. Martin wearied of the game and walked off. A few years later, Beaumont tracked him down in Canada. St. Martin -- now married and the father of two -- knew his value to Beaumont. He dickered for price. Finally, in 1829, Beaumont rehired him, and his family, so he could continue the tests.

Beaumont published a book in 1833: *Experiments and Observations on the Gastric Juice and the Physiology of Digestion.* It was clean, accurate scientific work. Picture 1 take from the book shows the wound.Beaumont set the basis for what we know about digestion today. The book had a powerful influence back in the medical centers of Europe.

And St. Martin? Well, he lived to 83. Long after Beaumont died, he was still showing himself at medical schools for pay.

So maybe this is a story about opportunism. After all, both Beaumont and St. Martin grasped the occasion in different ways. But Beaumont had the wit to see opportunity -- to use it for the general good. And if you've ever been cured of a stomach problem -- you should be very thankful he did.

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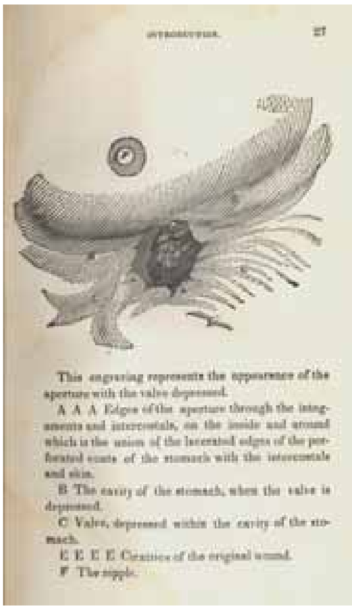


Picture 1. The wound

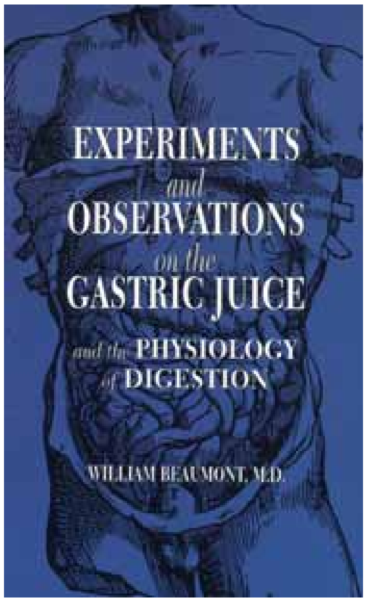
5. The Beaumont papers

In mid-April 1833, Beaumont went to Plattsburgh, New York, where Beaumont was reunited with his family and began work on publishing his observations in a book, *"Experiments and Observations on the Gastric Juice and the Physiology of Digestion."* Dr. William Beaumont's cousin, Dr. Samuel Beaumont, had published a small newspaper prior to becoming a doctor himself (he apprenticed under William), so Samuel was quite helpful to William with the book's initial printing in 1833 (and with its second edition in 1846).

Beaumont concluded in his book that digestion is a chemical process and that gastric juice acts as a solvent. His work won wide acceptance and his book became a trusted source for medical students and opened new avenues of research.

6. Importance of his work

- The accuracy and completeness of description of the gastric juice itself.
- The confirmation of the observation that the important acid of the gastric juice was the hydrochloric.
- The recognition of the fact that the essential elements of the gastric juice and the mucus were separate secretions.
- The establishment by direct observation of the profound influence on the secretion of the gastric juice and on digestion of mental disturbances.
- A more accurate and fuller comparative study of the digestion in the stomach with digestion outside the body, confirming in a most elaborate series of experiments the older observations of Spallanzani and Stevens.
- The first comprehensive and thorough study of the motions of the stomach, observations on which, indeed, are based the most of our present knowledge.
- A study of the digestibility of different articles of diet in the stomach, which remains today one of the most important contributions ever made to practical dietetics.



Picture 2. The book

7. Didactical value

7.1. An example of good scientific work

There had been other instances of artificial gastric fistula in man which had been made the subject of experimental study, but the case of St. Martin stands out from all others on account of the ability and care with which the experiments were conducted. The value of these experiments consists partly in the admirable opportunities for observation which Beaumont enjoyed, and partly in the candid and truth-seeking spirit in which all his inquiries seem to have been conducted. "It would be difficult to point out any observer who excels him in devotion to truth and freedom from the trammels of theory or prejudice. He tells plainly what he saw and leaves every one to draw his own inferences, or where he lays down conclusions he does so with a degree of modesty and fairness of which few perhaps in his circumstances would have been capable."

In the science teaching practice, it's necessary to get pupils to learn how to develop a scientific theory, based on hands-on science? Therefore the Beaumont work could be a perfect example.

7.2. Hands-on

7.2.1. Experimental Design Sheet

Develop for the pupils work in the lab an experimental design sheet. They should try to include the following sections:

- Title:What do you trying to find out?
- Background research: Collect information about the topic
- Hypothesis: Based on the research, what will happen when you do the experiment
- Materials: List of materials
- Procedures: How will you test your hypothesis?
- Results: Record your data in chart form, graphs, spreadsheet…
- Discussion: Explain the results; did you hypothesis prove correct of false?
- Conclusion: Briefly summarize your findings

The experiment of Dr. Beaumont could be a starting point to make students find parts of this experimental approach.

7.2.2 Class experiments

7.2.2.1. Digestion

There is so much material on the internet that a list of URL's might be very useful. The teacher can check the addresses with the pupils and select the experiments that are close to the original of Dr. Beaumont. But since Beaumont neglected the action of other digestive juice like saliva, the project could be broadened to the complete digestive system.

Here are some ideas that can find found on the web, with already student product sheets available:

- Imitate Protein digestion (breaking down hard-boiled egg with enzymes)
- Imitate Carbohydrate digestion (breaking down soda crackers)
- Constructing the complete digestive system with simple materials as class project
- Specific enzymes for the breakdown of nutrients
- Animation and simulation programmes
- Studying the structure of the main digestive organs
- Make a quiz about digestion

Useful websites:

http://samson.kean.edu/~breid/enzyme/enzyme.html
http://www.smv.org/jil/mll/high/MLL9-12dig-LP.pdf
http://www.tvdsb.on.ca/westmin/science/sbi3a1/digest/digest.htm
http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter43/animations.html#
http://www.whfoods.com/genpage.php?tname=faq&dbid=16#digestion
http://www.uclan.ac.uk/facs/health/nursing/sonic/scenarios/uclananim/wholebodyzoom.swf
http://kitses.com/animation/swfs/digestion.swf
http://www.zerobio.com/target_practice_quiz/target_practice_quiz_digestion.htm
http://highered.mcgraw-hill.com/sites/0072919183/student_view0/chapter37/elearning.html

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http://www.mhhe.com/biosci/genbio/maderhuman6/student/olc/vrl_animation-quizzes.html
http://www.bioplek.org/inhoudbovenbouw.html#spijsvertering
http://www.cheminst.ca/ncw/experiments/2001_baking_e.htm
http://www.gastrolab.net/ghe6.htm

7.2.2.2. Links with other food programmes

7.2.2.1.1. H.E.L.P. project

The basic experiments of Dr. Beaumont resulted in the publication of his book, where the digestion of all kinds of food in different condition has been accurately written down. In our modern scientific environment we have so many data of food analysis at our disposal, that it possible to make a virtual analysis of the food that we daily consume, to calculate the total energy content and to compare the results with a "healthy and balanced" diet.

A few years ago a team of 7 schools presented the H.E.L.P, a Comenius project organised by 7 European schools: **HE**alth, **L**ifestyle and **P**hysical condition of pupils. A part of the H.E.L.P.-project is about food consumption and the energy balance of the body. The programme files are mostly written in excel and food lists are made in Dutch, English, Norwegian, Italian and Spanish.

Description

The eurofood-part is one of the key-programmes in the HELP project. Using the eurofood programme, together with the energy-calculator it should be possible to create a complete "health-report" for an individual student or a class group.

The eurofood programme is created from a teacher's point of view: it is an aid to work specifically with youngsters in a classroom environment. Pupils don't need to have a prior knowledge of the subject, and working with the programme is as easy as we could possibly make it.

Objectives

A correct assessment of food intake and/or nutritional status is problematical in pupils. This food programme therefore aims to present user-friendly software on eating habits that can be used in a classroom environment. 16-17 year-old pupils can compare their own eating-habits with recommended data, with the data of their classmates and/or with the eating pattern of pupils in the other European countries. This part of the HELP-programme is linked to other parts of the same programme, so that results can be related (e.g. activity).

Picture 3. Beaumont and Spallanzani at work in the book: "Blood, bones and body bits". Nick Arnold and Tony De Saulles - ISBN 0 590 54365 2

The aim is not to present a scientifically "foolproof" program, but to provide a framework for the teacher through which he/she can discuss eating-habits in the classroom, involving the pupils in a very direct way.

7.2.2.1.2. Comparing food pyramids

Pupils can choose three specialized food pyramids to compare, in three different countries for specific age groups. The USDA offers many choices and some very useful links on their website at:
www.usda.gov/cnpp/
www.bal.usda.gov/fnic/etext/000023.html

One can visit, even for fun, the USDA "Interactive Healthy Eating Index" at http://www.usda.gov/cnpp/healthyeating.html to find out how the foods fit into the food pyramid. The website can also be used to look at the nutritional value of the foods you eat.

7.3. A book for fun and science

In the book "Blood bones and body bits" science has never been so horrible and funny. Nick Arnold and Tony De Saulles describe many historical biological and chemical experiments in a funny and pleasant way. Even the experiment of Dr. Beaumont has found a place in the book under the title: "The stomach for the job".
http://www.horrible-science.co.uk/magazine.htm

8. Beaumont websites

http://www.pebblepublishing.com/forgotten_missourians_who_made_history.htm
http://www.james.com/beaumont/dr_life.htm
http://www.umsystem.edu/upress/spring1996/horsman.htm
http://www.fortcrawfordmuseum.com/drbmt.htm

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A Survey of Properties of Solutions at the Olimpíadas de Química Júnior

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Abstract. The Olimpíadas de Química Júnior is an organization of the Chemistry department of Portuguese Universities and the Portuguese Chemistry Society. Each chemistry department is responsible for the local organization of the event, as well as the exam elaboration.

This event is addressed to students of 8th and 9th grades and the quizzes cover the subject matters of the 7th and 8th grades, such as, elements and compounds, phase transitions, solutions properties (concentration, pH and conductivity), chemical reactions, characterization and separation of mixtures and materials density.

This year at the University of Minho the exam included two assessments. One took place in laboratories and comprised 29 questions based on observation and manipulation of materials and apparatus. The second evaluation occurred at an auditorium and included quizzes based on the observation of puzzles, films and simulations of transformations presented through multimedia technologies totalizing 21 issues.

Photo 1. The experimental set up for the identification of solutions based on acid-base indicators colour

In this communication it is presented the answers' analysis of the 58 teams that participated in this year edition of the Olympics in what concerns one of the issues included in the exam. The subject Properties of Solutions was evaluated in a set of 8 questions, 6 in a laboratorial context and 2 puzzle questions in the auditorium evaluation.

In the laboratory evaluation, the answers were based on multiple-choice and it was expected that teams were able to:

- differentiate between electrolyte and non-electrolyte solutions;
- identify solutions by means of their colour in the presence of two acid-base indicators;
- measure the pH of a set of solutions using an universal paper indicator and arrange them by acidity;
- order solutions of different concentration, based on their colour;
- estimate concentrations given the mass and volume data;
- estimate concentrations following up a dilution.

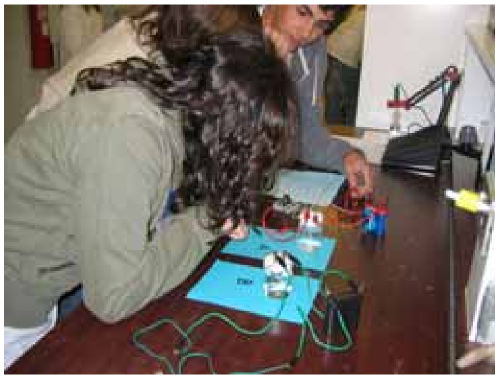

Photo 2. The experimental set up for the quiz regarding the conductivity of solutions

In the auditorium evaluation, it was expected that the teams were able to:

- identify the water through its properties presented as clues;
- identify an indicator through clues concerning its colours in acid and basic media.

The teams' answers to the selected questions are analysed considering the absolute and relative rates vis-à-vis the global assessment.

Photo 3. The experimental set up for the quiz concerning the estimation of a solution's concentration

Keywords. Science fair; Properties of solutions.

The Colour of the White

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Abstract. The aim of the project developed in the "Museum of the Biscaínhos" (Braga - Portugal) was to promote activities where different areas in the field of science, art and dance interact. It was targeted for children between the age of 5 and 12. The project is innovative due to this cooperative interaction between science and art, and allows the children to develop skills both in science and art

The project was carried out in association with the art' school "Arte Total" (Braga – Portugal) coordinating the artistic side, and the "Associação Portuguesa dos Pequenos Investigadores" (Braga – Portugal) responsible for the sciences field. The subjects which we deal with were colour, light and vision. In this work we will present the results achieved in the different approaches of the project. In the art activity were obtained devices to be used in the science workshop (an eye model, a kaleidoscope, a fibre optics simulator and a big Newton disk, among others [1-2]) and in the dance activity the moves and effects of the experiments are to be repeated. In the science workshop, the first day was dedicated to vision, the following days to colour and light, and the last day, as the final goal, to the discovery of the colour of the white by the use of the built Newton disk and other devices. Another bigger disk was also used as a scenario in the final dance show.

Keywords. Chemistry, Science Museum.

Figure 1

Figure 2

Acknowledgements

The authors are grateful to the cooperation of Cristina Mendanha and Joana Domingues of "Arte Total" and for the premises provided by "Museu dos Biscaínhos" (Braga - Portugal) . We thank the children for their cooperation and participation in this project.

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Teaching the History of Chemistry in a Freshman Chemistry Course

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Abstract. The present work consists of two stages: a) production of a Guide of Studies in which the history of the structural chemistry development was used as base for the discussion of aspects regarding the production of knowledge in science; b) development of pedagogical experience in which the Guide was applied in the undergraduate chemistry course.
The effect of the pedagogical experience on the students´ conceptions of the nature of science and the feasibility in using the history of chemistry to teach chemistry were investigated. Results showed evidence enabling the use of the Guide as an efficient instrument to help students develop adequate understanding of the nature of science.

Keywords. History, Chemistry; Higher education.

Scientific Articles Reading and Out-of-Class Essay Writing in a Scientific Communication Course

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Abstract. The present work describes a technique that used as assignment the reading of scientific articles and the subsequent writing about the texts. It was provided a method to acquaint students with the current chemical literature and the main goal was to develop students' interpretation abilities of this kind of material. The students were provided with guidelines to read research articles critically. It was concluded that the assignment enabled the students to express a great amount of ideas resulting from their reflections about the texts.

Keywords. Higher education, Chemistry, Scientific articles.

Inter and Intra-Molecular Bonding: Teaching and Learning Approaches in the Secondary School Cycle

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Abstract. The physical and chemical properties of different substances depend on the nature of their Inter and Intra-Molecular bonding. So the study of the different type of forces between their constituent "particles" is of fundamental relevance for the areas of Chemistry and Physics. This subject is in general complex, from the points of view of Teaching and Learning. However, its pedagogic treatment is of extreme importance, requiring an attractive and clear approach, which should lead to a better learning and comprehension of the phenomena that take place in our World. In a context of Mandatory Schooling it is important to provide the students an Education in Chemistry that allows them to live and act in a conscientious and informed way in a Society in which the Chemistry plays a fundamental role. In the Secondary School Cycle the teaching of Chemistry should develop the competences that allow a better understanding of the surrounding world, using concepts in a multidisciplinary and integrated way. The ScTS orientations for the Teaching of Chemistry are considered the ideal routes to achieve these objectives and motivate the students for the exploitation of this area of scientific knowledge. The objectives defined for the investigation reported in this presentation included to evaluate: (1) the knowledge of the students on the subject under study, in two years of the Secondary School Cycle (10^{th} and 12^{th} years), with the distribution of questionnaires; (2) the existing alternative conceptions, for each year, as well as to verify if they disappear, or not, with the subsequent learning and (3) to analyse, in a critical way, the obtained results. The study was

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developed in 4 phases interconnected by different but complementary objectives: Reflection, Design, Execution/Implementation and Evaluation/Conclusion.

Keywords. Higher education, Chemistry.

Web-based Curriculum Materials for Decision Making about Socio-Scientific Issues: The Example of Trace Chemicals in Drinking Water

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Abstract. This article is related to the ability of high-school students to develop decision-making skills, concerning important socio-scientific issues that are not traditional school curricula. The issue investigated by students is what makes typically included in water potable and what are the characteristics that should be considered by consumers, in order for them to decide about the quality of the water they drink. For this purpose, we selected the example of bottled water as a context in which students focus their investigations. The issue becomes complicated firstly because research evidence suggests that students aged 14 – 18 are not able to correctly interpret the information shown on the label of bottled water (i.e - they can not identify which of the constituents of the water are harmful for human consumption or which limits are prohibitory), secondly, the concentration of each constituent is not common for all bottled waters that are commercially available and thirdly, the content of solvents in the water, varies from one type of water to another. The paper reports on an attempt to design an activity sequence that will help students develop an optimization strategy in selecting the most appropriate bottled water considering a number of factors, such as the physico-chemical composition in terms of essential constituents, the suitability of certain waters regarding special age groups (infants and young children) and labeling requirements. Through this example, students learn to appreciate the importance of developing criteria by which they are able to settle on a specific option and document their decision. The web-based teaching and learning materials, rely on a special inquiry learning environment in which students collect information concerning the quality of drinking water and are guided to process the available information and construct arguments about evaluating the quality of drinking water. Preliminary results are presented from a pilot implementation of the materials.

Keywords. Decision making, Socio-scientific issues, Drinking water, Trace chemicals, Bottled water.

The Final Fate of Heavy Metal Residues: The Chromium Compounds. An Environmental Approach

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Abstract. Large industrial utilization of chromium compounds, linked to environmental pollution and health risks originate heavy concern. Chromium has a “double” behaviour: is an essential element, as Cr(III), but also very harmful (carcinogenic), as Cr(VI). Nowadays there is an increasing interest in chromium bioremediation in soils. Its final fate is important. The considered “safe” species, Cr(III), can be re-oxidized to Cr(VI) by, for example, manganese oxides.

One objective of new Portuguese Secondary School programmes is to understand our environment. A pedagogical treatment of chromium bioremediation is presented. It is a complex and rewarding challenge, requiring a scientific approach in a Teaching/Learning perspective.

Keywords. Chemistry, Environmental pollution.

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Contributions for the Undergraduate Chemistry Students' Formation Given by the Reading of one of Latour and Woolgar´s Text

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Abstract. The present work analyzes the contributions of the reading of a chapter of the book "Laboratory Life", by Bruno Latour and Steve Woolgar (1997), for the formation of the undergraduate chemistry students enrolled in a scientific communication course at University of São Paulo, Brazil. Before the reading of the text, the students considered that "to be a scientist" was "to be at the laboratory". After the reading, there were indications that they began to notice the limitations of their knowledge about other activities accomplished by the scientists, mainly what concerns the necessary pledge for the writing of scientific texts.The activity was analyzed based on the French Discourse Analysis.

Keywords. Reading, Chemistry, Higher education.

Promoting Argument in Chemistry Classroom

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Abstract. Studies have demonstrated the importance of argument in science teaching**.** Based on this assertion, we have tried to develop argumentative abilities in chemistry undergraduate students through a teaching methodology based on case studies. We have also tried to analize the potential of this methodology for developing such abilities. For this we have adopted Toulmin's work (The Uses of Argument).

The obtained results suggest a good receptivity of the methodology by the students and its suitability for developing argumentative capabilities, besides stimulating other abilities like group work and summary writing.

Keywords. Argument chemistry case studies.

The Organic Chemistry in Secondary School Education: Perceptions and Proposals

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Abstract. This study intended to analyse the perception both from students and teachers regarding organic chemistry subject in secondary school education. From that analysis some important proposals are presented to improve the teaching/learning process in this area of chemistry. Organic chemistry was chosen because this area of chemistry is undervalued in the teaching programmes proposed by the Ministry of Education although it is quite important in the day life. The new curricular amendment of the secondary school education which began in 2004/2005 follow the same guideline of the old programme, as the content of organic chemistry has decreased.

More than a simple analysis of the actual situation of the organic chemistry taught in secondary school, this study is a developing curricular project aimed to several persons: those from the Ministry of Education responsible for the elaboration and revision of the curricular programmes; authors of textbooks who use the programmes as a guideline to develop material supporting the teaching/learning process, and teachers of the secondary schools who shall provide to the students the necessary reasoning and promote the scientific literacy regarding the learning of organic chemistry.

This study involved the examination of the programs proposed by the Ministry of Education regarding the chemistry and biology subjects for the last two curricular amendments and of some textbooks. Also, it revised the quantitative descriptive analysis regarding three

questionnaires: the first was answered by the students of secondary school, the second given to first year university students and the third questionnaire was addressed to teachers of the biology and chemistry educational areas from secondary schools. The results of this study point out the need of intervention regarding the amendment of the curricular programs and textbooks in the secondary school in the educational areas in question. Moreover, the initial and continuous formation of the teachers at this level is a point to emphasize. For such it is necessary to adopt the teaching methodologies to the new learning requirements regarding Science, Technology, Environment and their inter-relations with the Society of Information we are living in nowadays. Diversified classes with a greater laboratorial component and take advantage from the communication technologies shall be the solution.

Keywords. Organic chemistry, Secondary school, Teaching/learning.

How to Engage Science Students Using Demonstrations

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Abstract. Science is inherently experimental, and students can gain a better feel for the subject, and perhaps greater insight into its principles, if they are active participants in scientific discovery. However, it is not always possible for students to perform experiments themselves. There is a clear role for demonstrations in the teaching of science, just as there is a role for student experiments. This paper, illustrated with examples of scientific demonstrations, covers some of the fundamental ways in which the interest of students may be maintained by classroom work, and illustrates how demonstrations can be effective in that context as learning tools.

Keywords. Demonstration, Experiment, Hands-on science, Student involvement, Scientific intuition.

1. Introduction - a warning!

An important aspect of the work of scientists is to write papers and to give talks; these are the primary ways in which the scientific output of an individual becomes more widely known. One might think that there would be little point in preparing a paper for the Proceedings of a Conference, and then telling readers to ignore it. However, that is what I am asking you to do with this paper - ignore it until the talk that it accompanies has been presented.

The reason is simple: some of the demonstrations in the talk will have more impact if you have not read about them in advance. So, let us assume that you have either been to the talk to which this paper relates, or have missed it.....

2. Hands-on Science - and when it cannot be used

The teaching of science is becoming increasingly machine-based. The Internet provides access to a wealth of information and it would be foolish not to take advantage of it. When used judiciously, the Internet allows teachers to accomplish more in the same period of contact time, or to teach material which otherwise could not be covered during class. If used in this fashion, the Internet is undoubtedly valuable.

However, there is an area in which the Internet is at present far less relevant, and perhaps even has a negative influence upon the teaching of science; this is the potential loss of Hands-on experience for students, with classroom experiments sometimes being replaced by Internet-based “investigations”.

Science is inherently experimental; even theoreticians must turn to experimentalists to provide the data upon which they work. Science is so strongly grounded in experiment that it is essential that our students have firsthand experience of the way that science is carried out in the laboratory if they are to fully appreciate the subject. Experimental work is a fundamental part of the training of students in science at all levels and most teachers would be extremely reluctant to remove this practical element from science courses.

Where possible, the practical element of science instruction should be Hands-on; indeed, that is very much the focus of this conference.

Most students learn more effectively when they can carry out experiments themselves than when they are mere spectators. Unfortunately, it is not always feasible to provide Hands-on experiments in the classroom. The experiment that best illustrates some scientific idea may be too dangerous for students to perform; it may require skills that the students do not possess; the chemicals or instruments required may be too expensive for an entire class to tackle the experiment; or the experiment might be a "one-off", in which no second chance is possible, and the teacher might be reluctant to allow a student to attempt the experiment on behalf of the class for fear of failure.

Whatever the reason, there are times when experiments are best performed, or can only be performed, as a demonstration rather than as a student exercise. What considerations should govern such demonstrations? Should they be treated in the same way as experiments that students themselves might perform, or are there other factors to take into account? It is such questions that this paper seeks to address.

3. Demonstrations and experiments, investigations and more...

During the talk from which this paper is derived I will illustrate some of the experiments that are discussed below. Further details can be obtained upon request.

The purpose of both the talk and this paper is to set out a number of factors that a teacher, especially one with limited experience, might reasonably want to consider before planning class demonstrations. Such demonstrations can be very valuable, but *they must have a rationale*; full use needs to be made of the opportunities that demonstrations provide.

We discuss in the following sections several justifications for introducing a demonstration into classroom teaching.

3.1. To create excitement and interest

Demonstrations whose role is to excite students are among the most widely used - and misused - of all. Such demonstrations are often of the "flash-bang" variety, designed to excite and impress; for example a sugar-chlorate flare or the explosion of hydrogen-filled balloons. These can be spectacular (though by their nature they may be dangerous if misjudged) and can usually be relied upon to generate a positive reaction from students.

So what is the problem? It is that of an opportunity missed. Any demonstration provides a chance to teach. If a teacher takes a chemistry class into the playground to show a spectacular chemical reaction merely with the aim of enthusing the class, it may create interest, but also be a wasted opportunity. Furthermore, a spectacular or noxious demonstration may create the impression that chemistry is all about bangs or smells, rather than being a fascinating intellectual subject. The demonstration should be the starting for point for discussion, not merely a means to set science apart from the humanities, in which the opportunity for demonstrations is much less.

The aluminium-iodine reaction, for example, is very impressive, producing clouds of purple fumes. One might ask: what are the purple clouds? Why are they formed? Are the purple fumes dangerous? Why? Why is light emitted by the reacting material? Would other chemicals react so vigorously? If not why not? If so, why are they not used? The level of the questions of course must depend upon the class, but advantage must be taken of the opportunity that the demonstration affords.

3.2. To illustrate the hidden nature of scientific laws

Scientific laws are revealed by experiment, not handed down written on tablets of stone. However, experiment does not reveal the laws themselves, but instead yields data that we may assess to see whether they agree with the predictions of a hypothesis.

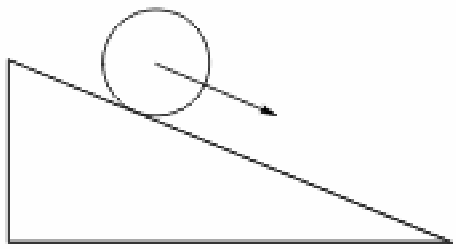

Figure 1. The biscuit tin demonstration.

Students often fail to appreciate this quite subtle point, but it can be exemplified through a simple experiment (Fig 1). A closed round biscuit tin is laid on its side on an incline, and students asked to predict the direction in which it

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will roll. Suspecting some sort of trick, suspicious students might argue it will roll "uphill", but most will agree it will roll down. However, when released the tin does indeed roll uphill.

What is going on? Clearly there is something unusual about the tin[1], and students can be asked to propose explanations for the observed behaviour. The sophistication of these explanations will depend upon the level of the students, but the presence of a magnet within the tin, and another hidden beneath the ramp to drag the tin upwards, is a common proposal.

The teacher could at this stage reveal the explanation, but it is more constructive not to do so. Instead, she could remove the lid from the tin and show what is inside to just one or two students, and then engage in a discussion with the class as a whole.

What sort of theories for the behaviour of the tin can they propose? What tests might they do to establish the validity of competing theories? If we can never actually "see into the tin" can we ever be sure that a theory is "right"? Will performing multiple experiments help? If every experiment that is performed is in accord with the theory, does that prove that the explanation is correct even though the contents of the tin cannot be inspected?

3.3. To show that not all is as it seems

Xylene cyanol is dichromic (literally "two-colour"), indicating that its solutions display two colours at the same time. In neutral solution dilute and concentrated solutions are only slightly different in colour; however in acid solution the difference is very marked. A solution of the indicator in moderately strong acid[2] is dark red, while a dilute solution is leaf green.

When students see two solutions of different concentration in two separate beakers, this difference in colour provokes little interest; when they see that a *single* solution can be two colours simultaneously they are fascinated and perplexed. If a white light is viewed through a thick layer of an acidic solution of xylene cyanol, the solution appears deep red; if the liquid is shaken thin layers appear deep green.

This extraordinary solution is two colours simultaneously. This raises several questions? How can one material be both red and green? Why does (red + green) not make brown, as it would in a paint pot? And most importantly, what is the explanation of this phenomenon?[3]

3.4. To show the unexpected in science

In science things tend to change gradually or, by contrast, almost instantly. The growth of plants and explosions are examples of these two extremes. It is natural for our students to gradually develop a feel for "the way things are" as they encounter more and more examples of the behaviour of the natural world. Indeed, this exposure to natural phenomena helps to develop what one might call scientific intuition, according to which students begin to know "how science works". However, intuition is not always a guide to reality, and clock reactions provide a fascinating example of this.

In a clock reaction two or more liquids are mixed with no visible change. Then a change of colour occurs abruptly. One clock reaction stands out as being widely used in schools, the iodine clock. This is easy to prepare, relatively safe and can be used not just to intrigue but also to teach

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[1]The tin has a small but heavy metal weight attached to one side of the interior. When placed with this weight suitably positioned, the tin rotates to bring this weight to the bottom, even if this means that the tin itself travels up the incline.

[2]Only a little experimentation is required to create a solution with the right characteristics. The pH of the solution can be within the range 1-3, and any common mineral acid can be used. The amount of xylene cyanol must be such that a source of white light appears red when viewed through the solution, but thin layers of solution, when shaken, appear green. It is not difficult to create a suitable solution.

[3]Further details are available from the author, but in essence the explanation is as follows: The solution absorbs blue light strongly and green light slightly but does not absorb red light. When white light is passed through a thin layer of solution all the blue light is removed, but most of the green light remains, as does all the red. The eye is far more sensitive to red than green, so the light appears green. When white light is passed through a thick layer of solution, both blue and green light are removed; red however passes through, so the solution appears red. Because the eye is not very sensitive to this region of the spectrum, the solution appears dark red, rather than bright red.

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science (for example, by studying the effect of the temperature on the time taken for the colour change).

More exotic clock reactions are generally more expensive, more dangerous, more tricky to prepare, or all three. However, the oscillating clock reaction[4] is such an intriguing reaction that it deserves a spot in the chemist's list of demonstrations, provided that one has the necessary knowledge to prepare it safely. In the oscillating clock, three colourless liquids are mixed to give a solution which is itself initially colourless. After a few seconds the solution changes to a gold colour, then abruptly to dark purple[5]. This colour fades to give a colourless solution, which then becomes gold before the dark blue suddenly reappears. This cycle may continue for fifteen minutes or more.

The reaction provides a route into a discussion of science at many levels. What is necessary for oscillations in a chemical system? (answer: an autocatalytic system; clearly an advanced topic) Where are oscillating reactions vital for us? (Answer: in the pacemaker than runs the heart). Will the oscillations in the oscillating clock continue indefinitely? (Answer: No; chemicals are being consumed, so it must eventually stop). Why, then, does our heart pacemaker continue working almost indefinitely? (Answer: because fresh chemicals are being supplied to it constantly). And so on.

Once again, the experimental "hook" that a demonstration such as this provides must be used to introduce topics that relate to it, so that advantage can be taken of the science that underlies the demonstration.

[4]The oscillating clock requires some potentially hazards chemicals, most notably concentrated perchloric acid (solid chlorates are explosive) and moderately concentrated hydrogen peroxide. It is not a reaction that should be attempted by non-chemists. Details, for those with suitable training, are obtainable from the author.

[5]This colour is due to iodine in the presence of starch, and will be familiar to those who use the iodine test in biology as a test for the presence of starch, and also to those who do the standard "one change" iodine clock reaction in which the same purple colour is produced as in the oscillating clock described above.

3.5. To bring into focus concepts which are difficult to visualise

Dry ice (solid carbon dioxide) and liquid nitrogen are easy to obtain, and sufficiently cheap that their occasional purchase is within the budget of most schools. Dry ice (when added to water) can be used to provide a boiling cauldron for any witches to gather round in the school play, and too often this is the way that dry ice is used in science lessons also - just to entertain.

However, the existence of a temperature below which it is impossible to go, Absolute Zero[6], is an important thermodynamic concept. This is implicit in the ideal gas equation, is important for our understanding of thermodynamics functions such as entropy, is important in statistical thermodynamical calculations and so on.

The idea of an absolute minimum for the temperature scale is an easy one to explain, but is far more difficult for students to accept. It cannot be made conceptually simpler by demonstrations that rely on dry ice or liquid nitrogen, but nevertheless by using these materials we can try to give students some feel for how far it is possible to approach that figure. Dry ice sublimes at a temperature of -78.5 C, which is about the coldest temperature ever experienced by a human. Liquid nitrogen boils at a temperature of -195.8 C, which is around 70% of the way down from the freezing point of water to Absolute Zero.

Markers such as these allow students to get a slightly better feel for what the zero of temperature means, and how cold it really is. One can also use demonstrations using liquid nitrogen to introduce a discussion of current ethical issues in science, such as In Vitro Fertilisation and the storage of eggs and sperm (and, indeed, entire bodies) in liquid nitrogen.

3.6. The small matter of involvement

Teaching is challenging at the best of times, and especially difficult if one's class is not really involved in the material being presented. When minds are on life after class, they will absorb little. Demonstrations often provide a way in which that involvement can be stimulated.

A simple example is burning a banknote. In chemistry shows I generally burn a small rag

[6]-273 C.

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soaked in a flammable mixture[7]. With care, the liquid burns in a satisfying fashion but the rag is left untouched. The demonstration relies upon the presence of water, with its high heat capacity, in the rag. This may be sufficient to keep the rag cool long enough that the rag itself will not ignite before the alcohol has all burnt.

In this simple demonstration the rag can easily be replaced by a banknote[8]. If this note belongs to the teacher, or has been borrowed from another teacher or parent, students' desire to see the experiment go wrong, and for the banknote to be destroyed, is always strong. With such a vested interest in the outcome of the experiment, the class is then far more open to a discussion of the science behind the demonstration - what has been done by the teacher to avoid disaster?

3.7. The element of fear

It will be clear that I feel student involvement in demonstrations - even if it does not amount to actually performing them - is vital. This involvement makes them far more receptive to a discussion of the science that underlies the experiments.

Just as, in section 6, students usually have a "stake" in the outcome of the experiment (longing for the teacher to make a mistake and destroy the banknote), it is also possible for students to be similarly involved because of an element of concern, even fear. Many teachers will explode a hydrogen balloon during class, and this can be done in such as way as to heighten students' anticipation.

One can even introduce the element of fear - is this balloon going to give an even bigger bang than the previous one? This balloon contains hydrogen, but the last one was only helium - how will the bangs compare? This involvement with the demonstration again provides an opportunity for the teacher to teach some real science - why does helium not burn? Why does the hydrogen balloon burn much faster when oxygen is present? And so on.

One must, of course, exercise some caution here. The object of a science lesson is to impart understanding, not develop a fear of chemistry in one's students; if the result of performing an experiment is to leave students in tears the teacher will have done far more to turn students off science than to encourage them to enjoy it.

3.8. To show how easy it is to be mislead

Indigo carmine is an indicator. It can be used in a very simple, but most intriguing reaction which can be presented by a teacher in a way that suggested a solution can do mathematics.

Neutral solutions of indigo carmine are blue, but strongly basic solutions of the indicator are green. Unlike most common indicators, which are used to show acidity, the colour of indigo carmine depends upon the amount of oxygen in solution. Therefore, if it is possible to change the amount of dissolved oxygen, the colour of the solution changes.

In the indigo carmine air oxidation reaction[9], the oxygen dissolved in an aqueous solution is consumed over a period of a few minutes by a reaction within the solution, and the solution therefore changes colour. The green colour changes to dark brown, then to red and finally to gold. If oxygen is added to the solution (which can be done simply by pouring the liquid from one beaker to another) the colour changes reverse.

This is most effectively illustrated by pouring about half of the liquid from one beaker into a second and then holding up the two beakers side-by-side; the colours of the two liquids should be perceptibly different. One can then suggest that this is a solution which appears to be able to do mathematics - it can at least divide by two. If the audience is sceptical, continue pouring the liquid into the second beaker, then announce the solution is still capable of dividing by two, and pour half the liquid back into the first beaker and hold the two liquids side-by-side once more; again the colour change should be clear.

[7] A 50:50 mixture of ethanol and water is ideally suited to this purpose. However, the mixture is very flammable, and care must be taken to ensure that there is no possibility of accidentally igniting the stored liquid.

[8] Practice first! The author of this paper takes no responsibility for your mistakes!

[9] Two aqueous solutions are required: (a) 16g glucose + a small amount of indigo carmine; (b) 7.5 g sodium hydroxide, each dissolved in roughly 400 ml water. The exact concentrations are not important. An immediate colour change occurs when the solutions are mixed for the first time. Upon standing the sequence of changes outlined above occurs over a period of several minutes.

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Few students will realise at first that the change has been brought about by mixing air into the liquids. The demonstration, which is easy to perform, provides an effective way of introducing hypotheses and ideas, especially if reference is made back to the dichromic solution, which often leads students to conclude that the same explanation might apply in this case also.

4. Safety

With all demonstrations and experiments, whether conducted in school or University, safety is absolutely vital. Some of the demonstrations outlined here and discussed in the talk are potentially hazardous. For example, perchloric acid, used in the oscillating clock, is a strong inorganic acid which can give rise to serious burns and can generate explosive solids. Both sodium hydroxide and hydrogen peroxide can cause very serious damage if splashed into the eye. If you are contemplating doing any demonstration mentioned in this paper or the talk from which it is derived, contact the author if you are in doubt about any aspect of safety.

5. Further information

Further information about the demonstrations discussed in this paper, or shown during the talk from which it is derived, can be obtained by emailing Hugh.Cartwright@chem.ox.ac.uk

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Results of the Leonardo da Vinci Project "Hands-On Approach to Analytical Chemistry for Vocational Schools"

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Abstract. This paper describes the objectives and outcomes of the two year European Leonardo da Vinci project "Hands-on approach to analytical chemistry for vocational schools". The approach developed in this project is based on innovative teaching tools, which are small, portable, easy to use and do not require laboratory skills and environment. Thus the real-life applications cannot only be performed but even developed by teachers and students, what contributes to their innovative abilities.

Keywords. Analytical Chemistry, Chromatography, Hands-on Approach, Small Scale Instruments, Visible Spectrometry, Vocational Schools, Water Analysis.

1. Introduction

Research shows that the overall quality of teaching and learning is improved when students have opportunities to clarify, question, apply, and consolidate new knowledge. In order to achieve active engagement of students a series of teaching strategies is emerging, including group discussions, problem-based learning, student-led review sessions, think-pair-share, student generated examination questions, mini-research

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proposals or projects; a class research symposium, simulations, case studies, role plays, journal writing, concept mapping, structured learning groups, cooperative learning, collaborative learning, and a hands-on approach to teaching and learning. The last strategy is especially suitable for learning experimental sciences such as chemistry.

Instructional approaches that involve activity and direct experiences with natural phenomena have become known as *hands-on science*, which is defined as any educational experience that actively involves students in manipulating objects. There is a plethora of literature defining and discussing different aspects of the hands-on approach. James Rutherford, director of the science reform initiative, Project 2061, describes his view of hands-on science [9]. "Hands-on quite literally means having students 'manipulate' the things they are studying - plants, rocks, insects, water, magnetic fields - and 'handle' scientific instruments - rulers, balances, test tubes, thermometers, microscopes, telescopes, cameras, meters, calculators. In a more general sense, it seems to mean learning by experience". Flick defines hands-on science on one hand as a philosophy guiding the usage of different teaching strategies needed to address diversity in classrooms, and on the other hand as a specific instructional strategy where students are actively involved in manipulating materials and instruments [2].

According to Shaply and Luttrell [10], the concept of hands-on science is based on the belief that a science program for elementary school children should be based on the method children instinctively employ to make sense of the world around them. Science must be experienced to be understood. But the hands-on approach involves more than mere activity of students, it provokes curiosity and thinking. Therefore a new element has been added to the previous definition of hands-on science, namely hands-on/minds-on science" [2, 5, 8].

The hands-on approach must not be made equal to the inquiry-based approach, since these terms are not synonymous. Instruction in inquiry classrooms reflects a variety of methods – discussions, investigation laboratories, debates, lectures, and also the hands-on approach [7]. In the hands-on approach students work directly with materials and manipulate physical objects to physically engage in experiencing science phenomena, while inquiry- or discovery-based learning involves thinking, reading, writing, or research that gives meaning to hands-on [1].

Generally, hands-on learning comprises three dimensions: the inquiry dimension, the structural dimension, and the experimental dimension. In inquiry learning, the student uses activities to make discoveries. The structure dimension refers to the amount of guidance given to the student. If each step is detailed, this is known as a cookbook style. These types of activities do not increase a student's problem-solving abilities. The third dimension is the experimental dimension which involves the aspect of proving a discovery, usually through the use of a controlled experiment [8].

Research provides evidence that the learning of various skills, science content, and mathematics are enhanced through hands-on science programs. Hands-on science programs in the classrooms are believed to offer many benefits to students, i.e. increased learning, motivation to learn, enjoyment of learning; skill proficiency, including communication skills; increased independent thinking and decision making based on direct evidence and experiences; and increased perception and creativity. Students in activity-based programs have exhibited increases in creativity, positive attitudes toward science, perception, logic development, communication skills, and eagerness to read. These benefits seem more than sufficient justification for promoting hands-on learning. However, an important addition for promoting hands-on science teaching is also the fact that through this approach, science can be also fun for both the student and teacher. Despite all these benefits, research also indicates that hands-on teaching is not commonly used in teaching science [5].

Unfortunately, the use of hands-on activities is far less frequent than lecture and discussion [11]. The major obstacles are science teachers who are reluctant to use active teaching strategies, since they are, according to their claims, time and materials consuming. Thus they are costly and do not allow them to realize the programs, which are overloaded with content.

2. Outline of the project

Vocational schools in different sectors and different countries do not have equal opportunities for teaching analytical chemistry by hands-on approach, since they are not equally

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well equipped and do not devote equal parts of teaching time to laboratory work. The project "Hands-on approach to analytical chemistry for vocational schools" has brought together five partner institutions from three participating countries: Portugal, Slovenia and United Kingdom. The partner institutions involved in the project were: University of Ljubljana - Faculty of Chemistry and Chemical Technology (SI) which acted as a promoter and contractor, University of Lisbon – Faculty of Sciences - Department of Chemistry and Biochemistry (PT), The Centre of Republic of Slovenia for Vocational Education and Training (SI), University of Ljubljana – Faculty of Natural Sciences and Engineering – Department of Chemical Education and Informatics (SI) and University of Hull (UK), Faculty of Science and the Environment – Department of Chemistry.

The project makes an original contribution to introducing changes into national vocational training systems and practices by introducing the hands-on approach to teaching and learning analytical chemistry. Since hands-on approaches to learning basic chemical concepts are relatively well developed and already integrated into school practice, the situation is different in analytical chemistry, where more complex instrumentation is needed. The approach developed in this project is based on innovative teaching tools, which are small, portable, easy to use and do not require laboratory skils and environment. Thus the real-life applications can not only be performed but even developed by teachers and students what contributes to their inovative abilities. Through this project the low-cost spectrometer for educational purposes (SpektraTM), previously developed [3] and patented by the promoter [4] has been introduced into schools for the first time. This small, portable tri-colour light emitting diode–based spectrometer uses polymeric supports called blisters as reaction and measuring chambers. Experiments are rapidly carried out with small volumes of solutions e.g. 350 microlitres and even drop based experimental approach can be used where appropriate. Due to the specific optical geometry and other characteristics this spectrometer enables hands-on activities which can not be carried out with classical spectrometers.

Approach introduced through this project enables schools where professional instrumentation is lacking to introduce practical aspects of analytical chemistry and develop real life applications relevant for their sectors. The target groups of the proposed project were teachers, laboratory assistants and students of vocational schools most in need of teaching and learning analytical chemistry by the hands-on approach. The main characteristics of the project are summarized in Table 1.

Table 1. The main characteristics of the project

Title	Hands-on approach to analytical chemistry for vocational schools
Acronym	AnalChemVoc (http://www.ntfkii.uni-lj.si/analchemvoc/)
Programme objectives	• to improve the skills and competences of people • to promote and reinforce the contribution of vocational training to the process of innovation
Priority type	New forms of learning and teaching and basic skills in vocational and education training (VET)
Duration	24 months (10 Nov 03 - 9 Nov 05)

The project met its targets in terms of outcomes. Expertise on teaching and learning analytical chemistry through hands-on approaches was shared among the participating countries through partners' meetings and related seminars, conferences and workshops. Solutions, approaches and teaching tools, which previously existed within individual partner institution/country, were complemented, harmonised, upgraded and integrated into the final project results namely:

- A web page of the project http://www.ntfkii.uni-lj.si/analchemvoc/ comprising the descriptions of equipment, hands-on experiments and upgrading of the Spektra^{TM} into gas and liquid chromatograph and hyphenation with a computer.
- Handbook "Hands-on Approach to Analytical Chemistry - Manual" (60 CD copies produced in each of the three project languages), supplemented with two teaching units with full support for students and teachers ("Hands-on

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Approach to Visible Spectrometry", "Hands-on Approach to Chromatography").

- An extended version of the "Portable Laboratory" manual.

All three main project results are described in more details in the following sections.

3. Web page of the project "AnalChem-Voc"

The web page of the project "AnalChemVoc" http://www.ntfkii.uni-lj.si/analchemvoc/ is a good tri-lingual source of information about the scope and results of the project, applications of small-scale instruments in analytical and general chemistry, and project partners. The main sections related to hands-on activities are "Equipment" and "Experiments". On the Slovenian web page there is also a "Forum" for more effective communication and share of information among the teachers of Slovenian vocational schools participating in the project and the Slovenian project partners, who support them in developing their own applications and transferring the hands-on approaches into their school practice.

In the section "Equipment" the small-scale instruments for hands-on approach to analytical chemistry are described, explained and instructions for use and hints suggesting how to start developing new applications are given. The section "Experiments" comprises detailed descriptions of more the 45 hands-on activities contributed by several authors from all three participating countries including project partners, teachers and their students. "Experiments" are organised into the three main sections: "Portable laboratory protocols", "Experiments with a Spektra^{TM} spectrometer" and "Spektra^{TM} upgraded into other analytical Instruments" with several subsections.

The main dedication of this web page is to give good examples of hands-on activities with small-scale instruments in order to promote hands-on approach to analytical chemistry and to inspire and support teachers and students not only in testing applications already described on the web page but also in carrying out their innovative ideas and developing additional applications.

4. Project result "Hands on approach to analytical chemistry – Manual"

This manual is a result of two years cooperative efforts of experts from analytical chemistry, chemical education, teacher practitioners, prospective teachers and high school students from Slovenia, Portugal and the United Kingdom. The manual which is structured into seven chapters is intended to help teachers to develop self-confidence when dealing with the selected topics of analytical chemistry and using hands-on approach as an active teaching strategy in their classroom.

In the introduction the rationale and goals of the project are explained, and the partners of the project and their role, as well as the target groups and the results of the project, are presented. In the next chapter there is a discussion on the importance of analytical chemistry for the quality of our lives, and the role of small-scale instruments in modern analytical chemistry. The third chapter gives an outline of active teaching/learning strategies and explains the methodology of developing hands-on approaches to visible spectrometry and chromatography. The fourth chapter presents an introduction to visible spectrometry by explaining basic concepts which will help teachers to develop self-confidence when dealing with the selected topics of analytical chemistry. In this chapter there is also an example of a small-scale spectrometer, Spektra^{TM} and its use in a hands-on approach to analytical chemistry is discussed. In the next chapter a low-cost solution to computerized data acquisition using the Spektra^{TM} spectrometer is explained. The last two chapters present two teachers' guides for the introduction of visible spectrometry and chromatography through the hands-on approach. Teachers' guides offer teachers a model of how to implement a hands-on approach in the classroom. We must stress that the approach discussed in both teachers' guides was evaluated in several steps, and after each evaluation step the materials were improved. In addition to two teachers' guides, additional teaching aids were designed to be used in the classroom.

In addition to two teachers' guides, additional teaching aids were designed to be used in the classroom, which together with the teachers' guides comprise teaching units with full support for teacher and students which are directly implementable into schools. These teaching units

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entitled « Hands-on Approach to Visible Spectrometry » and « Hands-on Approach to Chromatography » represent project results which supplement the manual. They are available in the related subfolders on the same CD as the manual. Both teaching units are structured similarly in addition to teachers' guide they comprise workbook with hands-on activities for students and PowerPoint presentation for guiding these activities in a classroom. Progress through the modules is quite gentle, it was confirmed in teaching practice that hands-on approach raises motivation in students and that the less able students are not left behind. In the following section we describe the development of the teaching unit "Hands-on Approach to Visible Spectrometry" in more details.

Teaching unit "Hands-on Approach to Visible Spectrometry" comprises seven modules. The purpose of the firs module "Light as radiation" is to introduce the relationship between the separation distances of interferential lines, and the wavelength of the light, using the analogy of waves on a water surface, their diffraction, and interference, and the diffraction of light, using a diffraction grating. In the second module "Light and colour perception", new concepts on monochromatic and polychromatic light are introduced, as well as the following: the basic colours of our visual perception, and the principles stemming from additive mixing of colours, and the concept of complementary colours. Module 3 "Colour of substances and light transmittance" focuses on the relationship between the colour of the absorption medium and light transmittance when light of different colours is used. The findings are then summarised in a presentation of overlapping colour circles which helps students to select a suitable light emitter for measuring the light transmittance. The relationship between the colour of the substance and light transmittance is basic for rough estimation of the form of a spectrum of a substance. The spectra, in the visible range, and its significance for determining the structure of a substance are discussed in Module 4 "Colour, absorption spectrum and structure of a substance". Module 5 "Measurement of light transmittance" focuses on the selection of suitable light for measuring the transmittance. This Module also describes how transmittance is measured in a solution using the Spektra^{TM} spectrometer. Module 6 "Spectrometric determination of concentration" introduces Lambert –Beer's Law through a hands-on approach. We stress the linear relationship between the absorbance and the concentration, and non-linear relationships between the absorbance and transmittance. Module 7 " Practical applications of visible spectrometry" presents the steps in the spectrometric determination of concentration. Students learn how to obtain a calibration graph and use it for determining the concentration of the analyte tested in the sample solution. Module 8 "Visible spectrometry as a means for better comprehension of fundamental chemical concepts" gives a hands-on approach firstly for recognizing the influence of a reactant and a common-ion addition on chemical equilibrium. Secondly, the hands-on approach is used to establish how the structure of a radical and the position of the hydroxyl group in alcohols affect their oxidation rate in an acidic medium.

4.1. Developing a hands-on approach to teaching and learning visible spectrometry

During the execution of the Leonardo da Vinci project "Hands-on approach to analytical chemistry for vocational schools", we have proved, that a negative attitude of teachers toward active teaching strategies could be changed if they are involved in all major phases of the design of hands-on teaching units, and if, after each developmental phase, the materials are evaluated and modified according to the results of the evaluation procedure. The teaching unit "Hands-on approach to visible spectrometry" comprises: Teacher's guide, Workbook for students, PowerPoint support for guiding classroom hands-on activities and a series of concept maps, offering to teachers a quick insight into the conceptual structure of each module. In the first phase a draft material was presented to the teachers of vocational schools for food processing. Using hand-outs teachers were conducting experiments, and fill in hand-outs. Their results were discussed and problems which they encountered within each step were identified and clarified.

In the next step an improved English version of the material was prepared which was used at the workshop conducted at the "7th European conference on research in chemical education" (2004, Ljubljana). Chemistry teachers of different levels, and experts in chemical education from five European countries participated at this workshop. As an evaluation tool a questionnaire was used. All participants agreed that the selected modules are particularly useful for the introduction of basic concepts of spectrometry through the hands-on approach in high school classrooms. They claimed that selected experiments are easy to conduct and the instrumental approach is not difficult to understand and apply to different purposes.

From this experience a third version of the material was designed and used with a group of 3rd and 4th year students – prospective teachers – in two sessions. Each session lasted 135 minutes. A structured interview was used as an evaluation tool, so that a deeper insight into students' difficulties in conducting experiments and understanding underlining concepts was obtained. Evaluation of the modules with students enabled us to restructure some parts of the PowerPoint support module and to rewrite some parts of the teacher's guide. A new version of the PowerPoint support module was then presented to the teachers from vocational schools for food processing and they expressed an interest in testing the modules.

A final version of all materials was finally handed out to teachers of partner schools and agreement on the performance procedure and evaluation of the unit in schools was reached. Teachers were also provided with a knowledge test, and an evaluation form for the syntheses of the results. Activities in the development of the unit on "Hands-on approach to visible spectroscopy" thus came to their crucial phase by evaluating the modules or parts of the modules with high school students for food processing. During February and March 2005 evaluation was carried out at two secondary schools in Slovenia: Secondary School of Food Technology and Veterinary Technicians, Ljubljana, and Secondary Biotechnical School, Kranj. The third partner, Secondary School of Food Technology in Maribor, had already commenced the evaluation in February but the initial version of the module was tested. Table 2 summarizes teachers' observations.

Table 2. Teacher's observations in testing modules with their students

Light as radiation: Student motivation is high.
Light and colour perception: Students understand the concepts of monochromatic and polychromatic light and complementary colour. Student motivation is high. Students found this type of teaching very interesting.
Colour of substance and light transmittance: High motivation of students was found; however the technical programme students need more time and a slower pace in explanations.
Measurement of light transmittance: Some students found the meaning of the term »blank« difficult to understand. They needed external help when doing the task from the worksheet.
Spectrometric determination of concentration: Some teachers observed deficient mathematical knowledge in some students. Consequently, the students could not understand some concepts that were used in this module. The students were highly motivated and found the learning very interesting. Teacher believe that the PowerPoint presentation greatly contributed to the quality of teaching. Students needed little time to complete the tasks; however some were not critical enough towards their knowledge.
Practical application of spectrometry Teachers believe that the poor result in understanding the meaning of calibration graph is due to careless reading of the instructions.

The general observation is that the hands-on approach to spectrometry motivates students and that the students found the materials interesting. The teachers found the PowerPoint presentation most helpful in directing the teaching process. Those teachers, who teach vocational and technical programmes, noted that students in the later generally needed more time for explanations and work. These students also had a less critical attitude to their own knowledge. Some students had problems understanding the concept of »blank« in Module 4. Surprisingly, the students had no problems understanding the concepts of: monochromatic, polychromatic and complementary colour.

Due to positive responses of teachers and students in the preliminary tests the authors hope that the manual will encourage chemistry teachers to use a hands-on approach more frequently during their classroom sessions, and that the materials will be inspiring to develop their own applications of spectrometry or chromatography, suitable for their respective discipline. The authors believe that the concepts selected and the teaching-learning strategy designed for their presentation through a hands-on approach are not by any means restricted only to high school students of vocational schools but the approach and the content could become a regular part of any high school chemistry programme.

5. Kit - Portable Laboratory

In Portugal The Ministry of Higher Education and Scientific Research runs a Programme "SCIENCE ALIVE" through which schools, by themselves or in association, receive financial incentives to conduct projects with a strong component of experimental approach to science, therefore the hands-on approaches to analytical chemistry, as well as sharing ideas for projects, are of great interest for their science teachers who are always looking for opportunities to upgrade their knowledge. Portugese teachers have joined workshops with enthusiasm and consider Spektra™ spectrometer useful for the introduction of both, the concept of colour and the principles of spectrometric analysis. Spektra™ spektrometer has added to the motivation of students to carry and use the "Portable Laboratory" in study visits, in order to analyse residual waters and/or other pertaining solutions. As a result of the transnational cooperatin Spektra™ was includded into "Portable Laboratory" and the Manual was exdended and upgraded with additional activities.

The Manual "LABORATORIO PORTATIL (KIT)" is an extended and upgraded version for the new expanded Portable Laboratory, of an old version of the guide book that had been developped for the prior/poorer edition of the "Portable Laboratory". It is now edited in format matching that of the other teaching units produced in the scope of the Project. It comprises an explanatory Preface which is followed by a poem concerning the analysi of a tear drop, from a portuguese scientist and school teacher (Rómulo de Carvalho/António Gedeão, 1906-1997) whose birthday, the 24th November, is officialy commemorated as the National Day for Scientific Culture. The index states the inclusion of a section of the objectives and the criteria for the selection of the 10 water quality parameters (1- Acidity, 2- Alcalinity, 3- Chloride, 4- Hardness, 5- Lead, 6- Phosphate, 7- Nitrates and nitrites, 8- Sulfates, 9- pH, 10- Conductivity) for which protocols are presented. Each protocol includes some introductory words about the chemical and environmental relevance of the quantity to be assesed. Pertaining safety instructions are included. A Table for recording measurement results and a numerical example of a set of previously conducted water analysis are also included, as well as a selection of comments from students and teachers who have experienced working with the Kit. Supporting bibliographis refernces are given at the end. The Manual has been produced for dissemination and use in teaching actions in printed form, A4 size paper, 34 pages and in CD format.

6. Conclusions

Small scale teaching tools implemented into schools through this project together with the project results e.g. the manual "Hands-on Approach to Analytical Chemistry", and the teaching units "Hands-on Approach to Visible Spectrometry" and "Hands-on Approach to Chromatography" and the collection of activities presented on the web page of the project enable teachers and students to develop skills and knowledge and get inspiration to carry out their own innovative ideas and develop new application relevant for their programme.

Teaching tools, approaches and activities developed, promoted and implemented into schools through this project offer teachers and their students experience that there is not only one exclusive way to achieve result and thus challenge the often misleading opinion that there is only one way of doing analytical chemistry and that is - with complicated professional and costly instrumentation, and if a school does not possess such instrumentation or has no access to it there is no other way. In the project it was demonstrated how the low-cost spectrometer for educational purposes can be hyphenated with a computer or even extended into a simplified gas or liquid chromatograph by using components readily available in the school laboratory, while still enabling the sound introduction of chromatography fundamentals. In professional practice the spectrometer and gas or liquid chromatograph are three completely different and quite costly instruments and neither of them can be put to the function of the other.

Another example of good teaching practice contributing to the process of innovation and demonstrating that commercial spot tests which are not primarily intended to be used in schools are not the only option for water analysis is a kit (portable laboratory) previously developed and through this project upgraded and extended by a group of students, under the supervision of the Portuguese partner.

Testing and evaluation of hands-on approaches to analytical chemistry in schools confirmed that approaches developed and implemented into schools through this project raise motivation in students and that the less able students are not left behind. Activities leading to the inclusion of these hands-on approaches into refined curricula, textbooks and school practices of the schools for food processing in Slovenia are already under way. The authors believe that the project results will encourage chemistry teachers to use a hands-on approach more frequently during their classroom sessions, and that the materials will be inspiring to develop their own applications of spectrometry or chromatography, suitable for their respective discipline.

7. Acknowledgements

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Direct Biomass Conversion of Cellulose to Ethanol for Alternative Fuel Development: A Molecular Cloning Approach

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Abstract. Ethanol (C_2H_5OH) can be produced through the fermentation of cellulose and used as a replacement for gasoline. To succeed as an alternative fuel, the cost of ethanol must be close to the wholesale price of gasoline. Currently, ethanol is being produced by fermenting corn as the raw material, which makes the cost $4.69 per gallon. The ability to produce ethanol from low-

cost biomass will be the key to making it competitive as gasoline replacement.

Revolutionary discovery, for efficient ethanol production from biomass, has been in invention of Clostridium. thermocellum. Clostridium thermocellum, an ethanogenic bacterium, produces a highly active cellulase system responsible for rapid and efficient cellulose hydrolysis and is capable of directly converting cellulose into ethanol.

In my investigations, a gene from a newly discovered cellulosomal gene cluster (Gene 5) in Clostridium thermocellum was amplified by Polymerase Chain Reaction. The gene was then cloned into the expression vector PTXB1 and transformed into Escherichia Coli. Expression of the protein coded for by Gene 5 was induced using IPTG. The E. Coli cells were then sonicated to release the protein. Purification of Gene 5 was accomplished by heat treatment of the cell lysate. With the enriched protein, the reducing sugar experiments were completed to see how efficiently our protein breaks down different cellulosic materials.

I found that Avicel, pure cellulose, was broken down by Gene 5 efficiently. This could mean that Gene 5 breaks down all pure cellulose, or just Avicel. Also, I found that Gene 5 is an exo-enzyme, which means that it can break down cellulose and produce a lot reducing sugars at the same time. This means that in the long run, more ethanol can be produced. However, this process of having exo-enzymes break down celluloses is slow because not many exo-enzymes exist. My discovery is significant because Gene 5 can now be used, along with the other few, to degrade cellulose faster and more efficiently.

Keywords. Chemistry.

Student's Learning about Acid/Base. A Case Study Using Data-logging

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Abstract. The aim of this project was the evaluation about the adequacy of several experiments using data-logging to enhance student' learning about acid/base.

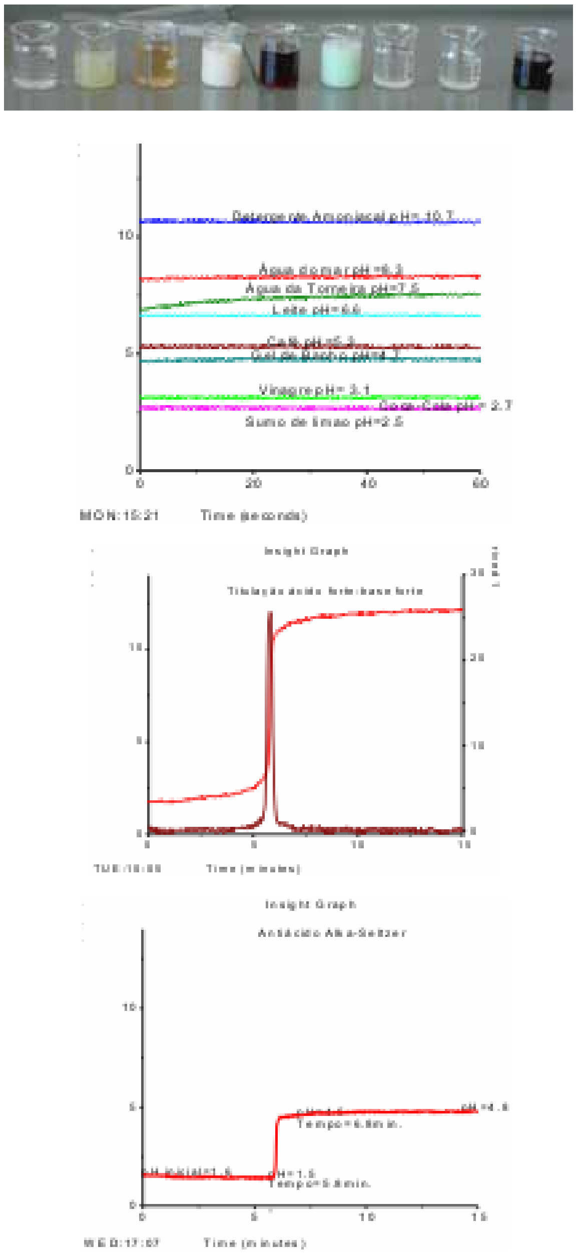

Figure 1. Experiments and graphics obtained

Twenty-two students, aged 14-16 years old, were involved. Students had to plan investigations, analyze data and to formulate conclusions based on calculations and graphs. To evaluate student' learning data were collected using several instruments: questionnaires, observation, group interviews, group discussions and participants' reflections about the work developed. The results suggested that these

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experiments strongly enhanced the students' understanding of acid/base and improved students' experimental and investigative skills in using ICT in chemical laboratory.

Keywords. Acid/base, pH, Learning, ICT, Data-logging.

Hands at Water

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Abstract. After the success of the first project (The colour of the white) was decided to make another one with the same orientation plan, but with a different subject. The aim of the project developed also in the "Museum of the Biscaínhos" (Braga - Portugal) was again to promote activities where different areas in the field of science, art and dance interact . Both projects are innovative due to this cooperative interaction between science and art.

The art' school "Arte Total" (Braga – Portugal) were, once again, coordinating the artistic side, and the "Associação Portuguesa dos Pequenos Investigadores" (Braga – Portugal) responsible for the sciences field.

The subjects which we deal with were the properties of the water. And it was targeted for children between the age of 5 and 13.

In the science workshop, the first day was dedicated to the basic properties of the water, as physical state and purity .At the second day others properties as refraction, conduction, density among others were worked. At the third day were made beautiful crystals, big soap bubbles and talk about concentrations .In the next day were made the distillation of water and a little waste water treatment station. The last day the water electrolysis was made [1-2-3].

In the art activity were obtained devices to be used in the science workshop as a water xylophone, paper boats and ice creams among others.

In the dance activity the moves and effects of the experiments are to be repeated.

A beautiful seventeen century lake and lots of water was the scenario in the final dance show.

In this work we will present the results achieved in the different approaches of the project.

Keywords. Chemistry, Science Museums.

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Using Microscale Techniques as a Cost-Effective and Time-Effective Alternative to Conventional "Hands-On" Practicals

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Abstract. Practical chemistry in many countries is blighted by a lack of chemicals, equipment, facilities, the cost of such resources, safety considerations, and practical teaching experiences. How can these problems be overcome?

It turns out that simple experiments on a Microscale (less than 200 mg of solid and less than 1ml of liquid) with very inexpensive equipment can complement experiments on a Macroscale which commonly require large amounts of reagents, expensive glassware, fume cupboards and complex disposal procedures to comply with increasingly demanding safety standards. Microscale experiments take much

shorter time than Macroscale ones and can be fitted more easily into practical sessions.

The Royal Society of Chemistry has produced a book of Microscale experiments for Organic, Inorganic and Physical laboratories, the Chemistry Video Consortium, based at the University of Southampton, has produced instructional interactive videos (VHS and CDROM; www.chemistry.soton.ac.uk/cvc/ => Abstract) showing demonstrations of experiments, the University of Lancaster has produced laboratory scripts based on many years of practical laboratory teaching and also examples of simple equipment. The latter can be obtained on-line.

This paper will describe how Microscale techniques can be used alongside Macroscale techniques to give students the opportunities to do "hands-on" practical work in schools, colleges and universities which otherwise they would not have had.

After the lecture it is hoped that participants will come and look at equipment and resources for Microscale experiments.

Keywords. Chemistry, Hands-on Experiments.

Strategies for Developing Scientific Literacy about Petroleum in the Chemistry Syllabus

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Abstract. Petroleum is a context used in several levels of the Portuguese chemistry syllabus. Nevertheless, students are not motivated enough for this subject in elementary and secondary schools. In a project in progress several activities and materials (paper and software) to increase scientific literacy about petroleum are being developed. These resources will focus on the role of chemistry in our daily lives. This poster presentation will discuss this issue and its location in the chemistry syllabus. It will also suggest strategies to allow students to become interested and intervenient citizens and to help them to develop scientific knowledge. In this presentation some results will be shown and their relevance discussed.

Keywords. Chemistry, Petroleum, Scientific Literacy.

Promoting Students' Learning About Covalent Bonding. A Case Study in Grade 10

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Abstract. This study investigated how eleven students, aged 15 -16 years old, grade 10, developed understanding of covalent bonding, when a methodology of 'global project' was used. Mind maps were also used. The study was developed in four stages. The objective of the first stage was to identify students' initial conceptions - students answered to diagnostic questions and constructed a "mind map" about the theme. The aim of the second stage was to help students to overcome their difficulties – students, working in groups, corrected their answers consulting and analyzing bibliography suggested by the teacher. Each group presented their work to their colleagues and teacher and the discussion about their work helped students to improve their ideas. In the third stage students learned about new ideas using the methodology used in second stage (analyzing bibliography to answer to questions about the theme). The initial mind map was then changed to include new ideas and knowledge acquired. In fourth stage, three months later, students answered to a group of questions to assess their knowledge. Results indicate that this instruction leads to enhanced conceptual development. For most of the students there was a conceptual development in several contents: chemical bonding, covalent bonding, bond parameters, molecular structure, geometry and polarity of molecules. The methodology used identifies students' initial conceptions, involves students in autonomous work to learn about new ideas, improves their knowledge and brings class discussion to the center of class work. Confrontation of initial

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mind maps with final ones showed that students understanding of covalent bonding improved substantially. Students felt strongly that working in groups, debating their ideas and constructing mind maps helped them to understand and to organize new ideas.

Keywords. Covalent Bonding, Learning, Teaching, Mind Maps.

Private Lessons in Chemistry – 12th Grade Students' Perception

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Abstract. The aim of this study was to investigate why students make use of private lessons during their school years. The aspects investigated aimed to determine: the age at which students began to attend to private lessons and the reasons they did so; if these lessons were useful and how they differ from their lessons at school. Eighteen 12th grade students who had private lessons while studying chemistry in school were interviewed individually.

The results suggest that students looked for private lessons to improve their marks, and the majority of them succeeded. The students pointed out some aspects that distinguished, in their opinion, the private lessons from their chemistry classes at school. In the private lessons they correct homework, assigned by the their tutor but also given in chemistry classes at school; they clarify their doubts; they review contents taught in chemistry classes; they sometimes study new contents (which have not yet been taught in school) which are better understood afterwards; the teaching pace is slower; the teaching is more individualized; there are less students and less noise in the private lessons. They also referred that in private lessons they pay more attention, feel more at ease to ask question, the tutor gives each student more attention and his mains concern is the student's success. In what concerns the school the students referred that the teaching pace is too fast, the teacher doesn't normally clarify doubts, and sometimes the students only copied what the teacher has written on the board without understanding what they have copied. They also think that the teacher is more concerned with teaching all that is in the syllabus than the student's effective learning.

Keywords. Learning chemistry, Private chemistry lessons, Student's perceptions.

Dimerization Study of Carbonyl Compounds mediated by Cr(II)

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Abstract. Very recently we developed a reductive pinacol type arylaldehyde homo coupling process using $[Cr(en)_2]^{2+}$ complex, under mild conditions. Yields of isolated meso-diols varied from low to moderate. Now we report an improved methodology furnishing a higher yield of meso-steroisomers. In addition we report our finding involving the effect of temperature and the role of (R) and (S) N,N-bis-1-phenylethyl-1,2-ethanodiamine upon the dimerization process. The results obtained in the reaction of benzoyl chloride and phenacyl bromide with the mentioned complex are also presented.

Keywords. Chemistry, Dimerization, homo coupling process with Cr(II).

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The Role of Physics Knowledge in Learning IT. An Educator's View

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Abstract. The lack of the fundamental physical knowledge significantly limits students' ability to comprehend IT courses. According to authors' survey, widespread problems with physics can be summarized as poor knowledge of basic electric, magnetic and optic phenomena. The portion of the physical knowledge involved in teaching IT can only increase in the near term, which raises a question concerning how teachers can provide efficient access to the necessary information *within* IT courses. Along with traditional physics courses, a Web-based instruction model with its deep linking strategy that links students directly to the structured components of online courseware provides a potential roadmap to a solution. Importance of and access to the gray literature is also addressed.

Keywords. Information Technology, Physics, Hardware, Web-based Instruction, Gray Literature.

1. Introduction

The origin and increasingly growing progress of information technology as a science with many applications was the product of multiple forces operating during decades prior to 1980s, when a wide use of PCs indicated the beginning of the IT era. These included many discoveries and accomplishments in physics, extensive research in material sciences, the innovative impact of the quantum theory, and the confidence produced by the success of transistor technology and semiconductor microelectronics at large. By virtue of this experience, IT became a prime example of quick application of new physical ideas, a circumstance which augured of its success.

2. Evaluation of students' physical background

The lack of the fundamental physical knowledge significantly limits effective learning IT and IT literacy in particular. Students depend on relevant physics information to be successful in mastering IT skills. To clarify a "physical bottleneck" in students' educational background we conducted the survey which sought (1) to learn the comprehension level regarding the knowledge of fundamental physics phenomena that students retained after a school physics course and (2) to explore students' ability to understand how physics phenomena are "transformed" into IT hardware solutions.

Two groups of 1st and 4th year students were recruited for the survey in Ternopil State Technical University.

The 1st year students were asked to answer 5 questions concerning electricity and magnetism:

1. What is a ferromagnetic?
2. Coulomb's Law.
3. Electromagnetic induction law.
4. What is a condenser capacity?
5. What are differences between metals, semiconductors and dielectrics?

Obviously, the questions were selected to reflect the phenomena applied in CPUs (transistors), memory and storage devices.

30 questionnaires were completed. Most students reproduced the formula of Coulomb's Law (70%), many wrote formulas of the electromagnetic induction law (37%) and the condenser capacity (43%). Only 33% students were able to answer the 1st question. About 60% students provided a simple conductivity-based explanation about the difference between metals, semiconductors and dielectrics. No interpretation was given to the formulas they wrote and no comments were made on possible application of the phenomena mentioned.

The 4th year questionnaire dealt with the topics which are addressed in the current Web-based course titled "IT Hardware" [1] and, similar to the previous questionnaire, focused on the physical basis:

1. Which physical phenomena are used in data storage devices?
2. Why optic buses are generally faster than electric ones?

3. What is a physical law applied in an optic fiber?
4. Indicate devices the operation of which is based on the phase transformation from an amorphous state to a crystal one and vice versa.
5. What physical factors can restrict the Moore's Law?

Questionnaires were completed by 18 students. 92% students easily explained the principles of data storage, but only 42% students were able to reason about optic versus electric buses using their knowledge of electricity, magnetism and optics which was found rather insufficient as shown through an additional survey with the 1st year student questionnaire. Many students (67%) successfully explained how an optic fiber and optic storage devices work. 67% students saw the link between the structure of semiconductor materials used in microelectronics and the current trends in this field described by the Moore's Law.

For comparison, the 4th year students were additionally offered to complete the 1st year questionnaire initially intended for the 1st year students. In contrast to 1st year students, the 4th year ones provided descriptive answers to questions #2 (62%), #3 (64%), and #4 (67%). Only one student of 92% students who properly answered the question #5 reasoned in terms of charge carriers, while others, similar to 1st year students, mentioned only different conductivity.

Question #	1st year students	4th year students: 1st year questionnaire	4th year students: 4th year questionnaire
1	33%	42%	92%
2	70%	62%	42%
3	37%	64%	67%
4	43%	67%	67%
5	60%	92%	67%

Table 1. Percentage of proper responses

The survey results are summarized in Table 1. We may suggest that as soon as we have made a special emphasize on what physical phenomena are used in IT hardware while teaching the "IT Hardware" course, the 4th year students demonstrate overall better vision of this link.

According to our survey, widespread problems with physics can be summarized as poor knowledge of fundamental electric, magnetic and optic phenomena that makes many students feeling a wide gap between physics and IT. This is not a criticism of current educational practice but merely an observation.

3. Physics in the IT context

Physics creates a strong foundation for IT literacy. The portion of the physical knowledge involved in teaching IT can only increase in the near term, which raises a question concerning how teachers can provide efficient access to the relevant information *within* IT courses.

3.1. Reasons to learn physics better

Knowledge of relevant physics information is important to students for a variety of reasons:

- it makes the link between the theory and the practice meaningful for students;
- it reinforces comprehension of how IT hardware work;
- it enables students to understand current trends in IT and see the principal limits of those trends;
- it provides support for decision making regarding the proper selection and use of IT hardware;
- it allows seeing new ways in future IT.

3.2. The access to physics educational materials within IT courses

Different strategies can be implemented in the science curriculum to address problems of IT literacy by improving instruction in physics and better coordination between subject-specific curricula.

It is the authors' contention that a great deal can be done throughout the modern educational system. Traditional physics courses provide a good primary basis, but a stronger accent on the potential of many physical phenomena, effects and concepts in IT would be useful.

Few efforts can be made to refresh the physical knowledge in students' memory. When faced with forgotten facts, students will often bypass their old textbooks and seek rapid access to easier understandable information.

One way is to make this information accessible through inserting special sections in the IT courseware. But we believe that access, not necessarily duplicating materials on particular physical matters, might be the most appropriate recommendation in this case.

Web-based instruction model [1] with its deep linking strategy that links students directly to the structured components of online courseware provides a potential roadmap to a solution. Therefore another way to view the situation at hand is from the perspective of the science teaching profession as a whole. The two examples are given below to illustrate the idea.

Entropy is a cornerstone concept in information theory defined by Shannon in the context of a probabilistic model for a data source. However students are likely having heard this word and have learned the entropy concept while were studying physics and thermodynamics in particular. Indeed, both concepts of entropy, information and thermodynamics, have deep links with each other. Then the sensible approach is to provide a link from IT courseware to a relevant physics resource, for example "Introduction to thermodynamics" developed at the Physics Department, Murcia University [2], and benefit from its opportunities including simulation. This facilitates achieving more pragmatic teaching goals, e.g. explaining what the amount of information is, why one binary element contains a unit of information named a bit, when lossless data compression is possible etc.

There is no doubt that graphics is a students' favorite. But do they always know which image format is more effective, i.e. yields a smaller file size, and why? Color models will be a good starting point to show how image data can be compressed using different formats. For example, "Make a splash with colour" [3] may nicely complement a technical description of image formats.

Each way mentioned above has its own strengths and weaknesses, and it may take a combination of strategies to address the complexities of IT literacy effectively.

4. Potential of the gray literature

Much useful information in science education is generated through academic and nonprofit organizations in the form of project reports or deliverables, conference proceedings, newsletters, lecture notes, assignments, topic presentations, and other formats. These materials typically do not find their way into established commercial outlets for publication and, as a consequence, are not consistently indexed in EBSCO and other bibliographic tools or databases for locating science teaching information. As a result, educational documents often fall into the category of "fugitive" or gray literature, i.e. literature that is difficult to locate because it is not available through traditional commercial pathways.

Gray literature is important to science teachers because:

- it enables them to learn from and build on the activities of other professionals working in the field;
- it provides them examples of successful practices.

The proliferation of such non-indexed, potentially valuable information has stirred interest among those involved in the development of, use of, collection of and access to this body of science educational literature [4].

Improving access to this literature faces a number of considerable problems. The sheer volume, diversity, and nontraditional formats make gray literature difficult to locate. Although gray literature documents have become increasingly available on the Internet, collocation, cross-linking of materials across sites is small.

Additionally, the two established models for systematic access to literature are limited solutions to the access problem for the gray literature in science education. The model of controlled vocabulary indexing by human experts has difficulty scaling up to accommodate the quantity and variety of gray literature documents. Although search engine technology is effective in locating some relevant documents, it is restricted in its coverage by problems of collocation across keyword texts and the absence or choice of descriptive information about the documents such as title, creators and topic. Thus, a teacher who is looking for information about a particular science topic faces a formidable challenge in finding pertinent gray literature in the education domain.

Recently experts in science education have made significant efforts to ensure a more systematic way of organizing the gray literature of science education [5-6]. A notable collection of educational resources has been developed within the Hands-on Science project [5], but it represents a small portion of potentially useful gray literature. Thus further research should be made to improve the collections which exist and develop a relevant approach to the access problem in science education gray literature.

5. Conclusions

Current teaching models for science subjects have reached a high state of collaboration. In this regard, establishing the content of and providing the access to cross-subject courseware components should be a profession-wide undertaking. However, such an undertaking would necessarily require profession-wide discussion on the scale of current practices in science teaching.

Finally, in such a fluid environment as the science and the Internet, successful support for teaching requires flexibility and creativity that may be an iterative process. New technologies may enhance courseware but also introduce problems because much in education remains more of an art than a science. Better technologies will certainly help us, but very often we will continue to rely on the expert opinion of our professional colleagues who know the science and, most important of all, know the needs of students we teach.

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Exploring Entrepreneurship from an Educational Perspective: A Case Study

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Abstract. This paper presents the findings of a study conducted at Sultan Qaboos University, College Of Commerce & Economics, to explore the validity of bringing about the idea of Entrepreneurship, through the delivery of an E-business course to major students in Information Systems. This study was initiated in an effort to produce self-employment opportunities for the youth in Oman as an alternative option to finding a job after graduation. The availability of industry and governmental financial support and the availability of incubators in Oman to host the new small enterprises were taken as means to possibly encouraging students to take the entrepreneurship path. Also, socio economic factors were taken into consideration to fully understand any challenges that might arise during the project phase. Even though the established businesses and associated E-Businesses were successful, and students exhibited the need for achievement, creativity and innovation, very few of the students really exhibited the need for autonomy-own way, for being opportunistic, striving for control, to have a vision, and to take risk. The latter dimensions were completely masked by the urgency to find a job to earn money as soon as possible to meet some socio-economic needs. Based on the study's findings, a number of suggestions were put forward to adequately support the government's initiative of exploring new avenues for employment through education.

Keywords. E-business, Entrepreneurs, Oman, Small enterprises.

1. Introduction

In an effort to support the initiative of the government of the Sultanate Of Oman to explore self-employment opportunities by the youth instead of job hunting after graduation, a study was conducted at Sultan Qaboos University (SQU), College Of Commerce & Economics, to explore the validity of bringing about the idea of entrepreneurship, through the delivery of an e-business course to major students in information systems. Johnson and Fan Ma [5] had emphasized that in very simple terms, business owners those who score highly on the dimensions of need for autonomy-own way, need for achievement, creativity and innovation, opportunistic, control, vision and, calculated risk taking-strategy, are more liable to be running a successful business. Marrying the Entrepreneurship skill potential with information technology solutions nowadays is the most effective way to take on to compete globally. Rola [7] had reported that Small and Medium Enterprises (SME) are responsible for sixty percent of the country's economic output; generate eighty percent of national employment, and eighty percent of all new jobs. And, those SMEs would put themselves at a competitive disadvantage if they do not adopt internet business solutions.

Hilson [4], on the other hand, had indicated that lack of talents also has negatively affected the ability of SMEs to embrace e-business. Talents are consumable by large firms and very hard to convince them that joining SMEs is also a rewarding career. Therefore, there is the need to collaborate with colleges and universities to develop new curriculum in Internet business solutions, not in technology—understanding how you reconstruct a business in a web-centric fashion. Also, Keough [6] had emphasized that there is the need to reengineer conventional educational institutions where More-Added-Value (MAV) learning is delivered by educational entrepreneurs who understand the Learning Customer (LC) psychology and be capable of self-evaluation and continuous improvement. Facilitating innovation was also highlighted by Eaton [2] where an innovation academy was mentioned that is aimed at creating organizational facilitators who can lead innovation based programmes. In addition, today's entrepreneur needs, as highlighted by Ronald Langston, national director of the US department of Commerce's Minority business development agency in Washington DC, is to be even more flexible in the face of the current business environment, which also mandates that entrepreneurs pool resources, leverage businesses, and forge alliances. It is valuable to have partners and form alliances so businesses can not only absorb changes in the economy, but take advantage of changes in the economy. Also, Harris [3] had highlighted the same idea of the need these days for entrepreneurs to use every resource available to develop and maintain professional relationships.

Zheng, Caldwell, Harland, Powell, Woerndl, and Xu [9] had reported their research findings that while offering opportunity to SMEs, internet-based commerce also threatens to introduce new competitors into what were domestic markets. They added that SME's seemed not to prioritize e-business, but were more concerned with how to survive in what they have perceived as increasingly competitive markets, and how to keep their existing customers, as opposed to seeking new ones. And that Owners-manager of SMEs tended to be more preoccupied with day-to-day viability; they were driven by operational rather than strategic issues and had therefore not considered the potential strategic benefits of e-technologies. However, it was also noted that behavioral and cultural barriers to e-adoption by SMEs were to be more critical than resource and technical issues. Their Research findings had also highlighted that in all chains, communications were based on well

Established, inter-personal relationships, and maintaining the resulting loyalty and goodwill was considered more important than increasing the efficiency of the mode of communication. SMEs feared losing the personal touch and the corresponding intimate knowledge of their customers, and still lacked confidence in Internet transactions.

However, according to Thomas [8], the push by the banking community to encourage businesses to use online services is the catalyst for driving e-business growth. Also, e-government initiatives in place will eventually speed up the adoption of such technology solutions. Zheng, Caldwell, Harland, Powell, Woerndl, and Xu [9] had indicated that the reasons for not adopting e-solutions by SMEs include cost of systems, time required to implement and skepticism over return on

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investment and management support for initiatives. The government can take initiatives aimed at helping them by embracing e-solutions at lower costs. In addition, EnCube CEO Ayman Ayad [1] of an internet incubator said that they are no longer an incubator but rather an e-business factory focused on building internet-enabled businesses. The Sultanate of Oman had established Knowledge Oasis Muscat (KOM). KOM is a public-private sector-led initiative that is totally committed to creating an environment in which entrepreneurs, researchers and small and medium-sized enterprises, as well as established multinationals, can innovate and flourish within a Gulf Co-operation Council (GCC) setting(www.kom.om).

Based on these findings and in an effort to the support the entrepreneurship initiative, a course on e-business was offered to the college of Commerce & Economics students. The course highlighted the technical, business, and organizational aspects of e-business while the course projects explored the potential of instilling entrepreneurship and innovation skills in the students. The projects that were explored, touched on the dimensions of need for autonomy-own way, need for achievement, creativity and innovation, opportunistic, control, vision and, and calculated risk taking-strategy, the characteristics of a potential business owner as referred to by [5].

2. Study Process, Scope, and Deliverables

Students taking the course were from different business majors but the majority was majoring in Information Systems. The course projects were valued at forty percent of the total grade. Students initially were asked to do the following:-

- Organize in teams of three to five individuals
- Think of a unique business that they would like to open in the future
- Make sure that the idea of your business is not shared with other teams; otherwise, the team will lose ten percent of their project grade
- Deliverables were communicated to the teams and that included a business plan, a prototyped internet-based solution, and an operating physical business with proven market feasibility. Writing a business plan was important as some of these businesses had the potential to be hosted at KOM. Establishing a physical company is necessary as the culture of Oman does embrace the personal relationships that are built on trust and loyalty as part of doing business.
- One hundred Omani Rials were given to the teams as a starting investment that was sponsored by local companies and other supportive governmental organizations
- Teams were encouraged to include students, not registered for the course, from other majors as helpers to get grade bonus points since their business plans would be more complete when other specializations join in to add their expertise

After the thirteen teams have assembled and had chosen their businesses, I as their course facilitator, arranged to meet with them individually to start the business identity definition, build the associated five related components (vision, mission, driving force, core competencies, and the stakeholders), and perform a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis to derive the first draft of the business strategy. The teams' businesses were kept secret to create a competitive environment at the time when all teams have to reveal their businesses for market feasibility testing.

Then, once the business strategy was clear which included an internet based solution, the teams were instructed to build the physical businesses for real. That means, they had to seek outside help whether suppliers or customers and negotiate contracts and start establishing the supplier side of the business value chain to start operations and be ready for market feasibility testing on campus. Market feasibility testing was essential to validate that customers who are at the end of the value chain did receive the value. The administration of SQU had already authorized testing these businesses on campus with full support when needed.

Later, the teams were asked to create an internet based solution prototype and a simple business plan to demo at an organized small e-business exhibition that is hosted at the college, combining the teams' businesses and the sponsor businesses. Media was invited in to provide local coverage of the event.

3. Study Findings

The thirteen teams' businesses fell into two categories: product and service. Product businesses included Halwa (Omani traditional sweets), fish, Arabic sweets, Omani fast-food, office furniture, Omani souvenirs, and beauty products. Services included real estate rentals and management, real estate, Hotel bookings, tourism, special car rental, and advertising. Product oriented businesses picked up very quickly and were very successful with good returns. Service oriented businesses were very slow and not profit making. Therefore, some students made money and others had just completed their projects with no profits.

The students at first did not want to sell their products or services as they can not accept rejection or are timid to get started. I, as their facilitator, joined the teams who did seek help and went out to help them finalize contracts, seek suppliers, or sell their products and services. The students, for the first time, had started to really put into practice the business foundation theory they have learnt and how it really applies to their businesses. Not all customers who are SQU employees were supportive and that served the students to experience rejections. Some other employees were good customers but demanded value added services, and therefore some of the teams had to expand their businesses to introduce new products and services to accommodate the customers' preferences.

Dealing with the outside world was very challenging to the teams and they needed mentoring to accomplish some tasks. With some teams, their immediate and extended families were involved to help them. In fact, some of the small suppliers were businesses owned by family members or relatives thereby marketing them at the same time of forming the teams' businesses. Also, in the midst of the study, Zayed University approached SQU for the students to enter an e-business competition, and the teams had to re-customize their business plans. Three teams out of fourteen out of forty five made it to the top ten winners.

At the end of the semester, an exhibition was organized for all these businesses to demo their products and services in addition to demonstrating prototyped e-sites for their businesses. The exhibition was very successful and the teams started getting invited to either enter into new competitions or participate in e-related conferences. In addition, a trip was organized to escort the teams to Dubai to receive their rewards for entering into the eBiz competition.

Even though the businesses were successful and students exhibited the need for achievement, creativity and innovation, very few of the students really exhibited the need for autonomy-own way, for being opportunistic, striving for control, to have a vision, and to take risk. The latter dimensions were completely masked by the urgency to find a job to earn money as soon as possible to meet some socio-economic needs. Such needs included having money to get married, or to feel financially secure, or to help their immediate families. Graduates were willing to stay unemployed for more than six months waiting for a job, without taking the chance to explore the entrepreneurship option that might lead to better financial gains in the long run. With all the support for financing, incubator support, and mentoring, still the students felt that it was very risky to go into business and fail. Failure was also not acceptable in addition to the pressure to meet their socio economic needs. In addition, there were many wrong perceptions about the limitation of getting financial support and the possibility of losing their Intellectual Rights if they apply for funds or incubator support.

Students, who became young entrepreneurs and are very successful, are the ones who have a job and run their businesses after working hours. Even though their small businesses are successful, still they can not let go of the steady job they currently hold.

With regards to college politics, some of the faculty resisted the idea of the study and fought very hard to instigate failure. The faculty who opposed the idea felt that selling products and services by the students is not acceptable, yet it is the college of Commerce where they facilitated. This study was very well embraced by the students and supported by the university administration. However, it introduced a major change to the conventional methods of teaching that was adopted by these faculties and they simply resisted the change. Students who did not have the chance to participate felt that they needed the rest of faculty to introduce practical projects like those that were introduced by the study. That meant that the faculty were steered to do more work, as per their conventional teaching, and that meant inconvenience, therefore there came the resistance to change.

4. Recommendations

The study was very successful and it is highly recommended that it is practiced at the college level or at the university level, depending on how the e-business course is offered. However, here are some recommendations that need to be considered. These recommendations will help steer a smoother implementation strategy for the assigned projects as follows:-

- It would be more rewarding to the students if the projects are product oriented businesses versus service oriented businesses. The need to feel accomplished by earning profits is very desirable to instill entrepreneurship spirit
- Faculty need to be trained to become educational entrepreneurs. According to Keough [6], educational Entrepreneurs (EEs) add value by defining instructional services responding to individualized Learning Customer needs. Conventional Educational Institutions (CEIs) are typically inept at advocating privilege and responding to the basic needs to be individually recognized and personally valued within a community of shared interests. To bring More Value Added (MVA) to products and services Educational Institutions (EIs) must understand Learning Customer (LC) psychology and be capable of self-evaluation and continuous improvement. MVA services respond to customers' needs and focus on the relationship of the learner with the overall institution.
- To instill the financial security issue related to starting a small business by the entrepreneurs, according to Tim Rowe CEO, Cambridge Innovation Center, USA, it would be best if big companies established funds to invest in these small businesses where entrepreneurs would be paid a salary while establishing their businesses. Such companies can steer innovations and support market economic needs by investing in these small companies.
- It is also advisable to reach out to the community and select small businesses established by individuals but need the support and know-how to grow. These projects can help these businesses while the students can gain the practical experience of developing a business. Also, the students can help build e-solutions to support these SMEs in increasing their customer base.
- It is very important to pay attention to cultural issues and try to work with them. Ignoring these issues will conflict with initiatives if not considered carefully.
- The projects demand many additional hours of work and mentoring. The facilitator has to be ready to volunteer his/her time to facilitate such projects. Also, entering competitions at the same time is time consuming but rewarding.
- Not all students foresee such projects as future career opportunities. They see them as simply course projects. Therefore, it would be best to let the students go through a long term planning session to draw a vision for their future, to really seek a better appreciation of the goals of the projects.
- Let the students attend seminars on how to apply for financial help, occupy an IT incubator, and how to protect their Intellectual Rights of their ideas.

5. Summary

In an effort to support the initiative of the government of the Sultanate Of Oman to explore self-employment opportunities by the youth instead of job hunting after graduation, a project was conducted at Sultan Qaboos University, College Of Commerce & Economics, to explore the validity of bringing about the idea of entrepreneurship, through the delivery of an e-business course to major students in information systems.

Students started their own physical businesses and tested their commercial validity on campus. Also, students explored the benefits of e-business sites for these companies. Industry sponsorship was available to fund the initial cost of the startups and the university administration support was strong. Product oriented startup companies were very successful and generated revenues to the students, while the service oriented startup companies were slower to get started and did not reap the same benefits within the project phase time. By implementing these businesses, students had a feel of how to start a company and make it work. However, very few students showed evidence of entrepreneurship skills and even after graduation, only few pursued a small startup opportunity immediately after graduation. The students, from a society perspective, feel strongly that they need to get a job to secure a continuous flow of income. Income was necessary to support their families or their future personal goals like marriage.

The availability of industry and governmental financial support and the availability of incubators in Oman to host the new small enterprises were not considered as strong alternative solutions, to provide financial stability for the students to embrace the entrepreneurship path. Students have had wrong perceptions of the difficulty of attaining the financial support due to many constraints imposed by the fund organizations or by the policies of the related ministries. Also, students had wrong perceptions about the protection of the intellectual property rights of their ideas and decided not to explore them with any support organizations. But, it is interesting to note that quite a few students, after acquiring jobs and within 3 months, started their small businesses and they are running them at the same time. Having a steady income and exploring the entrepreneurship opportunities at the same time was a more viable solution to validate the success of their small businesses, while securing their finances.

Based on the project's findings, it is highly recommended to introduce entrepreneurship ideas during the students' course of study by offering an e-business course, not only to consider physical startups but to encourage virtual businesses too. Also, it is recommended that the businesses deployed by students be product oriented to show revenues. In addition, it would be best to organize training workshops for the students on how to apply for financial support and how to secure the IP rights of their business ideas. These recommendations are necessary to adequately support the government's initiative of exploring new avenues for youth employment through education.

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Development of a Variable Frequency Power Electronics Inverter to Control the Speed of a Three-Phase Induction Motor

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Abstract. This work presents the development and implementation of a variable frequency Power Electronics inverter to drive a three-phase induction motor. The inverter allows a user to

control the speed and torque developed by the motor, as well as its rotating direction. The inverter digital controller was implemented with a microcontroller. The inverter is fed from a rectifier with capacitive filter, which is connected to single-phase, 50 Hz power mains.

Keywords. Power Electronics Inverter, Three-Phase Induction Motor, Speed Controller, Velocity/Frequency Controller.

1.Three-Phase Induction Motor Control

Induction motors are considered a good choice because of their robustness, reliability and low price.

The implementation features the use of a Microchip microcontroller, the PIC18F4431, used to produce the PWM signals which will drive the semiconductors of a three-phase inverter bridge. According to a velocity/frequency relation, PWM signals are generated in order to produce three sine waves 120 degrees shifted in time, itself producing a rotating magnetic field in the motor's stator. As shown in figure 1, the control signals which will drive the high side of the inverter bridge show that the average value of each arm is different. The difference is correspondent to a 120 degrees phase shift.

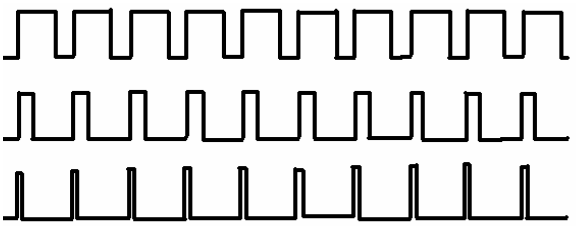

Figure 1. High side PWM signals

Between each two arms of the inverter bridge there will be an average voltage drop, normally described as "fundamental". The duty cycle of the PWM makes the semiconductors switch in a manner that produces, in average, a sine wave. The desired wave is obtained by following a table of values and updating the pulses' duty cycle. As an example, if a 50Hz sine wave is wanted, each PWM must update all of the table values in 20 milliseconds time, and it is updated 20 000 times each second, which corresponds to a 20Khz switching frequency.

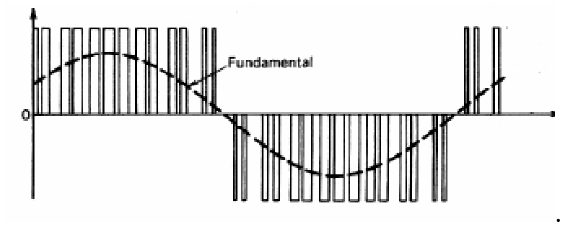

Figure 2. Average voltage

As there are three pairs of complementary legs in the inverter bridge, the result will be three sine waves phase shifted of 120 degrees in time.

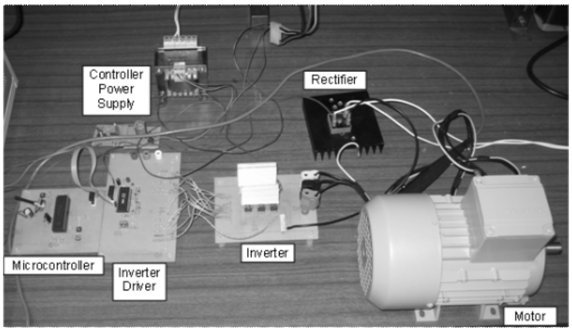

Figure 4. Circuit used to drive the motor

The ability to change the frequency, amplitude and order of these sine waves, makes the controller able to change the speed and rotation direction of the motor, fitting this application to be used in a vehicle.

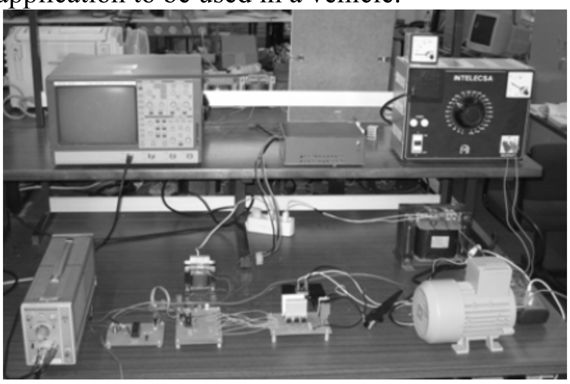

Figure 5. Circuit workbench with power supplies and measuring instruments

The rotating speed (in RPM) can be calculated having the number of the poles of the motor used, and the frequency of the rotating magnetic field. Its value is given by equation (1).

$$Ns = 120 \times \frac{f(Hz)}{p(number\_of\_poles)} \quad (1)$$

2. Acknowledgements

This work was supported by the FCT (Fundação para a Ciência e a Tecnologia), project funding POCTI/ESE/41170/2001 and POCTI/ESE/48242/2002. The authors are also grateful to PRIME (Programa de Incentivos à Modernização da Economia) for funding the Project SINUS.

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A Pedagogical Approximation to the Problem of the Structure of the Asteroid Belt between Mars and Jupiter

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Abstract. The study of the many body problem associated to the dynamics of the different elements of our Solar System is a complex subject for introductory level Physics students. But building and using computer simulations allows the students to be introduced to this subject. Here we present a study of the dynamical structure of the main asteroid belt between Mars and Jupiter. First we considered only the simpler problem of a fictitious negligible mass asteroid in the gravity field of a Star and a big Planet (Sun and Jupiter, for instance); then, the inclusion of inner and external planets (Mars and Saturn) allows the reproduction of the more realistic situation found in our Solar System. The orbits of several hundreds of asteroids are integrated numerically and the periods and other characteristics of stable orbits are obtained. Our results reproduce many of the Kirkwood gaps, observed in the main belt asteroids, associated to the different non linear resonances there found.

Keywords. Kirkwood's gap, Computer simulation, Nonlinear resonance.

1. Introduction

The students of General Physical course (1st. course of Physics at UMU) are making a set of computer assisted simulations in which they study a high variety of physical problems.

We have observed that the problems related to astronomy, relativity, quantum or magnetic confinement arouse a great interest to the students. Usually, the more attracting problems are the ones with difficult solution due to their academic level or great amount of calculations involved. This is the situation which is presented in this paper: to simulate the observed asteroid distribution between the orbits of Mars and Jupiter.

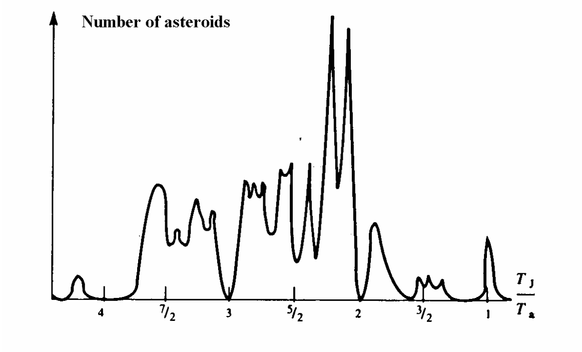

Figure 1. Kirkwood's gaps distribution

D. Kirkwood determined experimentally in 1867 the radial distribution of asteroids and he found that at given distances from the Sun seemed that there were no asteroids. These zones of smaller density of asteroids are denominated Kirkwood´s gap, Fig. 1, [1]. These gaps are not a random distribution; they satisfy that the ratio between the orbital period of Jupiter (T_J) and the

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period of the missing asteroid (T_a), is a rational number.

Asteroids motion, like for planets, is mainly due to the Sun attraction force. The gaps, nevertheless, are related to the gravitational Jupiter effect [2]; but for totally explaining the gaps distribution it is even necessary to include the Mars and Saturn gravitational effect [3]

From an academic perspective this is a simple problem: one considers the dynamics of a particle due to gravitational interaction with the planets and the Sun, so that the force on the asteroid depends on its position. From the didactic perspective, the cosmological exposition of the problem in the surroundings of the structure of the Solar System, makes our problem interesting for the student; in addition, if we connect this with the topics “chaos”, “resonance”, etc., it becomes a leading study, an open problem and the student, then, becomes a researcher.

In order to solve the motion equations, the numerical method of finite differences (FD) is used, [5]. This method has many nice features. First of all it is very intuitive and very easy to implement. Secondly, its application to solve the motion equations demands to know the initial conditions of the problem, therefore we need to know, the physical system state at the initial time. That idea: “I will guess the future knowing the initial state and the temporal evolution equations”, is basic in the deterministic presentation of the Newtonian Mechanics; the FD method shows this.

2. Modelling our system

2.1 Model assumptions and initial conditions.

Firstly we have to talk about the simplifications made in our model and the resulting initial conditions of the system:

-The Sun is located at centre of the reference system.

-We consider the planets to describe circular coplanar orbits and, initially, we locate them in conjunction. Then, we work out the problem in 2 dimensions.

-We allocate a value to orbital Jupiter radius (R_J=10 length units) and we scale the other radii: Mars (R_M=3), Saturn (R_S=20) and the asteroids ($3.5<R_a<8$), Fig. 2.

-We fix the Jupiter period to T_J= 10 time units and this allows computing the value of $G.M_{SUN}$. In addition, by the Keppler’s third law, the remaining periods (T_M, T_S) can be determined, [1].

-We assume the initial asteroids velocities as if they were in circular orbits due to just the gravitational action of the Sun. Logically, when, in their dynamical evolution, we consider planets gravitational fields, those orbits will not be circular anymore.

-The masses that we assigned to the planets, are, related to the Sun mass (M_{SUN}=10), much greater than the real ones; in this way, we improve the accuracy of our numerical computations (M_J=2, M_M=.01, M_S=.1)

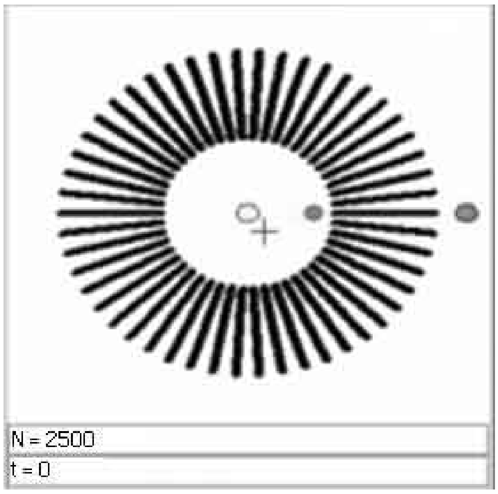

Figure 2. Initial distribution

2.2 Contents of the simulation.

Once the initial conditions were established, we go to the dynamics of the process. We impose the planets to describe a circular uniform motion and we obtain the asteroids trajectories by FD method.

The simulation includes the following elements:

-Dynamical evolution. We calculate the future positions of the different asteroids, taking into account the total gravitational field at its present positions.

-Asteroid’s update. Asteroids that are too close to the Sun or planets, or too far away from the interest region, are eliminated.

-Periods calculation. Asteroids periods are determined through the angle swept by the asteroid position vector along a fixed temporal interval.

-Asteroid Distribution. An algorithm calculates and represents the asteroid distribution versus the T_J/T_a ratio.

2.3 Results and Discussion

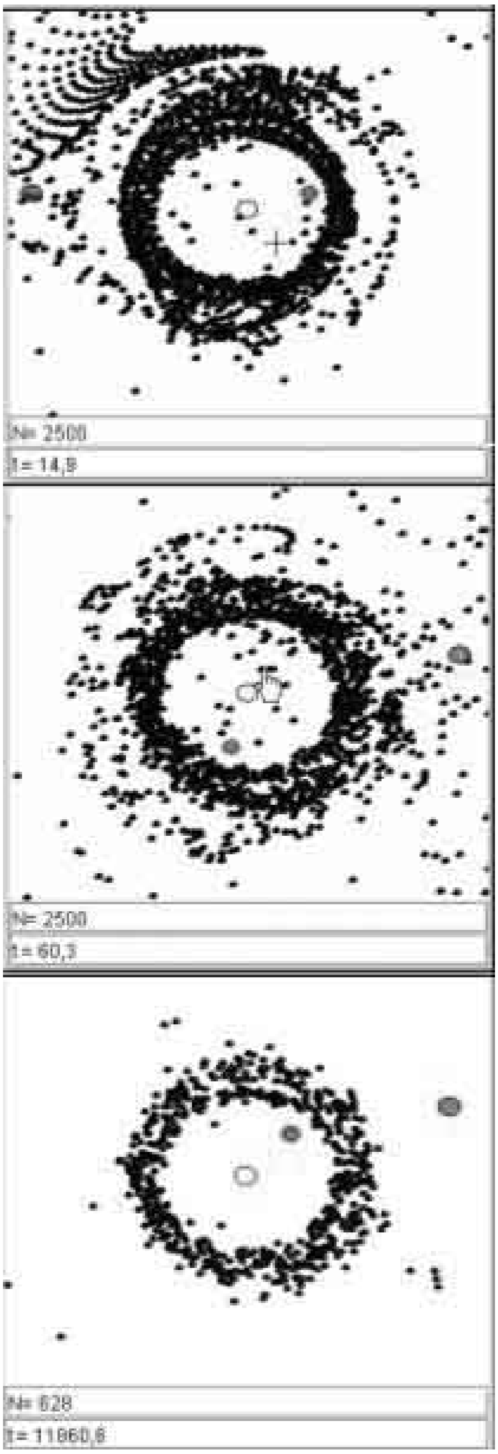

Figure 3. Time evolution of a 2500 asteroids in the gravity field of Sun, Mars and Jupiter

First, we have studied the influence of Jupiter and Mars in the asteroids dynamical evolution. Later, we have included Saturn, and analyzed its influence. In both cases, we have run our model for an initial number of 2500 asteroids distributed in a 50x50 circular mesh (50 rings with radii in the range $3.5 < R_a < 8.50$ asteroids each one).

At the beginning of our study we did not consider the Mars planet. A considerable increase of the orbits eccentricity was observed, although we did not find a clear gaps distribution. Those results were expected, due to the role of Mars in the elimination of the asteroids crossing its orbit.

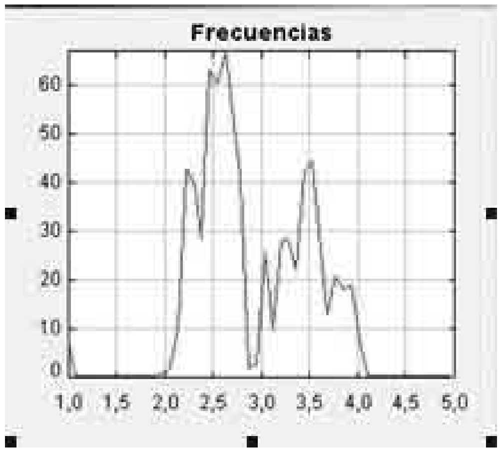

Figure 4. Distribution of asteroids

In the Fig. 3, different instants of the dynamic simulation are shown. A visual inspection of the asteroids spatial distribution, for large t, shows the mentioned gaps; those gaps are also shown in Fig. 4. Those gaps are present in the regions also found in the real distribution, Fig. 5, [4], corresponding to the resonances: 7/3, 3/1, 10/3 and 11/3. Also as in the real distribution very dense areas appear.

Including Saturn results in a new resonance at 8/3, Fig. 6 and Fig. 7.

Regarding the obtained results we would like to emphasize the following:

-In all studied situations, once the system is stabilized, we found radial zones with low number of asteroids. We verified that these zones correspond indeed with the distances to which the periods that correspond to the asteroids are simple fractions of the period of Jupiter. This result is related to a chaotic resonant phenomenon, whose effect is to destabilize some asteroids, sending them outside the belt, producing very dense population in other regions.

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-We have not considered the eccentricity of the orbits, and we think this is not very important to visualize the phenomenon. Its effect has been partially compensated with the increase of the Jupiter mass relative to the Sun. This increases the amplitude of the disturbance on the asteroids. This can also have negative effects on the stability, for instance, of the Trojan asteroids.

-The simplicity of the model and the inaccuracies of the numerical calculations could justify the non detection of other gaps.

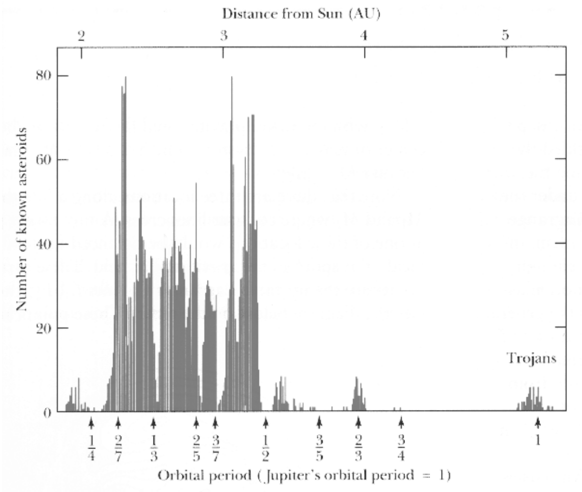

Figure 5. Asteroid Main-Belt Distribution. The T_J/T_a ratio increase to the left.

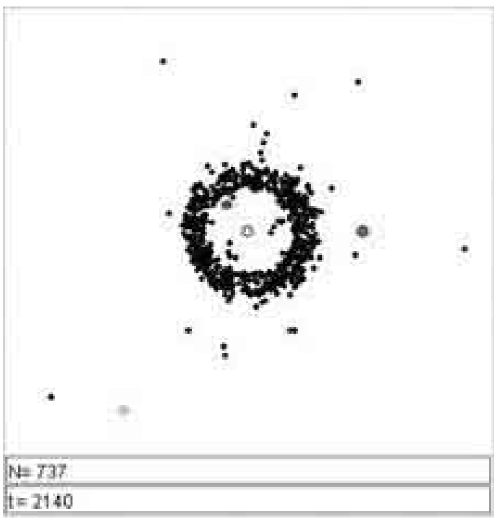

Figure 6. Spatial distribution considering in addition Saturn

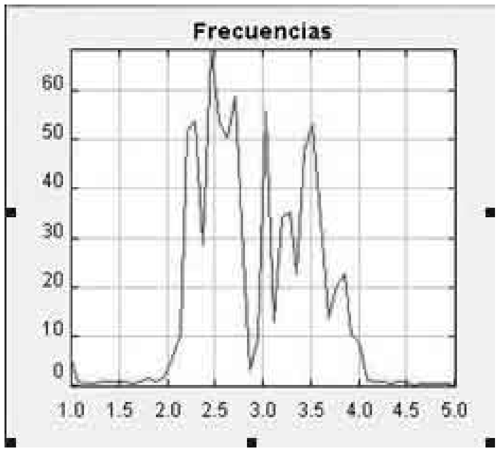

Figure 7. Radial distribution of asteroids considering Saturn

3. Conclusion

The radial distribution of asteroids between the orbits of Mars and Jupiter is an example of gravitational chaos. An asteroid is influenced mainly by the Sun attraction, but the minor action of Jupiter produces the resonance effect we have studied.

The scope of our study is very limited. A proper study should consider many more variables in order to be realistic, but this that was not the main interest of this work. From an educational point of view we were satisfied with obtaining qualitative results that allowed us to observe the fundamental phenomenon, the existence of gaps, learning, in addition, to implement some simple programming tools.

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The New Projects Achieved for Development of Romanian School

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Abstract. The project presents structural particularities from different domains of science, included in the web-pages.

The purpose of this work is to develop the interest of students for study of sciences and the Romanian education system.

Keywords. Web-page, Computer, Internet, Science.

1. Introduction

The project which is presented in this context represents an informative background which has the purpose of combining the creativity, the multimedia interface, and the interactivity with different domains from science. Like any other informative web page, this project will be in a continuous process of restructure and recondition of the information (in definite and précised terms). The search engine on the site will realize not only internal but also external connections.

Figure 1. The main page of the project

The web page represents a structural background which contains not only materials in script format (direct on the internet or downloadable) but also graphics, images or other multimedia elements. The site is easy to navigate so that the searched information from the respective domain is immediately obtained. The users of this site have the occasion of visualizing other informative projects (this aspect being certified by the presence of the links) and of receiving by email information from the searched scientific domain (the newsletter function).

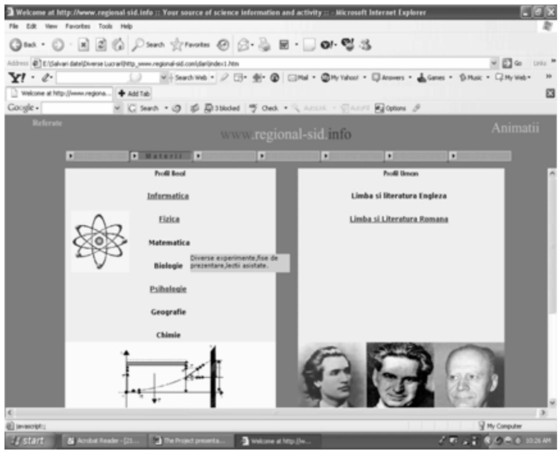

Figure 2. The page with matters of the project

2. The structure of this web-page

The main purpose for constructing and developing this project is to create a virtual informational base (database), precisely, a virtual library with informational material belonging especially to realistic scientific domains (Mathematics, Physics, Biology, Chemistry, Informatics- Programming Languages, etc.).The analytic and structural development of this project will soon allow the include (imbrications) in the interface (main structure) of this page (webpage) of a search engine, in the back of this structure activating hundreds of pages with informational material, an element or a structural factor which will allow the quick and efficient accessing of this webpage.

Like many other projects of development and comparative analysis the objective of this project is the development of creativity and the interests of students for study.

The format, interactive, structural and complex shape of this webpage, with different not only internal connections but also external ones will represent an ideal informational source

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not only in the presented domain but also in the external structures. For each matter or informational domain exists a "tree" structure with different sides or imbrications ("branches"), particularities which attest or name the structural character and also well-organized of this webpage, of the presented structural work. The "branches of the tree" represent the sides of the matter or informational domain presented in the main structure, so, accessed they will introduce new structures like the ones described until now, an element or a factor which attests the navigational character of this page in HTML version.

For a precise example of these structural particularities we will analyze the case of the matter or informational domain named Informatics-Programming Languages. For the "trunk of the tree" we have chosen the structure: "Pascal Language-Algorithms, Techniques, Programming Methods" (Characteristics, Presentation particularities, Examples, Different Connections) with it's 'branches' from the main domain: Backtracking Method (The definition of the method, Structural particularities, Examples, Characteristics, Different presentation structures, Different problems and exercises proper to the presented method, The reappearing structure of Backtracking Method and the major differences regarding quality, presented by both structures) - Divide et Impera Method (Structural particularities, The definition of the method, Examples, Characteristics, Different presentation structures, Problems proper for the Method, Classic Algorithms, Structural relations or connections with other methods of Pascal Language)-The Reappearing technique (Notion and definition of technique, Structural particularities, Examples, Characteristics, Problems proper for the presented technique/Quick Sort, The problem of the towers from Hanoi, Fibonacci reappearing expression (the current reappearing version /the economic version, Internal and external relations, the direct character of the Reappearing technique, Different informational material)-Under-Programs (Functions and Procedures in Pascal Language)-(Different problems which use this domain of programming, One-dimensional tables, Informative structural presentation, The operational character, Particularities of this domain)-Explanatory Memorial for Programming in Pascal Language (Informative, Structural presentation, Different programming techniques and structural relations, connections, The informative domain in relation with the Informational Material of Pascal Language, Other problems proper for the presented domain, Connections with other Programming Languages/ C++)-DOWNLOAD SECTION-NEW Informational Material Section-Web pages (Web design explanatory memorial structure).

Also, in the presented main informational material section (website interface) which contains material from Physics domain, and which will be restructured, with applications and actions direct in the context of the main page, the visitors of our project will have the possibility to observe and study the following "under-domains" and "branches" which will be very well treated: Mechanic Domain (Different types of movements-uniform, direct or line uniform, circular movement, different laws and formulas, different problems, quantum theories and atomic models)-Thermo-dynamics, The Optic and Spectroscopic Domain, Plasma Physics, Nucleus Physics, and also the complex structure of the domain of Electricity and Magnetism (Electrostatics-The electric status of objects and materials, The electroscope, Coulomb's law, The electric field, The intensity of the electric field, Gauss Theory-The electro-movement-The electric power, The electro-engine tension, The orientation (sense) of the electric power, The intensity of the electric power, Electric power characteristics-Electromagnetism-The magnetic status of objects and materials, The magnetic field, The induction of the magnetic field, The electromagnetic force, Lorentz force.

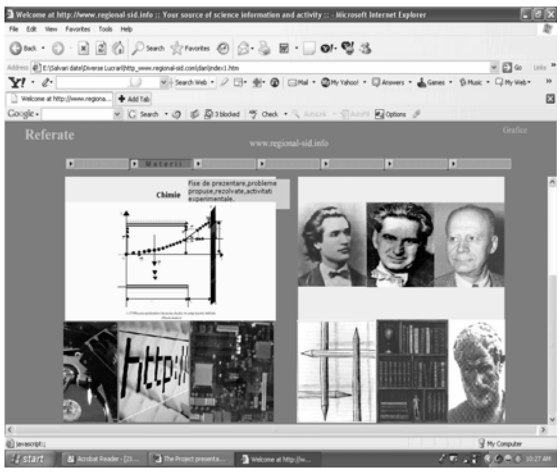

Figure 3. The page with matters of the project

Figure 4. The page with matters of the project (Romanian Language and Literature)

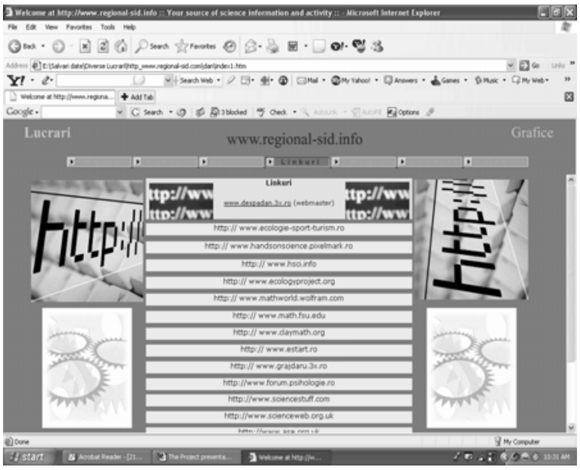

Figure 5. The page with links of the project

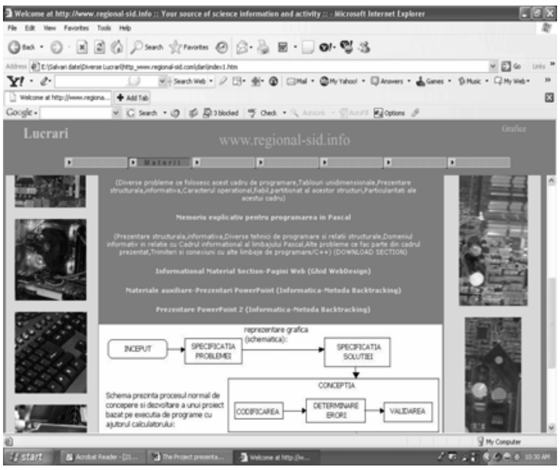

Figure 6. The page with matters of the project (Informatics)

Also, in the presented main informational material section (website interface) which contains material from Physics domain, and which will be restructured, with applications and actions direct in the context of the main page, the visitors of our project will have the possibility to observe and study the following "under-domains" and "branches" which will be very well treated: Mechanic Domain (Different types of movements-uniform, direct or line uniform, circular movement, Different laws and formulas, Different problems, quantum theories and atomic models)-Thermo-dynamics, The Optic and Spectroscopic Domain, Plasma Physics, Nucleus Physics, and also the complex structure of the domain of Electricity and Magnetism (Electrostatics-The electric status of objects and materials, The electroscope, Coulomb's law, The electric field, The intensity of the electric field, Gauss Theory-The electro-movement-The electric power, The electro-engine tension, The orientation (sense) of the electric power, The intensity of the electric power, Electric power characteristics-Electromagnetism-The magnetic status of objects and materials, The magnetic field, The induction of the magnetic field, The electromagnetic force, Lorentz force.

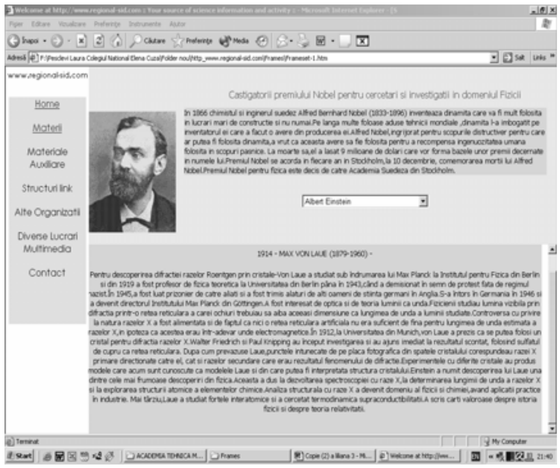

Figure 7. The page with matters of the project (Physics)

Until the final project of development and analysis there will be included different researching and scientific branches (domains and under-domains), with a presentation field (interface) more and more complex and interesting. In this moment in the structure of the presented page (project), (HTML design) there can be observed the mentioned "arboreal structure" particularities, the outside elements and domains (Physics, Mathematics, Chemistry, Biology) being under construction. Excepting these informational material domains in the

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structure of the presented page clients and visitors will have the possibility of visualizing Flash sections or structures which have the role of realizing the direct internal-external relation and also of creating a publicity domain of development and promoting factors.

The HTML design allows, also, the include in the structure of the page of some graphic external elements (Fireworks, Director 8, Shockwave) and internal structures like: tabular data with or without reference, linkage structures, frameset inserting, rotating images and different effects applied not only on the text (script) but also on other structures or under-structures (Java language script). All the presented particularities will be included in the structure of the page http:// www.regional-sid.info for a complex and developed domain, navigational, structured, restructured and conditioned aspect /character. For realizing this informational project of development and analysis we have chosen the website editor Macromedia Dreamweaver 4.0, a structure which helped us in the construction and concrete aspect of all the mentioned particularities.

Using integrated structures like Word (Office), PowerPoint (Office), Macromedia Flash 5.0,also WinZip archives, we succeeded in giving, until now, a structured informative domain, integrated and navigational, a web page which has the purpose of creating one of the biggest informational fields, not only from the national point of view, but from the international perspective.

Even though, the interface or the main structure of the presented page (project) doesn't imply an ideal domain from graphic point of view and the stile of presentation (design), the webpage offers a structured space for all kinds of informational material belonging to the presented domains. It can be easily observed that we are trying to put an accent not only on the quality but also on the quantity, the presented webpage (project) activating under the motto by which, not the presentation counts the first place, but the informational content.

3. Conclusions

It can be concluded that this page of internet presents and will present a structured background with a line of materials more and more complex, which will constitute a point of reference for the modern teaching system, based on the individual learning, independent work and research. In this way the attitude of the students in front of school and society will be radically changed in good!

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Implementation of a Virtual Photovoltaic Panel Experiment: Implementation and Pedagogical Impact

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Abstract. The new Portuguese curriculum of Physics in secondary school includes several laboratorial activities (LA). These LA are mandatory and, by performing them, three different moments must contemplate: preparation (in the previous class), execution and evaluation. In spite of some advantages of systemizing the conventional work in class, we believe that virtual labs (VL) can be a useful mean, particularly for the stages of preparation and execution. Our aim is not to substitute the usual way of teaching these classes. However, we’re convicted that VL can be an important tool in order to complement the information needed to the activities that require different concepts and to be an alternative way in the case of schools with no conditions to implement some of the LA. This work relates to the creation of a VL and the study of its pedagogical impact in two different situations:

- VL as a complement to the real laboratory,
- VL as a substitution of the real laboratory

- The results will be presented and discussed together with the results obtained with students that performed the real laboratory experiments with no help of the VL.

The authors thank the support of the EU "Hands-on Science" project (110157-CP-1-2003-1-PT-COMENIUS-C3).

Keywords. Virtual experiment, Computer, Internet, Science.

Introducing SCORM Compliant Courseware in Slovenia

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Abstract. The paper describes the approach leaded by Slovenian Ministry of Education in introduction of e-learning tools and contents in Slovenian schools. The basic idea is to upgrade the previous projects of the Ministry where most efforts were to provide the appropriate information and communication infrastructure. Current focus is oriented in the development of reusable and shareable courseware that could be possible to integrate in various learning management systems that are already implemented in some Slovenian educational institutions. It is important to follow internationally recognized standards. Thus, among various requirements for e-learning materials is the compliancy with SCORM standard. The current version of this standard is so called 2004. Despite of this the previous version, SCORM 1.2 was selected as the minimum requirement. In the paper the reasons for such decision and the proposed development and deployment tools are explained.

Keywords. E-contents, LMS, SCORM.

1. Introduction

The efforts of Slovenian Ministry of Education and Sport to increase the usage of computers on all levels of Slovenian educational system have a long history. However in the previous decade the focus was in providing the corresponding equipment and in the education of Slovenian teachers.

In the Year 2006 a new phase began which gave more focus in development and deployment of the required e-learning contents. This should also upgrade the previous intents of some schools which have established several Learning Management Systems (LMS). Several different LMS are used. Among them Moodle, Doceos, Manhattan, Echo and Claroline are most popular. The Ministry opened a project call for development of such e-contents which should be focused to particular subjects learned in the schools. Such tutorials should possibly cover all the subtopics of these subjects. Following the recent technological possibilities the multimedia elements and learner’s interactivity should be integrated in tutorials. Besides this they should be »platform independent« or better LMS independent. Therefore it was established that the developed tutorials should comply the world-vide recognized SCORM standard. The basic principle of SCORM is presented in the following picture.

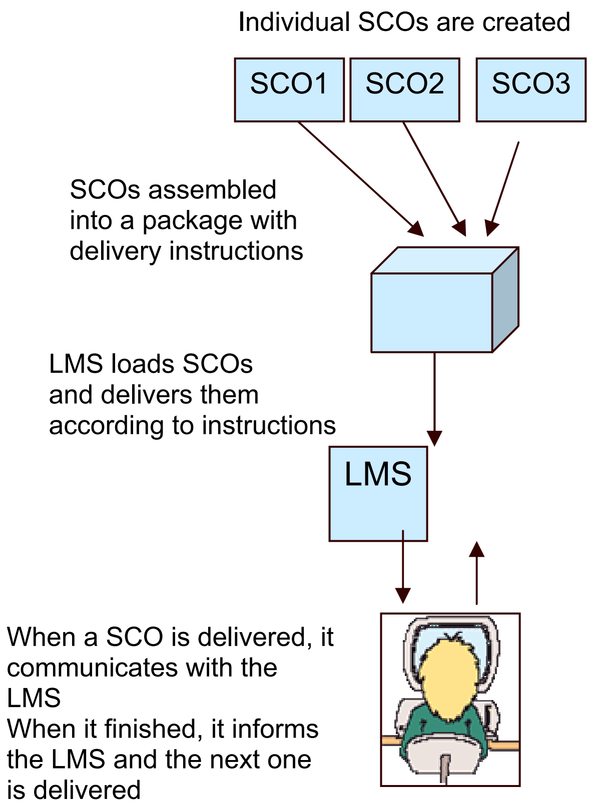

Figure 1. The basic principle of SCORM

The basic idea is to develop particular learning objects (so called SCOs) and to

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integrate them into content packages. A SCO is the lowest level component that might be used in another course. A SCO should provide useful *learning content* by itself and it must be designed to be launched and tracked by a SCORM-compliant LMS.

The building blocks for SCOs are assets. A SCORM asset is a collection of one or more resources that are appropriate for sharing among SCOs. When packaged, an asset should contain the appropriate meta-data making it searchable in a SCORM repository.

The SCOs must be found and organized into a structure. Instructions must be written that tell an LMS which SCO comes after which. The SCOs and instructions must be bundled into a portable package. This process is called content aggregation. Note that content aggregation includes instructions for moving between SCOs but not for movement within individual SCOs. A SCORM package contains a manifest file that declares the contents of the package and is set upt ot describe the order in which the SCOs are to be delivered. It also tells the LMS where to find the SCOs themselves.

A SCORM Content Aggregation is a collection of Sharable Content Objects (SCOs) described by a SCORM manifest file as it is shown in fig.2.

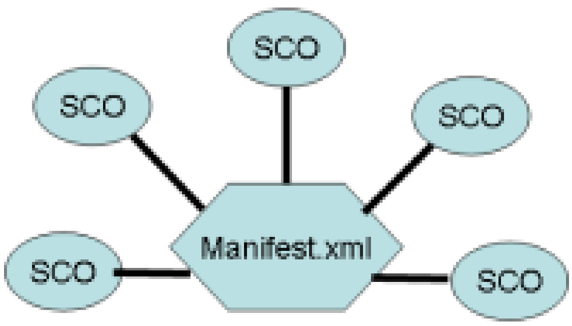

Figure 2: The role of manifest.xml file

The magic of SCORM is that SCORM content can communicate learner information with *any* LMS using a standardized method based on JavaScript.

In order to prepare and use SCORM compliant courseware the developers should understand this standard and should have the corresponding authoring tools. Besides this the used LMS should also have the compliant plug-in. The problem of SCORM is that this standard is still in development and there already plans how it will evolve in the next years. The recent version is so called SCORM 2004 or SCORM 1.3. However the corresponding tools are not so frequent. This was the main reason that the Ministry required the compliance of the new courseware with SCORM1.2 which is still widely used.

2. The approach

After the call of Ministry many teachers and also some companies prepared their proposals. In order to help them to satisfy the requirements the Ministry organized some workshops where the basic SCORM concepts were presented. It was also prepared a CD with some presentations, open source authoring tools, demonstrations, and other useful documentation.

Although SCORM itself does not mandatory require metadata it supports them.

Metadata elements are data about other data. In this context, they are used to describe the contents of teaching and learning resources (learning objects) in a structured and precise manner. The data may relate to the title, author, creation date and type of resource (book, journal), location of the resource on the library's shelves (location), user rights and administrative references.

It was discussed which metadata and at which level should be integrated in developed courseware. The basis of this discussion was the international experience in some other countries like Canada and United Kingdom.

The practical use of metadata in packaged e-learning content is fraught with many more difficulties than simply selecting a metadata schema. The CETIS Special Interest Groups and Learning and Teaching Scotland have agreed to work together to investigate whether a "common practice" could be established across all UK education.

The Canadian Core Metadata Application Profile, is a streamlined and thoroughly explicated version of a sub-set of the LOM metadata elements. The CanCore Learning Object Metadata Application Profile takes as its starting point the explicit recognition of the human intervention and interpretation that separates raw data management from the information or knowledge that can actually be "about" something. The CanCore element set is explicitly based on the elements and the hierarchical structure of the LOM standard, but it greatly reduces the complexity and ambiguity of this specification.

The Slovenian experience with metadata started may years ago when a repository of didactic materials was established and made available on internet. However this was prepared for local, Slovenian environment and should be upgraded according the needs of the international cooperation.

Local and international repositories of didactic contents in various digital formats are the primary sources when SCORM compliant materials are developed. The next precondition is the availability of user friendly and efficient authoring tools that export the developed courseware in a SCORM compliant form. Since most of the already developed didactic materials consist of PowerPoint presentations, Word and PDF documents, flash animations, and of course hypertext files the corresponding converters are also required besides editors that serve the creation of Assets and SCOs from scratch. Editors usually enable the aggregation of assets and SCOs into content packages. Useful tools are also so called players that emulate LMS environment and permit the verification of created packages.

It is assumed that the applicants will mostly use simple open source authoring tools like eXeLearning, Reload Editor, Reload Player and TinyLMS.

With the aim to facilitate the SCORM compliant development of e-learning contents more presentations and hands on workshops will be organized in July 2006. The main event for these presentations and workshop will be the traditional CoLoS-Hsci summer school in Ljubljana. This event connects by means of videoconference technology 10 Slovenian cities in a virtual classroom. Usually there are a hundred or more of Slovenian teachers attending the videoconference lectures, given in the morning. In the afternoon the lectures are completed by hands on workshops in computer classrooms in particular cities.

One of the topics will also be how to convert usual electronic tutorial into SCOs and SCORM packages. These tutorials are frequently hypertext based and some JavaScript should be integrated within them. This will permit the interaction with LMS according to SCORM standard as it is presented in the following picture.

Some different experimental, SCORM compliant LMS will be also implemented. The participants will have in such a way opportunity to prepare their own content packages, possibly based on their own didactic materials. Such packages will be then imported into the experimental LMS and the development and deployment cycle will be in such a way completed.

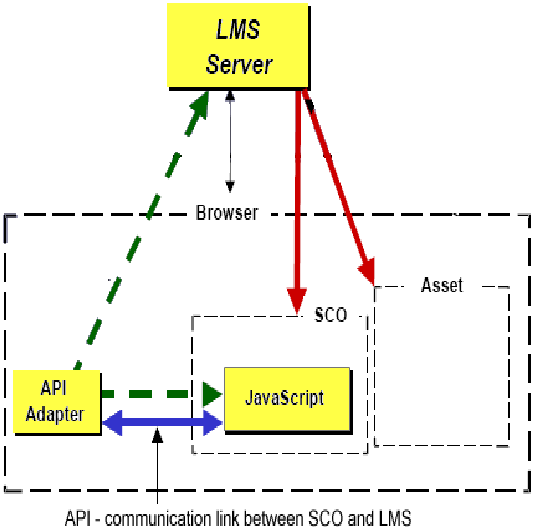

Figure 3. LMS and SCO interaction

3. Problems

The adaptation of usual hypertext readings in SCOs requires some reorganization of the source files. It is mandatory that all links to other hypertext files, not belonging to the same SCO are removed. A SCO should never link itself to another SCO. This functionality should be given to the LMS. The interaction with LMS is through API adapter and by means of corresponding JavaScript functions that should be integrated in the hypertext of the developed tutorial. At the same time this means that when we use such, modified hypertext by usual browser we get warning messages whenever we enter or exit such page. Of course this problem can be solved by replacing the proposed JavaScript functions (usually defined in a separate JavaScript page) with dummy functions (with no contents) that have the same name.

The problem of SCORM is that this standard is still in development. Today the most popular version is SCORM 1.2, the official current version is SCORM 2004 but there are already plans for SCORM 3.x which will include agents

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and semantic models and will have device- and network-independent requirements.

This means that not all software tools are compatible and you should take this into account. It can even happen, that you prepare courseware according the previous (still most popular) version SCORM1.2 and that the appropriate SCORM1.2 players or LMS complain. It is also possible that some tool declares to be SCORM compliant but it is not at all. SCORM is today one of so called buzzwords and can be easily misunderstood.

For educational community it is also important to have free authoring tools. But they are not so many. Besides this you can find on internet information about commercial versions but sometimes you do not have possibility to get them.

The main reason to prepare SCORM compliant e-contents is to include it in corresponding Learning Management System. This would require that the school establishes an LMS server and assures its administration. This is possible when the financial and technological preconditions are satisfied and when the understanding and enthusiastic teachers are available.

One of the problems is that some teachers complain that the implementation and usage of SCORM compliant courseware and LMS is too difficult for their educational environment. This could be particular true in elementary schools. However there are tools, like for example TinyLMS that emulate real learning management systems and still permit deployment and use such e-contents in a more common way, even on popular CDs and without the need of LMS servers.

In the next future a problem of the compatibility with SCORM2004 and its successors will arise.

4. Conclusions

Considering the ICT trends we should recognize that in the next future more and more attention will be given to the services that particular environments and institutions will be offered to the users. And the educational system and schools are a part of these environments.

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The Progress of the Science and Technology Integrated in Romanian Web Pages

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Abstract. This site is an informational site made for those that want to join the useful with the pleasant. The site presents information from different fields .With the help of this site we have wanted to draw the attention of the students to a way of learning and of accumulating the information more easily and more accessible from anywhere. The students' attention has increased thanks to the lessons made on computer.

Keywords. Creativity, Experiment, Web site, Computer.

1. Introduction

The programms permits a big progress if are use the computer in all the subjects, but especially in those ones where experiments can be made, like: Chemistry, Physics, Biology a.s.o. This is the reason for we are achieved this web site.

2. The structure of the web site

The first page of the site represents an index of the fields that are tackled on this site. The images that are moving when the cursor passes over them are some links to other pages of the

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site. To be mentioned, as well, the fact that the site has music on all pages. The use of the frame sets allows the easy navigation on the site, the buttons of the menu are present everywhere.

In the following section, called Essays, there are debates on a few scientific fields like: Informatics (The Backtraking method, The Recursivitation), Physics (where different essays, presentations in Power Point, didactic materials and useful information, School leaving examination and educational competition subjects, and graphics made by the pupils, a.s.o., can be found) and Psychology.

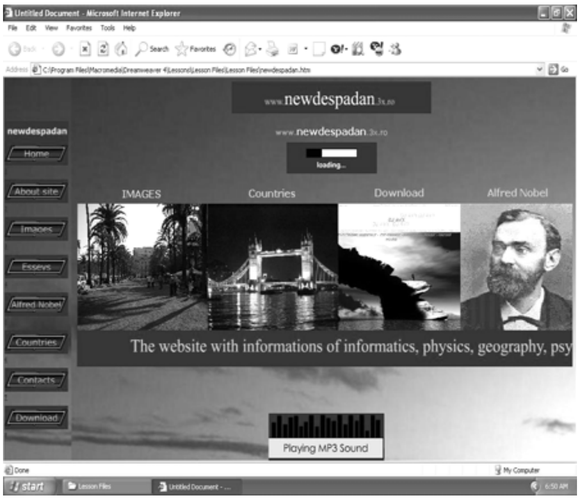

Figure 1. The first page of the web site

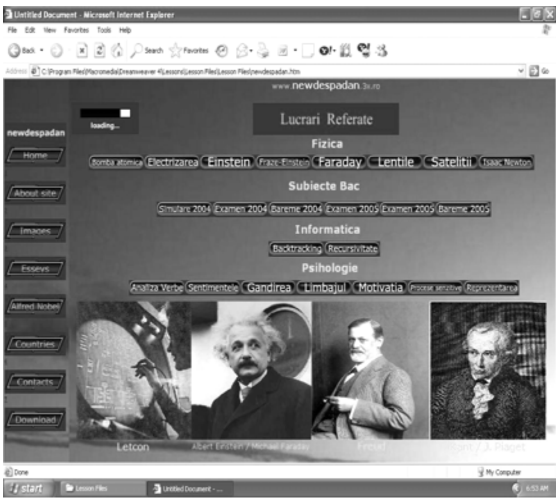

Figure 2. The section called Essays

In the section of Physics you can find and an essay made in Power Point about satellites. The presentation of the satellites in a few ideas: The launching of the first Soviet satellite, Sputnik, in 1957, marked the beginning of the conquest of the space by people. At present, almost all of the Earth's people are enjoying the turns brought about by the space satellites.

The word 'satellite' means 'companion', and it refers not only to the natural bodies, but also to the bodies produced by people, that revolve around another bodies in space. Like in case of the Moon, the artificial satellites are maintained on the orbit by the force of the Earth's universal attraction .

In the absence of friction in space, energy is not necessary to maintain the satellites in movement.

For all that, finally they slow down, they come down to lower heights and they burn when the heat produced through friction with the Earth's atmosphere becomes too high.

The process of the laying an artificial satellite on an orbit is essentially easy, but it requires a big precision. The satellite is hurled on its orbit by rockets, with big force.

Initially all the satellites were launched with rockets that were destroyed in that process, but now, a lot of satellites are launched using The Spacial Reusable Commutation of America. The speed with which a satellite comes down to Earth has been known for a lot of centuries. The English scientist, Isaac Newton, found a formula, in his work referring to gravity that established a relationship between the speed of a body on an orbit and the ray of the orbit. This formula is used at present for the calculation of the artificial satellites'rotations.

When a satellite is on an orbit, its tendency is to move on a straight line, a tendency produced by its movement, but this is altered by the gravity attraction of the body around which it revolves.

If a body is farther, the gravity attraction is less, and the relative speed necessary to produce an orbital trajectory is less, too. 2000 years ago, Socrates warned us that only if we lifted ourselves over the clouds to look back to the Earth, we would understand the true nature of the things. The eyes that we have directed to the sky helped us to carry out this urge. The images with a big resolution of the Earth taken by the observation satellites have given space, temporal and spectral information about our entire world, images which have been difficult to obtain up to now. To a great extent, they have helped us to survive and to continue to grow up in the most delicate period of time of our existence, as intelligent and technological species.

The most beautiful countries in Europe (Austria, Belgium, and Sweden) are described in the section called Countries. There you can find some pictures from the respective countries, information about the capital of those countries, about some important cities, about the climate and the economy. These pieces of information are necessary for the development of all-round education, for the learning of Geography and for a reference point when you are in a foreign country to spend your holiday.

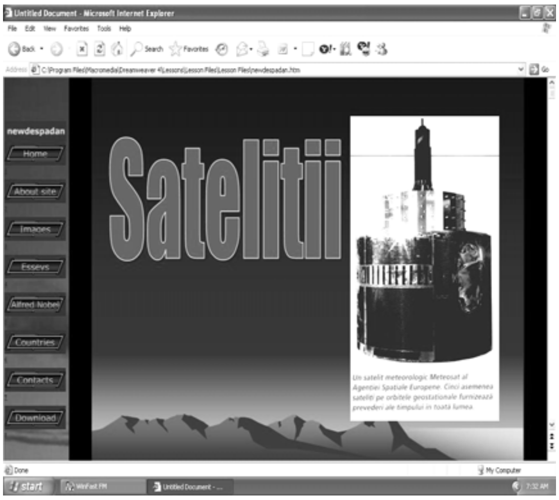

Figure 3. The Power Point made by students

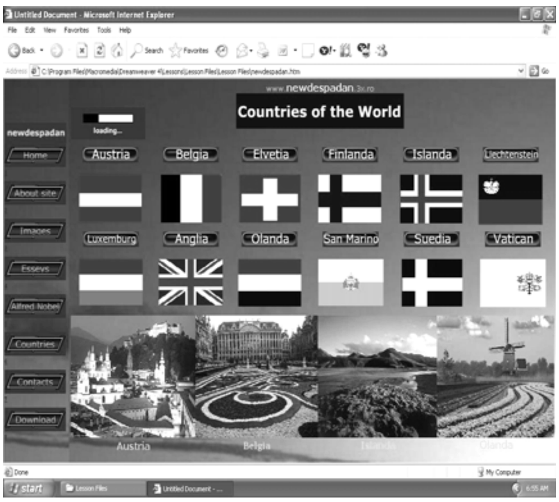

Figure 4. The section called Countries

In the section called Alfred Nobel you can find data about the winners of the Nobel prize in the last time like: Albert Einstein or Johannes Diderik van der Walls. This section has in the foreground the person that has changed the world through the invention of the dynamite.

In 1866 the Swedish chemist and engineer Alfred Bernhard Nobel (1833-1896) invented the dynamite, that would be much used in many construction works, and not only. The inventor of the dynamite became a rich man thanks to it. Alfred Nobel worried, because of the destructive goals for which it would be used. That made him to dedicate his fortune to peaceful actions. At his death, he left 9 million dollars that was used for some prizes in his memory. The Nobel Prize is granted every year in Stockholm, on 10 December. The Nobel prizes for Physics are decided by The Swedish Academy in Stockholm.

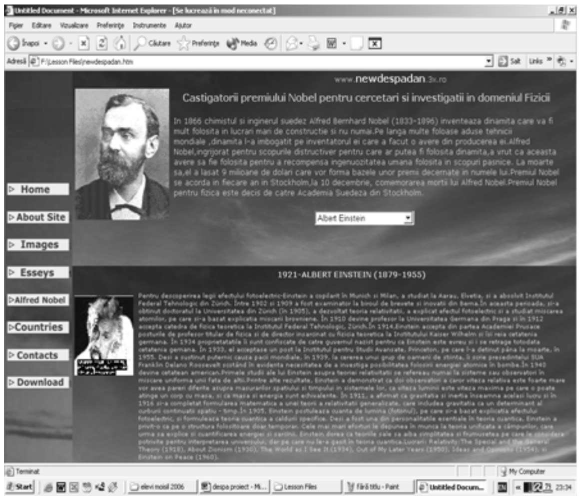

Figure 5. The section called Alfred Nobel

Interesting photos from the car exhibition from Bucharest and from Spain can be found in the Image Section. This page is intended for important events which take place in our country and abroad, as well. The advertisement made for such events whishes to awaken the students' interest for a variety of the fields, for the appreciation of the moral, cultural, artistic and scientific values of the society in which they live.

The section dedicated to the contacts was created for the communication with the visitors of this site.

One address of e-mail facilitates the virtual contact with the persons that are visiting this site. Of course on this address of e-mail you can send your suggestions concerning the site, concerning the pieces of information that are on it or that you would want to see on it. The visitors can send different papers, essays, music, pictures of nearly any field. These ones will be introduced into the structure of the site.

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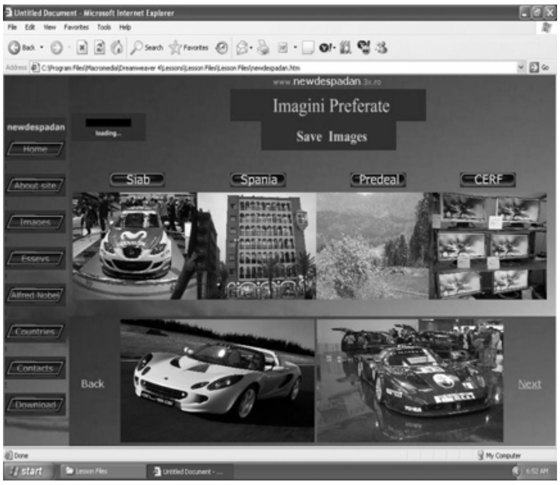

Figure 6. Interesting photos from exhibition

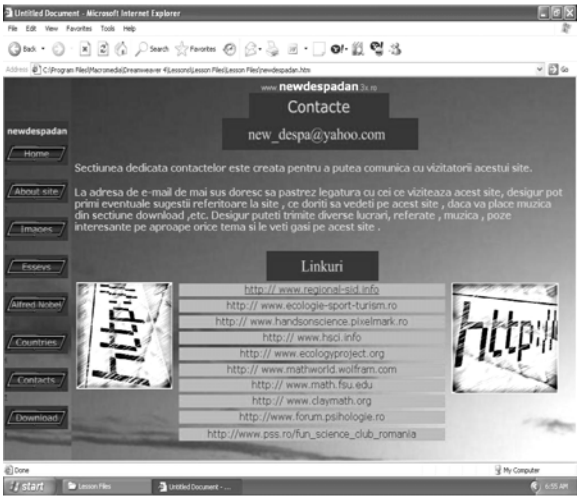

Figure 7. The section dedicated to the contacts

The achievement of this site which to join the useful with the pleasant, was possible by using the programs: Dreamweaver, Flash, Fireworks.

3. References

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Using Multiple Language Multimedia Resources to Support "Hands-On" Practical Science for Schools, Colleges and Universities

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Abstract. In the 21st century we have very many IT tools which can help make learning and teaching Chemistry more effective, stimulating and enjoyable for students and staff alike and can address the problems of the diminishing interest in science subjects in schools and colleges and the decline in laboratory skills.

How much use do we make of these IT tools? The answer commonly is "Very little". Why is this?

The lecture, which is based on 25 years of practical hands-on multimedia experience, will aim to explore why we do not make more use of IT resources. It will go on to show how multiple language multimedia can be applied to overcome problems in learning and teaching Chemistry and other science subjects, e.g. laboratory classes. Furthermore, it will be shown how is possible to cope with the current policy of many Governments that science teaching must be carried out in English, the established major world-wide language for communicating science.

The lecture is supported by the Royal Society of Chemistry (RSC) and by the Chemistry Video Consortium Project (CVC; www.chemistry.soton.ac.uk/cvc/ ; University of Southampton) under the "Chemistry Aid" programme (see RSC News for June 2004, February 2005, March 2005, April 2005 and June 2005). Some of the materials, which will be demonstrated, have been sponsored in part by ICI Plc.

It is hoped that, after the lecture, members of the audience will stay and try out some of the multiple language multimedia packages in a "hands-on" session (see

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www.unice.fr/cdiec/cdroms/le_bon_geste/le_bon_geste_uk.htm ; a joint project between Southampton and Nice, France), will look at the literature on Multimedia Resources and Microscale Chemistry which will be on display and will visit the RSC/CVC web site entitled "Chemistry Images" (see www.rsc.org/chemistryimages) where more than 1000 films, videotapes, CDROMs and DVDs for Chemistry are listed.

Keywords. Multimedia, Hands-on Science.

Education with ICT Tools

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Abstract: In keeping with the Millennium Development Goals set by the United Nations' Decade of Education for Sustainable Development (2005-2014), to promote education as a basis for a more sustainable human society and to integrate sustainable development into education systems at all levels, CLT strives to make quality education accessible to all children in under-served communities.

CLT India, founded in 1997, is a non-government, non-profit organization for Social Change, with Education and Developmental Alternatives model. Its focus is to strengthen Government schools in India.

The Government schools lack basic facilities for teaching/learning and Science has the least priority. CLT partners with the Department of Education with intervention and integration of e-learning modules to bring in best pedagogical practices. Digital Inclusion for the marginalized semi-rural government School community is the desired outcome of the CLT Learning model.

Keywords: Constructivist approach, ICT Tools, Life-long Learning-

LT's two-pronged approach

Empower teachers with Technology-Aided-Teaching tools to supplement the existing pedagogical system and enable them to create digital content in local languages.

Expose kids to Self-Directed, Constructivist Learning Approach

CLT Learning Model

Procure used computers to be added as an effective educational tool in schools.

Enable a key process to connect mentors / volunteers from the corporate sector to project sites.

Positioning of Technology in the Community. Technology is organically blended into CLT community initiatives. It is an effective medium for awareness generation on developmental programs.

Scaling the model. 'e-Patashala' - commonly referred as e-learning – is introduced at the grassroots level in semi-rural elementary schools.

Integrating Science in Local Communities

The Hands-On approach to Science aims to inculcate scientific temper, where the main focus is on the process of learning.

Acknowledgements

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New Fuzzy Logic Library – Implementation of a Fuzzy Logic Controller on a PC under Soft Real Time Constraints

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Abstract. In this paper, a new Fuzzy Logic library is developed. The purpose of this work is to allow students to easily control real kits in closed loop under soft real time constraints, using the PC in the classroom. The library itself represents a tool to implement Fuzzy Logic Controllers on real systems.

It makes use of the ease of programming under Delphi/Lazarus and also uses the GLScene add-on for rendering 3D graphics for the nonlinear control surface generated by the fuzzy rules.

The library is tested by building an educational version of the simulation of the classic problem of landing a rover.

Keywords. Control Systems, Delphi, Fuzzy Logic, GLScene, Lazarus.

1. Introduction

Fuzzy Logic is based on the article of Lotfi Zadeh [1]. It was later used for control [2] and is based on the transference of the knowledge of an expert to an automatic device (computer). The expert knowledge is inherent to human beings and it can be described in a simple manner avoiding complex mathematical equations in a way that allows the automatic controller to be easily programmed and substitute the human being at that particular task. Conventional controllers, in a general manner, need to have a math model of the complete behaviour of the system's 'plant'. Therefore, it is extremely hard to tune controllers for applications where the model of the system is not known or it's not simple to be obtained. In these applications, where a worker knows how to drive a task, by acting like a bridge between the worker's knowledge of the process and the automatic controller, a Fuzzy Logic Controller (FLC) represents a very good approach [3].

FLCs present very interesting characteristics when compared with the conventional ones because frequently the plant is non-linear in the interesting range of control. FLCs may be nonlinear but may also degenerate in a linear one. The nonlinearity of the controller is usually an advantage as it allows for a better adjustment to the process by using the full control range (not limiting the plant to its linear portion). FLC are also adequate to control complex MIMO systems because rules are easily written as "if – then" rules which also allow for a certain amount of incomplete/incoherent knowledge about the system [4]. Another feature related to the advantages of FLC comes from the fact of its usually easy tuning. The easy to tune it turns out to be a generic controller with a great versatility. Tuning is usually done by expert knowledge, trial and error and could also be accomplished by the use of Neural Networks or Genetic Algorithms [4].

The main purpose of this work was to provide a tool that easily implements Fuzzy Logic Controllers (FLC) and allows their use in real systems in the classroom at a low cost. For this a library was built to work under Delphi/Lazarus making use of the ease of programming under these environments (see following section).

The library is an on-going project wich implements a large number of features of which only the major ones will be referred. Many future enhancements are planned. The creation of fuzzy sets, variables, rules and its processing was at the center of this development as well as the user interfaces such as the graphic interface and the one responsible for saving and loading the system.

Beyond the creation of the library itself, it is also presented a case study where we implement a Fuzzy Logic Controller (FLC). This case study is based on the classical problem of landing a rover.

This paper is composed by three main sections. This introduction is the first section. The library, its requirements, implementation and Graphical User Interface (GUI) are described in section 2. In section 3 the reader will be presented the case study and proposed control rules, implemented using the library as a validation example. A final section contains authors' conclusions and future work.

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2. FEUP Fuzzy Library

The FeupFuzzyLib (FFL) was created in the classroom by students of the Faculty of Engineering of the University of Porto, Portugal (FEUP) in order to easily allow control of non-linear plants with a PC. The choice of programming language is Object Pascal under Delphi [5] and Lazarus [6]. Both of these environments are easy to use, visual, event driven and fast. Lazarus is even free and cross platform (Windows, Linux, Arm …)[6]. These tools are interesting soft real time control on the PC. Although the fuzzy library produced is validated here with a simulation, it is being tested also with real kits of non-linear experiments.

Other tools for Fuzzy Logic and Fuzzy Logic Control exist. Some libraries alike include the free but slow SciLab [9] and SciFLT toolkit [8], the very expensive and also slow Matlab Fuzzy Logic toolbox [11]. Some other tools do not provide visual aid and are not interesting for educational purposes such as the Free Fuzzy Logic Library (C++) [10].

2.1. Library Requirements

Assuming that the basic principles of Fuzzy Logic Controllers (FLC) are known, it's possible to define a number of basic foundations for the library.

As stated in the Fuzzy Logic theory, the control is based on a set of rules in which each rule is defined in "if-then" structure [2]. For instance, let us consider a position controller with **Position** and **Speed** as inputs and **Throttle** as output. A given rule may state that **IF [(Position IS Far) AND (Speed IS Low)] THEN (Throttle IS Accelerate)**. Definitions are needed for the Fuzzy Sets that classify the inputs in regions (sets). To evaluate rules we need to define sets that describe regions within variables (**Position**, **Speed** and **Throttle)**. Besides the variables definition it is also necessary to define the inference, accumulation operation and the "AND" operator. These rules may include linguistic modifiers such as "Not" or "Very" [4]. To evaluate the rule, the 1st proposition is evaluated to find up to what degree of truth (from 0 false to 1 fully true) the Position input is in region classified as "Far". A similar evaluation is done to find how much truth exists in the proposition "Speed IS low". Next, the fuzzy AND is calculated from the evaluation of the 2 propositions to produce a single antecedent value. The inference operator is used to change the shown assignment to the output, that is, "Throttle is Accelerate" changes the Throttle output variable according to the fuzzy set "Accelerate" and the degree of truth of the antecedent of the rule and the fuzzy inference operator. All rules are evaluated in sequence and results collected by the fuzzy aggregation operator.

As a start point and because this does not reduce generality, it is stated that for each rule there can only be one or two propositions, connected by "AND" or "OR" fuzzy operators. Each rule can also have only one output. Operators "AND" and "OR" can be implemented by several methods.

The Input and Output Variables are classified into regions that are Fuzzy Sets. Fuzzy Sets are often triangles or trapezoids and are the simplest element of the library. The implementation considers a Fuzzy Set as sequence of linked line segments. This is an approximation that makes sense under real time controller running on a PC. The triangular and trapezoidal functions represent frequently used shapes of the sets used to classify variables therefore this approach seems simple and effective. With this approach to define a Set, we can always define any Set with any given Membership Function if we select as many points as necessary to do an adequate aproximation of the function. As an example we could define a gaussian Membership function with its usual parameters defined plus an adequate sampling resolution parameter which would define how good this aproximation would be.

The whole set of variables and rules which represent the controller should be included into a structure that allows easy encapsulation of all relevant data.

Beyond these structures responsible for the basic properties of the controller, a number of functions related to the whole processing of the control block are still needed. The processing of the control block can be done in the following major stages:

Fuzzyfication – Convert a crisp (non fuzy) input into a fuzzyfied variable (defined between 0 and 1). The ouput value of this operation is the degree evaluated from the crisp input.

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Aggregation – This function combines two fuzzy variables given from the Fuzzyfication procedure according to the operator given in the rule. For instance this operator can be the operator "and" or "or".

Inference – For a given initial Set and an evaluated degree of an antecedent, this function will modify the output Set based on the given evaluated degree. This is done through a minimum function between the Set and the evaluated antecedent of the "if-then" rule. The output of this function will be the truncated Set.

Accumulation – This function combines the different outputs given from the Inference procedure for each rule that has the same output variable. There are several ways of combining theses Sets though the most common one is the maximum operation

Defuzzification – This procedure will convert the Set given in the Accumulation to a crisp value that can be applied by the controller. Several methods of converting the Output Set are possible like the Mean of Maxima method, the Centre of Gravity, the Centre of Area.

The implementation of these different procedures will allow the Fuzzy Inference System to be correctly processed.

2.2. Library Implementation

As stated in the point 2.1, the Feup Fuzzy Library (FFLib) should meet a certain number of requirements. These requirements led to the creation of several structures and classes.

The first class we've defined was the **TFFSet** (type Feup Fuzzy Set) class. A Set is a sequence of line segments and was implemented simply by a dynamic array of FuzzyPoints (each Fuzzy Point has X and Y coordinates). The class also needed a property to identify the Set for humans, a name. There are also a certain number of methods belonging to his class wich are related to the user interface like loading and saving to and from disk, showing the set, adding and changing points (etc.).

```
TFFSet = {
   Points : DynamicArray of TFFPoint
   Name   : string
}
```

The points inside the set are assumed to be ordered along the XX axis.

The structure defined next was the **TFFVar**. A variable contains several Sets and therefore should be composed of a dynamic array of Sets and should have a name as well.

```
TFFVar={
 Sets : DynamicArray of TFFset
 Name : string
}
```

There is no provision of the domain of the variable. If necessary (example: for drawing) domains should be calculated on demand by evaluating first and last points of all sets.

```
TFFVar.Domain.Min=
   Min(FirstPoint(Sets))
TFFVar.Domain.Max=
   Max(LastPoint(Sets))
```

The next definition is the TFFRule structure. As suggested earlier, the rules have been defined in a non flexible way. They have at most two propositions (2 inputs tested) and one output assignment. For each variable we also required a Set in order to the Fuzzification procedure and a linguistic modifier (none, not, very, almost). In TFFRule the operation done in the aggregation procedure has also to be defined (it could be a fuzzy_and like a min operator or a fuzzy_or like the max operator). Different implementations for the fuzzy_and and fuzzy_or operators will be done in future work.

```
TLingModif={
      None, Not, Very, Almost
   }
   TAgregator={
    No2ndProposition, AND_min, OR_max
   }
   TFFRule={
    InputVar1, Set1     : integer
      InputVar2, Set2     : integer
      InputVarOut, SetOut : integer
      LingModif1, LingModif2,
            LingModifOut : TLingModif
    Agregator : TAgregator
   }
```

For simplicity, Variables and Sets are pointed to by numbers. This implicates that Variable and Set deletion must be carefully implemented. Note that Sets and Variables can change (even emptied) but correct deletion means that rules must change to be kept up to date. Variable and Set deletion are not very frequent and almost unnecessary because generally the used resources are modest.

The Fuzzy Controller was defined in the class TFFSystem. To define the controller, it was necessary to include in the class two dynamic arrays, one for Rules and another for Variables. With these two arrays the system is practically defined, it only needs an identifier (name) and some methods. The methods included in this class linked to the user interface were based in the counting of the variables and rules and the saving and loading from file of the entire System. Other important procedures have been included and are responsible for the processing a single or all of the rules. This means that this procedure implements the Fuzzy Inference System described in the previous point.

```
TFFSystem={
 Rules : DynamicArray of TFFRule
 Vars  : DynamicArray of TFFVar
 Name  : string
}
```

Rules do not have a name and are identified by their position inside the System.Rules array. Variables have name but this string is merely for human readability purposes. As mentioned earlier, the TFFRule struture points to variable numbers that is, the variable's position within the System.Vars array. TFFRule also points to Set number that refer to its position within the Vars.Sets array.

Rule processing is always done by the definition, by calculating the inference that includes fuzzyfying, calculating propositions, using aggregation and inference, accumulating results and defuzzyfying output variables (see future work section).

2.3. (Graphical) User Interface

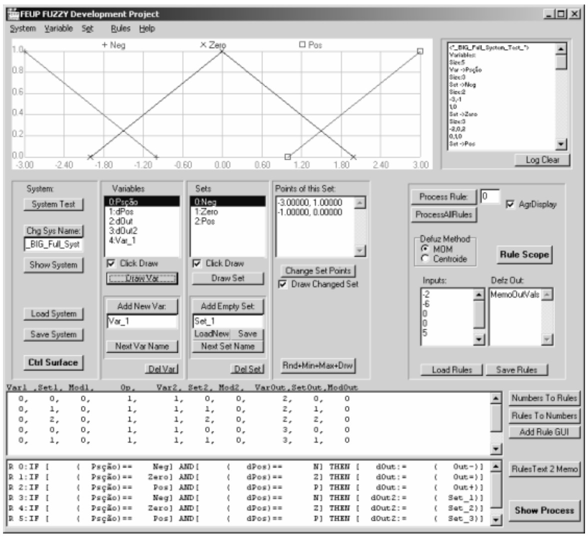

Figure 1. User Interface (FFL v0.9)

The purpose of the library is to be an educational tool for FLCs.

The Graphical User Interface (GUI) is used to build the fuzzy system with sets, variables and rules. Each structure can be loaded and saved separately as well as the whole system can be loaded/saved all at once both by use of program calls, also accessible by GUI commands/menus. A view of the implemented GUI with lots of debugging info may be seen in Fig. 1.

FFSets and FFVariables can be drawn on the screen and edited by simply dragging set points. Changed points are reflected in the Memo Box that lists the fuzzy points – these points can also be hand edited.

The GUI always commands a single System. Although not likely but a given program can make use of several fuzzy systems.

2.4. Rule Scope

The Rule Scope is a feature which provides users a display of the fuzzy inference process for a selected rule for debugging and educational use. As seen in Fig. 2 there are four small plots on the Rule Scope's form. The first two plots on the three plots row are the two input variables of the selected rule. In them the respective membership function is shaded and representing the Fuzzification result is a bold cross on the set. On the third plot you may see the Set representing the Implication result for that Rule and above it the output variable's plot. Last plot represents the resultant Set of Accumulation.

Rule Scope is also equipped with buttons and text input fields which may change rule's inputs values, and text output fields displaying Defuzzification results.

On this form, the user is also able to modify Sets points 'online', by clicking and dragging them on each plot.

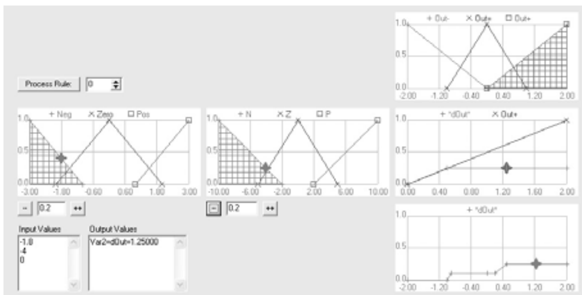

Figure 2. Rule Scope (FFL v 0.9)

2.5. Control Surface

The control surface is the summing up of all combinations possible of inputs and calculated outputs (one 3D control surface per each pair of inputs and a single output).

To easily render and manipulate (rotate, zoom, etc) the 3D surface, the GLScene [7] graphic add-on for Delphi and Lazarus is used.

Many fuzzy control systems require more than two inputs or more than one output (generic MIMO system). Accordingly, the Surface Control Form in Delphi's Application is equipped with drop box lists and text input fields which allow users select any two inputs and any one output for plotting as well as defining values to fixed inputs. Users are also able to define the two inputs' plotting limits, surface resolution. These parameter influence surface calculation time. Surface calculation is done by a GLScene call back that calls the process all rules method of the GUI's FFSystem for every sample point. Drawing functions are handled by the GLScene wrapper over the Open GL routines that interface the graphic card directly (if the card has 3D). This results in very fast (and pretty) drawings and manipulations of the control surface. Fig. 3 shows an example of the surface generation.

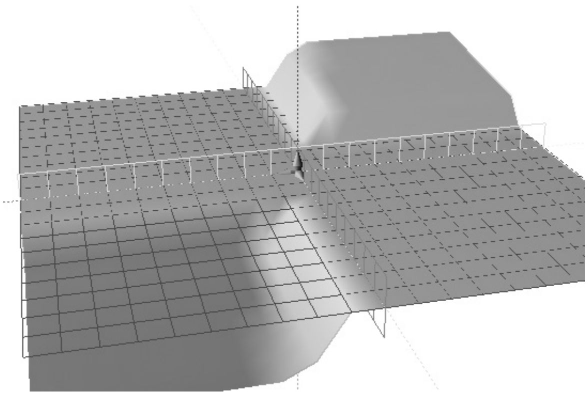

Figure 3. Control Surface

3. Case Study and Results

In order to do an adequate validation of the library described in the previous point a system was created with that purpose. The system is based on landing a rover on mars surface, similar to the popular 80's game Luna Lander.

The objective is quite simple: landing the rover in the only possible site and at a very low speed.

The ship's model is very simple and it can be described by the equations in (1). These equations assume that the system can be described by linear equations. The ship has propulsion in the XX and YY axis with the following restrictions: the propulsion in the Y axis can only be positive or zero. If the propulsion on the y axis is zero that implies that only the gravitational force is being applied in the ship. For the x axis, there are two propulsion engines, one in each side. Therefore we consider the force produced in the x axis to have both positive and negative signals meaning that the ship is either moving to the left or to the right side. In order to create a more real and non linear model, a minimum force applied is considered for the propulsion in both axis. It is also considered that there's a maximum value to the propulsion applied.

There are antother restrictions that may be considered which don't really affect the performance of the controller, but may be interesting from the point of turning the system more realistic. The fuel restriction as well as meteors or solar wind can always be added.

$$
\begin{aligned}
V_{x,k} &= V_{x,k-1} + C.F_{x,k} \\
V_{y,k} &= V_{y,k-1} + C.(F_{y,k} - F_g) \\
x_k &= x_{k-1} + V_{x,k}.T_s \\
y_k &= y_{k-1} + V_{y,k}.T_s
\end{aligned}
\qquad (1)
$$

In the equations described in (1) Ts represents the sampling period and the constant C represents the inverse of the ship's mass. For the purpose of this game, a Ts of 50 ms was established.

So that the simulated system could produce an environment in which the performance of the Fuzzy Logic Controller could be observed, the rover was set at a random initial position as well as the landing site (Fig. 4).

Figure 4. Mars Lander "game" screen

3.1 Fuzzy Control

In order to control the position of the rover knowing that the inputs available are the propulsion engines in each axis, we need to measure its position at any given instant. As this system is totally simulated, we assume that the position of the rover is measurable and use this value for feedback control.

To control this system a first approach using conventional control was used. Typical PIDs were tuned for the separate behaviours in the XX and YY axis.

The FLC for this system is essentially a proportional and derivative non-linear controller in which X and Y errors to destination position are the inputs. The system forces as inputs and positions as outputs and as such does not need integral par on the control because integrators are already present in the plan. The input variables are the error (E) and the change of error (dE). This is a usual representation of the FLC, as presented in Fig. 5.

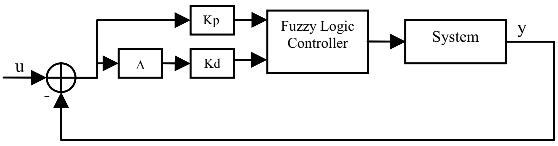

Figure 5. Diagram for the controlled system

As shown in Fig. 5 the inputs for the FLC are the error and the change of error. Each of them is afected by a gain similar to the gains in the classical PD. In this case and though the notation is the same as in the classical case, the reason for the existence of theses gains is to normalize the input variables. By doing this the FLC appears the most generic as possible and its tuning may be done by adjusting those three gains. There is also another gain that may be considered which will convert the normalized output of the FLC to the pretended value.
It's always important to keep in mind that these gains are only responsible for normalising and denormalizing variables. The design of the FLC itself has the following major steps:

1. The creation of the Variables and Sets.
2. The creation of the control rules.
3. Enhancing closed loop behaviour

The Sets used were based in triangle forms. These membership functions were good enough to an adequate evalutaion of the variables. Using a five level evalution, we could define the following Sets for any of the variables (inputs or outputs).

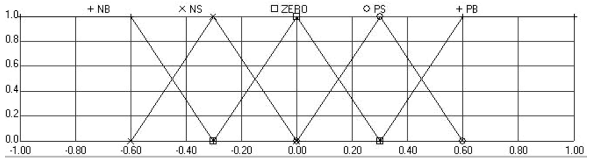

Figure 6. Starting (Generic) Variable Sets

As shown in Fig. 6 the variable is defined by five different levels which are: positive big, positive small, zero, negative small and negative big (PB, PS, ZERO, NS and NB). These Membership functions will evaluate how close the ship is from the landing spot. This evaluation is based on the controller's inputs which as stated before are the error in position and the change of error in position.

Another different set of Membership functions was tested which allowed better results to be achieved. These new Sets allowed a more accurate definition of the values around zero and they are shown in Fig. 7.

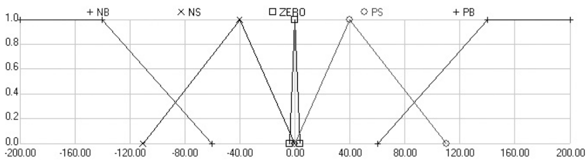

Figure 7. Variable Sets

Table 1. Controller in XX axis

CE/E	NB	NS	ZERO	PS	PB
NB	NB	NB	NS	NS	ZERO
NS	NB	NS	NS	ZERO	PS
ZERO	NS	NS	ZERO	PS	PS
PS	NS	ZERO	PS	PS	PB
PB	ZERO	PS	PS	PB	PB

As the position for this system is defined both in x and y axis, we realize that the FLC will have four input variables and two output variables.

From the equations presented for the ship's model the movements in each axis can be decoupled, turning this system into two splited systems with two inputs and only one output controllers. This leads to first set independent rules for each axis controller.
It is possible to synthecize them in the tables 1 and 2 which give the output values for the inputs error and change of error.

Table 2. Controller in YY axis

CE/E	NB	NS	ZERO	PS	PB
NB	ZERO	ZERO	ZERO	ZERO	ZERO
NS	ZERO	ZERO	ZERO	ZERO	PS
ZERO	ZERO	ZERO	ZERO	PS	PM
PS	ZERO	PM	PM	PB	PB
PB	PS	PM	PB	PB	PB

These tables provide the rules necessary to compute in the FLC. They are initially obtained by a simple inspection based on the knowledge of the typical system response. This gives the behaviour pretended to the controller. There is still the need to adjust one or other value at the table. This is done with the observation of the System's response with this kind of controllers. These adjustments are mainly made by trial and error procedures as they are intended only for certain critical aspects of the whole behaviour.

In order to take advantage of the characteristics of the FLC, another couple of rules were added that allowed a correct behaviour of the system by cross checking X and Y axes. Having two different controllers to adjust the position in the both axis was interesting because of the easiness of programming the controllers. This was leading to the adjustment of the position in the x axis at a different speed comparing to the adjustment of the position in the y axis. This fact was allowing that, for a certain given initial position, the possibility of crashing into the surface in a not wanted location existed. Therefore it was interesting to create rules that avoided this kind of situations. The rules added had to relate the position information in both axis as well as the propulsion engines. For instance:

if (y is PS) **and** (x is PB) **then** (outY is PS)

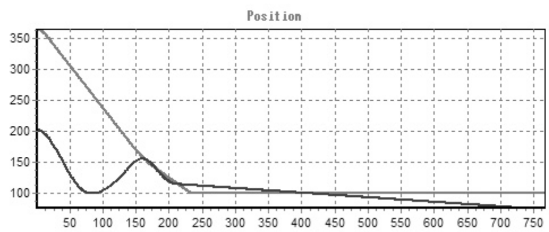

Figure 8. Trajectory of the Ship

Fig. 8 illustrates the ship's trajectory from a random point to the arrival point given as (x,y)=(100,65). The oscillation in the y axis is possible to understand because the position in the x axis was still very far from the arrival point therefore throttle in the y position was given. It's important to keep in mind that overshoot in the y axis is not tolerable as this would mean a crash into the planet's surface.

It is still possible to see from the picture a good convergence of the position into the desired platform.

4. Conclusions and Further Work

The FEUPFuzzyLibrary is an on-going work that will be developed greatly. It can be freely downloaded from the web page of the supervisor of this project [12] and possibly will be made available via widely known web sites related to the used software [6] [13].

It was developed by the students in order to be used in next editions of the class. Much work was dedicated to programming this software and much was learned both in what regards to Fuzzy Logic as well as in programming in a visual, event driven, object oriented language.

The system now works well under Delphi and the Lazarus version is being debugged. The use of the GLScene package greatly eases manipulation of 3D graphics development and provides for some nice graphics which also have important educational interest.

The library is proved to be working by the shown simulation. It is expected to also work for control of real systems.

Rule processing can be improved by interpolating memorized control surfaces but this is yet to be implemented.

Execution times are, for running of all of the Mars Lander rules, below 10 ms on a Pentium3 733MHz PC. Execution times greatly depend on the amount of information output to the screen (library compiled with Delphi).

It would be interesting to change the rule structure in order to allow a more flexible number of input evaluations in each rule. At the present time the rules are defined to have only two propositions.

The definition of sets seems to be perfectly usable. With the approach presented it's possible to approximate any Membership Function. One thing we would like to improve is to allow users to have different kind of membership functions predefined. For instance: Gaussian Membership Functions with only three parameters to define (mean, standard deviation, sampling resolution).

Future developments also include methods choice within the FFSystem: inference, aggregation, fuzzy_and, fuzzy_or and defuzzification methods should be selectable from a number of choices. Other methods for Defuzzication could also be provided. At this point, only the Centre of Mass and the Mean of Maxima are implemented.

The GUI would also benefit from programming directly the controller using the tables described in point 3.1. In the current version of the library it is necessary to implement the whole table rule by rule.

The rule scope can also suffer major improvements as displaying all rules so that the Fuzzy Inference process could be totally visual for even more educational interest.

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From Simple to Complex but What is Simple and for Whom?

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Abstract. Most physics textbooks and lectures introduce mass points before rigid bodies, and the treatment of elasticity follows. This sequence correlates with increasing complexity of the underlying mathematics. Translational movements are simpler to describe than rotational motion, and this in turn is simpler than the internal vibrations of elastic bodies. Other examples from the physics curriculum follow a similar sequence. This structure is questioned, and alternative approaches are demonstrated, based on the support of computer technology, particularly in the form of interactive simulations and computer generated animations

Keywords Computer generated animations, Interactive simulations, Physics.

1. Point mass, rigid body and elasticity

When preparing learning material for newcomers it should be sequenced in such a way that progression from simple to more complex topics is facilitated. This is one of those rather rare principles on which most educators will agree.

However, what is simple? Here the problem starts. Is Newton‘s point mechanics simpler than the treatment of elastic bodies with internal vibrations? It certainly is simpler mathematically, and this was definitely the case when no computers were available. Conceptually, Newton’s point mechanics may also be simple if we replace the mathematically defined mass point, which by definition has no size or zero dimension, with a little volume, filled with matter, which, however, is so small and compact that internal vibrations can be neglected.

The next step in increasing complexity is the rigid body. This model too is simple, in a mathematical sense, because it can be reduced to Newton’s point mechanics by referring to the concept of center of mass. Conceptually, however, the rigid body is simple only if this reduction is taken for granted and no deeper questions are raised. The model of a rigid body implies some kind of "magic" concept relating to the transmission of force. Whenever a force is applied to a rigid body, the same force is present at all parts of this body at the same moment in time (infinite transmission velocity) and this happens without any change in its internal structure .

Such a process is conceptually rather difficult to understand; we physics teachers would have a difficult time if our students insisted on an explanation. However, the model of the rigid body coincides perfectly with our everyday understanding of how objects move. In physics the movement of an extended object is explained by the movement of its parts. In daily life this concept is exactly reversed: movement of the parts is explained by movement of the whole [7].

A sentient being starts moving because it decides to do so. And if it moves as a whole, all parts must do the same. A car starts moving because the motor starts to apply a force. Again all parts must do the same and no further explanation is needed.

This coincidence of an everyday concept (based on some kind of "magic", unreflected mechanism) and the model of the rigid body (based on force transmission with infinite velocity) makes teaching easy. Students see no problem and the laws of physics, for instance those about the simple mechanical machines and the so-called golden rule of mechanics, can easily be covered. However, a chance is missed to point to problematic aspects of daily life concepts and to argue for a more careful analysis of transmission processes in space and time.

Following the treatment of rigid bodies, elasticity can be introduced. However, this topic implies a major increase in mathematical complexity if closed solutions of the underlying differential equations are of interest. The treatment of elasticity is therefore restricted to advanced studies with special interests in this field.

2. Didactical consequences

This sequence from simple to more complex has some clear advantages, if the focus is on the mathematical methods and on closed form solutions of the underlying differential equations.

Some didactical problems have already been described in relation to the rigid body. However, there is a more general didactical problem. From the perspective of the learner this sequence has advantages in introducing an unknown field and hopefully leads to early learning success. There is, however, a price to pay. The topics to be learned become more and more difficult and the chances increase that the final experience, which may well be decisive in motivating future learning, may be one of failure.

A second more general aspect is related to the fact that the learner has no choice in the direction of learning, but relies completely on input from the teacher. No aspects of the rigid body are visible when Newton's point mechanics is treated and no elastic behaviour comes to mind when the focus is on rigid bodies.

Ausuebel proclaims the importance of advanced organisers for learning [1] and Wagenschein has focussed on the concept of the exemplary in teaching and learning [8]. The ideas of these authors can be interpreted as an attempt to start with some kind of seed, which already contains some important ingredients of the new and as yet unknown learning field. This seed needs to be unfolded during the learning sessions that follow. The advantage is that during the learning process nothing essentially new need be introduced but any new aspect will be experienced as something which follows logically from what is already known.

The important didactical question is if such a seed can be found which is complex enough to cover a reasonable amount of a learning field and simple enough to be acceptable for newcomers.

In the light of modern computers, a new question can be posed: can modern media help to develop such seeds and can it facilitate the learning process?

3. Further Examples

Before such questions will be considered with possible answers, some more examples from the physics curriculum will be given, where the sequence "from simple to complex" seems to be dominated more by mathematical than by didactical arguments.

In electricity, the topics "dc-current", "Ohm's law" and "Kirchhoff's laws" are covered before ac-currents and high frequency phenomena are introduced. This relates to the increasing complexity of the related mathematics, moving

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from simple algebraic equations to trigonometric functions and then to wave equations.

When teaching dc-current and the so-called simple electric circuit, the elements of "current", "resistance"and "voltage" are treated in sequence before any system aspect is considered [2].

In electrostatics we first introduce charge and the Coulomb force as acting at a distance. Later the field is introduced, sometimes by claiming that the latter is caused or produced by the charge. Since a charge without a field does not exist, this sequence in not only questionable didactically but also in terms of correct physics.

If vector terms like velocity, acceleration or force are treated they are discussed first as scalars and later, if at all, as vectors.

Elementary particles like electrons are first introduced as particles, later as waves and finally as "wavicles" in the light of the particle/wave dualism.

When covering the topic "oscillation and waves" the simple harmonic oscillator is treated first, then the coupling between two oscillators is introduced, which is then expanded to a system of coupled oscillators to describe the phenomena of waves.

When waves in one dimension are studied, sinusoidal solutions of the wave equation are taken as basic building blocks, and only via Fourrier analysis and Fourrier integrals, do other forms of waves and pulses come into reach.

In each case the order of presentation is determined mainly by the underlying mathematics, moving from simpler methods to more complex ones.

This link between the structure of the discipline and the structure of learning has its drawbacks, principally because it limits activity on the part of the learner. New knowledge can hardly ever be developed independently by the learner, who instead relies on external input.

Further, it is questionable whether simple mathematical objects, such as point masses, really are simple to understand, and whether mathematical derivations, when applied to physics, have much explanatory power.

With computers available the definition of mathematical simplicity must be completely revised. A new mathematical "language" is provided by computer displays and this opens up a new dimension for explanation and understanding.

4. Computer supported solutions

4.1. Interactive simulations

This new language has been used to develop a new approach for all the examples mentioned above. In nearly every case the traditional sequence is changed, starting from a more complex construct, similar to a seed. It contains in elementary form the major aspects of the topic to be covered and should be unfolded during the learning cycle.

4.1.1. The simulation program xyZET

In our simulation program xyZET [3] we represent all objects in 3d and when ever feasable we start from there. Two and one dimensional movements can be introduced later.

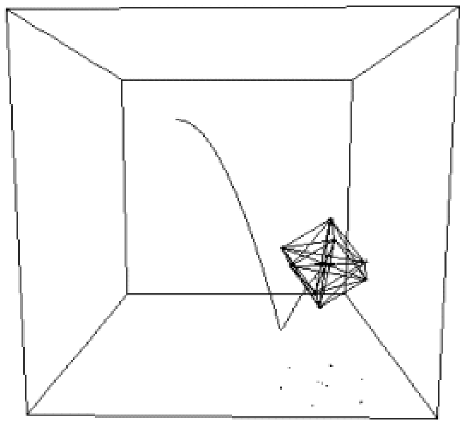

Figure 1: Elastic object dropping to the ground with a trace of it centre of mass

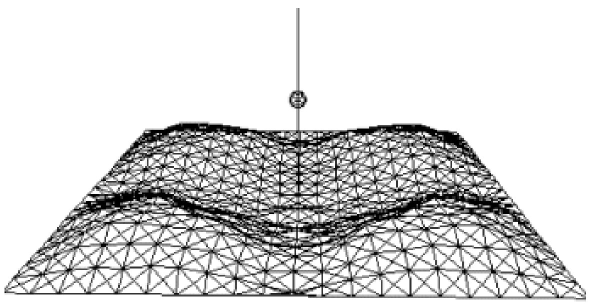

Figure 2. Vibrating elastic plane

All connections between mass points are elastic and the behaviour of elastic objects can easily be shown. The rigid body has to be introduced as a simple but unrealistic model.

Charge and field can be shown from the very beginning as two sides of the same phenomenon.

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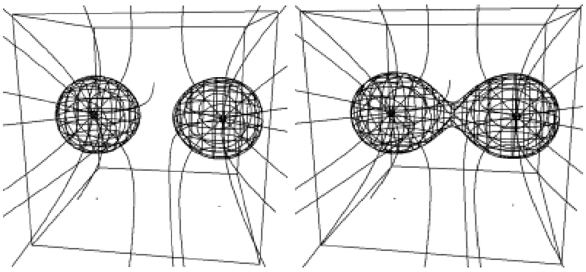

Figure 3: Dynamic arrangment of charge carriers with field lines and equipotential surfaces

For any arrangement of charge carriers, field lines and an equipotential surface can be shown in animation.

4.1.2. Microcosm

In our program Microcosm we can visualize atomic particle in different forms and even with dynamic features.

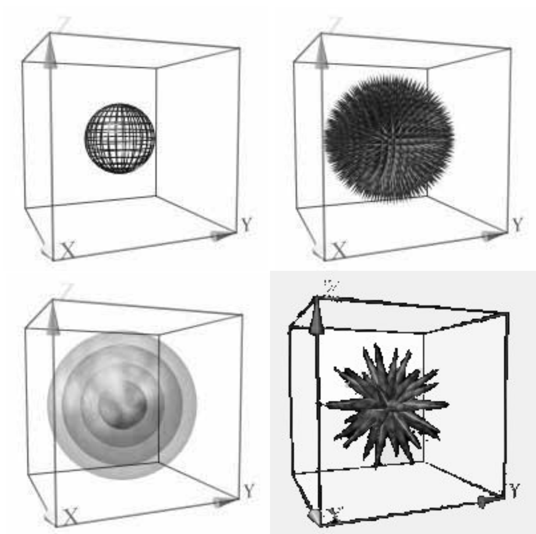

Figure 4: Atomic particles with forms to be discussed

4.1.3. Transmission Line

In our simulation program "Transmission Line" [4] - the transmission process of single pulses can be studied in detail, including reflection, change of impedance and losses. Ohm's law follows as the equilibrium state, after all reflections have died out.

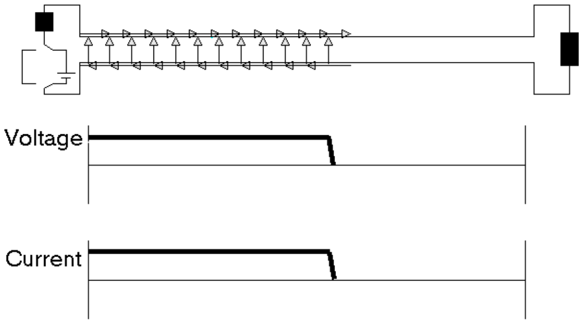

Figure 5: A pulse along a transmission line

4.1.4. TICS – Transport in Circular Systems

In our simulation program TICS - Transport in Circular Systems [5]- we can edit any kind of simple circuit and visualize how current and voltage is reaching equilibrium. The potential is visualised as a quantity in the dimension perpendicular to the circuit.

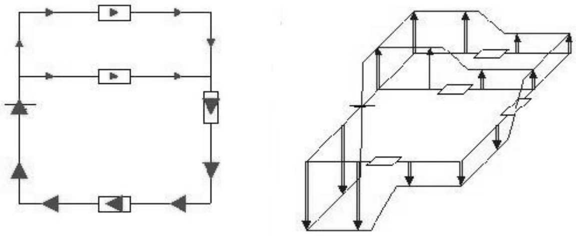

Figure 6: Current and potential along simple electric circuits

4.2. Computer generated animations

To use advanced organizers may imply a higher complexity of the concepts and topics to be introduced to the learners. Such a higher complexity may be reduced by using the flexibility of computer graphics in form of continuous transitions, virtual trips and motivating visualizations. This allows to bring together as close a possible the different levels or aspect of the principles or concepts to be learned. From a series of about 30 videos [6} a few examples are given to demonstrate the underlying idea.

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4.2.1. Orbit of a Molnya satellite

On the upper northern hemisphere the normal geo-stationary satellites are not visible. The video shows how the orbits of the so-called Molnya satellites have been selected to serve over part of there orbit as nearly gestational.

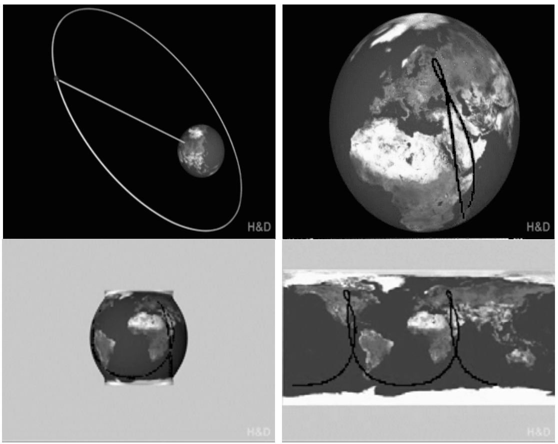

Figure 7: Orbit of a Molnya satellite in 3D and 2D

4.2.2. Centripetal or centrifugal force

At the beginning an experiment is shown where a sphere spins upward in a beaker. Shifting over to a computer generated animation the focus is set on the question of the direction of the centripetal force.

Figure 8: A combination of a real experiment and an animation to enhance attention and motivation

4.2.4. Electric motor in real and as animation

In combination with a real electric motor the animation visualizes the magnet field lines and helps to understand, when and why the direction of the current is changed to cause a continuous rotation.

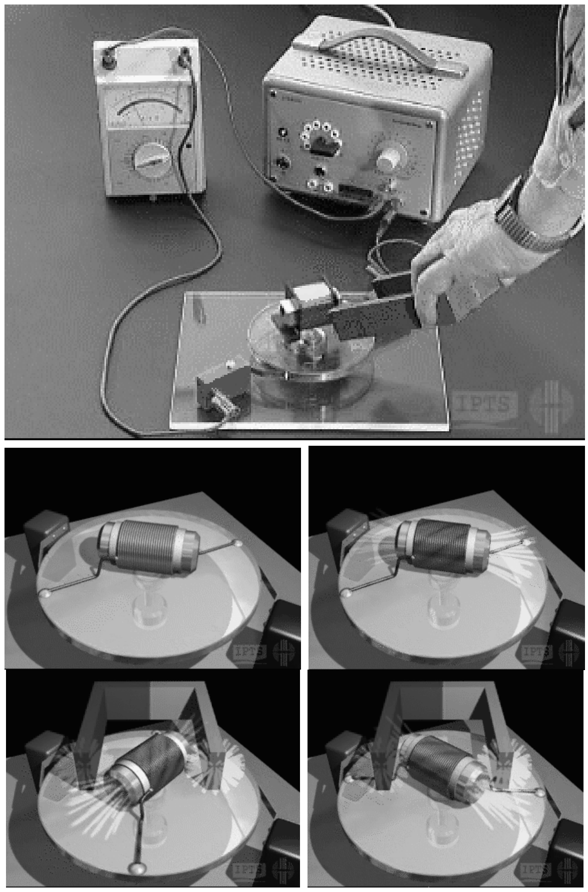

Figure 9: Combination of a real electric motor and a computer generated animation

4.2.5. Visualsation of potential along electric circuits

For different circuits – serial, parallel, mixed , flip-flop – the potential is visualized along the 3rd dimention.

5. Research program

In all these programs an attempt has been made to use the flexibility of computer displays to visualize some basic features of the topic under study to serve as guide line or advanced organiser for the unfolding learning process.

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The price to pay is higher complexity initially, which may act as a barrier and which the newcomers have to overcome. Research will be needed to determine if this approach favours only strong learners and those who have acquired some pre-knowledge, or if the interactivity and flexibility of computer displays as the new language can help to improve learning and understanding for a broader spectrum of students.

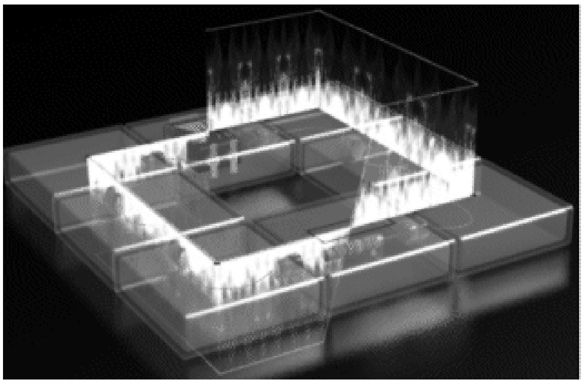

Figure 10: Potential along a simple electric circuit

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The Scientific Experiments Database

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Abstract. Modern teachers that are going to teach an experiment in class, are expected to prepare and illustrate one or more relevant experiments and give worksheets to the students; in many cases they have to write notes on the relevant theory or select material from a book, and even give references, find sites with simulations on the Internet, or book a date to conduct a web experiment online.

Furthermore, they might be asked to give information about the researcher who introduced the experiment, his/her life and personality and the impact of his/her work on the scientific community. All the information surrounding the experiment must be available. Last, but not least, it is useful if sets of measurements, tables and diagrams from previous experiments are at the disposal of the students.

The modern teacher would be pleased with a tool that permits him/her to store all the necessary data about what he teaches; the proper tool for a data collection around experiments and the relevant theories is a simple, functional, user-friendly database.

One such database is presented in this paper; it is created with MS Access, a tool widely used. It is possible to store the data in the form of texts, pictures, memos, etc.

It tries to serve the following purposes:

1. The teacher can find all the information he has gathered in the past in one place.
2. In the forms the users can see in a glance all the different pieces of information.
3. The data of the new experiments can be stored easily through the forms

Keywords. Hands-on experiments.

1. Introduction

A great deal of the teachers' preparation nowadays is to find information about a subject from different resources and select those parts that correspond to the level of the class and the interests of the students; next, the modern teacher has to combine them and present them in class as

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clear and simple as possible. Nowadays, the number of resources is huge; they are spread on the Internet, on books and magazines. An experienced teacher might have his own collection of notes and worksheets, which might be stored somewhere on his/her hard disc. It is becoming more and more difficult to remember where all the information is stored.

The solution for the teacher is, obviously, to classify and store the educational material. No doubt, a database is the appropriate tool for classification. The data in Science refer to topics, theories, experiments and experimentalists. You can classify the data based on the experiments. There is always an experiment involved in a science topic; an experiment is related it to a certain location and period, so it is easily defined.

A database is presented in this paper; it is created using MS Access, a tool widely used. It aims to serve the following purposes:

1. The teacher can find all the information he has gathered in the past in one place
2. In the forms the users can see in a glance all the different pieces of information
3. The data of new experiments can be stored easily using the forms

A database, which tries to serve the science teacher, must be open to adjustments; quite a few science teachers are creative enough, so we should give them a tool that they can tailor to their own needs.

2. The objective – The target group

A database is an *organized* collection of data relating to the same topic; in a database you can find a particular item of information and add new items.

The objective is to give the teachers (and probably some students) a tool to store data about scientific experiments; it is user friendly and open to adjustments (e.g. add fields in a table or add a new table). A manual of how it has been built up would be useful for those that are willing to (partly) change it.

3. The tools

The program that has been used to create the database is MS Access. It is a simple and easy to use environment, even for beginners.

4. Why create a database for collecting information about Scientific Experiments?

Information about a Scientific Experiment covers different topics: the Scientific Subject, the Scientist, the Location where and the Period in which it took place. It appears in different forms e.g. URL addresses, books, pictures etc.

You can of course try to store all the information about a scientific experiment in a single table e.g. in an Excel spreadsheet; in this case though, it would not be easy to sort, select part of the information or to insert new data.

It is more efficient if you break down the stored information in smaller parts which will enable you to easier deal with it. For example you can enter the name of a country and find out how many scientific experiments took place in it. Or type the name of a scientific subject and find out the experiments related to it. All this is possible in the environment of a relational database.

5. The content

<u>The Tables</u>

A Table: is a collection of records (entries). A database consists of one or more dynamically connected Tables. A table may include a Primary Key and Foreign Keys.
A Primary key: it is a field in a table that takes a unique value for each record. The value is given either by the program (Autonumber) or by the user (in this case it can be number or text)
A Foreign key: it is a field in a table that connects with the Primary key of another table defining the relationship between the two tables. Primary and Foreign key must take the same values and refer to similar properties.
The database "Scientific Experiments database" consists of 11 tables, the following:

a) *tblSciExp*

It consists of 7 fields. The first field, *ExpID*, is an Autonumber and Primary Key of the table. The names of the other fields: ExpTitle (Text), ExpSubject (Number), ExpWhen (Number), ExpWhere (Number), ExpDescr (Text), ExpPicture (OLE Object).

b) *tblScientist*

It consists of 3 fields. The first field, *ScientistID* is an Autonumber and Primary Key of the table. The names of the other fields:

ScientistName (Text), ScientistPict (OLE Object)

<u>Note:</u> *The most important tables of the database are the tables above. All the rest are auxiliary. There is another important table in between the two tables, the next one.*

c) *tblExpScientist*

It consists of 3 fields. The first field, *ExpScientistID* is an Autonumber and Primary Key of the table. The second field ScientistID is a Foreign Key and it should take the same values as the field ScientistID in the tblScientist. It is defined as a Look up field. The third field, ExpID, is a Foreign Key and it should take the same values as the field ExpID in the tblSciExp. It is defined as a Look up field.

d) *tblWhen*

It consists of 2 fields: WhenID and WhenCentury. The first field, WhenID is an Autonumber and Primary Key of the table.

e) *tblWhere*

It consists of 2 fields: WhereID and WhereName. The first field, WhenID, is an Autonumber and Primary Key of the table.

f) *tblSubject*

It consists of 2 fields: SubjectID and SubjectName. The first field, When ID is an Autonumber and Primary Key of the table.

g) *tblEquation*

It consists of 3 fields: EquationID, ExpID and Equation. The first field, EquationID, is an Autonumber and Primary Key of the table.

h) *tblMaterial*

It consists of 3 fields: MaterialID, ExpID and Material. The first field, MaterialID, is an Autonumber and Primary Key of the table. The field ExpID is a number and Foreign Key for the tblSciExp.

i) *tblResourceType*

It consists of 2 fields: TypeID and TypeName. The first field, TypeID is an Autonumber and Primary Key of the table.

j) *tblResource*

It consists of 4 fields. The first field, LinkID is an Autonumber and Primary Key of the table. The field ExpID is a Number and Foreign Key for the tblSciExp. The field Link Type ID is a Number and Foreign Key for the tblResourceType.

<u>The Relationships</u>

The way a database works is that you break down the stored information in smaller easily manipulated parts, you store the parts in different tables and then you connect the tables in such a way that a record from one table is connected to a certain record from the other table. For example a scientific experiment (Free Fall) is related to a scientist (Galileo). The two records are related as follows:

- The Foreign Key ScientistID of the record Galileo - Free Fall in tblExpScientist points to the Primary Key ScientistID of the record Galileo of the tblScientist.
- The Foreign Key ExpID of the same record Galileo – Free Fall of tblExpScientist points to the Primary Key ExpID of the record Free Fall in tblSciExp.

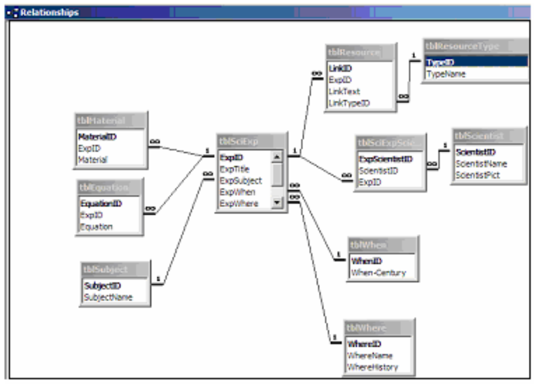

Figure 1: The relationships

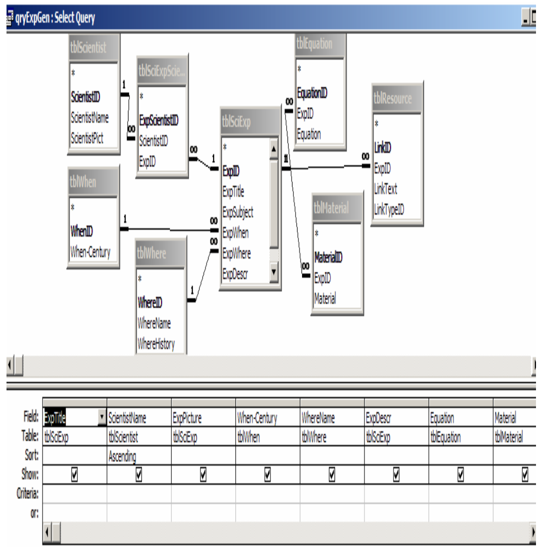

Figure 2: The main Query

<u>The Queries</u>

A Query: is a set of criteria you choose in order to view the database records in a particular way, e.g. sorted alphabetically. Filtering is very useful because you reduce the information displayed, either by showing fewer fields in each record (e.g. where and when the experiments took place), or by showing those records that match certain data (e.g. the experiments of the 19th and the 20th century).

The Forms

A Form: is a way to present the information from a database. It is based on the tables and the queries; it presents the information for one record at a time. Using a form, the user can insert new records into the database. You can also modify the information in a record. Simple forms can be created using a wizard. More complex forms, like the form frmExpGen, are created manually in Design View.
It includes all the fields organized as shown in figure 3 to 5 on the right:

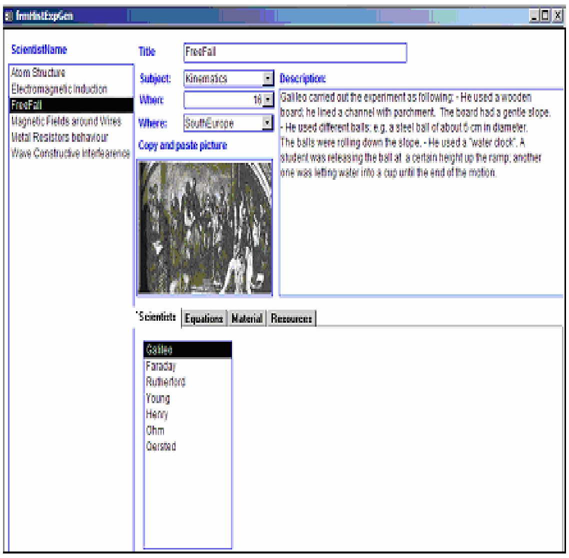

Figure 3: The main Form-View1

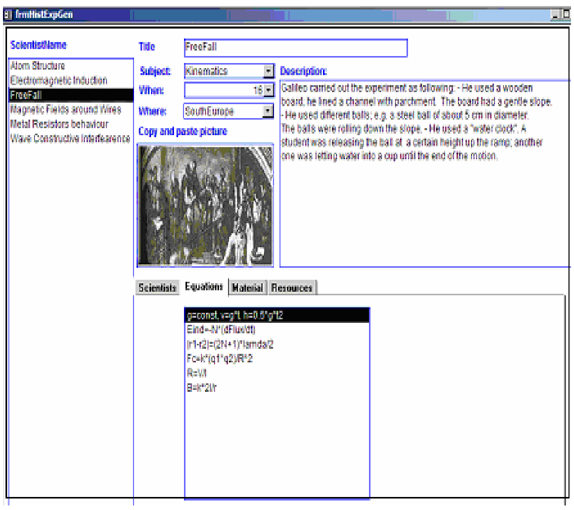

Figure 4: The Main Form-View2

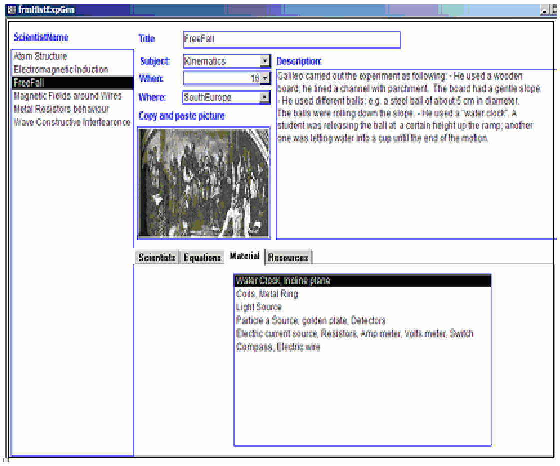

Figure 5: The Main Form-View3

Since the tables are connected through the relationships, the selection of e.g. an experiment title is enough to change the content of all the other fields of the different related tables.
Another type of form that the database includes is the navigation Form. It contains navigation buttons and it appears on screen when you activate the database:

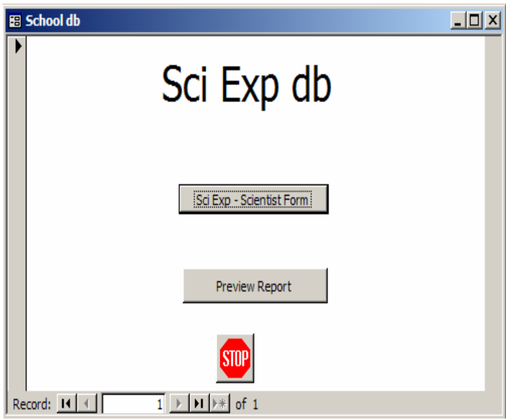

Figure 6: The navigation Form

The Reports

A Report is a printable document that represents information in a structured way and can be displayed on screen. A report enables you to extract information from the database as printouts. It can present the data in the database in a useful and accessible way. Many reports can be created using a wizard. The report repSciExp in figure 7, however, was created in Design View.

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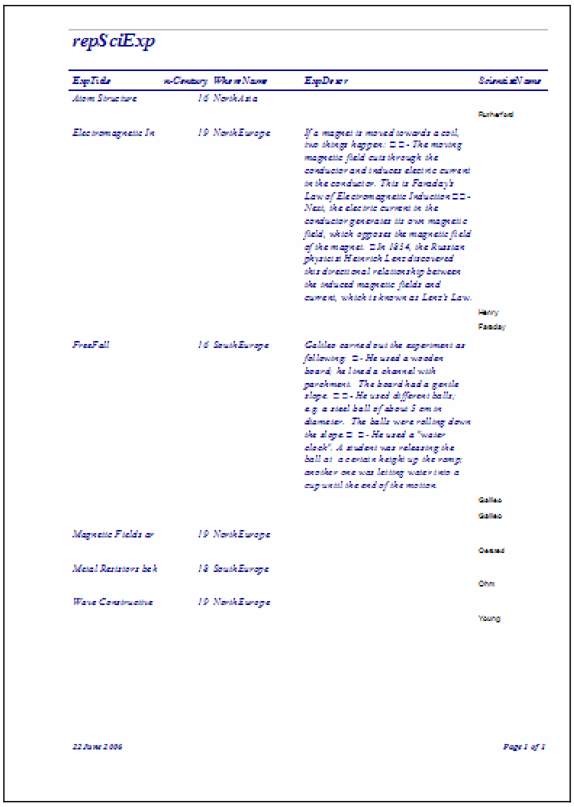

repSciExp

ExpTitle	n-Century	WhereName	ExpDescr	ScientistName
Atom Structure	16	NorthAsia		Rutherford
Electromagnetic In	19	NorthEurope	If a magnet is moved towards a coil, two things happen: □□- The moving magnetic field cuts through the conductor and induces electric current in the conductor. This is Faraday's Law of Electromagnetic Induction□□- Next, the electric current in the conductor generates its own magnetic field, which opposes the magnetic field of the magnet. □In 1834, the Russian physicist Heinrich Lenz discovered this directional relationship between the induced magnetic fields and current, which is known as Lenz's Law.	Henry Faraday
FreeFall	16	SouthEurope	Galileo carried out the experiment as following: □- He used a wooden board; he lined a channel with parchment. The board had a gentle slope. □□- He used different balls; e.g. a steel ball of about 5 cm in diameter. The balls were rolling down the slope.□ □- He used a "water clock". A student was releasing the ball at a certain height up the ramp; another one was letting water into a cup until the end of the motion.	Galileo Galileo
Magnetic Fields ar	19	NorthEurope		Oersted
Metal Resistors beh	18	SouthEurope		Ohm
Wave Constructive	19	NorthEurope		Young

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Figure 7: A Report

6. Students' participation

The "Scientific Experiments database" was given as a project to the 5th grade of the Greek Gymnasium Lyceum of Brussels and to a group from the 5th grade at the European School III of Brussels. Both groups consist of students of 15 years old. The students could carry out the work with remarkable convenience. They were able to present easier variations of the forms and equally advanced reports working in Design View or with the Wizards.

7. A course in Moodle – The plan Further

Moodle is a software package for producing internet-based courses and web sites. Moodle is provided freely as Open Source software Moodle is guided by a particular philosophy of learning, a way of thinking that you may see referred to in shorthand as a "social constructionist pedagogy".

A course of how to create the "Scientific Experiments database" has been developed in Moodle. It consists of simple instructions, which guide the user step by step in creating the database. The user can optionally use more advanced features in order to have a better end result.

The Moodle course of how to create the "Scientific Experiments database" is available in the science portal Xplora Moodle community (3).

For those who don't like to create (and adjust) the database themselves, the ready product is available, also on Internet. The database file **sciexp.mdb** can be found and downloaded at the site:

http://home.tiscali.be/gr.school/galileo/downloads

I hope that some colleagues will find the idea useful, use the "Scientific Experiments database" in their everyday routine and give me their feedback, for further improvement.

8. Important web sites

[1] http://www.microsoft.com
[2] http://www.moodle.org
[3] http://www.xplora.org

Data Acquisition and Processing in School Laboratories Using Virtual Instrumentation - A Tutorial

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Abstract. The advances in virtual instrumentation made possible the use of a single computer system to control several measurement apparatus. By miniaturization and the spreading of wireless communication, users can now monitor and even interact with their experiments while being half a world away. In the classroom physical phenomena can easily be explained either by simulation or by the automation and control of real experiments using the power of the LabView environment. The possibilities that virtual instrumentation along with virtual experiments can offer will be discussed and simple step-by-step tutorial demonstrations will be made.

Keywords. Virtual instrument, Graphical programming, LabView, Data acquisition.

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Computer Graphics and Virtual Reality in Science Education. A Tutorial

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Abstract. Novel ways of teaching are beginning to establish themselves as powerful tools in the didactical process. Among these computer-based applications allow extended mobility, versatility and access to information. Virtual reality recreates ancient machines or far-away settings and delivers them to the students. This opens new possibilities such as virtual museum visits, virtual experiment attendances, in-depth study of mechanical systems to name a few. The lecture focuses on state of the art computer graphics and virtual reality, on how virtual objects and places are actually made and on the benefits of using computer generated graphics and environments in the teaching process.

Keywords. 3D modeling, Computer graphics, Animation, Virtual reality.

Recoil Project and Colab Modelling Tool

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Abstract. In this communication the European Recoil project will be presented together with an introduction to the system dynamics like modelling editor used in Colab, a previous European project included as part of Recoil.

Recoil project aims to facilitate teachers the adoption of a collaborative inquiry learning approach. In Recoil three former projects have participated: Viten, Modelling Space and Colab. Support to the teachers comes in the form of a web based Access Point including some ready to use material configured as Coils (collaborative inquiry learning stuff) oriented to allow the students to act as scientists, making empirical research, expressing and communicating their knowledge and working together.

The model editor, developed for Colab and used in the Colab like Coils of Recoil, is in the line of the system dynamics modelling tool used by STELLA, allowing not only quantitative modelling but also qualitative modelling, somewhat similar to ModelIt. It has been written in Java as an open source tool.

Keywords. Modeling, Simulation, Inquiry learning.

Introducing Computer Assisted Modelling In The Physics Curriculum: Learning Physics by Building Simulations

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Abstract. Our experience on teaching Physics at the 1st course of the Physics career at Murcia University, using computers to build simulations, is presented. This is carried out in a 60 hours practical Computer Laboratory course, in parallel with the General Physics course, both along a full 1st academic year in the Physics career. In the Computer Laboratory our students develop a systematic series of physics models covering different topics dealt with in the General Physics course. At the same time, the basics of building models with a computer is introduced along with the necessary numerical techniques involved. For this we use the Easy Java Simulations (EJS) authoring tool, which allows an easy way for building java applets with interactive interfaces.

For building a simulation the students have an outline of the system under study, including the minimum relevant model related information and a questionnaire to be filled with the help of the simulation to be built. At the end, the student have to make a report in the form of a HTML document including the basics of the phenomenon under study, information about the simulation itself, the answers to the questionnaire and the java applet simulation. In this communication we shall present the program of this Computer Laboratory course together with some of the works done by our students.

Keywords. Applets, Modelling, Simulation, Physics.

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Categorization of Computer Based Models Representations, Made by Students, Through the Development of Evaluation Criteria

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Abstract. This study was inspired by the long-standing interest in using modeling as a learning tool in science. The process of scientific modeling may be compared to the process of computer programming, and modelling can be carried out through developing a computer program. In this way, the programming language becomes the design medium for the scientific model and the programming outcome becomes a way of clearly articulating one's understanding about scientific phenomena. The purpose of this study was to analyze a large number of student-constructed models of natural phenomena specifically developed with the use of computer-based programming environments, aiming to provide science educators with specific, research-validated criteria for monitoring and evaluating student progress while developing modeling in the elementary science classroom. We analyzed a number of different models that two different teams of learners developed over the time of 4 months, in a variety of contexts (including relative motion, free fall, projectiles and accelerated motion). For the purpose of the analysis we used a modified version of artifact analysis that we refined for the purposes of this study. Findings suggest a number of unique criteria that can be applied for the evaluation of student-constructed program-based models of natural phenomena that include (i) the way students represent objects or characters in their programs/models, (ii) how they represent physical concepts, (iii) how they represent behaviours that objects or characters have and finally (iv) how students represent interactions between objects, physical concepts and behaviours. We suggest that these criteria can provide a framework for understanding student-constructed models of physical phenomena.

Keywords. Education, Computer based modelling, Models classification, Model evaluation.

Web Evaluator for Students – A Case Example

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Abstract. Getting the attention of students has always been a hard task for most teachers. In this context the use of new technologies can be taken into consideration for giving the teacher new means to incentive his students.
The tool described in this article gives importance to the opinion of the students for their own evaluation. Thanks to it a group of students from the University of Minho was able to post questions to their colleagues and to evaluate their peer's works on the discipline of Power Electronics Complement.

Keywords. e-Learning, Internet, Renewable Energy, Electrical Engineering.

1. Introduction

The birth of the Internet opened a door to a whole new world of possibilities where almost anything was possible. With that liberty many areas began to evolve their means of work, grasping this new opportunity to grow. In teaching, for example, there was the opportunity to spread its wings and finally reach students and teachers anytime at anyplace. The definition appeared: e-Learning, a way to obtain information, knowledge and data for learning purposes through programs using the Internet as its vehicle. Taking the eLearning into consideration a teacher can generalize and specify his teaching methods in ways that would be almost impossible to achieve without it, wining time, money and perhaps the rising on its students' motivation and learning results. In the Univ. of Minho, the students of Complements on Power Electronics had their grades and works influenced by their comrades. A tool was created to aid the students in the process of making their works and to make their opinion count when their grades would be delivered.

2. The Web Evaluator

Almost every student dislikes certain subjects mainly because he doesn't know its full purpose. And in a discipline, were there are so many

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works and subjects, almost every student concentrates its time and energy on the theme of his work and leaves the rest behind. Another thing to have in consideration is students aren't happy being just passive watchers in every step of the evaluation process, they make the best they can but the final word is always from the teacher. Then why not reformulate the evaluation process? First step: the students have to say which questions should be answered in a certain work, making them analyze all the themes and not just their work's theme. Second Step: have the students' evaluation weight on their final grade, considering how true his vote was.

To make this possible a web application was created, using HTML, PHP and a database in MySQL. This application, the Web Evaluator, has two primary functions: the post question and the student evaluator.

2.1. Part One: Posting Questions

On a first period of time each group of students was asked to post two questions to the other groups. The questions were considered valid, invalid or repeated by the group they were direct to; and if a question was considered invalid or repeated, the group that posted it had to post another question to substitute it.

The teacher's may access the post question part, at the "posting questions" window, where he can say the last word about a classification (although the point is for the students manage all the system, the teacher acts only has a referee when there is an invalid classification by the students).

After the process of posting questions was complete, it was up to each group to have each question answered in the final version of their work.

2.2. Part Two: The Evaluation

When the final version of each group's work was presented to an audience (teachers, students and some guests) the second part of the process began. In this part each student, not the group, had to evaluate every work presented (including his group's work). The evaluation was made by positions, placing the best group in first position, the second best in second position and so on.

Right after the user confirmed his choice, the program gave him the opportunity to change his choice in the period of 24h. When this period was over, the application kept his vote and waited for all the other users to vote or for the teacher to close the votes. By the time the voting period was over, the teacher could see if there was some kind of vote manipulation and in that case ask for the students who manipulated the voting process to vote again or to exclude them from the evaluation. If any of the groups was in the same position as another group, the teacher was responsible to break the tie, but that's the only thing he could do. At the time the evaluation was considered valid by the teacher, and only after that time, each student could see his results (as member of a group and as an evaluator). Every student received points for its group's position and for his accuracy has an evaluator (the more accurate his choice was, compared with the final, better qualified he was as an evaluator). The teacher was the only one to have access to all the grades.

Each grade is calculated by the program, the teacher only defined the maximum and minimum grade that a group and an evaluator can have (in this case: group grade was between 3.5 and 1.5, evaluator grade was between 2.5 and 1.5).

3. Conclusion

Thanks to this method of evaluation the students got more involved with the discipline, by having to get familiar with all the themes.

The evaluation made them feel involved and closer not only to the teacher but to the colleagues as well; and when that happens working is worth while.

4. Acknowledgements

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Affordable and Efficient Science Teacher In-Service Training

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Abstract. Based on a previous work, we present here a scheme for continuing in-school training of primary and secondary school Science teachers which is currently being developed. When completed, this system, using extensively the Internet and based on distance education methods, will exhibit significant advantages compared with other forms of training. In this work, we present first results from the trainees' evaluation of the test cases we used during the development of the training modules.

Keywords. INTERNET, Training, in-school training, Science teacher training.

1. Introduction

In all modern, technologically advanced societies, special measures are taken for an effective Science teaching [1] with the necessity for a generalized Science and Technology Literacy an explicit objective [2]. In order to be useful, this literacy must be focused on principles and methodology rather and not being limited to factual knowledge on specific data, techniques or themes. This implies that in order to be understandable and assimilated by the students, the scientific knowledge that the Science and Technology teachers possess has to be transformed appropriately to teaching activities but it seems that teachers lack, in general, this skill. As a consequence, Science and Technology are considered as difficult subjects [3] although they are rather simpler [4] and possess inherent advantages [5]. This constitutes a significant problem in most of the advanced countries. Another relevant matter is the existing outline of the Science and Technology syllabus and the way of teaching. In the majority of the cases the subject matter does not include advances like relativity or quantum physics that are known for more than 5 generations and require a (qualitatively) different approach than the Aristotelian one of classical physics [6]. The teaching is in general narrative [7] with the teaching book as the only resource [8]. This practice implies that scientific inquiry skills, an explicit common objective of the Science curriculum, are not developed. As a further consequence, a difficulty seems to exist to discriminate between data from observations and their interpretation.

Within the observations made above, it is evident that there is a need for an affordable, sustainable and efficient in-service training scheme for the Science teachers. Such a scheme has been described in [9]. This scheme has two main axes: a. face-to-face training courses, and b. online training courses. The face-to-face courses focus on the learning of the recent theoretical paradigms on the Science teaching and the relevant supporting pedagogical principles. The e-learning system to be developed will be used by Science teachers and specialized scientists in the area of Science Teaching and is based to the configuration of Figure 1 (for more details see [9]).

The focus of this scheme is on the promotion of the collaboration and cooperation between teachers, schools and institutions involved in the Science teaching and in Science Teaching education. The fundamental philosophy is that learning can be developed and enhanced through the sharing of knowledge and best field practice experience of different groups involved in such activities. A further objective is the establishment of a network of people including scientists, school-teachers and researchers to promote Science and Technology education. In this aspect membership consortium is intended to be open to any colleague wishing to participate.

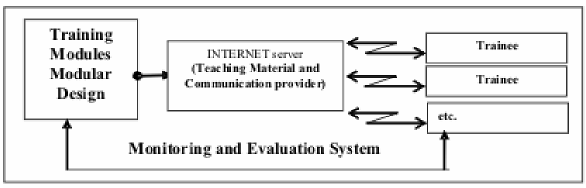

Figure 1: The e-learning system

This scheme presents a direct inherent advantage to the Science Teachers of primary and secondary schools, especially those in rural areas where modern equipment and counselling are sparse. Indirectly, through the improvement of their teachers, the pupils of the corresponding schools and the various groups involved in the activity will benefit. Groups that may be involved in this activity are Universities, schools, Institutions for Science Teaching, Science teachers and specialized Science trainers. It is expected that the different groups will collaborate in order to have a better achievement according to their aims and objectives with every group being able to benefit from the exchange of experience and knowledge in the field. This 'individualised benefit' is another advantage of the scheme.

Based on the context described an application was approved by the European Commission under the SOCRATES – Comenius 2.1 (Training of School Education Staff) [10].

The activities of this project are organized in three phases

1. The first one consists of the development of training modules.
2. The second phase consists of a traditional test delivery of (some) training modules developed and (a rather extensive) evaluation. Phase 2 is necessary in order to obtain comparative evaluation results between the traditional face to face and the e-learning deliveries.
3. The 3rd phase will consist of the transformation of (some of) the training modules developed to distance education training material with a test delivery and its evaluation. It is expected to last 10-12 months.

The project has begun its implementation and we present here results from the test evaluation phase from The University of Crete partner. Similar work is ongoing with the other partners of the project.

2. Implementation

One traditional face-to-face seminar was delivered four times during the period from March to May 2006 in the form of an intensive training course. The 1st was delivered in Nicosia Cyprus, to (secondary education) Science teachers as part of their pre-service training (3 training hours). The 2nd was in Heraklio Crete, to secondary education Science teachers (6 training hours in two consecutive days). The 3rd was also to secondary education Science teachers in Rethimno Crete (6 training hours in two consecutive days). The 4th was to primary school teachers in Rethimno Crete (6 training hours in a whole afternoon). In all 4 seminars the same two persons (P. G. Michaelides and M. Tsigris) were used as trainers. In the 4th seminar (to the primary school teachers) another person (N. Tsagliotis) presented also the basics of the reformed primary school Science books. In all seminars there was also an observer (A. Margetousaki of the authors).

The contents of the seminar were a selection of topics from different areas of the school curriculum, mainly from Physics and (to a lesser extent) from Chemistry. The seminar was mostly focused on the didactics adopting a teaching approach within a Hands on Science Teaching context [12]. More specifically, examples of relating Science to everyday life observations [13], [14] and experimentation with self made equipment [15] were discussed. The seminar was organized as follows:

- One (short) part where the theoretical basis of the teaching approach adopted was presented in an interactive with the trainees way.
- One part where examples of relating observations from everyday life were located and a study approach indicated.
- One part where examples of self made experimental devices and instruments were presented. The construction of self made equipment and instruments was made with simple, easy to find materials and is appropriate for a better understanding of the basic Science concepts. Teachers had the opportunity to watch all the process of the construction, the use and the 'debugging' that in some cases is necessary when constructing these devices. During this stage the trainees had an opportunity (limited because of time constraints) to get involved in these constructions and carry out the corresponding experiments or measurements. A short discussion on errors and of possible construction pitfalls was also made.
- Then a rather extensive discussion took place on the usefulness of the material presented to the school curricula, on possible problems, constrains or difficulties that teachers could face in the classroom or during the preparation of the lesson of the day and how to deal with them ….

It must be noted that:

- Science in primary school is a common course. In the first 4 classes it is within a 'Study of the Environment' school subject with topics from the natural and the human environment. In the 5th and 6th classes there is the school subject 'Science' with topics from Physics, Chemistry and Biology. There is also the school subject 'Geography'. In this, topics from natural Geography, especially of the Greek and the European area, form most of the syllabus but there are also topics from anthropography and from the solar system and its neighbourhood.

- Teachers in primary school do not have a specialist education or initial training in Science. They teach all school subjects one teacher to one class or, sometimes in small villages, to two or more classes... This is true for schools with less than 6 teachers who have to teach the 6 classes (grades) of the primary school. In primary schools with a large number of students and 6 or more teachers an informal allocation (sharing of teaching responsibilities) is usually made with two teachers teaching the upper two (5th and 6th) classes (grades) one responsible for Mathematics, Science, and Technology (usually a male teacher) and one responsible for Humanities [11].
- Secondary education schools in Greece include the middle school (Gymnasium, grades 7th to 10th) and the upper school, Lyceum or Technical Vocational Lyceum (or, previously, Technical Vocational school, a middle school). Science in secondary education schools is taught as separate subjects (Physics, Chemistry, Biology, etc).
- Science Teachers in secondary school have a (University) degree in a Science subject (Physics, Chemistry, Biology, Geology, etc) and they are entitled to teach any of the Science subjects in secondary education schools, as needs arise. In practice they are assigned to teach Science subjects according to their own Science specialty. There is also an informal tendency [11] for male teachers to be assigned the responsibility of the higher grades and of Physics and Chemistry.
- Students' attitude to Science subjects (along with every other school subject) in the upper secondary school (general Lyceum) is oriented towards the written entrance to higher education general examinations. This means that learning activities like experimentation are not within the students' priorities or within the tasks undertaken by the teachers (in these conditions, it seems to be loss of time).

Upon the completion of each seminar the (teachers) trainees were asked to fill anonymously a written questionnaire. The aim was to check on the trainees' impression to the teaching approaches adopted and to trace (possibly) their training needs.

3. Analysis of the questionnaire.

An analysis of the questionnaires is on going and some results already obtained are presented in this section.

There were 107 trainees participants in total from which 93 were Secondary school teachers and 14, the Rethimno (p) row, were Primary school teachers as is depicted in 'Table1. Participants.'.

As shown in Table 2. Sex, 48 (45%) of the participants were females and 59 (55%) were males. For the primary school teachers the participation was 9 (64%) females and 5 (36%) males.

Table1. Participants

	Frequency	Percent
Heraklio	47	43,9
Rethymno (s)	39	36,4
Rethymno (p)	14	13,1
Cyprus	7	6,5
Total	107	100,0

Table 2. Sex

	Frequency	Percent
Female	48	44,9
Male	59	55,1
Total	107	100,0

The figures above are consistent with the corresponding percentages of teachers in the Greek schools. From these 107 participants we got 72 (67%) questionnaires as is depicted in the following Table 3. Questionnaires from the seminars and Table 4. Sex. Of the 8 primary school teachers who filled the questionnaire 4 were males (50%) and 4 were females (50%). Their degree qualification is depicted in Table 5. Degree where the 8 primary school teachers are classified as 'Other'.

Table 3. Questionnaires from the seminars

	Frequency	Percent
Cyprus	7	9,7
Heraklio	29	40,3
Rethymno (s)	28	38,9
Rethymno (p)	8	11,1
Total	72	100,0

Table 4. Sex

	Frequency	Percent
Female	27	37,5
Male	45	62,5
Total	72	100,0

Table 5. Degree

	Frequency	Percent
Other	32	44,4
Physicist	40	55,6
Total	72	100,0

A (significantly) lower response rate is observed for the female participants, likely even more for the female primary school teacher participants. On this observation, it is evident that a detailed analysis should rather differentiate between male - female participants and between primary – secondary school teachers participants. Because of the as yet small sample we examine the rest of the questionnaire as a whole restricting the results to the general trends only.

The participants were asked:

If the topics presented were useful with choices to answer; extremely useful, useful, just a little, not at all. The answers are presented in Table 6. Usefulness.

Table 6. Usefulness

	Frequency	Percent
Extremely useful	32	44,4
Useful	39	54,2
Least useful	1	1,4
Total	72	100,0

If the topics discussed were related to the school curricula with possible choices to answer; much related, a little relate, not at all related. The answers are presented in Table 7. Relation with the Curriculum.

Table 7. Relation with the Curriculum

	Frequency	Percent	Valid Percent
Very much	32	44,4	50,8
Little	29	40,3	46,0
Not at all	2	2,8	3,2
Total	63	87,5	100,0
Missing	9	12,5	
Total	72	100,0	

If the seminar presented another teaching perspective with possible choices to answer; Yes, No. The answers are presented in Table 8. Different teaching perspective.

Table 8. Different teaching perspective

	Frequency	Percent	Valid Percent
No	8	11,1	11,4
Yes	62	86,1	88,6
Total	70	97,2	100,0
Missing	2	2,8	
Total	72	100,0	

If they would attend again a similar seminar with possible choices to answer; Yes, No. The answers are presented in Table 9. Attain again.

Table 9. Attain again

	Frequency	Percent
No	1	1,4
Yes	71	98,6
Total	72	100,0

If they think that this seminar would be interesting to their fellow teachers with possible choices to answer; Yes, No. The answers are presented in Table 10. Are other teachers interesting?

Table 10. Are other teachers interesting?

	Frequency	Percent	Valid Percent
No	3	4,2	4,5
Yes	64	88,9	95,5
Total	67	93,1	100,0
Missing	5	6,9	
Total	72	100,0	

On the two (open) questions about the positive and about the negative aspects of the seminar the responses are presented in 'Table 11. Positive points of the seminar' and in 'Table 12. Negative points of the seminar' respectively. Of the participants (refer to 'Table 11. Positive points of the seminar'):

- 31% found the simplicity of the constructions very positive,
- 18% mentioned that they found very prototypal the experiments,
- 43% mentioned as very positive the teaching method proposed during the seminar,
- 8% think that the seminar was a chance for further speculation on the teaching of Science.
- There was a percentage 29% who did not answer this question.

Table 11. Positive points of the seminar

	Frequency	Percent	Valid Percent
Simple constructions	16	22,2	31,4
Prototypal	9	12,5	17,6
Teaching approach	22	30,6	43,1
Speculation	4	5,6	7,8
Total	51	70,8	100,0
Missing	21	29,2	
Total	72	100,0	

Table 12. Negative points of the seminar

	Frequency	Percent	Valid Percent
Little Time	18	25,0	43,9
Subject	5	6,9	12,2
Organization	10	13,9	24,4
Theory	8	11,1	19,5
Total	41	56,9	100,0
Missing	31	43,1	
Total	72	100,0	

Correspondingly as negative points of the seminar were mentioned**:**

- The time spent was not enough to cover the subjects by 44% other participants.
- The organization was not appropriate (24%). This category covers a wide variety of statements including: 'the subjects should be related to the curriculum', 'teachers (i.e. the trainees) should participate at the procedure' or 'I would prefer to participate myself at the experiments'.
- Almost 20% of the respondents mentioned as a negative point that there was too much theory in the seminar.
- 12% of the respondents mentioned as a negative point that the topics discussed were mainly from Physics.
- A significant 43% did not answer this question.

On the question if they would participate in a similar seminar organized with Distant Education methods the results are depicted in Table 13. Distance learning seminar.

Table 13. Distance learning seminar

	Frequency	Percent	Valid Percent
No	22	30,6	32,4
Yes	46	63,9	67,6
Total	68	94,4	100,0
Missing	4	5,6	
Total	72	100,0	

Interesting is the respondents' answer to the question 'Can you apply the topics discussed/ the knowledge acquired to your classroom?' which is depicted in Table 14. Application. The vast majority (more than 84%) answer 'yes'. However a (small) number of these positive answers continue that this may be done on the prerequisite that they would have the time and the infrastructure.

Table 14. Application

	Frequency	Percent	Valid Percent
No	6	8,3	9,0
Yes	61	84,7	91,0
Total	67	93,1	100,0
Missing	5	6,9	
Total	72	100,0	

4. Commentary

The data presented earlier show that the seminars were accepted by the teachers – trainees in a very positive way. However, a detailed analysis, especially on the criticism performed is appropriate and on going. However we would like to add a few comments based on the (informal) discussions the authors had with the trainees.

1. Many of the participants believe that the theoretical framework was extremely extended and in many cases was characterized as useless (see also Table 12).
2. There was a vivid interest on the experiments and the constructions (see also Table 11).
3. Straightforward or indirectly many of the participants admitted that they have not experience at all with this kind of application or teaching approaches in the classroom.

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Comments made are 'There are no books' 'It is not anticipated by the ministry'.

4. Schools in secondary education are equipped with labs and the necessary tools for the experiments. Although there is equipment in schools, the main negative point mentioned was that there is no need for this kind of experiments because they are not useful for the entrance examinations to higher education.
5. Many of the participants mentioned the simplicity and the prototypic nature of the constructions (see also Table 11).
6. It was understood that through this kind of applications it is possible for the teacher to be a collaborator or partner of the children through the learning process in the laboratory.
7. In the end of the seminar many expressed the desire to be capable of performing these experiments presented during the seminar, and bypassed the point that these experiments were part of a broader context applying in a certain teaching methodology. They seemed to focus on the certain cases, instead of the teaching method proposed with those cases as starting points.
8. Another thing that came out from the discussions is the need expressed from the teachers to work on the constructions and try to perform the experiments themselves, a point mentioned also in the questionnaires too.

5. Epilogue

The results show that there is great interest for the teaching model of Science proposed during the seminars. Teachers seem to be interested in the idea of quantification of the experiments and the involvement of the pupils to the experimental process. Teachers are willing to have further training in this field and are also ready to use the online training method of Science teaching. It is also obvious that there is an extended training gap concerning the science teaching as shown from the fact that teachers are willing to participate in a training seminar of this kind again and from the fact that they think that other teachers would also be eager to participate too. The main negative point of the seminar mentioned from the participants was the lack of time, which seemed to be very short in comparison with the subjects inquired. Maybe there is a need for a more extensive seminar where there will be provision for teachers' active participation to the construction of the equipment - instruments and the development of the experiments. This way they will have a direct experience and they will be able to work on the idea of self-made apparatus.

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Geometric Reasoning and Proof Problems in Geometric Dynamic Environments

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Abstract. As stated in the Principles and Standards of School Mathematics the National Council of Teachers of Mathematics [8], technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning..

In geometry, an area of the curriculum intimately connected with the development of the deductive method, computer software packages, generally known as dynamic geometry environments, become known by their potential

to provide students with several experiences of geometrical models, increasing their intuition and leading them to formulate conjectures coming across with possible explanations for their findings.

In this paper we describe an empirical study related to the influence of dynamic geometry systems in the promotion of deductive reasoning through proof problems in Geometry. It first explores geometric reasoning in dynamic environments, and provides some justification for the importance of exploration and visualization on advance understanding of proof. The tasks we propose were designed for Portuguese secondary school students, by means of various geometry models (Cartesian model for the Euclidean geometry, the Poincaré upper half -plane model for Hyperbolic geometry and the Spherical model for Spherical Riemannian geometry) having in account that they will be tested in Portugal. Their conception follows the mathe-matics curriculum organization qualified to secondary school students. The curriculum provides opportunities for conjecturing and describing observations in open-ended problem situations, creating subsequently a friendly atmosphere to introduce formal aspects of proof and proving.

Keywords. Deductive reasoning, Dynamic geometry, Mathematics education.

1. Introduction

There is a consensus that deductive reasoning still has a central role in geometry learning. As settled by Gila Hanna [5], in the classroom the key role of proof is the promotion of mathematical understanding, and so, it is of significant importance to find out (more) effective ways of promoting mathematical understanding in proof environment. Considering some researcher's arguments G. Hanna [6] one of these potentially more effective ways is given by the use of dynamic geometry software (e.g. Geometer´s Sketchpad, Cabri Geometry), since they have the potential to encourage both exploration and proof, making it easy to pose and test conjectures. But, as pointed out by other researchers' studies (e.g. De Corte E. [1]) the use of computer technology is useless if the educational strategies and activities are not revised.

As mentioned by Mariotti, M. [7] it is reasonable to predict that the presence of new technology deeply transform the relationship between problems and knowledge and that the change will occurs at least in two respects: The problems that can be proposed to pupils and the solution processes, the available resources change and consequently the processes used to get the result change.

A number of researchers are now investigating the use of dynamic geometry environments and in particular their potential contribution to mathematical reasoning.

At Educational Studies in Mathematics 44 (2000), the first outcome of the PME Special issue series. This issue is devoted to analysing the influence of dynamic geometry software (DGS) on student's conceptions of mathematical proof while students are solving geometry problems involving proofs in an environment mediated by such software.

At ICMI study series, *Perspectives on the Teaching of Geometry for the 21 st Century,* are discussed a variety of aspects ranging from social and didactical issues to curriculum design and teacher preparation, beginning with a brief look back at the multiple and varying roles which geometry has played during the XX century.

In this study these two last documents are an important basis of this work. The study empirical in focus, deals with some theoretical aspects of Duval [2] view geometrical reasoning.

2. Geometrical reasoning within mathe-matical thinking

In line with Pegg [9] we may distinguish two classes of cognitive growth: the **global frameworks of long-term growth (**e.g. van Hiele's theory of geometric understanding, Piaget's theory of cognitive development) development, and the **local frameworks of conceptual growth (**e.g. the unistructural-multistructural- relational- unistructural sequence of levels in the SOLO-**S**tructure of the **O**bserved **L**earning **O**utcome - Model, Biggs & Collis, 1991, Pegg 2003) **.**

It may happen that a theory incorporates both global and local frameworks as is the case of the theories above mentioned.

Usually the global theories begin with the physical interaction of the young child with the world and, specify successive levels of abstraction based on the use of languages and symbols sophistication stage.

In Good [3] it can be found an interesting characterization of the thinking process: *an unregulated flow of ideas or stream of images, impressions, recollections and hopes; an undisciplined guessing that treads lightly and superficially over grounds and evidence in an effort to reach conclusions; the contemplation of ideas, or meditation, without any endeavour to control nature or experience; reflexive, cognitive, or critical looking into something for the sake of establishing belief and controlling action*.

As pointed out by D. Tall [12] one of the secrets of simplicity of thought in mathematics is its power of compression. Mathematical concepts compress in different ways in different realms of mathematics. It is an enormous compression to use a single letter like lN to stand for the whole natural numbers. In fact a great part of mathematics' notation provides illustrations of mental compression. The mental compression plays a crucial role in the development of mathematical thinking; it allows powerful thoughts in extremely simple ways.

For a successful development of mathematical thinking, solid links between ideas that are compressed – cognitive units (created by focus of attention) must be achieved going together with building links between these entities, in a boarder global awareness.

Clearly, activities performed repeatedly become automatic, allowing the creation of rich cognitive units promoting more sophisticated links.

In mathematics the nature of concepts may differ greatly. As exemplified in [12] the status of the concept *triangle* and the *concept* five are completely different. The concept *triangle* can be visualized as a mental object and described in terms of its intrinsic properties. This does not happen with the concept of number, which is attached with the process of counting.

Following Duval view, [2], geometrical reasoning involves three cognitive processes fulfilling specific epistemological functions, which can be performed separately: **visualisation** (related to space representation), **construction** (use of tools) and **reasoning** (particularly discursive processes for the extension of knowledge, for explanation, for proof).

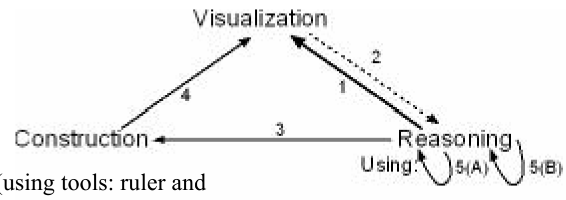
Figure 1 reproduces the Duval representation of the underlying interactions involved in geometrical activity. Each arrow represents the way a kind of cognitive process can support another kind in any geometrical activity. Arrow 2 is dotted because visualization does not always help reasoning. Arrows 5(A) and 5 (B) put in evidence that reasoning can develop in a way independent of construction or visualization processes.

For the skilfulness in geometry, according to Duval, is necessary to get pupils in school to see the communication between these three cognitive processes. His research on the development of geometric reasoning points to the following promising framework:

1. to develop the three cognitive processes separately;
2. work on differentiating visualization processes and between different reasoning processes in the curriculum;
3. bring to the scene the coordination of these three cognitive processes.

In section 4 we describe an empirical study where this framework is visible.

Identification of gestalts and configurations in 2D or 3D. This identification depends on particular laws which are independent of the way of construction or of the discourse.



(using tools: ruler and compass, available primitives in a geometrical software)

(A) natural speech (inner or external for naming, description or argumentation

(B) propositions with the theoretical status of definition, theorem… for a deductive organization discourse.

Figure 1. Duval's representation of cognitive interactions

3. The geometric reasoning within dynamic environments

Computers are seen for many teachers and researchers in mathematics education as a powerful tool to create rich environments for

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problem solving. Dynamic geometric software provide visual evidence which is considered to be a mean for generating conjectures using users prior geometrical knowledge and/or empirical experiments with the software (e.g. Geometer´s Sketchpad, Cabri Geometry).

The accessibility of dynamic software's with graphing capabilities, in classroom environment has given a new attribute of geometrical exploration; helping students in theirs geometric understanding. There use permits: to perform geometric constructions with a high degree of accuracy; to identify the meaning of geometrical statements; testing conjectures, exploring properties of the constructions they have produced or even "discover" new properties. (Hanna, [5]).

A key question raised by the intensified study of visualization is whether, or to what extent, visual representations can be used, not only as evidence for a mathematical statement, but also in its justification (Hanna, [5]).

Hadas, N. *et all* [4] present an original approach to induce students to produce deductive justifications. The authors intentionally wanted to identify the frequency of deductive explanations and the conditions which encourage them. However the appearance of other explanations, for instance visual explanations based on dynamic environments, lead to a categorization of the student's answers to the problems proposed intended to cause surprise and uncertainty.

By manipulating objects students can investigate invariant features, formulating hypotheses and test them visually. According to Schumann and Green [11] at present dynamic geometry environment are used for the following types of learning activities:

- *figure acquisition* (the student constructs a figure which satisfies a given requirement);
- *figure appropriation* (the student graphically transform the figure observing the preservation of its intrinsic properties).
- *property exploration*; The student also constructs or uses a predefined figure (activity) to explore a specific theorem or even a proof.

The evolution of dynamical environments led to a switch from the local step-by-step activity to the development of global awareness of relationships to solve problems.

4. The empirical study

The study we have carried out consisted in a design of a geometry problem folder and its implementation in a mathematics class with the objective of getting some understanding about the research question underlying this study, *How non Euclidean geometry can help student's developing their deductive reasoning?*

We made use of non Euclidean geometries, namely the hyperbolic geometry (using the Poincaré's upper half plane) to achieve these propose (the improvement of their proof understanding through a higher level of geometrical thinking).

In this paper we describe the performance of one pair of students during their activity in solving the proposed problems, adapting Duval´s representation of cognitive interactions. It should be pointed out that the study has involved 20 students in theirs 10^{th} of a Portuguese Secondary School (ages 15-16 years). The focus of our attention on only one pair of student's since they represent a class of student's performance.

4.1. The design of the problem solver

Here we exemplify the type of problems we have chosen for this experiment. Dynamic geometry sketches and scripts were prepared for students investigations during de sessions. Each sketch was constructed using The Geometer's Sketchpad and the sketches included facilities for hide/show.

As mentioned before we have followed the Duval's representation of cognitive interactions.

During phase 1, the students gained preliminary experience with Geometer´s Sktechpad Program.

In Phase 2, the students were involved in a proof-problem requiring definition and models of Incident Geometry.

Examples:

1. Find, in the Poincaré upper half plane Plane, the hyperbolic line through (1,1) and (3,3).
   In this geometry, through any two distinct points there exists a unique line? Justify. (The same question was developed in others models, namely in the Cartesian plane and in the spherical model).

2. Let l_1 and l_2 be hyperbolic lines. Show that if $l_1 \cap l_2$ has two or more points then $l_1 = l_2$.

Finally, in phase 3, students explore situations in order to become aware, for instance, of the significant statements as *Euclidean geometry theorems that require the Parallel Axiom will be false in hyperbolic geometry*.

4.2. Participants

A group of 20 students in their 10^{th} , 11^{th} of a Portuguese Secondary School (ages 15-16 years) participated in the teaching experiment. It was carried out during the standard class time with the research and their own teacher. The students worked in groups of two. None of them had significant experience on deductive reasoning and with dynamic geometry.

Figure 2. The use of artifacts

Three pairs of students were selected by the research to participate in the case study. These six students, one boy and five girls, had different learning and cognitive strategies. Riding & Rayner [10], investigating individual differences characterized learning style as being a tendency to approach cognitive tasks with a preferred strategy or set of strategies, corresponding with a preferred mental set. They suggest that learners differ, in terms of two fundamental dimensions:

- *wholist-analytical*; the wholists ones prefer to keep a global view of the topic and the analysts ones tend to process information into component parts;
- *verbaliser-imager*; the verbalisers ones tend to present information in words, while imagers tend to present information in pictorial form.

Learning and cognitive strategies may be characterized by observing students or by allowing them to think aloud as they study.

In a questionnaire and in a test diagnostic given to the student's at the beginning of this study, it was identified their weak experiences with solving problem, their poor basic geometric knowledge and their inexperience with geometric dynamic software.

4.3. The student's approach

In this sub-section we describe student's productions related to phase 2.

Models of geometry were introduced with the use of artifacts[1] (a music instrument, a sphere of acrylic) and scripts in dynamic geometry environments, see figures 2 and 3.

According to Mariotti [7] the possibility of an instrumental approach seems rich and fruitful, contributing to the construction of meanings.

Figure 3. The use of artifacts and visualization in dynamic environments

After this stage, the students were involved in a proof-problem requiring models of Incident Geometry.

Construction ○——————> Visualization

In phase 2, in the task: *Find, in the Poincaré upper half plane, the hyperbolic line through (1,1) and (3,3),* Susana and Patrícia, after reading the problem, used the GSP tool to draw the hyperbolic line (Euclidian semi-circle) with the script Hyp_line.gss.

[1] There are many terms to refer to artefacts conceived for a specific use and a specific goal: tools, ins-truments…(Mariotti, [7])

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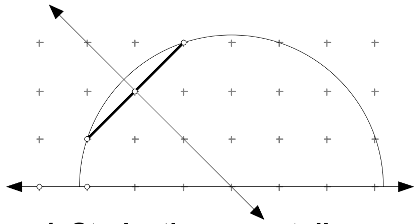


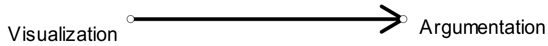
Figure 4. Student's support diagram during their solving problem

In what follows we describe the dialog between the students Susana (**S**) and Patrícia (**P**) and the teacher during their deductive task using an analytical approach.

S.: *I see…this is the line that goes through A and B. (Susana makes a diagram using Hyp_line.gss)*
Teacher: *But what is the analytic expression of this line?*
S.: *I don't know!*
P.: *Me neither!*
Teacher: *What is the analytic expression of the semi - circle?*
S.: *Now I know…*(The student writes the general expression of an entire circle).
Teacher: *Then, and in this case?*
P. But we don't have the centre of this circle…..
S.: *Actually, we only have the two points A and B… and the program does not give us the coordinates for the centre.*
Teacher: *Well, given two points of the circle, you can readily find the centre coordinates. Do you know how to do it?*
S.: *If we join A to the centre, we have the radius of the circle, similarly to what happens if we join B to the centre. However, we still don't know the centre…..*
P.: *I don't know….*
S.: *Wait… We know that the centre lies within the line that divides [AB] into two identical segments. Isn't that right Teacher?*
Teacher: *That is correct. Can you now give the expression for this hyperbolic line?*

The students were able, with the teacher's assistance, to do the required specification. In this procedure the diagram (figure 4) was in fact their real support to make deductions. They have used the visual reasoning not as an intuitive global stage but as a support to their deductive conclusions.

After they have written the analytic expression of the hyperbolic through points A and B, they "confirmed" by GPS (e.g., they have verified that the radius they found analytically was exactly the length between the semi circle centre and the point A).



The posed question - *In this geometry, through any two distinct points there exists a unique line? Justify* – raised a discussion about its meaning in others geometries which was regulated by the use of GPS. They come to the conclusion that in the spherical model the incident property was not verified.

In the second posed problem Susana gave an explanation based on the following diagram.

Discussion (argumentation) between Susana (**S)** and Patricia **(P).**

S.: *Haven't we already solved this problem? (1:30)* (This question was formulated right away to Susana reading the statement of the problem)
P.: *If they intersect in two points they are coincident…*
S.: *We have one, you see that …. (the student makes diagrams). It is not possible to draw another line (through the two points).*
P.: *Do they intercept each other?/*
S.: *The two lines only intercept each other in one point. You see!? (the student continues using visual support)*
P.: *They can intercept each other in more....*
S.: *How? How? Only if they were coincident…*
P.: *ok!*
S.: *Yeah… but how do we justify it??*

Here Susana (S) and Patricia (P) provide, once more, an argumentation through visualization.

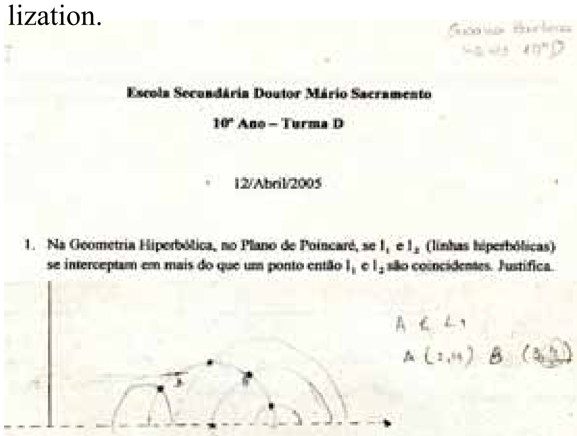


Figure 5. Task's first approach

Discussion (argumentation) between Susana **(S)** and Patricia **(P).**

S.: *Haven't we already solved this problem? (1:30)* (This question was formulated right away to Susana reading the statement of the problem)
P.: *If they intersect in two points they are coincident…*
S.: *We have one, you see that …. (the student makes diagrams). It is not possible to draw another line (through the two points).*
P.: *Do they intercept each other?/*
S.: *The two lines only intercept each other in one point. You see!? (the student continues using visual support)*
P.: *They can intercept each other in more....*
S.: *How? How? Only if they were coincident…*
P.: *ok!*
S.: *Yeah… but how do we justify it??*

Here Susana (S) and Patricia (P) provide, once more, an argumentation through visualization.

The Susana`s question "*Haven't we already solved this problem*?" shows that she was thinking in the solution of the previous task but she was not able to apply it. She went immediately to the exploration phase, using diagrams, without establishing links with results already obtained.

The students have felt necessity to justify their conjectures but they have not make the connection with the known result; *in the Poincare upper half plane, through any two distinct points goes a unique line.*

Meanwhile, these students were trying to find arguments to support their conjectures. Simultaneously they used some functionalities of GPS (Hyp_line.gss, Construct Menu), exploring a diversity of diagrams. Finally, they solve the proposed problem using an analytic approach spending a lot of time in the implementation of this approach.

5. Conclusion

Our study confirms the assumption that visual reasoning is more than an intuitive global and preliminary stage for the reasoning processes in general, supporting further reasoning. As expected the use of physical models in combination with virtual models brought a better insight to the significant role of a mathematical proof. If they were not confronted with situations were a minimal line joining two points could be a curved line instead of a straight line they were not able to see why we should prove that for instance, in the Euclidian plane the sum of the internal angles of a triangle is 180^o.

In this empirical study the students followed the triangular representation (4,2 3) of cognitive interactions described by Duval. In other words, they went through the cognitive interaction path:

construction – visualization – reasoning.

In respect to the construction level they went through all the three types of learning activities: *figure acquisition, figure appropriation* and *property exploration*, (Schumann and Green [11] description).

The learning activities they went trough were determinant for the development of their deductive reasoning.

It seems that the Duval's approach is in fact a useful framework when working in dynamical environments and that the use of non-Euclidian geometry is not only a way to make student's familiar with axiomatic systems but also a way to make evident the strength of a formal proof.

6. Acknowledgements

This study was carried out under the project **GeoMind** include in the Network - **Rede Inter-Centros Didáctica da Matemática** under the coordination of João Pedro da Ponte.

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Student's Learning about Chemical Kinetics. A Case Study of Real-Time Graphs

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Abstract. The study of chemical kinetics is mainly experimental and involves the rate of chemical reactions and their mechanisms. The aim of this project was the study of the chemical kinetics of several chemical reactions using data-logging and real time graphs. The evaluation about the adequacy of the experiments to enhance student' learning about chemical kinetics was also a goal.

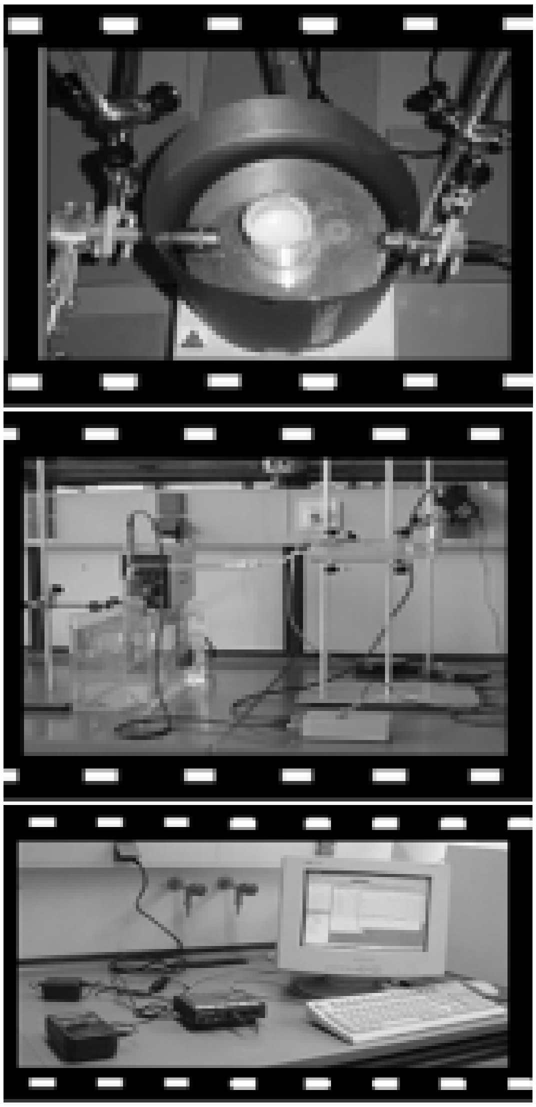

Figure 1 - Images of experiments used

The chemical reactions chosen involved different scientific evidences and different sensors were used. The effect of initial reactants concentration on the rate of the chemical reaction was studied on the chemical reaction between sodium thiosulphate and hydrochloric acid - a light sensor was used to monitor the precipitate formation. Effect of temperature and surface area on the rate of chemical reactions was studied on the chemical reactions between metallic magnesium and hydrochloric acid and between

Alka-Seltzer and water - a position sensor was used to monitor the gas evolution. The effect of catalysts on the rate of the reaction was studied on the chemical reaction between potassium permanganate and oxalic acid - a colorimeter sensor was used to monitor the changes in the colour of the solution. The chemical kinetics of these chemical reactions using these experiments was in accordance with the results obtained by other methods.

The effect of these laboratory experiments on students' understanding of chemical kinetics was studied. Seventeen students, aged 14-16 years old, were involved. Students had to plan investigations, analyze data and to formulate conclusions based on calculations and graphs. To evaluate student' learning data were collected using several instruments: questionnaires, observation, group interviews, group discussions and participants' reflections about the work developed. The results suggested that these experiments strongly enhanced the students' understanding of chemical kinetics and improved students' experimental and investigative skills in using ICT in chemical laboratory.

Keywords: Kinetics, Chemical Reaction, Learning, ICT, Data-logging.

Students from a Secondary School and their Teacher Learn more about Water and Soil Pollution Working with Scientists

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Abstract. If we want students motivated to science we need enthusiastic teachers, who understand actual scientific research, prepared to promote development of scientific inquiry skills in their students. But is it possible to address, in school science, problems characteristic of actual science? This study refers to an experience where sixteen students and their teacher study a problem of soil and water pollution, caused by pesticides, in collaboration with a scientific laboratory.

The study has been developed in two parts. In the first part the teacher integrated a research team in a scientific laboratory and studied the interaction of a pesticide with fulvic acids (a fraction of soil organic material). In the second part she transferred the study of this problem to a pedagogical context when teaching about 'solutions' and 'unitary operations'. Action/research was the methodology used by the teacher to evaluate teaching and learning all along. Data were collect through observation of students working, written students' work, debates, questionnaires and individual interviews (at the end of the process to evaluate student' appreciation of the experience).

The collaboration with the scientific laboratory motivated the students. They could do some of the experiments and were motivated to use and interpret some data obtained, with more sophisticated equipment, in the scientific laboratory. Students learned about 'solutions' and 'unitary operations' as they were working on a problem that interested them. On the other hand they were working as 'scientists' as they asked questions, did bibliography research, learned new techniques, used new scientific vocabulary, planned experiments, designed protocols, developed the experiments, analysed data, presented and discussed results, compared their results with others' results.

The teacher developed a valuable research work. Participating in a research team immersed her in the culture of science. It also improved her confidence.

Keywords. Environmental Education, Experimental work, Teaching, Learning, Research.

Professional Development for Science Teachers through Partnerships between Teachers and Scientists

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Abstract. The development of scientific inquiry skills is considered to be the most effective way to create a society of scientifically literate citizens. This study intent to contribute to the development of a model of professional development for science teachers in Portugal through partnerships between teachers and scientists, in order to improve their understanding of how science is done and how scientists work.

The study has been developed in two parts. In the first part the teacher/researcher integrated a research team in a research laboratory, where she developed a series of special skills to test and analyse geosynthetic materials, used in sanitary landfill. In the second part the teacher/researcher incorporated the experience obtained in the first part of the study in teaching about solid urban waste manegement.

The teaching methodology was oriented as project work and included oral discussion of ideas and results, group work, analysis of bibliography, experimental work, and construction of mind maps and finally the use of a questionnaire to evaluate student's learning and appreciation of the experience. Action/research was the methodology used by the teacher to evaluate the process of teaching and learning all along, so that changes could be incorporated if needed.

It was possible to conclude, generically, that there was a significant learning progress made by students in subjects like solid urban waste, solid urban waste management, reducing, reusing, recycling, composting, incineration, sanitary landfill. The research results obtained by the teacher were valuable and were incorporated in the results of the research laboratory.

According to the teacher/researcher's reflection she increased content knowledge, improved her confidence and innovation in science teaching, and developed skills that allowed her to propose activities for the development of experimental work that created opportunities to the development of scientific inquiry skills.

Keywords. Environmental Education, Experimental work, Teaching, Learning, Research, Sanitary Landfil.

Data-Logging in Primary Schools: Studying Thermal Equilibrium

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Abstract. The aim of the study was the evaluation of the usefulness of experiments using data-logging and real time graphs to enhance learning about temperature, thermal isolation and thermal equilibrium in primary schools. This study involved 14 pupils aged 8-11 years old. Eight experiments were done. Initially pupils used thermometers to study the establishment of thermal equilibrium. Then, after getting familiar with temperature sensors and data-logging, they used temperature sensors to study the establishment of thermal equilibrium in several situations, including the use of thermal isolators. They also compared results obtained with both maximum-minimum thermometers and temperature sensors to measure changes in temperature for several days.

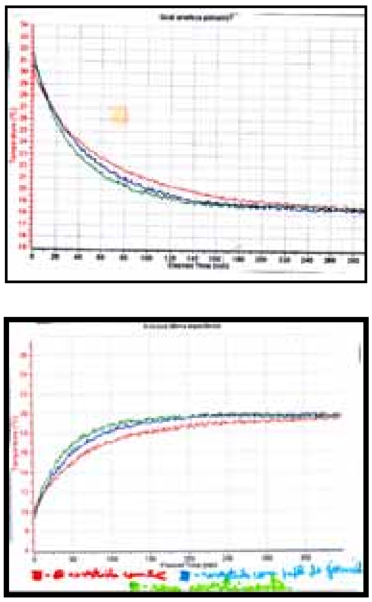

Figure 1. Images of some graphs obtained

Figure 2 - Images of pupils working with data-logging

Experimental activities were supported by work sheets. In some activities investigative work was developed where they had to make their own decisions in groups, using procedures such planning, measuring, observing and analyzing data. Several instruments were used to collect data to evaluate pupils' learning: questionnaires, observation and individual interviews. The results suggested that these experiments enhanced pupils' learning. Pupils became familiar with the use of computers, thermometers, data-logging and sensors. They learned to interpret real time graphs, to identify thermal equilibrium situations and how thermal isolation occurs. They were able to transfer new ideas to new situations that were presented to them. Pupils showed great enthusiasm and motivation for the activities they were involved in and improved their global school performance.

Keywords: Primary Schools, Temperature, Learning, ICT, Data-logging.

The Enigma of Science Education: Integrating Contemporary Research and Practice

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Abstract. There is a great need for new concepts and methods of teaching in science education against the background of studies showing large-scale failure of contemporary teaching (Pisa 2000, 2003).

The acquisition of scientific knowledge in the developing child is not merely a process of cultural transmission and knowledge acquisition in formal educational contexts. Research shows that children come to school with representational structures that allow them to construct and test their own theories about the environment and thereby CONSTRUCT their own knowledge. The concepts become more refined over developmental time.

Growing competence in the application of science research methods, propositional logic, hypothetical reasoning and combinatorial thinking is enhanced if primary school students are exposed to an atmosphere of learning based on concepts and findings of researchers in the field of cognitive science and cognitive development.

The paper presents actual teaching method and results from a small group of German students and suggests novel ways of approaching science education in early years.

Keywords. Science education. Primary level.

Who's Afraid of Electricity? Virtual Laboratories for the Understanding of the Electric Field Concept

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Abstract. The aim of this work is to present the pedagogical approach and the technical aspects of the two fundamental experimental activities – Electric Field and Capacitors of the subject "Electricity and magnetism" on the basis of informatics resources.

In this context, web contents have been developed:

- historical information related to the main issues "electric field" and "capacitors", including biographies of related physicists,
- explanation of the concepts,
- explanation and guides of the laboratory activities,
- problems and questions,
- related technological applications,

among other useful information.

It is also contemplated the virtual simulation of the experiments. The virtual laboratories will allow the user to change the several main parameters of each experiment and observed the

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variation of related physical quantities, both in the form of graphs and numerical tables of values. Further, films of real laboratory experiments are also included. These will allow the student to recognize the material to be used in the real experiment and the experimental procedure before entering to the real laboratory. The website can be used for preparation, revision or even for substitution of the laboratory activities.

The authors thank the support of the EU "Hands-on Science" project (110157-CP-1-2003-1-PTCOMENIUS-3).

Keywords. Virtual laboratories, Electricity and magnetism, Electric field and capacitors.

A Web-based Inquiry Environment for the Development of Environmental Decision-Making

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Abstract. This paper describes a web-based inquiry environment designed to support students' environmental decision-making, helping them develop the abilities to productively defend their decisions based on available evidence. In this environment, students are provided with data regarding a real-life, socio-scientific issue which has not as of yet been solved. During the investigation, students are divided into groups, each of which is assigned a role. Students need to decide how to address the problem and collaboratively collect data to defend their position in the context of a debate with other groups. Students are provided with conceptual scaffolding through a web-based workspace. Both the inquiry environment and the workspace are implemented in a new web-based platform called STOCHASMOS.

Keywords. Scientific literacy, Decision-making, Web-based inquiry environment.

1. Introduction

One of the main aims of education is the development of students' scientific literacy. It is important that students become able to make decisions by analyzing, synthesizing and evaluating information related to ethical and socio-scientific issues [1]. Inquiry is a way of teaching and learning which can make this aim possible. Suitably designed online environments can provide valuable scaffolding for students to plan, organize and carry at their work in interpreting evidence.

2. Conceptual framework

2.1 Inquiry

Inquiry learning is the basic approach to teaching science for more than a decade [2]. As pointed out in the National Science Education Standards, students who are involved in inquiry science learning, engage in similar activities and thinking processes as scientists who try to expand what we understand about the natural world [3]. This fact makes inquiry, as a way of learning, important because it gives students valuable opportunities to comprehend established scientific content as well as the nature of science [4].

Inquiry teaching involves authentic questions and activities in which students develop knowledge and understandings of scientific ideas, as well as an understanding of how scientists study the natural world [2]. One approach to inquiry teaching involves open-ended investigations in which there are more than one possible explanations or solutions to a problem.

2.2 Socio-scientific issues and decision-making

Socio-scientific issues are those issues which are related to social dilemmas that are conceptually or technologically linked to science. The inclusion of these issues in science curricula aims to relate classroom science with society [5] and also to bridge the gap between doing science and learning science. Students need to make decisions about such issues by giving careful consideration to scientific claims through making connections among data, inferences and conclusions. Students' capability to make such decisions demonstrates a functional degree of scientific literacy [1].

3. The inquiry environment

3.1. The problem

In this environment, students are provided with data regarding the following real-life, socio-scientific issue which has not as of yet been solved: "Many Welsh farmers feel that their lives are destroyed since their cattle die because of Bovine Tuberculosis (TB). They strongly believe that the reason the disease is spreading are badgers and they demand they be culled. Non-governmental organizations for the protection of the environment argue for a different solution to the problem. The government wants to help but needs more data about the problem in order to make a decision. Data from a scientific study show that the culling of badgers can often spread the diseases. The study took place in 30 sites in Western England and showed that culling badgers caused a 19% reduction in the incidence of cattle TB in the areas culled but led to a 29% increase in surrounding areas."

3.2. The intervention

The intervention is designed for elementary school students. During the investigation, students are divided into groups, each of which is assigned a role. There are four different roles: farmers, government employees, members of an organization for the protection of the environment, and scientists. Students need to decide how to address the TB problem and collaboratively collect data to defend their position in a debate with the other teams. Students are provided with conceptual scaffolding through a web-based workspace. The workspace is used by students in order to organize and reflect on the data they collect from the Inquiry Environment. Both the inquiry environment and the workspace are provided by the STOCHASMOS web-based platform.

3.3. STOCHASMOS platform

STOCHASMOS is a new, web-based platform in which teachers can easily author inquiry environments and design templates to support students' reflective inquiry processes [6]. STOCHASMOS consists of two parts: the *Inquiry Environment*, where the teacher can organize the investigation data in the form of text, graphs, tables, pictures and videos, and the *Workspace* where students can organize the data they isolate from the Inquiry Environment, explain and reflect upon them [7]. The *Workspace* is the area where students also synthesize their claim and their argument by interpreting the evidence that they deemed as relevant.

4. Presentation

In our presentation we describe a web-based investigation for supporting students' environmental decision-making. This investigation relates to a real-life problem and all the data are organized in the STOCHASMOS platform. Students are assigned roles in order to discuss the different solutions to the problem. A first enactment of this intervention will take place in 2006-2007 in Cyprus.

5. Acknowledgements

This work is partially supported by funding from the Cyprus Research Promotion Foundation and the European Community, Marie Curie Actions (IRG).

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Supporting Students' Reflection in Data-rich, Inquiry-based Investigations: A Multiple-case Study Report

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Abstract. This paper presents a multiple-case study which examines the role of different types of reflective scaffolding used by 6th graders in trying to solve a data-rich ecological problem. The need for reflective support, especially when students are engaged in complex investigations, has been extensively outlined in previous research. Students need help in order to manage the complexity of data-driven inquiries. Without appropriate support, it is reported that it might be difficult for many students to engage in high-level reasoning with scientific evidence. Two 6th grade classes took part in this research (53 students divided into 25 couples and one triad) using a web-based investigation on the STOCHASMOS platform. The students explored a local problem regarding the death of migratory flamingo birds at a salt-lake in Cyprus. Students in one class were provided data organization and conceptual scaffolding in a student workspace that is part of STOCHASMOS, whereas students in the other class used Microsoft PowerPoint to organize their data. We collected and analyzed both quantitative (pre- and post-tests) as well as qualitative data (videotaped six groups' investigations). In this case study, we analyze three groups' videotaped interactions and discuss the different ways the reflective scaffolding in STOCHASMOS influenced the course of the students' problem solving. The results have wider implications for the design of web-based learning environments and for the role of self- and group-reflections on facilitating inquiry processes with scientific data.

Keywords. Inquiry-based science, Web-based learning environments, Reflection.

Enhancing Student Learning with Interactive Physlet- and OSP-Based Curricular Material

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Abstract. From the invention of the television to the invention of computers and the World Wide Web, educators have often pinned their hopes of better instruction on technology. Yet teaching with technology, without a sound pedagogy, can yield no significant educational gain. Just-in-Time Teaching (JiTT), an interactive pedagogy constructed around current internet technologies, is one of the few approaches that has been shown to produce positive cognitive gains. Just-in-Time Teaching combined with Physlets (small, scriptable, Java applets) and Open Source Physics (OSP) programs have been used at Davidson College to actively engage students both inside and outside the classroom. We have assessed students' conceptual understanding after instruction, and actively engaged students are better prepared for class, are better motivated to learn the material, and perform better on standardized assessment instruments.

The Open Source Physics code library, documentation, and sample curricular material can be downloaded from **http://www.opensourcephysics.org/**.

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Keywords. Physlets, Open Source Physics, Conceptual physics.

Five Cornerstone Strategies to Make Science Classes More Enjoyable

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Abstract. Science Teaching is a joy, and a challenge. As teachers, we struggle with the same questions whether we have been teaching for two years or twenty years: how can children learn science easily? How do we help them to develop the skills needed to test ideas scientifically? What should we do to help our children experience the joy of science through a different lens?
There's an old proverb: "I hear and I forget. I see and I remember. I do and I understand." This belief lies at the heart of the "Science Teaching". If the teacher always is in the center of the learning process, children hear and see which means that they remember what they have learnt but, they forget it easily. While "teacher centered" classroom approach will always be a necessary part of teaching, it may not always be the most effective part. We learn by doing and exploring in life. So, we should give children a chance to learn science by doing and exploring.

Keywords. Informal learning, Hands-on experiments, Conceptual Learning.

1. Introduction

Students do not come to the science classroom empty-headed but arrive with lots of strongly formed ideas about how the natural world works. As teachers, we should use these ideas for building towards more effective and scientific ideas. To gain our aim, we should prepare a positive learning environment for children. In this environment, they should be actively engaged in creating, understanding, and connecting knowledge with others and with daily life. They should experience the joy of science through a different lens. But, how do we make it work in the classroom? Science includes lots of specific terms, processes, etc. It is hard for children to learn easily without getting bored or without having any problem during the learning process.
To solve those problems and to provide positive and enjoyable learning environment, you can use five cornerstone strategies. These strategies have been gleaned from the experiences of many teachers' science classes from different schools. Together these five cornerstone strategies, if implemented effectively, will help your students experience the joy of science through a different lens. can be used. In this work different strategies are presented.

2. Using a cartoon as an assistant

You can create your own cartoon and use it as your assistant during your explanations, experiments, games, activities, etc. For example, while explaining blood cells, my assistant, "Endocytotic Jason", introduces his brothers and relatives to my students that they are other blood cells or while explaining "fertilization in plants", I and my assistant suddenly arrange a magical tour inside of a flower.

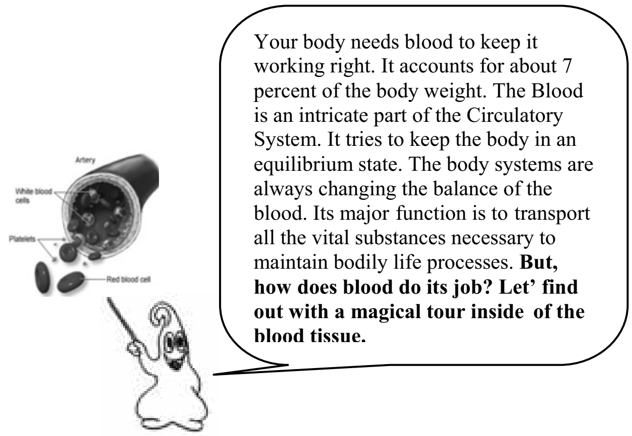

Figure 1. Introduction to the blood cells

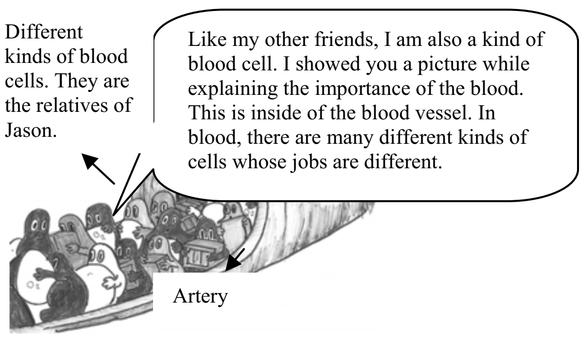

Figure 2. Jason's family and their importance for circulatory system

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When presenting a lesson with an assistant like Jason, it helps you to state the objectives clearly and to find out what the students already know about the subject. It also helps you to get students' attention and to motivate them easily during the lesson. Also, activities like these give students a chance to look the subject from different sides and reinforce their creativity.

3. Science through Time

Humans have made scientific researches through time with their powerful intelligence, ability to analyze, communicate and record and natural curiosity. So, why don't we use these researches and ancient myths for motivating children or understanding their misconceptions?

Every student brings to any subject some basis of knowledge, along with acquired preconceptions and misconceptions. As teachers, we can find out their misconceptions and their ideas, then, we can use them as a starting point for building towards more effective and scientific ideas. Also, you can make connections between other fields of science and subject areas such as history, sociology, geography, archeology, astrophysics, etc. and have a chance to enable students to test their ideas for explaining phenomena or events that are new for them. When topics are relevant to the students' lives, needs, and interests, learning becomes more meaningful and students learn easily without having any problem.

3. Hands-on and Minds-on Activities.

Hands-on and Minds-on activities help students learn to solve problems in ways that often lead to a far deeper understanding of the principles involved. This way of learning helps to support those problem solving skills that are a key part of the *Habits of Mind.*

These activities can be experiments, worksheets, puzzles, games, etc. either individual or in cooperative groups. These activities provide you greatest opportunities to turn your classroom a place of excitement. It helps teacher promote students' abilities, creativity and familiarity with modern technology by considering individual needs and learning styles. Also, they provide students question their ideas and test them against previous experience and new information. With daily hands-on and minds-on activities designed to help students learn more about topics, science concepts come alive! Teachers who are not getting students involved with science don't know what they are missing!

5. Science for entire family

Science learning is a life long learning process. It is not limited with the classroom. So, students can also have fun with their families when they do simple but meaningful experiments with them. By working with their parents to discover answers for themselves, students develop confidence in their ability to figure things out in life using their own innate knowledge and imagination. They discover that learning can be fun!

6. Assessment

They can be alternate and performance assessment such as observations, presentations, discussions, projects, investigations, portfolios, journals, experiments, field trips, etc. These assessment methods give an opportunity to the teacher in order to measure the skills and knowledge of a student and to evaluate student's understanding and abilities to use concepts and process skills. They also give teacher a chance to involve students in assessing their work which means that students improve their self-esteem and motivation.

As a result, five cornerstone strategies are useful for both students and teachers, if implemented effectively. They help teachers improve and reinforce children's skill, abilities and knowledge. They give a chance to students in order to experience the joy of science through a different lens!

7. Further information

Further information about the contents discussed in this paper can be obtained by emailing *syamanlar@gmail.com.*

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An Innovative Approach to Promoting Science with Young Children

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Abstract. This paper describes how a theatrical production was developed with the aim of promoting hands on experiments with 5-8 year old children. The production was about a girl, Fiona, who enjoyed doing experiments. As the story unfolds, the Children are asked to come up on stage and participate in the experiments. Children were eager to participate and enjoyed teh performance. A booklet was also prepared for teachers so that they could also do additional experiments related to the musical when they are back at school. Overall, the performance had a good and effective impact across primary schools in Malta.

Keywords: Primary science, Creativity, Theatre, Promoting science.

1. Introduction

The usual image of doing science is often that of students doing experiment in the laboratory, or in the case of younger children, in their classrooms. Often, unfortunately, doing science is relegated to learning concepts from book with little student engagement. Such science education does little to love science and to pursue a scientific career later on in their education. Students often view science as an abstract subject, not relevant and detached from everyday life. In addition to this, educators often discourage children from asking questions, extinguishing the enthusiasm and curiosity that young children naturally possess and which is essential to science.

How can we promote science? We need to find alternative ways and approaches to the traditional ones to promote science. It is important to find ways and methods that bring science closer to children's interests in order to attract them to science from as an early age as possible. One thus needs to think up innovative and unusual channels to promote science and which children enjoy. Channels that serve to kindle in children the interest to know more about the world around them, to ask questions, to investigate their ideas - that is, to do science. This paper is about one such innovative approach which uses a theatrical performance to promote science and which, with the help of the Hands on Science network, could be achieved.

2. The background

Every year, the B.Ed(Hons) students training to become primary level teachers at the University of Malta, are involved in putting up a theatrical performance from scratch. This is usually done in their last year of training and is done to provide prospective teachers with the required skills to put together a performance from scratch. They are thus responsible for the script, the props, the publicity, the direction and all the work that comes with putting together a professional production. Such skills are necessary as primary teachers are regularly involved in producing plays and other theatrical performances with the children that they teach. It usually also serves to help students develop their personality further as they learn how to act and perform in front of an audience.

This training has been running for a number of years, with the level and quality of the productions improving from year to year. The themes chosen have often been fairy tales, either in their original form or adapted to the local context or to the age of the children. The co-ordinator (Ms. Isabelle Gatt) is continually looking for new ideas and challenges as Teatru Qroqq (as she calls the groups) puts up different performances every year. It was thus that the production co-ordinator and the Hands on Science National co-ordinator in Malta that it was agreed to have a production dedicated to science and which aimed to promote doing experiments with young primary level children.

The theatre was chosen such that children will have easy access to the stage. In fact, the performance was produced in a theatre where the audience is seated on three sides and the stage lies below rather than above the seating area. As Fjona performed the experiments with the help of the children,

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the rest of the audience had a good view of what was happening.

3. The Story

Since there do not exist many stories relating to science and doing experiments on stage, a local professional author was contacted and invited to write a possible production. The author accepted the challenge and following a brainstorming session, it was decided to centre the story round a girl. A girl was chosen specifically to fight against the male stereotypic image that science is only for boys. The idea was to send children the message that even girls can be interested in science and be good at doing experiments. It was also important that the girl's character remains soft and that of a normal girl, avoiding the possible danger of presenting a girl who. Although female, still has a male personality. The insertion of magic in the production was another topic of discussion. Young children are often fascinated by magic, fairies, witches and fantasy. The debate was on whether to include fantasy with science. Following the first draft of the story, it was decided that it was best to leave the character of the witch but to keep the magical element to a minimum.

The story is thus about a girl called Fjona, who liked to do experiments. She had a sister who like to participate in her experiments. They were poor as their father, who had been a scientist was dead. Although poor, the two girls were not lonely, as they enjoyed the company of ten cats, each with their own particular personality. Fjona's mother was not happy with her daughter's interest in science. She believed that it would be better if her daughter was more interested in sewing as she could earn money and help the family. The opening scene, thus introduces Fjona doing an experiment with bubbles where she asks some children to participate and to study the shape of the bubbles produced by the different shapes. Fjona is an asset to a number of characters. Her aunt and uncle would like to adopt her as they believe that with her interest in science she may have some invention that her father had developed before he died and make them rich. So does the ugly and horrible witch, who wants to kidnap Fjona and keep her with her. As the aunt and uncle make attempts to take Fjona away and the witch plans how to steal her, Fjona is engrossed with her experiments. Whereas Fjona's mother resists the aunt's request to take away Fjona, the witch manages to kidnap Fjona. AS Fjona find herself in a room full of odd things, she starts experimenting, trying things out. The cats are angry at the witch and go to Fjona's rescue. As the cats free Fjona. They lock the witch, her assistant 'Buzillis' and her black cat in three large Easter eggs – the small cat in the small Easter egg, the medium 'Buzillis' in the medium Easter egg,, and the big witch in the big Easter egg.. To pay back the uncle and aunt, the cats give the Easter eggs to them. At the end, Fjona does some sorting and grouping with the children as they help her prepare gifts for her family. The last few lines of the performance invite children to keep on experimenting like Fjona, to ask questions to try things out, as science is fun and an enjoyable experience.

4. The Experiments

The performance included a number of simple experiments that involved the interaction of the children in the audience. They were simple, yet in the context that they were presented, they became attractive. This could be easily seen in the enthusiastic response from the children. There were overall five main experiments. One targeting the shape and production of bubbles; the second focused on white light and how it is made of the different colours of the rainbow; the third experiment targeted magnetism and included a simple fishing game; the fourth experiment was about sound and it transmission through a stretched string; while the last experiment involved classification.

The Bubbles Experiment

This experiment targeted the production of bubbles. Although at no point did the actors go into the technical aspect as to how bubbles are produced and the concept of surface tension, they managed to tackle the shape of the bubble produced. Fjona produced a number of bubble blowers with different shapes – some were circular, others in the shape of squares, triangles and all possibilities. The children were then asked to blow bubbles. After having some fun blowing small and large bubbles, the children are asked to note the shape of the blow bubbles and that of the bubbles produced. The aim is to help the children realize that the shape of the blow bubble has no effect on the shape of the bubble produced. It will always be spherical. The spherical shape is preferred as it is the shape that produces the smallest surface area to volume ratio.

The Colour Wheel

White light is made up of the colours of the rainbow. In the same way as white light can disperse in the different colours of the rainbow, in the same way, the colours of the rainbow can be made to produce white light. In trying to sort out an unsolved problem left by her father, Fjona is seen to try and find out the right colour that would produce white light. As she tries the correct colour and the cats turn the colour wheel at a fast rate of rotation, the colours are observed to disappear and white light results. The cats, in this case, produce the right medium to promote discussion of the scientific principles involved. They ask questions in trying to make sense of what had happened, and give Fjona the opportunity to offer a series of scientific explanations.

The Fishing Game

Fjona is up to another of her experiments. She wants to study the effect of magnets on different materials. She brings out a huge circular mat that represents a pond. She drops large fish of different materials onto this mat and takes out her fishing rods. Her sister is interested in the experiment and Fjona invites her to try and catch a fish from her pond. Which ones does her sister think will stick to the magnet? As the sister succeeds to pull up one fish, Fjona invites children from the audience to come up. The children are eager and a few are brought up to the stage by the cats. The children have fun collecting fish as Fjona asks how they know which ones will be attracted. Of course, some materials are attracted while others not. It is not all metals that are attracted by magnets, but particular metals such as iron and steel.

The Telephone Experiment

Fjona is now at the witch's place and finds a lot of things with which to experiment. Among them she finds some tins and string and wants to see if she can use them to communicate across a distance. She makes two holes in two tins and treads a string through them to make up the phone. But she has no one to help her try out her new experiment. What can she do? As she tries to sort out her problem, Fjona asks one child from the audience to help her. In one case a girl came up. She was asked to go to the other end of the stage and to keep the string taut. When the girl was ready, Fjona talked to her. Did you understand what I said, she asked her. The girl nodded, showing how easy it is to talk over a distance with no need to shout.

Sorting and Grouping

This was done in two instances. The first instance involved the three Easter eggs. These Easter eggs were made to hold the cat, the assistant and the witch. They were classified as small, medium and large. The Easter eggs were thus also classified as small medium and large. The second case of classification came at the end, when having got rid of the aunt as well as the witch, Fjona wanted to thank her family and cats for al that they had done for her. As she prepared the presents, she asked the children to help her choose the right size of boxes. Which box would best hold the big vase for her mother or the round ball for her sister? The children shouted out their choice from their place as they participated and helped Fjona.

One might argue that all these experiments are simple and do not require the need for a theatrical production to carry out. The difference, in fact, does not lie with the experiment in itself, but rather with the context within which it was done. The children were provided with an opportunity where they can enjoy carrying out experiments in a different context.

One important aspect of out-of-school learning experiences is the need for reinforcement once the children go back to their classroom. In view of this need, the student teacher who were specializing in science, worked on producing an accompanying handbook. This handbook focused on each of the five experiments done in the performance. For each performance, the booklet had a section which described in simple language the scientific concepts involved and provided some practical tips on how to reproduce the experiment in the classroom. In addition to these, the booklet also included suggestion for additional activities and experiments, together with worksheets that can be photocopied and used directly with the children. This way, the theatrical performance could be a learning experience also for the teachers, who can go back and learn and explore science together with the children.

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5. Conclusion

Reconciling science and the performing arts is no simple thing. Using the performing arts to promote science was an achievement beyond the expectations of the Hands on Science network. In wanting to share this experience of success, the production coordinator, together with the Hands on Science National coordinator in Malts, and the two student directors would like to share this experience with others. The Hands on Science network will also fund the translation of the sript to English and have it published for circulation in primary schools across Europe. The teachers accompanying book has also been published for dissemination.

This initiative provided the possibility for student teachers to contribute to the primary schools that offer them the opportunity to train as well as the children with whom they learn and develop their teaching skills, the chance to experience science in an innovative way. It also serves to promote science with primary children. Hopefully, there will be more opportunities in the future when the production will be put up again, possibly with more experiments such that more children can gain from such a positive experience.

Conceptual Change in the Topic "Earth in Space" Based on an Interdisciplinary Approach of Physical and Natural Sciences in Basic Education

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Abstract. The present investigation was developed with 7th grade students and took place in a school of Bragança, in the northeast of Trás-os-Montes. Two groups of work were built, to which two different didactic approaches to the topic "Earth in Space" were applied: a subject approach and an interdisciplinary one, both having conceptual change as basis.

Unlike the subject approach, in which the contents were taught according to the syllabus sent out by the Ministry of Education, the interdisciplinary approach implied a cooperation work between two teachers of Physics-Chemistry and Natural Sciences. Since the syllabus of both subjects has got contents that are repeated, they made their selection, reorganization and sequence, in order to be taught by each of the subjects in an interdisciplinary way.

The survey test, which was given as pre-test and post-test, was used to identify some of the ideas that the students bring with them to the classroom and also to verify if there was (or not) progress regarding conceptual change, thus testing the effectiveness of the adopted approaches. It was proved that several researchers had already identified some of the alternative conceptions held by the students.

The results suggest that the interdisciplinary approach, applied to one of the groups, was more effective (about 26%) than the subject approach, since the most significant progress was detected in questions that implied, more directly, an interconnection between contents of both subjects.

Keywords. Conceptual change, Integrated science teaching.

1. Introduction

This study was carried out with seventh grade students in a school of Bragança, in the northeastern part of Portugal. Two work groups were considered to whom two didactical approaches were used to teach the topic "Earth in space": a disciplinary approach and an interdisciplinary approach, both aiming at the conceptual change.

With the disciplinary approach the contents were taught according to the curriculum guidelines issued by the Ministry of Education, while the interdisciplinary approach was based on the collaborative work of two teachers of Physical and Natural Sciences. The programs of both disciplines have subject topics that overlap and because of that the content of both disciplines was reorganized in order to be taught in an integrated way.

In order to test the teaching methodologies used we submitted the students to a knowledge pre and post-test, to identify some of the ideas the students have and bring to the classroom and also to assess what kind of conceptual change took place. In fact, other researchers had already diagnosed many of the alternative conceptions that the students showed.

As the teaching of science has not been taught in an integrative way, it seems relevant to reflect about its evolution. During the fifties, the teaching model widely accepted was the transmission model, in which the teacher was seen as the centre of the learning process, and his job was to deliver scientific knowledge to the students according to the program. Freire (1975) called this teaching approach the "learning bank" in which the students were seen as banks where the scientific knowledge was deposited. What mattered was the learning of the scientific concepts even if it took place by rote learning. The students did not relate the scientific topics but did accumulate them instead. The students were not allowed to raise questions, to develop decision-making skills and so construct their knowledge [13].

By the end of the fifties, a new teaching model came out in which the student took the main role. He learned by discovery, meaning that he was supposed to observe the facts and deduct the ideas from them [26]. This teaching model collapsed during the eighties as some authors considered that this model allowed the illusion of discovery of the scientific concepts by the student merely based on the observation of phenomena. By the end of this decade appeared the alternative conceptions movement that paved the way to the constructivist perspective of teaching and learning science. Von Glaserfeld [30] called this constructivism the "theory of knowing", in opposition to the "knowledge theory". Therefore, the constructivism is the way to know and understand the world, meaning that knowledge is constructed by the individual. Learning is seen as a conceptual change process and not as an acquisition process. Moreover, the teaching of science also implies a methodological and attitudinal change.

For many years, the curriculum was a whole of subject matter of several disciplines and people were not concerned about coherence and integration. This knowledge was organized in programs to be followed by teachers and students, in the same sequence and amount of time allocated to the teaching and learning process. The teachers were supposed to teach the contents of the program, "to deliver the program" [22].

Along the way this notion of the curriculum changed as changed the teacher's role to implement it. According to Simão [28], there was a transition from a disciplinary logic to transdisciplinary logic.

In the academic year of 1998/1999 started the national project "Flexible Curriculum Management" (FCM) which was made possible by the autonomy given to the schools (D.L. nº.115 A/98) and is implemented through the School Educational Project. This can be understood by the definition of FCM: "Flexible Curriculum Management means the possibility of each school to organize and manage with autonomy the teaching-learning process, having as reference the nuclear knowledge and skills to be developed by the students at the end of each term and at the end of the basic education, taking into account the needs of the school context and contemplating the introduction in the curriculum of local and regional components" (Despacho 9590/99, 14 de Maio).

With the objective of "going beyond the vision of the curriculum as a set of rules to be strictly followed in every classroom, the development of new curriculum management practices", was created the D.L. 6/2001. According to this law, it is recognized "to implement a curriculum reorganization (...) in order to reinforce the articulation among the three cycles (...) of the curriculum content and the organization of the induction and follow up processes which guarantee (...) a better quality of the learning process".

The emphasis put on the integrated curriculum management of the educational project of every school is intended to reinforce the curriculum flexibility, allowing the teachers to be constructors instead of consumers of the curriculum [19].

A study done by Sequeira et al. [27] shows that the FCM contributed for the distribution of the subject content through the three years (7th, 8th and 9th grades) and the cooperation of teachers to articulate the content. In this study, Sequeira et al. Also concluded that the teachers have little experience with the FCM and feel the need for preparation in that area. Regarding the Physical Sciences and the Natural Sciences there was an adaptation and an integration of the contents of the disciplines. Sequeira et al. [27] also concluded that the FCM influenced those disciplines at the organizational level and that was evident the need to develop didactical

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materials, as well as to prepare teachers to contribute to the learning process of the students.

According to the D.L. 6/2001 of January 18th, sets of competencies were defined for the students to attain at the end of each cycle. The objective is to promote the integrated development of the students' capabilities and attitudes in order to use their knowledge in different situations. The teaching of science in Basic Education (first to ninth grade) is organized under four topics: Earth in Space; Earth in Transformation; Sustentation on Earth and Living better on Earth. It is important to emphasize the need to explore these topics in an interdisciplinary way, in which the interaction Science/Technology/Society and Environment should be the basis for a global and integrative organization of the acquisition of scientific knowledge.

It is possible for the teachers of Physical Sciences and Natural Sciences to organize their teaching and the contents of their disciplines in such a way that can prevent the overlapping of contents and guide the students to develop common projects. The topics and their sequence in the curriculum may be altered, depending on the teachers' collaboration and coordination [19].

As we all know interdisciplinary is not a new pedagogical approach but rather an initiative of the teachers with the purpose of improving their teaching practices and the educational reforms that have taken place in Portuguese schools in the last two decades. In this sense, it was created an interdisciplinary area called School Area (Área-Escola) it the purpose of articulating the programs of several disciplines in order to integrate the content [23].

The latest educational reform reinforced the importance of the interdisciplinary work introducing new curriculum areas of non-disciplinary nature- Project Area, Guided Study, Citizenship Education.

However, we can also organize interdisciplinary work amongst several disciplines. The latest reform, as said before, took into account the reorganization of the programmatic contents of the disciplines Natural Sciences and Physical Sciences in order to complement the content and prevent repetition of topics. In order to achieve this goal, teachers need to communicate and collaborate constantly to help students establish a relationship between the contents of both disciplines. The program of both disciplines has common topics and they have some overlapping contents. One of these topics is Earth in Space and one of the contents that are repeated is the construction of scientific knowledge and technology.

In Physical Sciences, the topic Earth and Space approaches some contents that offer explanations to several visible phenomena to which man without education in this area does not have an acceptable scientific explanation, hence the existence of different conceptions-the alternative conceptions. Therefore, research is needed to identify those conceptions and try the conceptual change, although there is already some research which indicates that the students do have several alternative conceptions about topics related with the subjects under study [3], [10], [21], [25], [29], [31].

Albeit these studies have identified the alternative conceptions it is always relevant to verify if these conceptions are present in our students and try the conceptual chance through the collaboration of two teachers in an interdisciplinary way.

The topic of Earth in Space is essentially about aspects related to astronomy in Physical Sciences with the interaction Science/Technology/Society and the planet Earth as a living planet in Natural Sciences, is of great importance, as there is no Portuguese research on conceptual change based on an integrated approach in physical science and Natural Sciences. Furthermore, this topic is not properly treated at a university level in teacher education.

Another motive for this topic to be studied is due to the fact that it fits well to the teaching strategy of conceptual change, which will be used in the analysis of the interdisciplinary of the aforementioned subjects.

This study has the following objectives: a) 7th grade students previous knowledge associated to the topic Earth in Space; b) to analyze of 7th graders capacity to interrelate concepts in the topic Earth in Space; c) to develop an integrated didactical approach to the topic Earth in Space; d) to compare the efficiency of the proposed approaches of the Basic Education Guidelines and the integrated didactical approach of the topic Earth in Space.

The review of literature on studies of conceptual change on Earth in Space carried out by foreign and national researchers showed that there are many alternative conceptions amongst students and adults.

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There are several studies related to the identification of students' misconceptions on different topics and different educational levels but we cannot find studies relative to the importance of interdisciplinary in conceptual change.

Therefore, the integrated didactical approach of the topic earth in space is interesting and relevant, as it tries to identify the existing the alternative existing conceptions of a group of students. Later on, through a collaborative work between two teachers using a teaching approach oriented to help the students change their alternative conceptions, we want to find out in what way the didactical approach is more efficient than the different approaches of the disciplines of physical sciences and natural sciences, as proposed in the basic education guidelines [8].

It is also very important the evaluation of this teaching approach as the learning of this topic is associated with some difficultyand we also want to verify if the teaching approach helps the students understand the topic.

2. Methodology

To organize the teaching methodology oriented for changing students misconceptions and the analysis of their capacity to interrelate scientific concepts that were implemented in the classrooms in which the study took place:

a) The 7th grade programmatic content of the disciplines Physical Sciences and Natural Sciences on the topic Earth in Space was analyzed and reorganized in the experimental classes. A disciplinary approach was used with the control classes, following the contents sequence proposed by the basic education curriculum Guidelines [8];

b) The student's alternative conceptions were identified and their capacity to interrelate the scientific concepts needed to understand the topic under study;

c) A review of the literature on student's difficulties on the topics under study was made;

d) The teaching of the topic was contextualized.

The analysis of these aspects allowed establishing a sequential connection to approach the topic and also to select and apply teaching materials that helped the construction of a meaningful learning.

The teaching method based on constructivist principles was based on the model by Champagne et al [5] "Predict, Observe, Explain", and later on added "Reflect", as suggested in other studies [1]. The classroom activities had as main objective to help the students to:

a) Identify and point out the difficulties detected in the pre-test, in order to be aware of the existence of other explanations;

b) Establish conflict relationships between data and the causes that originated their predictions;

c) Restructure their ideas in order to reach scientific accepted concepts, when confronted with the fact that their predictions were not scientifically correct;

d) Be able to pave the way to create their own knowledge;

e) Create opportunities in order to apply the learning models to new situations.

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3. Results and Conclusions

This study attempted to analyze how an interdisciplinary approach to teach the topic Earth in Space is more efficient than a disciplinary approach to the same topic. Therefore, taking into account the objectives of this study we reached the following conclusions. Relatively to the objective of identifying the 7th grade student's alternative conceptions associated to the aforementioned topic, we concluded that the student's construct intuitive explanations of physical phenomena which have their origin in daily life and more often differ from the excepted scientific explanations. Therefore it was verified that the students, before the teaching of the topic Earth in Space, had alternative conceptions, some of which had already been identified by several researchers and others had not yet been identified in the literature.

Regarding the second objective, that attempted to analyze the capacity of 7th grade students to interrelate knowledge on the topic Earth in Space, it was seen on the pre-test on both experimental and control groups that resented many difficulties in interrelating the contents of both disciplines physical sciences and natural sciences. When we compare the results obtained on the pre-test we see that both groups were quite homogeneous, and we could not register meaningful differences at the level of the student percentage who showed to have

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alternative conceptions, as on average about 68% of the students of the experimental group and about 69%of the students of the control group showed alternative conceptions related to the scientific accepted ones.

Given that the third objective was the development of an integrated didactical approach to the topic Earth in Space, and because it was intended to help the students to change their initial conceptions and build models closer to those scientifically accepted, it was used both with experimental and the control groups, a teaching methodology oriented towards conceptual change. However, in the experimental group the conceptual change was tried with an interdisciplinary approach of the contents of Physical and Natural sciences while in the control group was adopted a traditional teaching strategy, meaning that the contents of it's subject were approached according to ministry of education guidelines. It should be emphasized that the sequence of the contents was also different-while the experimental group followed a common planning strategy to both subjects; the control group elaborated different plans for each subject. In both groups the teaching of the topics was developed with the method "predict","observe","explain" and "reflect".

The fourth and last objective attempted to compare efficiency of the teaching approaches proposed in the basic education curriculum guidelines and the integrated didactical approach to the topic Earth in Space. The evaluation of the efficiency of the methodology was carried out on the basis of the evolution of the participants. Hence, it is important to remember that on the pre-test both groups showed to be relatively balanced regarding the capacity to establish an efficient articulation of the contents of Physical Sciences and Natural Sciences.

However, after the instruction, as can be seen on table one, the results obtained point out to a very significant evolution of the experimental group, because the change of the initial conceptions was on average of 63%, and it was never less than 56%and over 94%(percentage of the evolution of categories Does not answer, alternative conception and incomplete to category Scientifically accepted and from categories Does not answer and alternative conceptions to the category incomplete answer) .The control group showed a more discrete evolution, given that the percentage of that evolution was on average around 42%(less than 31% relative to the experimental group).The percentage of the lowest evolution (of categories Does not answer, alternative conception and incomplete to category Scientifically accepted and from categories Does not answer and alternative conceptions to the category incomplete answer) was 17% and the highest 69%.It should be noted that the questions that implied a higher relationship of the information were the ones where we could verify the biggest difference in results between both groups.

The students of the experimental group showed less difficulty in establishing a concrete interrelation of the subject content of both subjects than the control group.

Comparing the percentage of evolution from categories Does not answer, alternative conception and incomplete to category Scientifically accepted, we can see that on average the control group had a higher evolution about 29% in relation to the control group. In the experimental group the percentage of this type of evolution is not less than 23% while in the control group there were topics in which no evolution was registered. When comparing the evolution of categories Does not answer and alternative conceptions to the category incomplete answer, did not take place, on average, any significant differences both in the experimental and in the control group, as well as between the experimental group and the control group.

Generally, it was identified that the students' ideas of both groups changed towards the scientifically accepted model. However, the results obtained indicate that the teaching methodology based on interdisciplinary was more efficient to attain the desired learning level, that is, it promoted quite satisfactorily the change of the students' initial ideas. In fact, after being thought, some students still presented similar explanations to the ones they had before being taught, but in a much lesser degree.

On the other hand, in the posttest some students demonstrated conceptions that were not found during the review of the literature, which could be due to some sort of confusion of concepts. In other situations, the students show some progress in comparison to the initial conceptions, although these ones are still included in alternative conceptions. As an example, there were students on the pretest that associated dusk to the absence of the sun or to the appearance of the moon and stars and, on the post-test, although they still mention the appearance of the stars as cause, there was already a connection to the rotational movement of the Earth.

Sometimes conceptual change is difficult, because the students construct their own modals based on their sensorial experiences as can be seen, for example, in their conceptions that relate the origin of night with the absence of the sun and the appearance of the stars and of the moon or when the students say that falling stars are stars that are moving across the sky. There were also in this study conceptions with a deductive or analogical character, as the students explained certain phenomena by deduction, for instance, there were students that explained seasons of the year by inferring that the earth runs faster or slower according to the season of the year; some others say that in summer we are closer to the sun, comparing their experience to the vicinity from a given heat source; some others still justify the fact that the earth does not have impact craters because it has a lot of water, in which the meteors fall down not causing any craters.

The students' alternative conceptions requires, quite often, more than an accommodation of new information to the existing mental schemes, that is requires restructuring and substituting of the previous conceptions by new ones. The interdisciplinary approach gives the students the opportunity to reflect, to relate knowledge and discuss many actual questions, contributing to the change of their conceptions about the way they should be on this world and in the universe they belong to.

On the first cycle (first four years of study) some of these topics, namely the ones related to astronomy and the Earth characteristics that allow the existence of life, are superficially approached, and therefore it is crucial that the teachers in every one of the cycles, understand which are the basic information they should give to their students, considering that citizenship education is an ongoing process. As the topics mentioned in this study are included in the first cycle, even though superficially, it is important that teacher education includes these topics at the level of the first cycle of basic education. It is also important that the teachers of this cycle, and more, elicit the children's curiosity by organizing study visits to planetariums. If this type of activities is not possible, it is always possible to organize science open days in schools with experiments that the students can perform. Relatively to the resources used in the classroom, it makes sense to develop efforts to construct/apply diversified and adequate didactical materials, given that the major part of the ones that already exist present very similar approaches, that can originate less interesting classes for the students. This aspect is still more important if we consider the manuals, in most cases, to be the only material that the teacher uses to prepare his classes, reinforcing sometimes some conceptions that are supposed to be restructured. On the other hand, has referred by Leite [18], the teachers themselves must be criticize the textbooks in order to "make supported decisions about the use of activities (and the) evaluate the (in)compatibility of the activity proposals with the main points they want to teach and the skills they want to develop in their students"(p.246).

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Table 1- Percentage of the evolution of students' answers in the pre and post-test.
(N=75)

Category evolution from pre to post test.	Experimental Group (N=44)	Control Group (N=31)
Does not answer, alternative conception and incomplete to the category scientifically accepted and from the categories Does not answer and alternative conceptions to the category Incomplete answer.	73	42
Does not answer, alternative conception and Incomplete to the category scientifically accepted.	47	18
Does not answer and Alternative conception to the category Incomplete answer.	26	24

The Importance Teacher's Produced Syllabus Curricula: New Perspectives of Geography Learning

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Abstract. In Brazil, it isn't common the teacher's them selves to produce the school's curricula. In fact, almost all of them reproduce the official curricula, because everything comes ready for them. They become a "reproducer" of the knowledge not a "producer" of it.

Giroux (1997) said that teacher is a "intellectual" but in Brazil, we may say that it is difficulty to see that. He feels he is considered to have no "value", he is de-motivated by low salary disrespect of the class and bad work' conditions. Some authors like Sacristán (1995) confirms how important is the teachers to be conscious of their formations and they have to look for a better ways to reason about what they do. Arroyo (1999) comment that the teachers in Brazil should be responsible for the construction of the curricula, to organize and develop the "learning school", and the Govern should be responsible for guarantying good conditions to become possible to the teachers to think about and construct things for their school. The students generally studied what the Govern wanted. Geography was mainly used to promote a national ideology (and the Govern used it for to winning wars, for exploring the nature and so on) Lacoste (1988). During the years, many studies in Brazil and all over the world saw the importance to show the real necessity to study the Geography that is: making peoples understand how to organize the space they live and show them how they produce and they influence this space too. So that why is important to geography teachers to produce their curricula, because they know what is important to their students study. Principally, they´ll be able to product the present-knowlegde.

Keywords. Geography, Teacher´s formation, Geography´s curricula.

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Step-by-Step Scientists

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Abstract. The way that science is taught in our schools profoundly affects student perception of the world and consequently their interest in following scientific careers. An inspired teacher can decisively improve scientific skills of his/her students, by teaching them good conceptual grounds of relevant scientific phenomena with activities relying on experimentation. Although such practices seldom come naturally, they can be learned or improved.

Since chemistry is a complex concept for many students in secondary school, the proposed experimental work is intended to motivate the assimilation of some concepts by developing an experimental method [1-3].

When hands-on activities are planned, certain precautions must be taken to protect the students. The protection is necessary regardless of the nature of the activity, even if the "safest of chemicals" are being used [4].

This paper presents two attractive experiments: The oscillatory reaction and the magical indigo in Jeans clothes. These experiments spans several scientific areas in chemistry, ranging from organic synthesis making use of indigo dye, in physical chemistry with concepts from equilibrium chemistry to red-ox reactions and the relationship between colour and spectroscopy techniques.

Figures 1 and 2 show the information that was presented during the experiments in order to help the students understand what was occurring during all steps. The proposed experiments are simple and easy to perform with readily available and inexpensive equipment and materials.

Keywords. Children, Chromatographic activity, Osmosis in food activity.

(i)

(ii)

Figure 1. Oscillatory reaction experience: (i) presentation and (ii) how it looks in the laboratory

The active participation of students in experimental work sessions gives them the chance to express the concepts, perceptions and feelings about science and at the same time will increase their knowledge and skills. This type of analysis would be an excellent experiment to introduce students to the world of chemistry, an important domain of our society.

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(i)

(ii)

Figure 2. Magical Indigo experience: (i) how it looks in the laboratory and (ii) presentation

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The Joy of Science

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Abstract. Children's have always been curious how things work and interested in creating and living new experiences.

This work was developed for the children between six and seven years old from Colégio D. Diogo de Sousa in Braga (Portugal). The scientific activities included in this presentation are based on experiments which illustrate school curriculum content. Teachers are usually familiar with teaching content, however investigative skills are crucial to our understanding of how science works. How can we teach content and at the same time teach students how to ask (and answer) researchable questions, design projects, differentiate between observation and inference and construct reasonable explanations?

Figure 1. The activity with autumn leaves

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The children carried out experiments with sample materials for study of the tasks attributed to them. Their teacher introduced several subjects, for example, the seasons, health and food or colours, and elaborated different activities with the children. The active participation of the children in experimental work sessions gives them the opportunity to record observations, ask questions and express perceptions and feelings about science and at the same time increase their knowledge and skills.

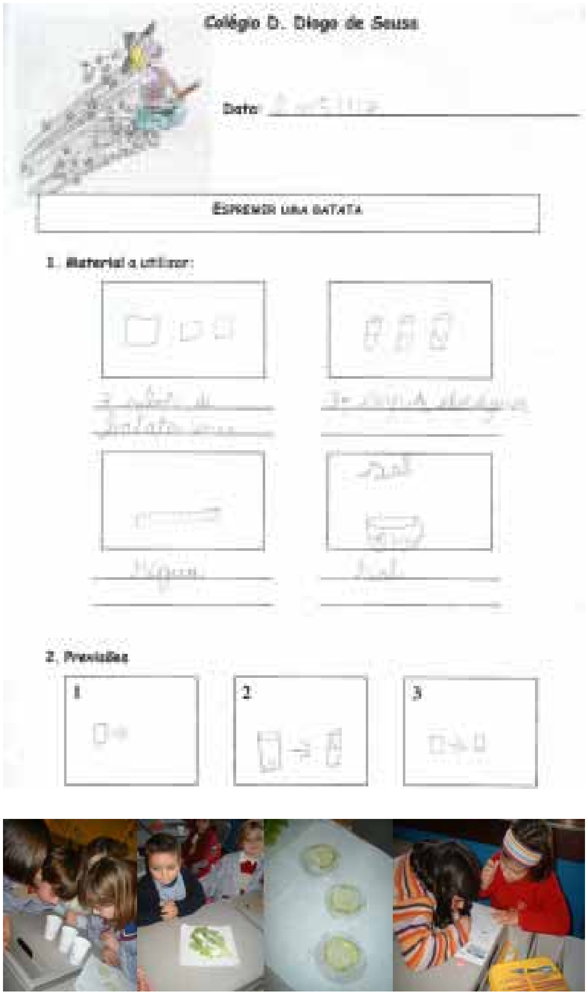

Figure 2. The activity with osmosis in food

This paper presents the results of different activities carried out with the children: The chromatographic study of autumn leaves and osmosis in food [1, 2]. The proposed activities are simple and easy to perform with readily available and inexpensive equipment and materials.

Figures 1 and 2 present the reports obtained from the children for the activities with autumn leaves and osmosis in food. These reports are prepared during the activities.

When hands-on activities are planned, certain precautions must be taken to protect the children. This protection is necessary regardless of the nature of the activity, even if the "safest of chemicals" are being used [3].

Keywords. Chemistry, Oscillatory reaction, Magical indigo.

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Construction of a Water Flow Energy Generator Prototype

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Abstract. The main goal of this project is to construct a giant wheel that when placed in a

water flow, generates electric energy. This prototype should work independently of the direction of the water flow, producing direct current whenever the flow is in one sense or in the other. The project can be divided in two tasks, accomplished to build the prototype: the "mechanical support" and the "electric circuit". Each task has its own physical problems and conceptual approaching, as we shall explain.

Keywords. Energy Generator, Angular Speed, Electric Current, Diode Bridge, Electric Voltage.

1 Mechanical support

The giant wheel was built by using the commercial kit "Giant Wheel" from Fischer Technik. The structure was then attached to a wood platform and free to rotate in either sense – this simulates the platform that fluctuates in water (Figure 1).

Figure 1

The easiest way to produce electric energy is to rotate the axis of an electric motor. In order to enhance a high angular speed (w) to the motor's axis, we adapted to the periphery of the giant wheel (radius R) a small gear (radius r) attached to the axis of the electric motor.

For a better mechanical connection between the giant wheel and the gear, friction was increased by gluing a sponge scotch to the wheel's periphery.

2. Electric circuit

When the axis of the motor rotates, an electric voltage is produced between the motor electric contacts, in order to generate an electric current when inserted in an electric circuit. However, each time the rotation is inverted, the current circulates in the opposite sense.

To avoid this and to ensure that we always have direct current, at least in one branch of the circuit, one must insert diodes in the circuit. By using a diode bridge, electric charges can be accumulated in a capacitor or be used to light a lamp.

3. The Prototype

In our prototype, we used two electric motors in two electric circuits with diode bridges: one with LEDs of different colours to identify the current's direction and a red diode in the direct current branch, and the other with a capacitor in the direct current branch (Figure 2).

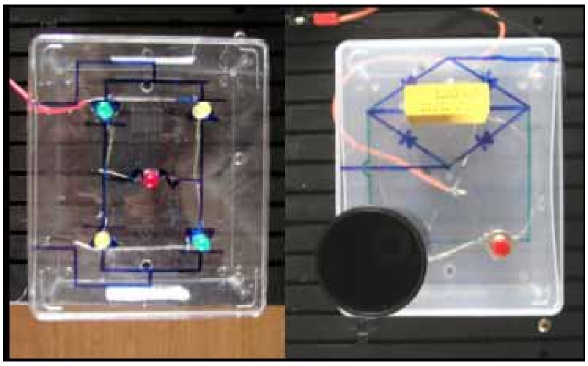

Figure 2

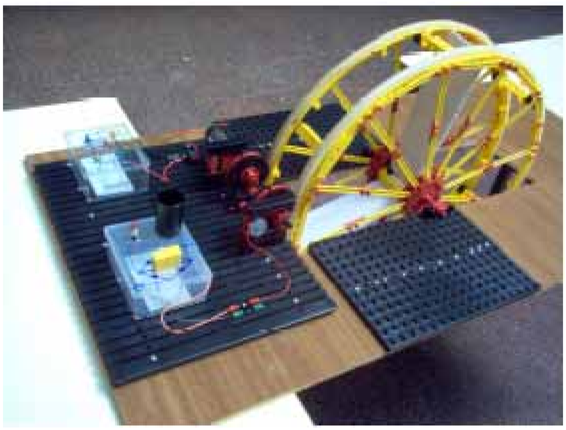

Figure 3

A relative small rotation of the giant wheel in either sense (in a real context, produced by the water flow), easily produces electric current enough to light the LEDs and charge the capacitor (Figure 3).

Therefore, electric energy can easily be produced at zero cost in rivers and near the shore, while we take a swim or simply watch the waves up and down the beach.

In this project we faced real problems, involving different physical concepts and established relations between them, in a similar way scientists do to overcome a problem and create new applications.

Experimental Devices Made by Students and Experiments Realized with Them

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Abstract. "Global Science Club" is a Club of our high school students' which contains activities within the European project "Hands on Science". Global Science Club has initiated a « work environment » which has as objective « Students making experimental devices with the things they have at hand ». Thus, the identification of practice applications is emphasized, applications that allow the students' interest growth in the sciences' study, as well as projecting and making samples and experimental devices by students, which can facilitate the learning of sciences. Among the experimental devices made by the students, the following are to be remarked:

1. Oblique plan – device for the study of rub force slipping on angles of 30^0 ;45^0 and 60^0 ;
2. Pyramid and its mysteries – pyramid's energy, pyramid water and it's therapeutically effects and others;
3. Magnetic – device to prove the heat's influence on steal objects and on magnets (which lose their magnetic properties);
4. Steam little turbine – device to prove the steam little turbine's principle;
5. Pyrometer – device for the study of solids' linear dilatation;
6. Applications of circuital electrics – electric device for illuminating

Method and Set-up to One-step Recording Rainbow Holographic Art Exhibits

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Abstract. During its history, Photography has transformed itself from a method to record bi-dimensional images (of artistic objects - paintings, f. e.) in an art by itself – the Photographic Art. Holography, more than one century younger than Photography, by its capability to record and resituate information on the third dimension of objects (by recording and reconstructing the phase of the object wave) has played, for sculpture, architecture, design, the role photography has played for bi-dimensional arts. Holography, is evolving itself towards an independent art.- the Holographic Art.

Keywords: Holographic Art, One-step Hologram Recording. Rainbow Hologram Interferometry, White Light Reconstruction.

In the last years, in the Laboratory of Holography of the University "POLITEHNICA" in Bucharest (UPB), the author has voluntarily trained, every two years, 2-3 master students from the National University of Arts in Bucharest (UNAB), with the intention to open way to introduce Holographic Art at UNAB, which, by now, does not have a Holographic Studio.

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By considering the present scarcity of financial resources of both universities implied, it has been necessary, for training future art holographers, to make use of the existing in UPB: expertise, - holographic equipment, - silver halide holographic plates; to produce holographic exhibits to offer reconstruction of images in white light (not applying to lasers for reading,, as for normal holographic reconstructions) and to reduce, as much as possible, the technological chain of the holographic process from idea to the final exhibit.

The conclusion has been that the Rainbow Holograms would be the most convenient holograms to start with to introduce Holography at UNAB and that there would be necessary to design a one-step technique to obtain directly the Rainbow Hologram Art exhibits, without intermediate recordings.

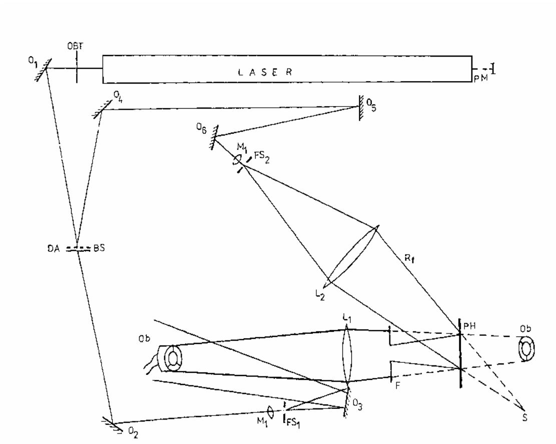

Fig. 1. The Holographic Set-up for one-step recording rainbow art holograms (diffuse objects)

A Holographic Set-up, close to the one used by the author to develop Rainbow Hologram Interferometry [1], a set-up able to comply with the mentioned requirements, has been assembled and used with a scheme represented in Fig. 1 (when operating with diffused objects but conveniently changed for transparent objects – in a transmission configuration).

This approach might be considered a “Retro” one, but oriented towards a new opening – the Holographic Art.

The coherent light wave is generated by a LASER (HNA 188, CARL ZEISS 1976), the emitted light having a wavelength (633 nm) convenient to the photosensitive materials used (Holographic plates ORWO) and enough coherence length. (~2m) for the set-up.

The laser wave is re-directed by the mirror O_1 and divided in amplitude by a beam splitter BS (DA, in French and Romanian), in two mutually coherent waves (finally - Object and Reference).

One of these two waves illuminates the object Ob (of interest to the Art Holographer), after being enlarged by the lens M_1 (usually a microscope objective) and filtered by the Spatial Filter F S_2

The Lens $L_{1,}$ not quite usual in the standard holographic set-ups, is adjusted to generate, behind the Holographic Plate, PH, a real image of the object, Ob.

The cross section of the wave coming from the object is limited, by the specially introduced slit F, which plays an essential role in one step recording of the rainbow hologram.

By significantly restricting, in one direction, the size of the aperture which limits the cross section of the object wave, the slit F is ensuring the reconstruction with a polychromatic reading source, even of white light...

With a second lens $L_{2,,}$ there is projected a real image of the very small aperture of the Spatial Filter SF_2 on a point S, behind the holographic plate PH, as to act as a virtual point reference source S for the hologram (which is to finally become an art exhibit).

All the components of the holographic set-up are fastened (magnetically or mechanically) to a holographic table of high stability, mechanically insulated from outside vibrations, vibrations that unfortunately could change the optical distances between components during the exposure time and destroy the stationary interference pattern when recording. The environment’s temperature is maintained constant, during exposure.

The latent image generated in the photo-sensitive layer, during exposure, is embodying the real (recordable) interference pattern of Object and Reference waves impinging on the Hologram, and, by this, is recording the complex amplitude of the Object wave, as both the real amplitude and the phase of the Object wave.

After conveniently processing the photosensitive material (so that the amplitude modulation of the incident light by the

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recorded pattern, become proportional with the intensity of the incident field), the latent image becomes an image to be read.

To get a better luminosity, the hologram may be bleached – the absorption image being transformed in a phase image.

The micro-relief structure appearing in the photosensitive layer (as local variations of the refractive index or of the thickness) may be used by transmission, as a transparent, phase, micro relief or may be covered with a reflecting thin layer of uniform thickness to be used by reflection, depending of the designed use of the Holographic Art Exhibit.

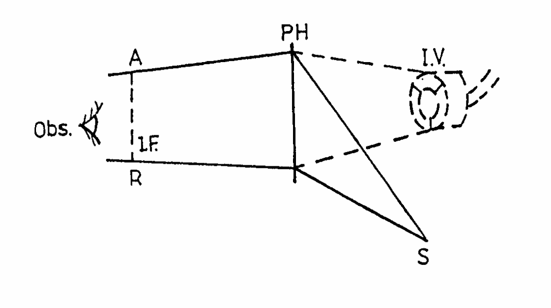

Fig. 2. The reconstruction of the primary object wave with a point source S

When illuminated by a reading source S (Fig. 2), the Hologram reconstructs, both, the object's Virtual Image I. V. and the real image of the slit F used when recording the hologram. If the reconstruction light is polychromatic, there are reconstructed a set of dispersed parallel slits, and correspondingly a set of dispersed object images (“rainbow”), in the colours corresponding to each spectral component of the reconstruction light.

The Observer (Obs. In Fig. 2), with the eyes placed along a really reconstructed slit image, sees the reconstructed virtual image of the object when looking "through" the reconstructed slit, in the colour corresponding to that slit. Moving the eyes normally to the slit direction (between A and R), the reconstructed image of the object (3-D, having “depth”, too) is seen changing the colour (and position), depending on the spectrum of the reconstruction source and on the eye’s position with respect to the reconstructed slit.

The reconstructed image has artistic value. It is bright, colourful, and changeable. The physical recording may be replaced by simulation on computer. . The Art Hologram may be replicated on standard equipment, existing on the market.

The UPB and UNAP trainees in Holographic Techniques in Art have produced dozens of holographic Art exhibits which have been displayed on different exhibitions, usually graduation ones.

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Seawater Electrolysis is Used to Use Energy from Solar Radiation

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Abstract. This experiment consists in sea water electrolysis, using electricity produced in a photovoltaic panel. The hydrogen produced is then used to in a fuel cell which creates an electrical output in order to move small helices.

Figure 1. Image of the experiment

The experiment occurs in two different electrolysers. In the first electrolyser graphite electrodes are used as anode and cathode. In this case, hydrogen is released on the cathode until magnesium hydroxide precipitates and chloride is released on the anode. The second electrolyser has a graphite cathode and an iron anode. In this case, the iron anode is progressively oxidized to its ionic form and hydrogen is released on the cathode. In both electrolysers, the hydrogen produced is used to create an electrical output through a fuel cell.

This experiment demonstrates that it is possible to store energy from solar radiation for further applications in hydrogen cells.

Keywords: Electrolysis, Experiments, Chemistry, Teaching.

Figure 2. Image of the experiment

Having Fun Learning about Chemical Kinetics

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Abstract. The study of chemical kinetics can be fun, especially when investigative experimental work is combined with data-logging and ICT.

The addition of hydrochloric acid to a sodium thiosulphate solution makes possible that the thiosulphate ions react with the hydrogen ions, as the following chemical equation describes:

$$S_2O_3^{\,2-}\,(aq) + 2\,H^+\,(aq) \rightarrow S\,(s) + SO_2\,(g) + H_2O\,(l)$$

During the chemical reaction the formation of a sulphur precipitate can be observed. This precipitate interferes with a beam of light that is transmitted trough the solution, diminishing its intensity at the sensor receptor (Figure 1). The variation of light intensity transmitted trough the solution is monitored using a light sensor.

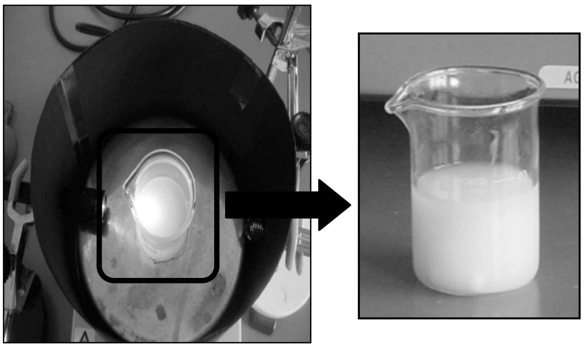

Figure 1. Aspect of the solution due to the chemical reaction between sodium thiosulphate and hydrochloric acid

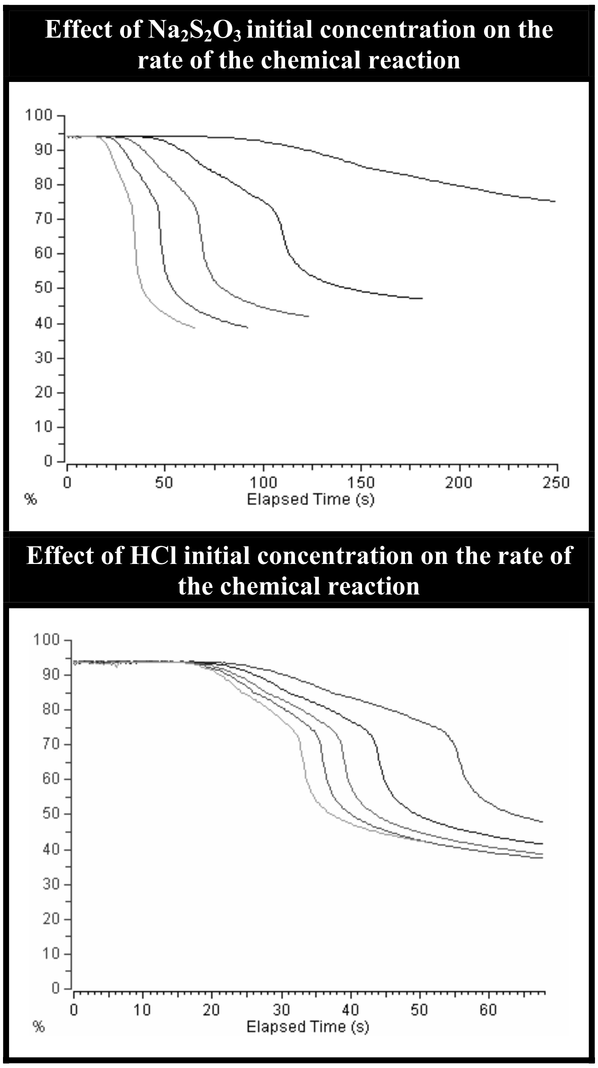

Figure 2. Graph of light intensity = f (t) obtained on this study

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To study the effect of reactants initial concentration on the rate of this reaction sets of sodium thiosulphate solutions and hydrochloric acid with different concentrations were used.

The analysis of graphs (Figure 2) representing the decrease in light intensity transmitted through the solution along time, for the different essays, allows us to determine the time interval needed to the formation of a certain quantity of precipitate. As the rate of the chemical reaction in inversely proportional to that time, it is possible to evaluate the effect of the initial concentration of reactants on the rate of this chemical reaction.

Keywords: Kinetics, Chemical Reaction, Learning, ICT, Data-logging.

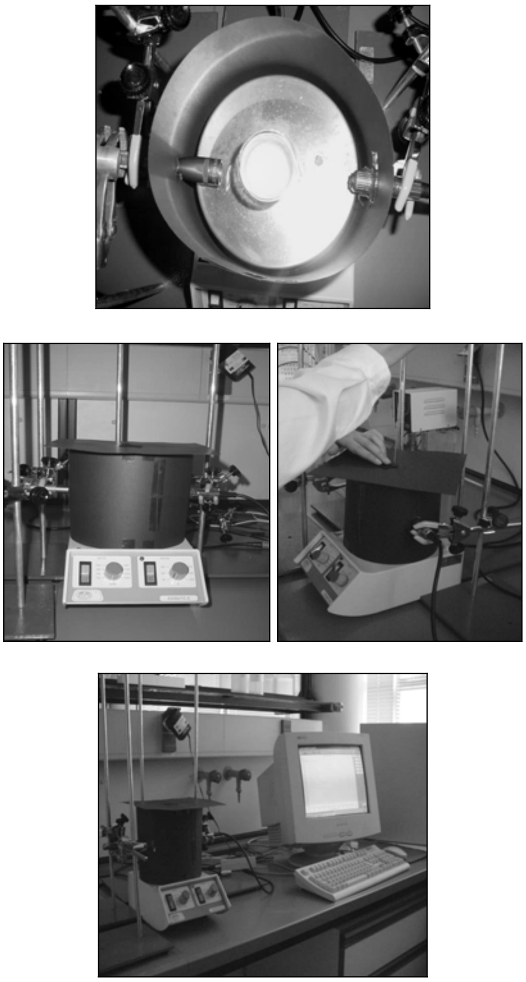

Figure 3. Images of the experiment

Hands-on Experiments for Primary Schools Using Temperature Sensors and Data-logging

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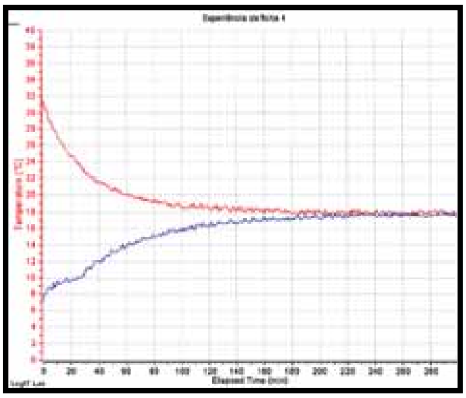
Abstract. Experiment 1 - In this experiment two jars are used with the same volume water. In one of the jars the temperature of the water is below environment temperature and in the other the water' temperature is higher. Using temperature sensors the establishment of thermal equilibrium is studied (Figure 1).

Experiment 2 – In this experiment three flasks are used with the same volume of cold water. Two of them are covered with different materials that are used as thermal insulators. Thermal equilibrium is studied using temperature sensors (Figure 2)



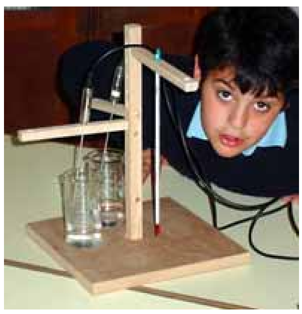
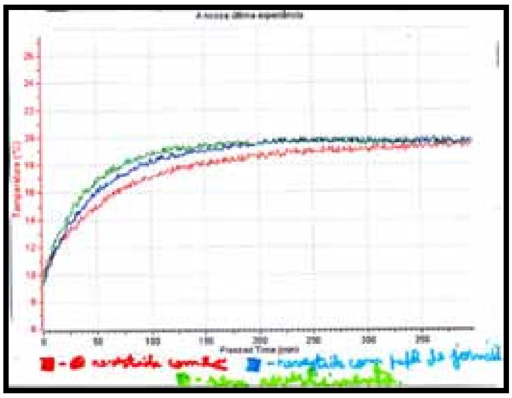


Figure 1. Experiment 1



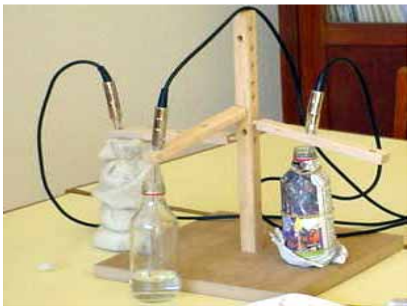


Figure 2. Experiment 2

Keywords. Primary Schools, Temperature, Learning, ICT, Data-logging.

Hands-on Experiments in Chemistry

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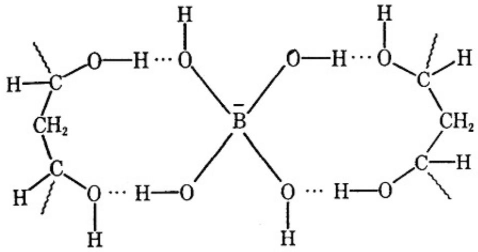
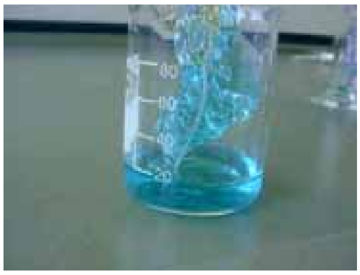
Abstract. Seven chemical reactions were chosen:

1 – A chemical reaction that happens by mechanical action.
Two solids mixed yielding new products in different states.

$$2NH_4Cl\,(s) + CaO\,(s) \rightarrow 2NH_3\,(g) + CaCl_2\,(s) + H_2O\,(l)$$

2 - A chemical reaction of polymerization.
The borate ions react with the hydroxyl groups on the alcohol to form weak cross links between the polymer strands yielding a viscous gel.





$$SO_3\,(g) + H_2O\,(l) \rightleftharpoons HSO_4^-\,(aq) + H^+\,(aq)$$
$$SO_2\,(g) + H_2O\,(l) \rightleftharpoons HSO_3^-\,(aq) + H^+\,(aq)$$

4 - Simulation of the impact of acid rain on marble

$$Cu\,(s) + 2HNO_3\,(aq) \rightarrow Cu^{2+}\,(aq) + 2NO_2\,(g) + H_2O\,(l)$$

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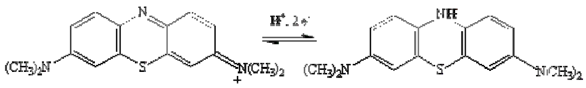
$Fe\ (s) + H_2SO_4\ (aq) \rightarrow FeSO_4\ (aq) + H_2\ (g)$
$Fe\ (s) + 2HNO_3\ (aq) \rightarrow Fe(NO_3)_2\ (aq) + H_2\ (g)$

$Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$
$Zn\ (s) + 2HNO_3\ (aq) \rightarrow Zn(NO_3)_2\ (aq) + H_2\ (g)$

6 – Blue bottle experiment - oxidation / reduction

$$HOCH_2(CHOH)_4CHO\ (aq) + 3OH^-\ (aq) \rightleftharpoons HOCH_2(CHOH)_4COO^-\ (aq) + 2\ H_2O\ (l) + 2e^-$$

In alkaline solutions, glucose is oxidized to D-gluconic acid or alpha-D-gluconolactone. In the course of this reaction, methylene blue is reduced from the blue (oxidized) form to the colorless (reduced) form.



Shaking the flask O_2 dissolves in the solution, which oxidizes the indicator back to the blue (oxidized) form.

7 – Silver mirror

$$R\text{-}CHO + 2[Ag(NH_3)_2]^+\ (aq) + 2OH^-\ (aq) \rightarrow R\text{–}COOH\ (aq) + 2\ Ag\ (s) + 4NH_3\ (aq) + H_2O\ (l)$$

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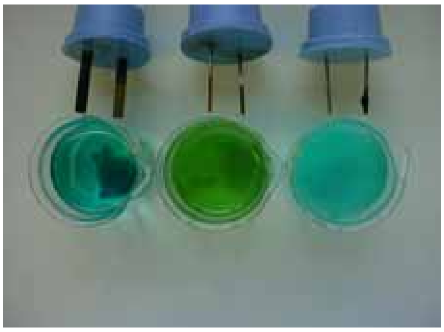
The inside surface of the test tube is coated with a silver amine $[Ag(NH_3)_2^+]$. This compound is reduced to form silver. Because the ions of the silver solution and the reducer only touch each other on the inside surface of the flask, the inside surface is the only place where silver metal forms

8 – Electrolisis of copper (II) chloride

Cu^{2+} (aq) $\rightleftarrows$ Cu (s) + $2e^-$ E° = + 0,34V

$2Cl^-$ (aq) $\rightleftarrows$ Cl_2 (g) + $2e^-$ E° = + 1,36 V

$CuCl_2$ (aq) $\rightleftarrows$ Cu (s) + Cl_2 (g) E° =- 1, 02 V



Handmade Series Direct Current Motor

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Abstract. Using common materials, it is possible to build a variety of very simple – and yet functioning – electric devices. These devices can be used to verify Electromagnetism fundamentals. Electric currents within magnetic fields originate forces and that is the basic principle of operation of electric motors. This paper describes a universal series motor made with iron bars, insulated copper wire, two small brass plates, insulating tape, six screws and a couple of hoops. The motor is fed with a personal computer 12V DC switched power supply. Rotor speed can achieve several rotations per second.

Keywords. Electric Motors, Universal Series Motor.

1. Introduction

The device described in this paper (Fig.1) is a handmade *universal series motor* [1]. It is called *universal* because it works both with direct current (DC) or alternating current (AC) and *series* because the windings of the stator are in series with those of the rotor [2]. Both windings must have the same polarity.

An electric current flowing in a solenoid originates a magnetic field in the surrounding space and two magnetic fields interact with each other originating forces [3,4]. These are the Electromagnetism fundamentals that explain the principle of operation of the constructed motor. Direct current was used to feed it.

Materials used to build the motor are listed in Section 2. Construction details are given in Section 3. The principle of operation of the motor is explained in Section 4.

Figure 1. Handmade universal series motor

Conclusions are presented in Section 5, followed by the due acknowledgements (Section 6) and the list of references cited (Section 7).

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2. Materials used to make the motor

The following materials were used to build the motor:

- a 20cm x 20cm wood board;
- a 68cm x 10mm iron rod;
- a 18cm x 15cm x 3mm iron sheet;
- a 25cm x 10mm x 3mm iron bar;
- a copper wire with 10cm of length;
- 25m of varnished copper wire;
- a copper tube with 14mm inner diameter and 2cm of length;
- two handles, each with a 13mm hole;
- a roll of insulating tape;
- six medium screws.

3. Motor construction

To build the core of the stator a 53cm x 10mm iron rod is bent as shown in Fig. 2 and the 140mm sides of the resulting piece are covered with insulating tape.

Then, the stator windings are coiled over the insulated portions of the core, as shown if Fig. 3. Each winding is made of 200 turns of varnished copper wire Special care has to be taken in order to coil the windings in opposite directions, as Fig. 3 suggests. After this, the finished stator should look like the one depicted in Fig. 4.

The traverse bar of the rotor core is made of two equal 12,5cm x 10mm x 3mm iron bars. An arch is made at the middle of each bar (the side view of the bars is shown on Fig. 5). The bars are then fastened on a 15cm x 10mm iron rod using insulating tape, as shown in Fig. 6. The rod is previously insulated with tape (only its extremities are left without insulation).

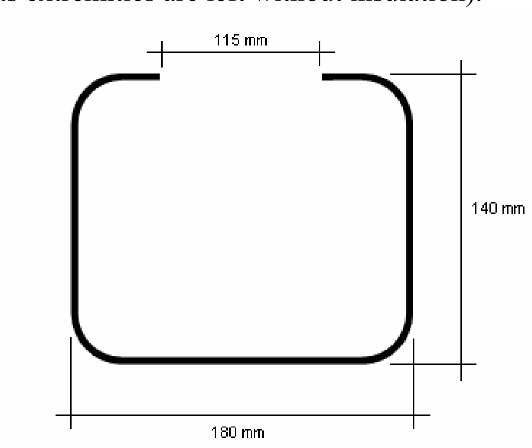

Figure 2. Core of the stator

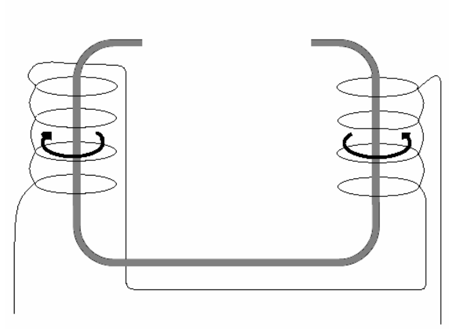

Figure 3. Making the windings of the stator

Figure 4. Final aspect of the stator

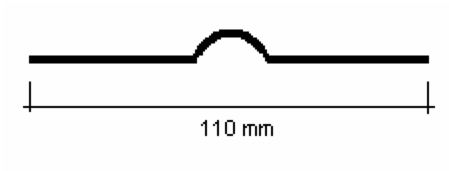

Figure 5. Side view of the iron bars used to make the traverse bar of the rotor core

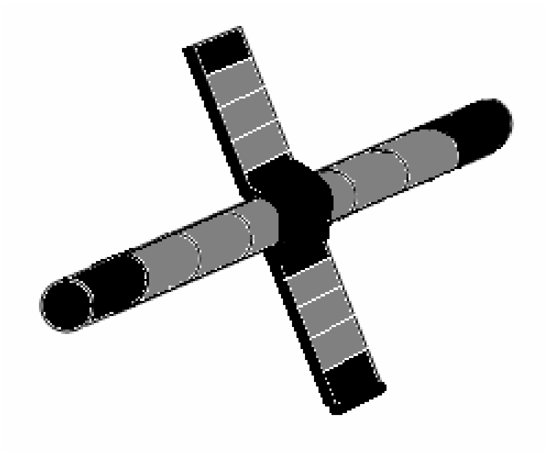

Figure 6. Core of the rotor

The rotor windings are coiled over the insulated portions of the traverse bar of the

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rotor core (Fig. 7). Each winding is made of 200 turns of varnished copper wire Special care has to be taken in order to coil the windings in the same direction, as Fig. 7 suggests.

A copper tube is cut to half. Each of the resulting halves is connected to one of the terminals of the rotor windings. The two halves are then fastened on the rotor, forming the collector. The finished rotor looks like the one depicted in Fig. 8.

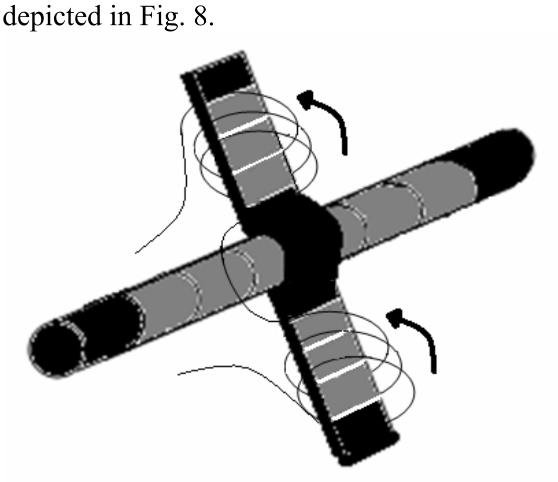

Figure 7. Making the windings of the rotor

To hold the rotor, two identical pieces of 3mm iron sheet were made according to the blueprint depicted on Fig. 9.

Two terminals of the stator windings are connected to a personal computer 12V DC switched power supply. The other two are leaned on the collector. Connections must be made according Fig. 10. Rotor speed can achieve several rotations per second.

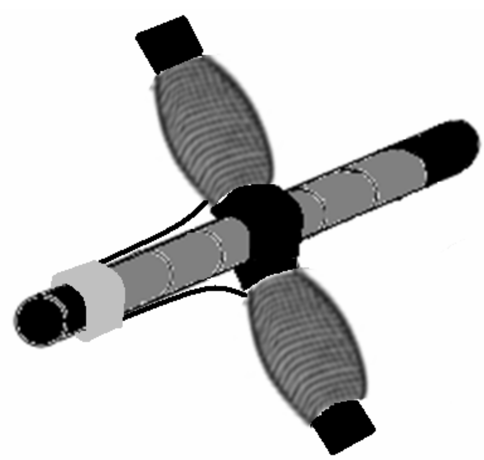

Figure 8. Final aspect of the rotor

4. Motor operation

Feeding the windings of the stator with a constant current originates a constant and uniform magnetic field in the space between the two magnetic poles shown in Fig. 11.

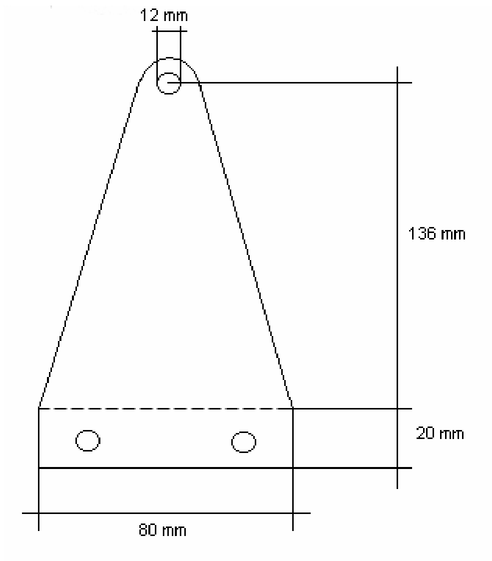

Figure 9. Support of the rotor

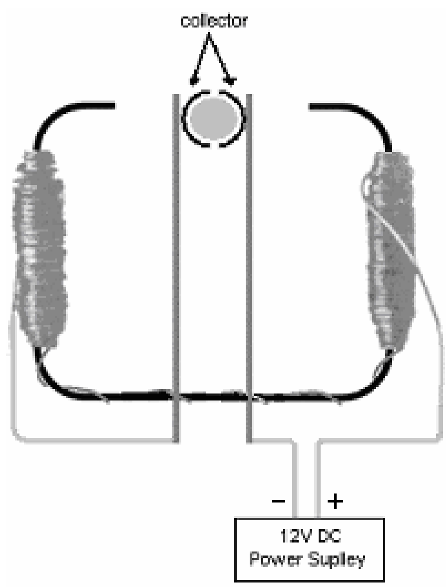

Figure 10. Connections of the stator windings terminals

When the rotor is connected in series with the stator, the current passing in the stator windings flows through the rotor windings, too, creating a second magnetic field around it. Since the rotor is within the magnetic field of the stator, the two fields interact with each other, originating forces that move the rotor. These forces, which determine the sense of

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rotation of the rotor, are such that opposite poles attract each other and similar poles repeal each other (Fig. 12).

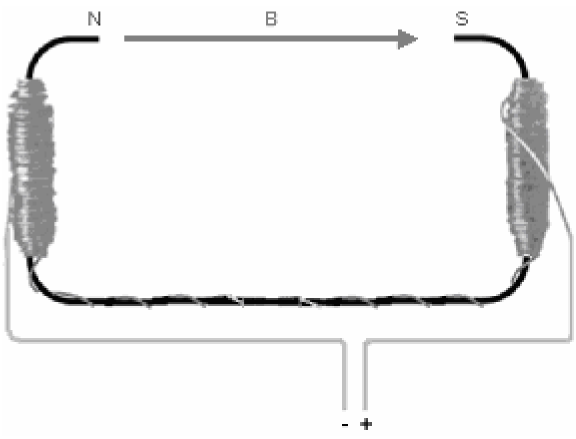

Figure 11. Magnetic field of the stator

When the rotor reaches the position depicted in Fig. 13, the current flowing in its windings falls to zero due to the connections between collector and brushes. There are no forces in this situation. However, the rotor keeps turning due to inertia. Immediately after, its current is re-established but with the opposite direction, which changes the polarity of the magnetic field of the rotor. Forces appear again, keeping the rotor turning in the same direction (Fig. 14). Without the polarity change of the magnetic field of the rotor – which occurs every half turn – the rotor would stop in the position shown in Fig. 13.

5. Conclusions

A handmade universal series motor has been presented. The device, very suitable for science fair events, was built with common materials and can be used to verify Electromagnetism fundamentals that explain the operation of all electric motors. Feeding the motor with 12V DC makes the rotor turn at a speed of several rotations per second.

6. Acknowledgements

The authors are grateful to João Sepúlveda and João Luíz Afonso for the explanations and to Cátia Chamusca for the revising of this paper.

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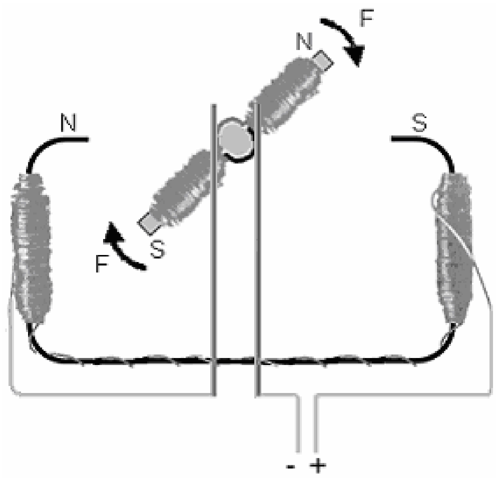

Figure 12. Forces actuating on the rotor

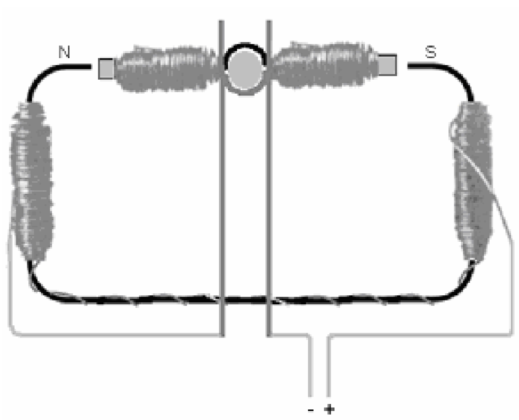

Figure 13. There are no forces actuating on the rotor

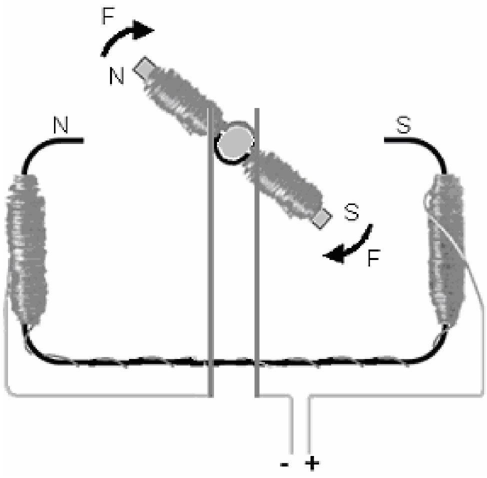

Figure 14. Forces actuating on the rotor after a polarity change of its magnetic field

Slewing Crane With Electromagnet

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Abstract. This paper describes a slewing crane with electromagnet, operated by three three-phase induction motors. A switchboard described in a separate paper, which also depicts the electromagnet construction details, drives the motors and the electromagnet. From its seat – mounted on the crane – an operator can make the crane arm slew left or right. The electromagnet can be moved back, forward, up or down. The crane is made of iron, has a height of 3m and a length of 2,5m. Such proportions make it very suitable for science fair events.

Keywords. Electromagnet, Slewing Crane.

1. Introduction

A slewing crane equipped with an electromagnet is a very useful tool to move ferromagnetic pieces from a place to another. This paper describes such a crane, built for science fair events. Its first public appearance was the *Robótica 2006* festival (Fig. 1). Building this kind of equipment improves construction skills and promotes the study of Electromagnetism fundamentals, such as Biot-Savart's law [1, 2].

2. Crane dimensions and operating details

The crane has a weight of 395 kg, a height of 3m and a length of 2,5m. The base is a 1,20m x 1,20m square. More detailed dimensions are shown in Fig. 2.

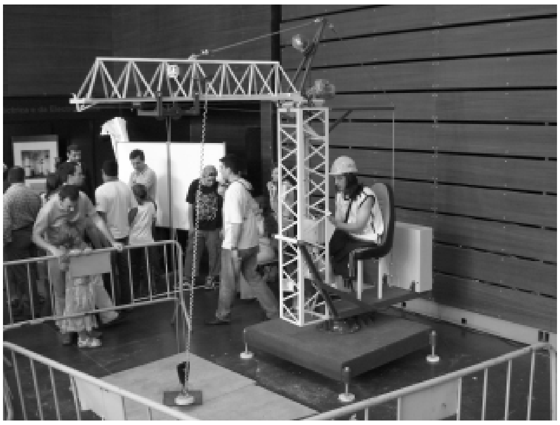

Figure 1. Crane operating at *Robótica 2006* festival

Three three-phase induction motors, each one equipped with a reduction gear, produce the crane movements.

A switchboard located at the rear of the crane controls the motors and the electromagnet. The switchboard and the electromagnet are both described in a separate paper. A control panel is located on the front part of the crane, where the operator has a good view of the pieces to handle. From a comfortable seat (Fig. 2), the operator can make the crane arm slew left or right. The electromagnet can be moved back, forward, up and down (Fig. 3).

For safety reasons, the crane is only allowed to slew within an 180º angle. This results in a working space whose top view has the shape depicted in Fig. 5.

The electromagnet (Fig. 6) and the structure of the crane are strong enough to elevate a weight of 50kg to a height of 2m from the ground.

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The crane is foldable (Fig. 7, Fig. 8 and Fig. 9), which is very convenient for transportation and storing.

3. Materials used to build the crane

The crane was built with:

- 10m of 30mm x 30mm angle iron;
- 24m of 16mm x 5mm iron bar;
- 6m of 25mm x 25mm iron tube;
- 2m of 30mm x 30mm iron tube;
- 5m of 150mm U-shape iron bar;
- 4m of 50mm U-shape iron bar;
- 2m of 65mm U-shape iron bar;
- a 1,7m x 1,2m iron sheet;
- 4 medium pulleys for steel cable;
- 8m of 4mm steel cable;
- 5m of 8mm steel cable;
- a truck hub;
- a seat;
- 4m of steel chain;
- 3 three-phase induction motors, each one equipped with a reduction gear

Figure 2. Operating the crane

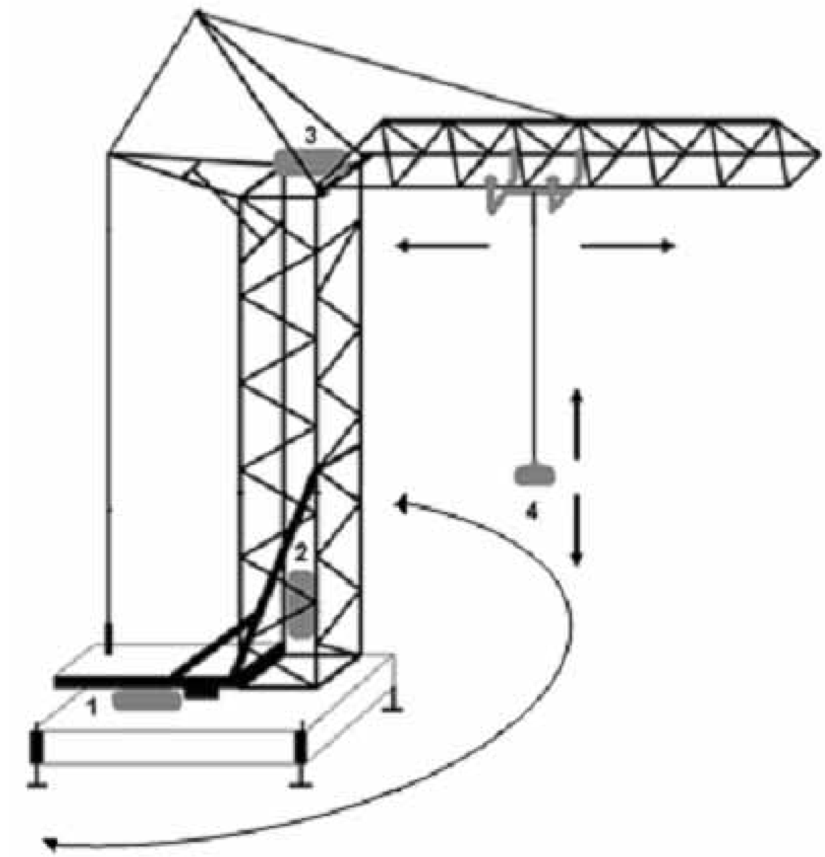

Figure 3. Crane and electromagnet movements

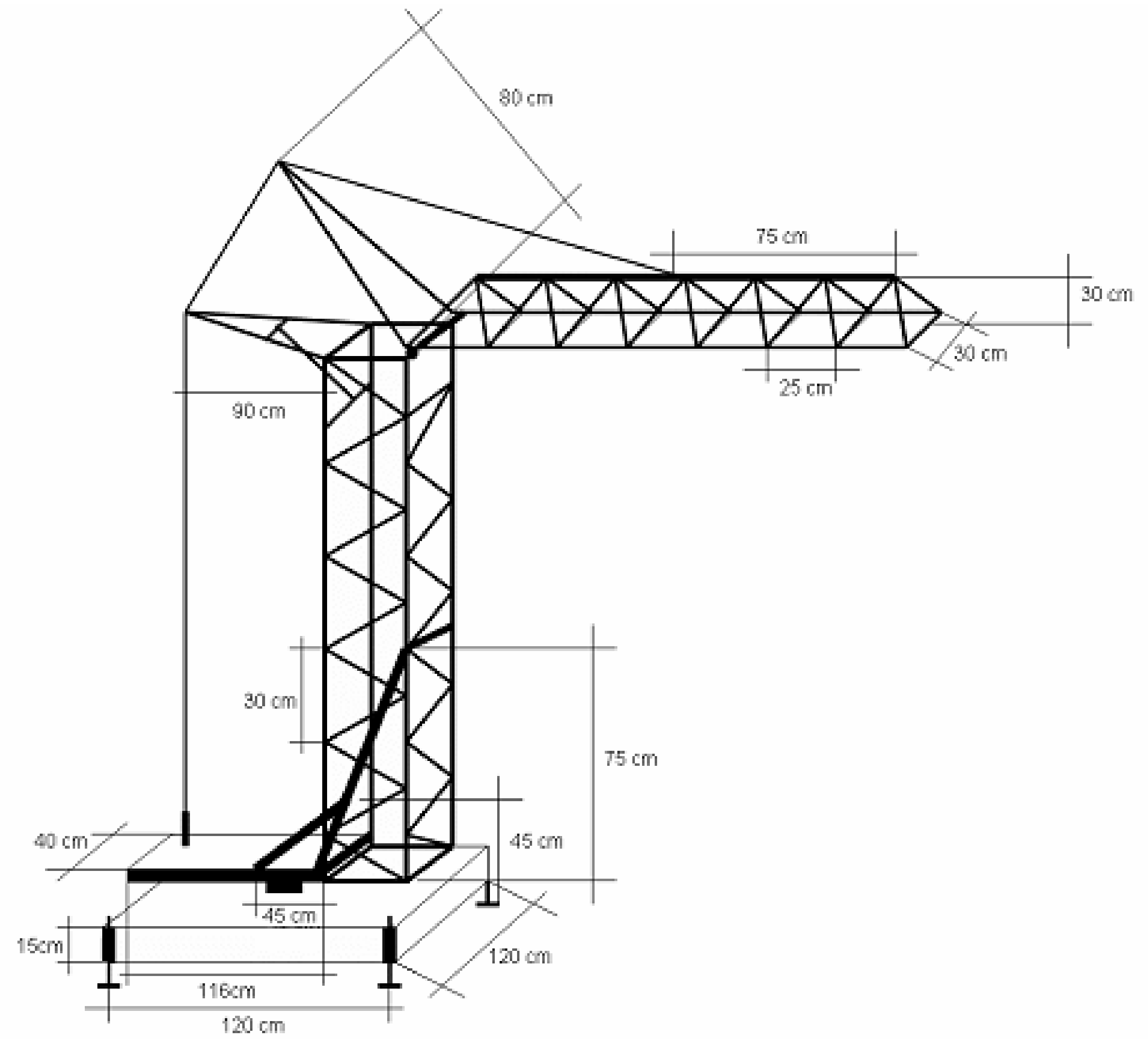

Figure 4. Dimensions of the crane

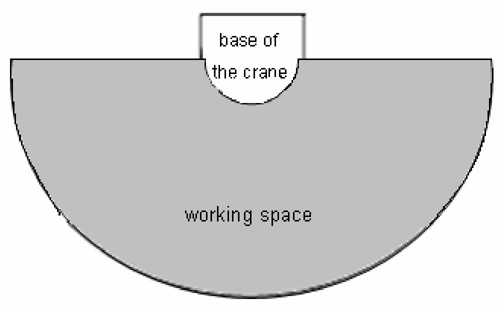

Figure 5. Top view of the working space of the crane

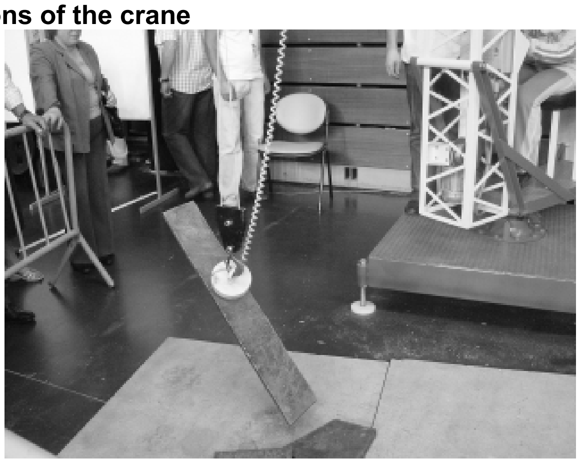

Figure 6. Electromagnet elevating an iron piece

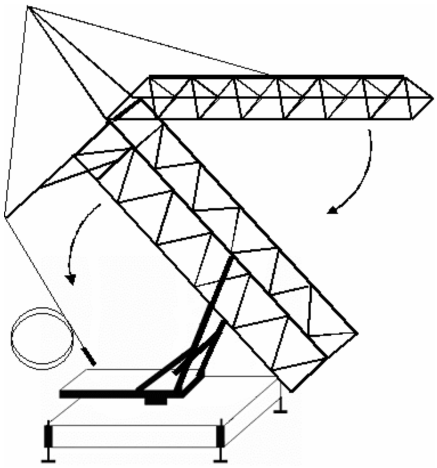

Figure 7. Folding the crane

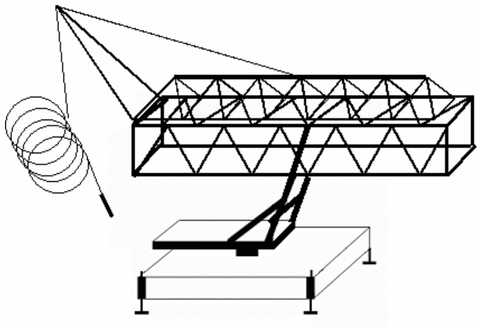

Figure 8. Folded crane

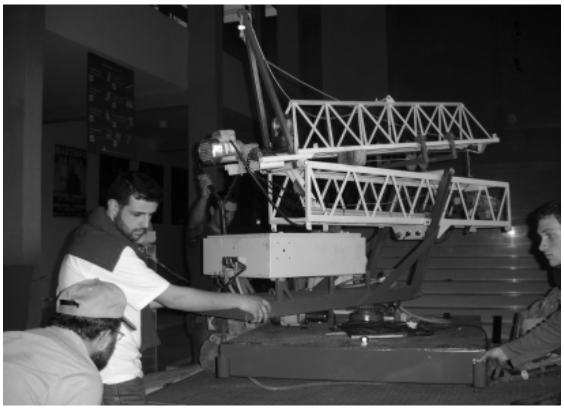

Figure 9. Folded crane being transported

3. Conclusions

A slewing crane equipped with an electromagnet has been presented. The device, built for science fair events, is capable of elevating ferromagnetic pieces of 50kg to a height of 2m from the ground.

Three three-phase induction motors produce the crane movements. An operator can make the crane slew left or right within an 180º angle. The electromagnet can be moved back, forward, up or down.

This kind of project develops the construction skills of the builders and promotes the investigation of Electromagnetism fundamentals.

4. Acknowledgements

The authors are grateful to Cátia Chamusca for the revising of this paper.

5. References

[1] Plonus, Martin A. Applied Electromagnetics. McGraw-Hill, 1986.
[2] Mendiratta, Sushil Kumar. Introdução ao Electromagnetismo. Fundação Calouste Gulbenkian, 1984.

Computer-Controlled Model Railroad

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Abstract. Model railroads are good test beds for several scientific experiments on Electromagnetism, Electronics, Automation, Control and Computer Science. Moreover, they are eye-catching structures very well suited for science-fair events. This paper describes a 2m x 1m model railroad layout and a user-friendly program, built with LabVIEW graphical language. The program is able to control train direction and speed, and also allows the control of thirteen switch-points, lights and a mountain funicular, all included in the layout. The interface between personal computer and railroad circuits is done with a standard multi-purpose data-acquisition board for the PCI bus.

Keywords. Automation, Computer Control, Interface Circuits, *LabVIEW* graphical language.

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1. Introduction

This paper describes an example of using computer control to perform an everyday task: the control of speed, direction and points of a model railroad. Such an application is a good test bed for real life systems. It is, also, a way to demonstrate how automation and computer control is present in people's daily life, although many times we do not even think about that.

2. Model railroad layout description

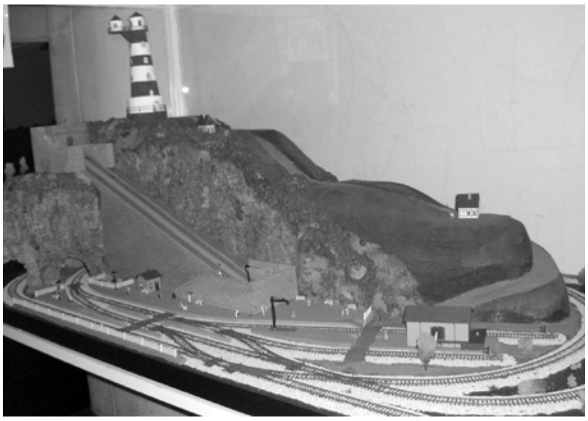

Figure 1. Model railroad

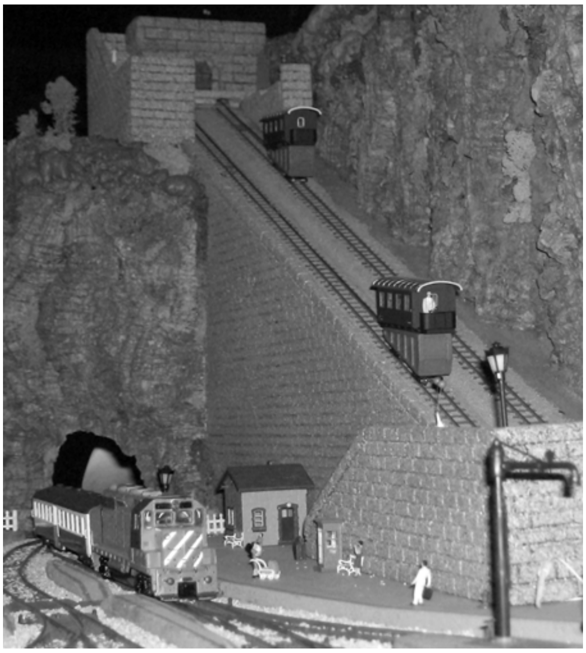

Figure 2. Model train and funicular

The model railroad (Fig. 1), with 2m x 1m, was built in HO scale (1:87). It has 13 switch-points, lights and a mountain cable funicular. The model train (Fig. 2) has a permanent magnet 12V DC motor. Train speed is controlled by the voltage applied to the tracks. Once the train starts moving, speed increases approximately linearly with the applied voltage. The lights and the points are also powered with 12V DC. A servomotor powered with 1.5V moves the funicular (Fig. 2).

The point switches have two coils over a sliding iron core (Fig. 3) and they are moved to each side by energizing the correspondent coil.

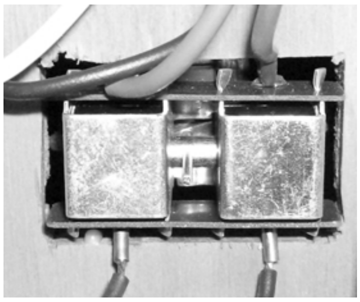

Figure 3. Point switch

3. Computer control with *LabVIEW*

The computer control of the railroad was planned in order to achieve a user-friendly interface and easy operation.

The computer control program was implemented using the graphical programming language *LabVIEW* version 6.1 [1]. The input and output of the control signals to the computer is done with a standard multifunction data acquisition board for the PCI (Peripheral Component Interconnect) bus, made by *National Instruments*, model PCI-MIO-16E-4 [2, 3, 4] (Fig. 4). This board has 16 analog inputs, 2 analog outputs, 8 digital inputs/outputs and timers.

Figure 4. Computer, data acquisition board and railroad layout

The control program user interface is based in the actual model railroad layout. The virtual control devices (switches) were placed in correspondent positions of the model railroad switch-points.

The software development was initiated having in mind the particular needs of the application and a number of practical limitations of the data acquisition board. The 13 switch-points of the railroad model are actuated by 13

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virtual switches. Since each switch-point has two coils (one for each direction), 26 digital output signals are needed. Also, the lights have to be switched on or off, as well as the funicular, and the train direction of movement must be controlled. So, 29 digital output signals are needed. But the board only has 8 digital outputs. The solution was to implement signal multiplexing: a control bit is periodically outputted to each device to be controlled, using 1 digital output. Whenever a control bit is outputted, a 5-bit code is also outputted (using 5 digital outputs), identifying the device to be controlled (a 5-bit code allows using up to 32 devices). One disadvantage of multiplexing is a short delay between user command and actuator output.

Train speed was controlled using an analog output. The selected speed in the program user interface is converted in a voltage value outputted by the data acquisition board.

From the remaining 2 digital outputs, one was used to command the layout power switch.

The built *LabVIEW* application is shown in Fig. 5 and Fig. 6.

The data acquisition board does not provide enough power or number of signals to allow it to be directly connected to the model railroad. Several interface circuits are then required:

- One circuit is the speed regulator: since the correspondent board analog output does not supply enough voltage and current, it must be connected to a power amplifier, namely a power transistor.
- Another circuit is the direction of movement controller: this is also implemented with four power transistors, which act as a voltage inverter.
- The switch-point actuators must also have a drive circuit, which may be a power transistor for each one of the two coils.
- Finally, another very important circuit is the demultiplexing unit. It is responsible for decoding the 5-bit code that represents a determinate action to be performed. This unit is implemented with four 3 to 8 demultiplexers plus two 2 to 4 demultiplexers.

4. Interface circuits

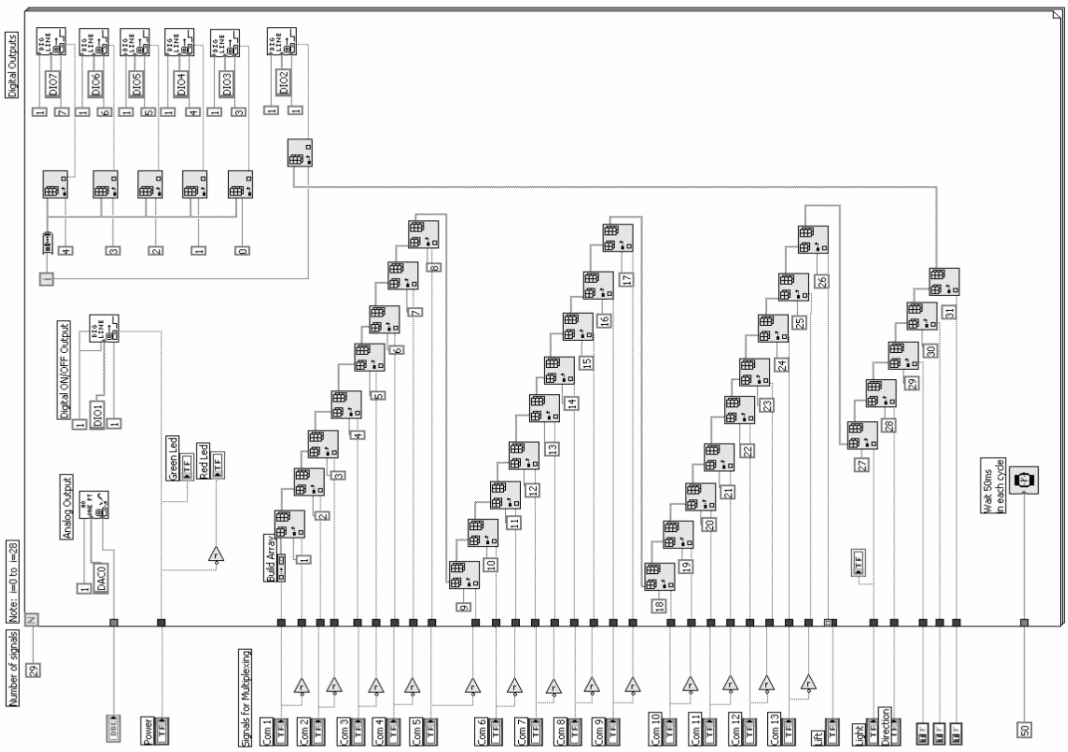

Figure 5. ***LabVIEW*** **Program block diagram**

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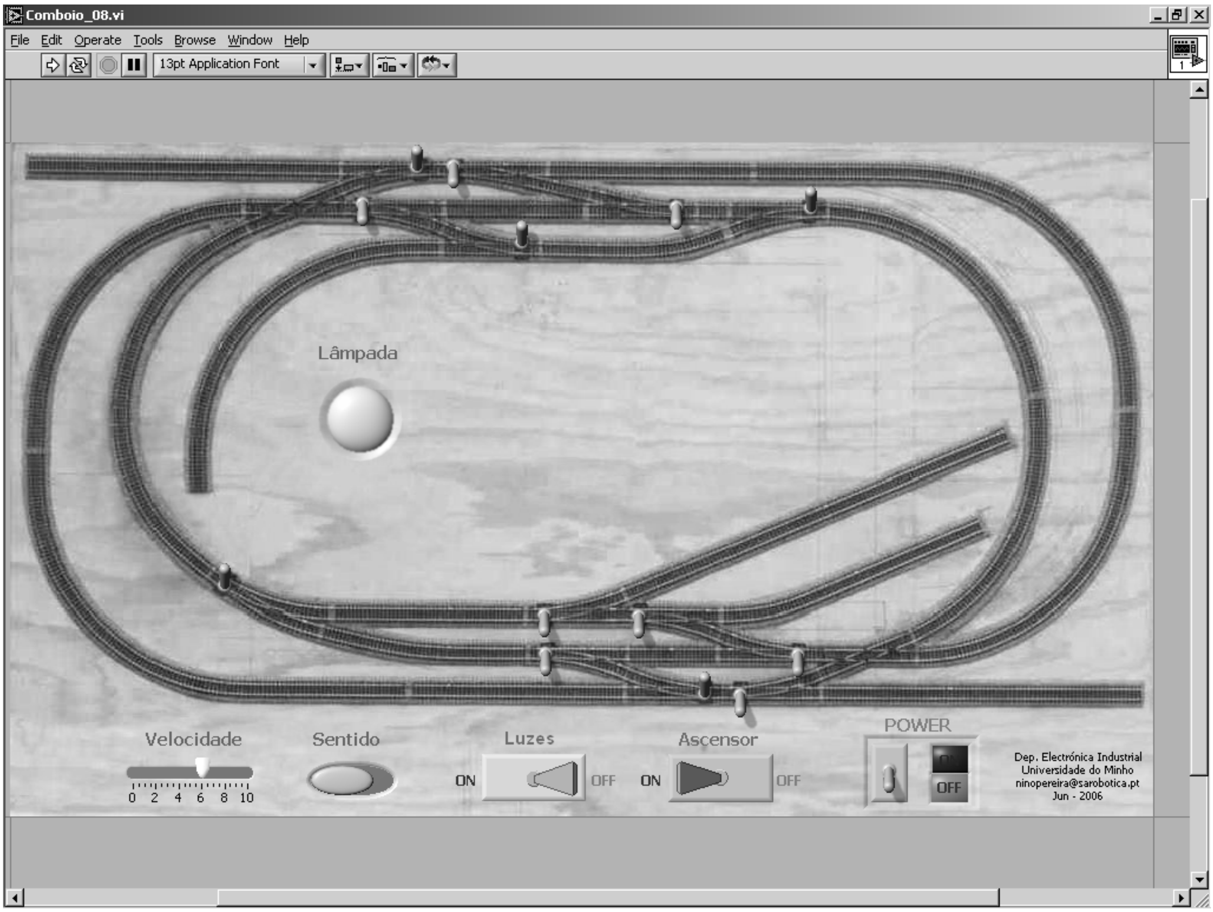

Figure 6. *LabVIEW* Program front panel

5. Conclusions

A user-friendly program, built with *LabVIEW* graphical language, has been developed to control a 2m x 1m model railroad layout. The program is able to control train direction and speed, and also allows the control of thirteen switch-points, lights and a mountain funicular.

This work demonstrated that automation and computer control may be used in daily applications. However, interface circuits between computer and actuators are almost always required, as well as standard data acquisition boards, because a personal computer was not originally designed to perform these kinds of tasks.

The *LabVIEW* graphical programming language provides a very user friendly and easy to use interface.

This system proved to be very flexible, easily allowing other kinds of tasks – which were not implemented – such as sensor reading, system monitoring and data logging.

6. References

[1] *LabVIEW*™ User Manual, Part Number 322661A 01 - National Instruments Corp, July 2000 Edition.
[2] DAQ Getting Started Guide, document nº 373235H - National Instruments Corp. September 2005.
[3] INSTALLATION GUIDE Traditional NI-DAQ (Legacy), document nº 374279A-01 - National Instruments Corp. October 2005.
[4] Full-Featured E Series Multifunction DAQ 12 or 16-Bit, up to 1.25 MS/s, up to 64 Analog Inputs - National Instruments.

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Electromagnetic Shoot

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Abstract. The science fair device described in this paper shoots a miniature soccer ball using a solenoid and a two-piece rod made of iron and nylon. The nylon part of the rod is introduced inside the solenoid and a ball is placed at its extremity. When an electrical current passes through the solenoid, the iron part of the rod is pushed into its center, causing the shooting of the ball. This mechanism, originally developed for Minho Team soccer robots, has been successfully used for several years. The science fair version includes a slewing iron case and overheat protections.

Keywords. Soccer Robots, Electromagnetism.

1. Introduction

The *Electromagnetic Shoot*, described in this paper, is a device built for science fair events. It was used for the first time in *Robótica 2006* festival (Fig. 1).

Figure 1. ***Electromagnetic Shoot*** **at** ***Robótica 2006 festival***

The device was a success, in part because it is related with football, which attracts specially the younger ones. A ball is placed in a ball holder. When a button is pressed, the device shoots the ball at a distance of several meters.

The shooting mechanism, shown in Fig. 2, was originally developed by João Sena Esteves for *Minho Team* soccer robots and it has been successfully used for several years.

2. Materials used

The *Electromagnetic Shoot* uses the following materials:

- Diode bridge;
- Capacitor;
- Button;
- Coil (solenoid);
- Two-piece rod made of iron and nylon (Fig. 3);
- Contactor with timer.

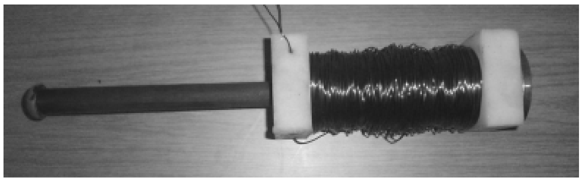

Figure 2. Shooting mechanism

Figure 3. Two-piece rod made of iron and nylon

3. Device operation

This device operation is based on Electromagnetism laws. When a button is pressed, a current passes through a coil, creating a magnetic field whose direction is given by the right hand rule (Fig. 4). The field attracts the iron part of a two-piece rod made of iron and nylon, whose displacement causes the shooting of the ball (Fig. 5).

The circuit used to produce a current on the coil is shown on Fig. 6. The 220V/50Hz mains voltage (Fig. 7) is rectified (Fig. 8) in order to produce a stronger current and, therefore, a stronger shooting force.

A diode bridge is used to rectify the mains voltage. At its output, the voltage is not constant, yet. To accomplish this, a capacitor is added to the circuit.

The described circuit is switched on when a button (not shown in Fig. 6) is pressed.

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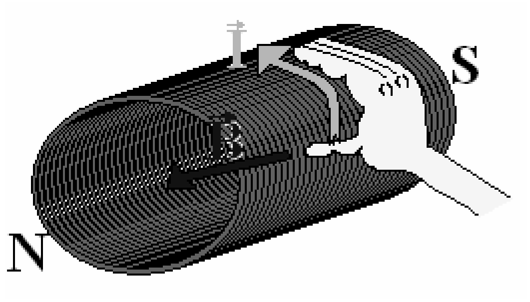
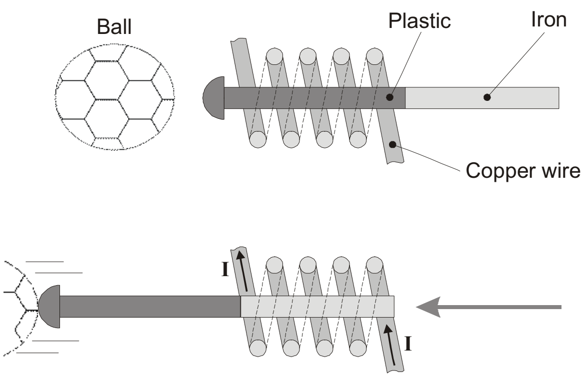


A coil (solenoid) is made of a large number of series-connected wire loops. When a current flows in a coil, it generates a magnetic field whose direction is given by the right hand rule. With your right hand, extend the thumb and curl the other fingers around the coil, in the direction of the current. The thumb points to the north of the magnetic field [1,2].

Figure 4. Solenoid



Iron has orbital electrons that are organized in small groups called *domains*. The domains are randomly positioned. When an electrical current flows in the coil it produces a field, which will order the magnetic dipoles of the iron. This alignment of the orbital electrons will push the iron part of the rod into the center of the coil, making the nylon part shoot the ball.

Figure 5. Shooting mechanism operation

A temporized contactor (not shown in Fig. 6) was added to the circuit. This contactor prevents overheating of the coil, since it switches power off automatically – after a predetermined time – even if the power button is kept pressed.

The shooting mechanism was fastened inside an iron case mounted on a turning base (Fig. 9), which was developed to allow shooting the ball in any direction within a 90º angle.

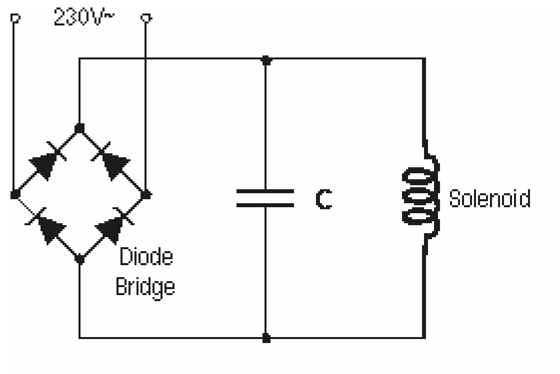


Figure 6. Electric circuit

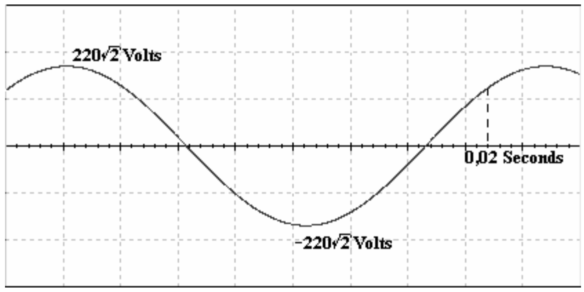


Figure 7. Mains voltage waveform

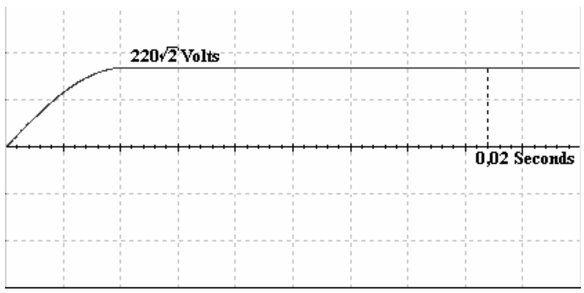


Figure 8. Rectified wave applied to the coil

4. Conclusions

An electromagnetic shooting mechanism, originally developed for soccer robots and capable of shooting a miniature soccer ball at a distance of several meters, has been presented in a science fair version. The device includes a slewing iron case and overheat protections.

The *Electromagnetic Shoot* is a fun experiment because it's related with sports, more precisely with soccer. But it also is educational, since it illustrates Electromagnetism laws. Its operation principle is the same used in other electromagnetic devices like relays and contactors.

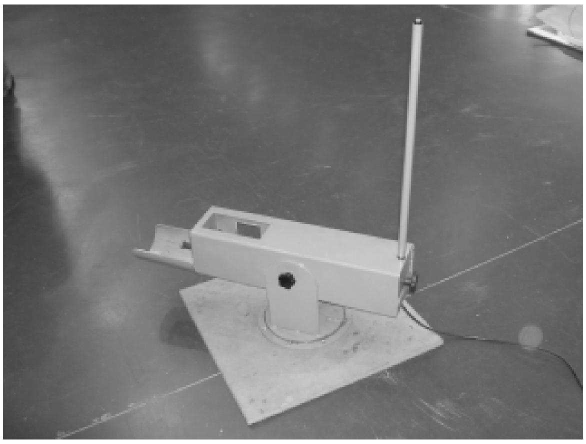


Figure 9. The *Electromagnetic Shoot* has an iron case mounted on a turning base

The device has been a success as a science fair attraction. Building it was exciting. It was an opportunity to learn a lot and gain experience, too.

5. References

[1] Plonus, Martin A.; Applied Electromagnetics. McGraw-Hill, 1986.
[2] Mendiratta, Sushil Kumar. Introdução ao Electromagnetismo. Fundação Calouste Gulbenkian, 1984.

Induction Coil Gun

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Abstract. This paper describes a device capable of throwing metal rings at a range of a few meters. Part of an iron pipe is inserted on a coil. A conducting non-ferromagnetic ring is inserted in the pipe through its other extremity. An alternating current flowing through the coil creates an alternating magnetic field, which magnetizes the iron pipe. So, an alternating magnetic field is created around the pipe and induces a circumferential current flowing in the ring. This current is repelled by the magnetic field, forcing the ring to jump out of the pipe.

Keywords. Coil Gun, Jumping Ring, Thompson's Coil.

1. Introduction

The apparatus described in this paper was invented by the American engineer and inventor Elihu Thompson (1853–1937) [1] to demonstrate his pioneering research in alternating current and high frequency.

The recreated device is capable of throwing metal rings using Electromagnetism laws formulated by Biot-Savart, Ampère and Faraday-Lenz [2,3]. Further explanations will be merely qualitative. Thompson's jumping ring is a great experiment to demonstrate Electromagnetism laws in science fairs and hands-on classes.

The device is composed by a coil, winded around an extremity of a ferromagnetic core, leaving about two thirds protruding (Fig. 1). The projectiles are conducting non-ferromagnetic rings. The coil is driven by an alternating current for a short period of time, until the ring leaves the core.

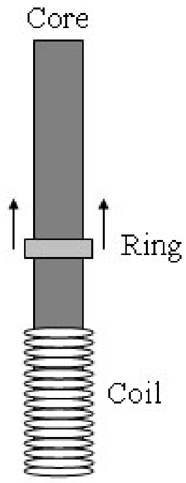

Figure 1. Schematic of the apparatus

The recreated device (Fig. 2) was made with an iron pipe with 600mm length and 60mm diameter, as core. Around 200mm of the length of the core, about 800 turns of 0.90mm insulated copper were winded. Rings were made to fit around the core and are made of aluminum, copper and brass.

For safety reasons, core and coil were fit in a structure that prevents aiming upward, in a direction perpendicular to the ground. A fixed angle of 30º with horizontal direction was imposed, making rings jump forward.

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The structure can rotate, so the operator can choose the horizontal direction. This way, the device can easily be used as a *'shoot the target'* science fair game, with variable direction and multiple projectiles with different shooting ranges.

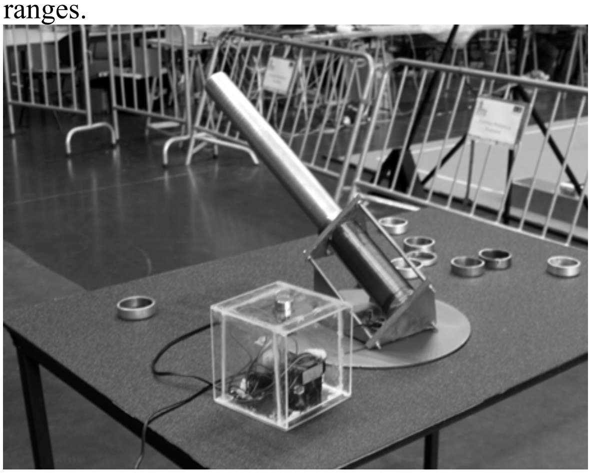

Figure 2. The apparatus

2. How it works

The coil gun works on the principles of electromagnetic induction and repulsion [4]. When it is fired, an alternating current flows through the coil creating an alternating magnetic field. The field magnetizes the iron, which induces a circunferencial alternating current in the ring. This current is repelled by the magnetic field, making the ring jump from the core at a distance of a few meters.

The faster the magnetic flux changes, the greater are the induced currents in the ring, resulting in a stronger force.

3. Step 1 – Creating a magnetic field

As described in the previous chapter, the device is driven by an alternating current, which flows through the coil creating a magnetic field around it (Biot-Savart's Law).

When the current flows in a circular direction, the resulting magnetic field is similar to a magnet, with the field flowing from the North pole to the South pole.

The created field is not strong enough to magnetize the core unless strong currents are used. In order to reduce the employed currents maintaining the field value, it is required to add more turns to the coil. This way, the field created by each turn will add up, resulting in a stronger magnetic field.

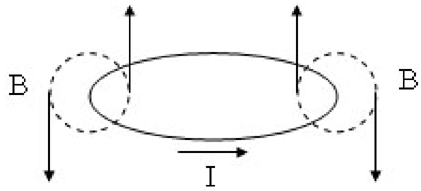

Figure 3. Magnetic field in a circumferential current

Fig. 4 and Fig. 5 represent the magnetic field lines created by a coil with an air core. Using a core protruding from the coil will change this magnetic distribution, resulting in a slightly different magnetic field (Fig. 6).

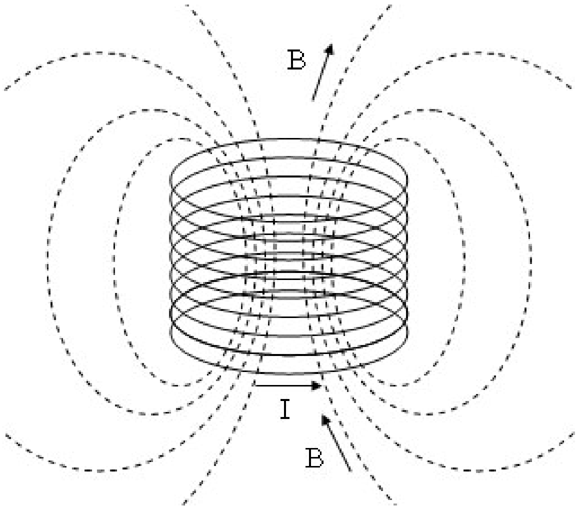

Figure 4. Magnetic field generated by several turns

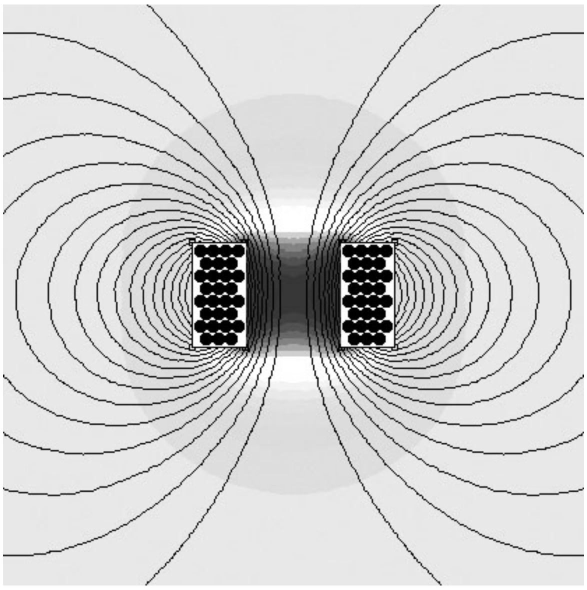

Figure 5. Magnetic field generated by a coil (simulation)

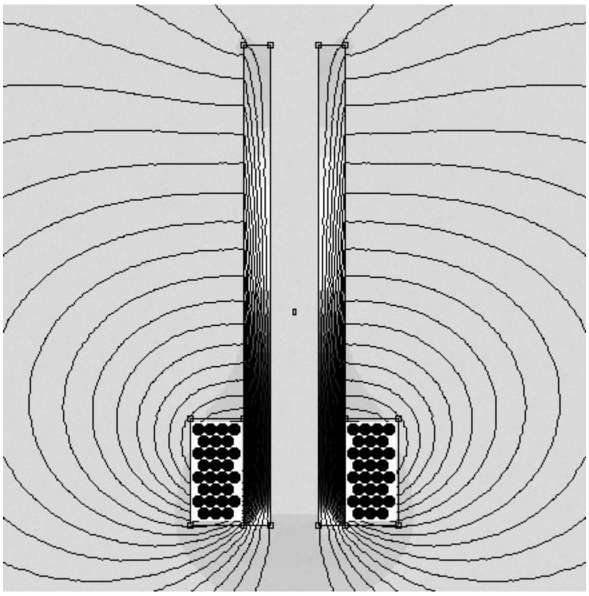

Figure 6. Magnetic field generated by a coil with core (simulation)

4. Step 2 – Inducing a current in the projectile

Because the current in the coil is alternating, so will be the magnetic field in the coil and the magnetic flux in the core (Fig. 7). This alternating flux induces a voltage in the ring (Faraday-Lenz's law). Since the ring is a closed circuit with low resistance, the induced voltage creates a circumferential current in it. The faster the magnetic flux changes, the greater is the induced current.

From this point, every time the induced current is referred, it should be understood as the current resulting from the induced voltage.

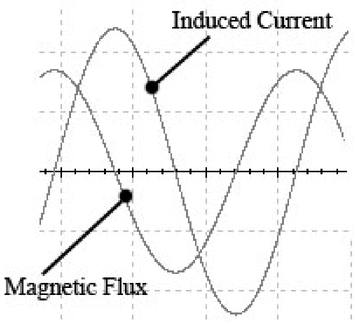

Figure 7. Induced Current and Magnetic Field

5. Step 3 – Magnetic repulsion

A current flowing in a magnetic field suffers an action of a force (an equation to determine this force was a result from the experimental work of Ampère and Biot-Savart [2]). Two conductors with currents flowing in the same direction are attracted to each other and two conductors with currents flowing in opposite direction are repelled from each other (Fig. 8).

The same applies to two parallel conductors with the shape of a ring. Using currents that flow in the same direction makes them attract each other. Using currents that flow in the opposite directions makes them repeal each other (Fig. 9). This is the repulsion principle of the apparatus. The current in the coil is opposite to the induced current in the projectile, resulting in a force applied to it (Fig. 10).

But is the current from the coil really opposite to the induced current? The alternating current applied to the coil creates in the core an alternating magnetic flux that is directly proportional to the current and induces an alternating current advanced $\pi/4$ from the source current [5]. So, the resulting force is repulsive in half a period and attractive in the other half. If repulsive and attractive forces were of the same magnitude, the projectile would remain motionless, or oscillate around a point, due to the balanced resulting effect. A more careful analysis shows that this does not take place. The ring is actually launched, so the resulting effect cannot be a balanced one. In fact, the repulsive forces are stronger that the attractive ones, creating an overall repulsive force.

6. Other experiments

Many other experiments could be performed with this apparatus. For instance, making someone hold the projectile and applying an alternating current to the coil. The person holding the projectile will immediately drop it, as it heats up due the induced currents. This experiment illustrates the principle of operation of induction ovens.

Directing the gun upward, applying an alternating current to the coil and only then inserting a projectile on it will make the ring levitate. This results from a balance between the force of the magnetic field and gravity force.

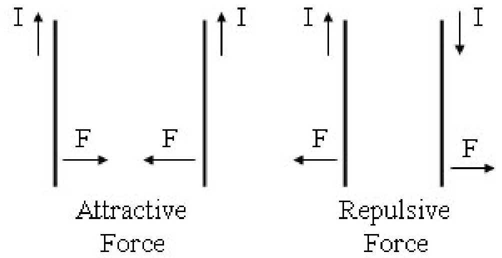

Figure 8. Forces between two parallel conductors

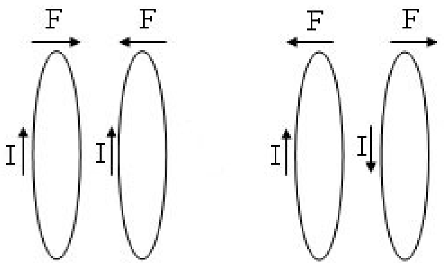

Figure 9. Resulting forces between two rings of the coil

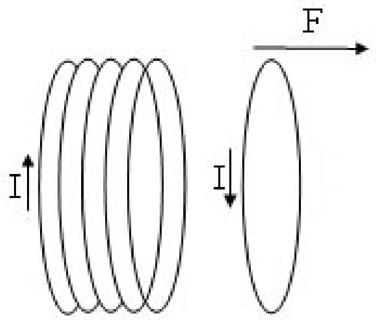

Figure 10. Resulting force in a ring

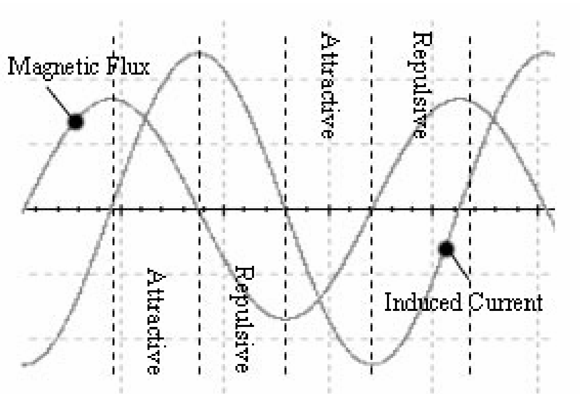

Figure 11. Resulting forces in a period of time

7. Conclusions

A device capable of throwing metal rings at a range of a few meters has been presented. The physical principles that rule its operation were briefly introduced. Also, some construction details have been given. The experiment is very appropriate to demonstrate Electromagnetism laws in science fairs and hands-on classes.

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Miniature Thermoelectric Power Plant

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Abstract This paper describes a miniature thermoelectric power plant made with the boiler and the water pump from an old starch iron. It also uses a computer cooling fan, which serves as electric power generator. The boiler vaporizes the water it receives from the water pump. Then, the steam is injected over the turbine of the fan making it twirl. The voltage generated by the fan is enough to lighten a couple of LEDs. A wooden case with a chimney encloses all the referred devices.

Keywords. Electrical Power Systems, Thermoelectric Power Plant.

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1. Introduction

Electric energy availability has become of primordial importance in modern societies. In fact, it is so important that its fail can stop a whole city: modern trains, hospitals and industries, for example, would stop without electric energy. There are several ways to produce electric energy (for example, through hydroelectric, thermoelectric or wind power plants [1,2]). This paper describes a miniature steam thermoelectric power plant (Fig. 1) made with old starch iron parts.

2. Power plant operation

This section describes the functioning of the main components of the power plant, which were:

- 1 water pump
- 1 boiler of a starch iron
- 1 electrical valve
- 1 computer cooling fan
- 1 water tank
- 1 ejector
- 2 LEDs
- 2 resistor of 500 Ω
- 2 position button
- 1 Pressure button
- 1 Teflon pipe

Additional materials were, among others, a cork sheet, a wooden base and spray paint.

2.1. Water pump

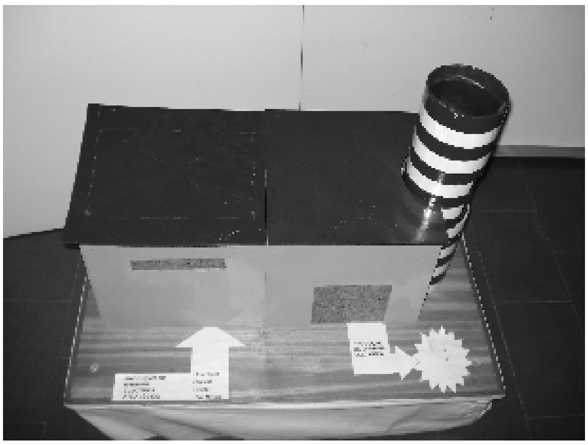

Figure 1. Miniature thermoelectric power plant

The water pump (Fig. 2) is needed to pump water from the water tank to the boiler, so that can be transformed into steam. The pump works with 220V.

Figure 2. Water pump

2.2. Boiler

The boiler (Fig. 3) works with 220V and its power is 1350W. The current absorbed by the boiler is 6A. The pressure inside of the boiler is approximately 3 bar.

When the temperature inside of the boiler is higher than 105ºC, a LED placed near the buttons is on (see figure 5) to indicate that the boiler is heating up.

When the temperature arrives to 120ºC, the LED is switched off and the boiler starts to cool down. Now, the button of the ejector is ready to be switched on, freeing the water steam through the fan.

The boiler has an electrical valve that cuts current when the temperature inside of the boiler arrives to 200ºC.

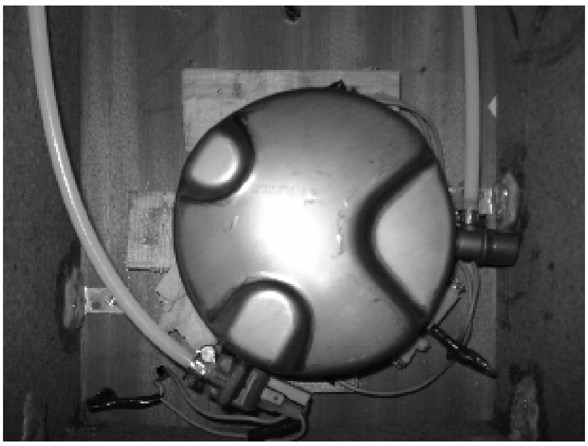

Figure 3. Boiler

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2.3. Computer cooling fan

The fan used in the miniature is a 12V computer cooling fan, installed inside the power plant chimney (Fig. 4). When the water steam leaves the ejector, the fan starts turning, generating voltage at its terminals. When the voltage is enough, two LEDs connected to the fan terminals lighten up. The ejector is pointed in a way such that the voltage at the terminals of the fan is as high as possible.

2.4. Buttons

The miniature has three buttons (Fig. 5), two of position and one of pressure. The pressure button (Button 2) corresponds to the water pump. When it is pressed, it switches the pump on, filling the boiler with water. Button 3 is needed to turn on or off the boiler. Button 1 opens the ejector so that the water steam may go to the fan.

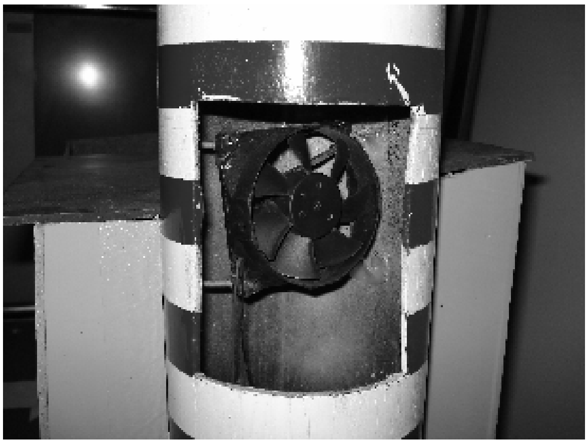


Figure 4. Fan inside the chimney

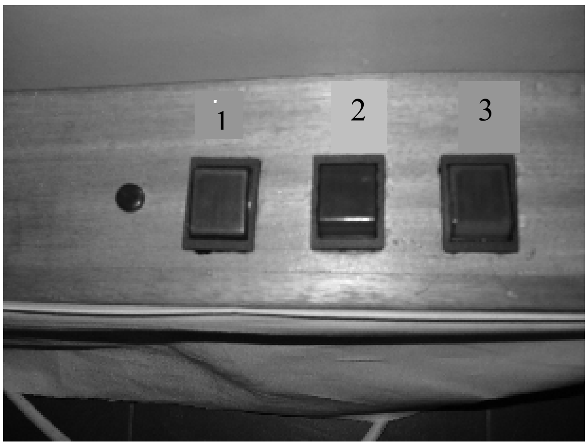


Figure 5. Buttons

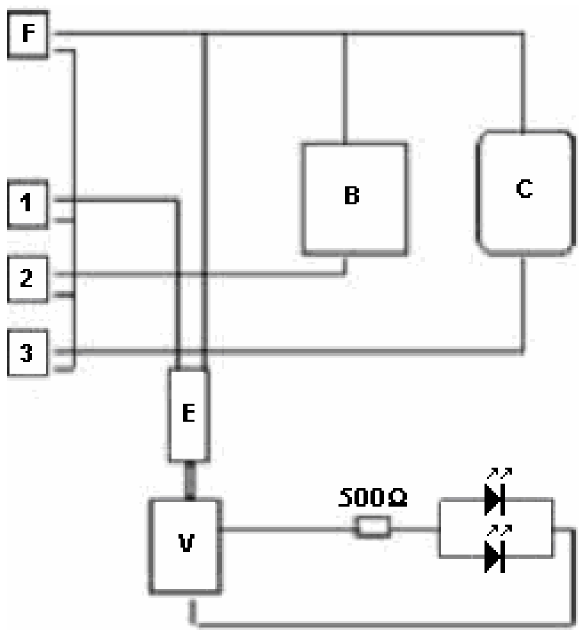
2.5. Electrical outline

Figure 6 depicts the outline of the electrical circuit used in the miniature.

3. Tests and construction details

Before the construction of the miniature thermoelectric power plant, several tests were performed in order to verify the reliability of the materials used.

First, the boiler was filled using the water pump. Then, through a pipe of Teflon, the boiler was linked to the ejector. The pipe of Teflon was used because the temperature of water steam in the output of the boiler is higher than 100ºC and pressure is, approximately, 4 bar (value not measured). The pipe tolerates temperatures up to 200ºC and 10 bar pressures.



F – Power source
1 – Ejector button
2 – Water pump button
3 – Boiler button
E – Ejector
V – Computer cooling fan
C – Boiler
B – Water Pump

Figure 6. Electrical outline

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The next step was testing the voltage generated at the terminals of the fan by the passing steam. The maximum peak voltage obtained was 2.5V. The series made with a 500Ω resistor and two LEDs in parallel was connected to the terminals of the fan. The resistor was required to limit the current in LEDs.

The power plant has a very poor efficiency. In fact, the current required to heat the water is 6A, resulting in a 1320W input power.

When the tests phase concluded, the construction of the structure was initiated. First, the walls of the miniature were constructed and painted with spray. Then, the boiler was fixed in the wooden base. The next step was the construction and painting of the roofs and the chimney (this latter that was painted in white and red). Finally, the ejector and the fan were fixed inside the chimney.

Part of the water steam used in the energy generation turns back into water inside the chimney and returns to the water tank.

4. Conclusions

A miniature steam thermoelectric power plant was presented. It was built using old starch iron parts and a computer cooling fan. Construction and operation details were explained. The voltage generated by the power plant is enough to lighten two LEDs. Despite of its very poor efficiency, the device is eye-catching and very suitable for science fair events.

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Microcontroller-Driven Hydrogen Car

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Abstract. This paper presents a hydrogen-powered car with 8 minutes autonomy. The hydrogen is produced by electrolysis, which requires an external power supply. The gas is retained on an isolated compartment in the car. Then, it goes to the fuel cell, which produces the energy for the car motor. The car follows a white line on a black track using five infrared sensors that detect white and black colors. A servomotor controls its direction. Guidelines to the servomotor are given by a system based on an 8051 microcontroller, according to the information it receives from the infrared sensors.

Keywords. Fuel Cell, Infrared Sensors, 8051 Microcontroller, Hydrogen, Electrolysis.

1. Introduction

The project described in this paper applies fuel cell technology [1, 2] to a model car.

Figure 1. Hydrogen powered car

To control the vehicle, more conventional technologies were used. Infrared sensors and an 8051 microcontroller are some of the components integrated in the control system.

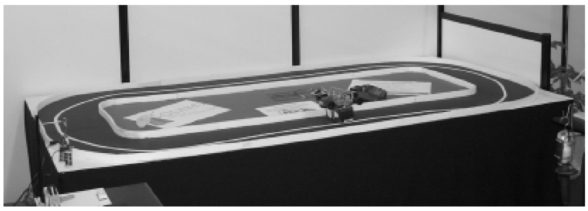

Figure 2. Car track

Since the hydrogen car (Fig. 1) is very suitable for science fair events – its appearance at *Robótica 2006* festival was a success – an oval track (Fig. 2) was built for exhibition purposes.

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Over the black surface of the track, a white line was drawn. The car follows this line using its infrared sensors.

2. Key aspects of the project

These are the key aspects of the project, which will be emphasized:

- The use of fuel cells;
- The use of infrared sensors;
- The use of an 8051 microcontroller.

2.1. Fuel cell

The primary objective of the project was to create an autonomous car running on water, capable of circulating on a track. To power its electric motor, a fuel cell (Fig. 3) was used.

Figure 3. Fuel cell, between the hydrogen and oxygen tanks (on the left) and the servomotor (on the right)

This fuel cell can work in *electrolyzer mode* or in *fuel cell mode* [2]. Since it is the most important part of the project, these modes will be described with more detail.

2.1.1. Electrolyzer mode

In this mode, the fuel cell "produces" hydrogen and oxygen from water. This is a very useful capability, since it avoids the use of a refilling station.

The fuel cell needs an external power supply to do the electrolysis of the water, which separates the hydrogen from the oxygen. The chemical reactions are the following:

$$2H_2O \rightarrow 4H^+ + 4e^- + O_2 \quad \text{(cathode side)}$$

$$4H^+ + 4e^- \rightarrow 2H_2 \quad \text{(anode side)}$$

2.1.2. Fuel cell mode

The terminals of the external electric circuit to be powered are connected to the anode and the cathode of the fuel cell. The car has two separate and isolated tanks. Both tanks are partially filled with water. Through water electrolysis, one of the tanks is filled with hydrogen (H) and the other is filled with oxygen (O). Then, hydrogen flows to the anode and oxygen flows to the cathode. On the anode side of the cell, a platinum catalyst separates the hydrogen into electrons and protons. The protons flow towards the cathode through a Proton Exchange Membrane (PEM). However, the electrons cannot pass this membrane. Instead, they go to the cathode through the external electric circuit, establishing an electric current in this circuit. On the cathode side of the cell, the electrons are combined with the protons and oxygen, with the help of a platinum catalyst. The chemical reactions are the following:

$$2H_2 \rightarrow 4H^+ + 4e^- \quad \text{(anode side)}$$

$$4H^+ + 4e^- + O_2 \rightarrow 2H_2O \quad \text{(cathode side)}$$

2.2. Infrared sensors

Five infrared sensors are placed in the front of the car, facing down (Fig. 4). They allow distinguishing white surfaces from black surfaces, so the car can follow a white line drawn on a black track.

Each sensor has an emitter and a receiver. The emitter sends to the track infrared radiation that is reflected back to the receiver if the white line is detected.

If the leftmost sensors detect the white line, the car turns left; if the rightmost sensors detect the white line, the car turns right. This way, the car follows the white line.

2.3. The 8051 microcontroller circuit

A circuit that contains an 8051 microcontroller (Fig. 5) was designed to receive and process the information sent by the infrared sensors [3] and then send the correct information to the servomotor that controls the direction of the car.

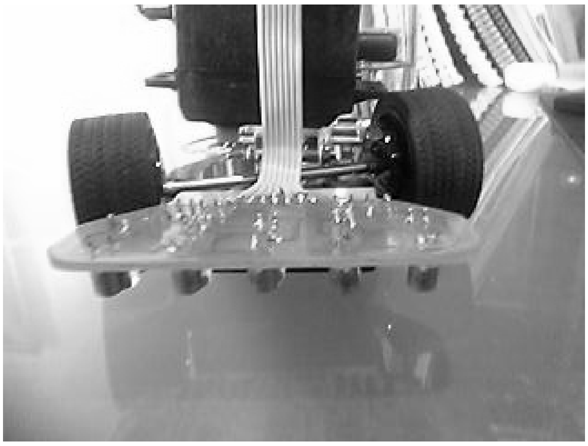

Figure 4. Five infrared sensors are placed in the front of the car, facing down

The program installed on the 8051 microcontroller [4, 5] has two functions: controlling the direction of the car and switching on and off the car motor. The source code was written on C [5]. This task offered the authors the opportunity to practice this programming language.

The microcontroller requires a 5V power supply. This is provided by a 9V battery, which also supplies the servomotor and the infrared sensors.

3. Car operation

To start the car, the fuel cell must first be filled with water into the tanks located in the middle of the car. Then, an external power supply is attached to the anode and cathode of the fuel cell, so it can produce hydrogen and oxygen.

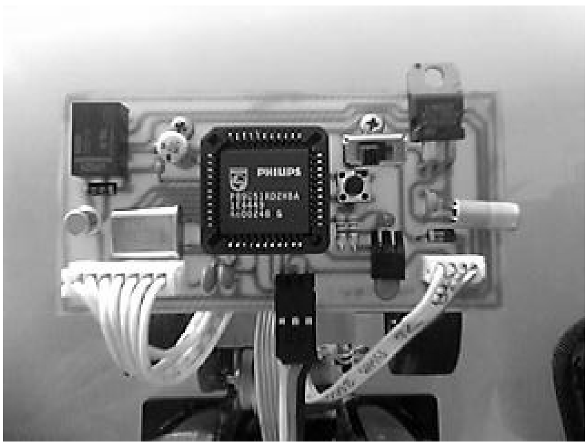

Figure 5. The 8051 microcontroller circuit

The second step is starting the car: a switch most be turned on and a key must be pressed. After this, the car will automatically run on the track, following the white line.

When a horizontal line appears, the car stops for a few minutes to refill. This only takes place after the car completes three or four laps.

The autonomy of the car is up to 8 minutes with the compartments initially filled with hydrogen and oxygen.

4. Conclusions

A hydrogen-powered car with 8 minutes autonomy has been presented.

The hydrogen, produced by electrolysis, is used by a fuel cell to generate the electric current supplied to the car motor.

The car follows a white line on a black track using infrared sensors that detect white and black colors.

A system based on an 8051 microcontroller has been developed. It receives information from the infrared sensors, controls a servomotor that steers the car and switches on and off the car motor.

The car is very suitable for science fair events. Seeing a fuel cell working arouses the interest for this technology. The project offered the authors the opportunity of learning more about fuel cells, practicing electronics and improving programming skills.

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Traction System for Electric Vehicles Using a Variable Frequency. Three-Phase Induction Motor Driver with Regenerative Braking

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Abstract. This paper describes the development and implementation of a traction system, based in the utilization of a three-phase induction motor, controlled by a Power Electronics inverter, to be used in electric vehicles. This system allows the speed control of the vehicle, forward and backward, and also permits regenerative braking. The induction motor is fed, through the inverter, by a set of batteries. During the operation in the regenerative braking mode, the induction motor returns, through the inverter, the vehicle kinetic energy to the batteries.

Keywords. Electric vehicles, Three-Phase Induction Motor, Power Electronics Inverter, Speed Controller, Regenerative Braking.

1. Introduction

As fossil fuels become less abundant and expensive, and with the problems of worldwide pollution, they also become inadequate to be used in such a large scale. The automotive industry is one of the biggest spenders of this limited resource. This fact may be changed with the use of electronic propelling systems, such as the appliance of a three-phase induction motor driven by a controlled inverter, replacing the internal combustion engine.

Formerly, DC series motors were preferred for traction applications, as the drive systems are relatively simple. Nowadays, more precise digital algorithms, using microcontrollers, have been developed to control power inverters with the purpose of driving induction motors, which makes them a far better choice than DC motors.

Induction motors are considered a better choice because of their robustness, reliability and low price. The electronics involving the drive also makes them the most efficient choice. The regenerative braking system, which allows delivering power back to the batteries while braking, or even when vehicles go downhill, is also possible when using induction motors.

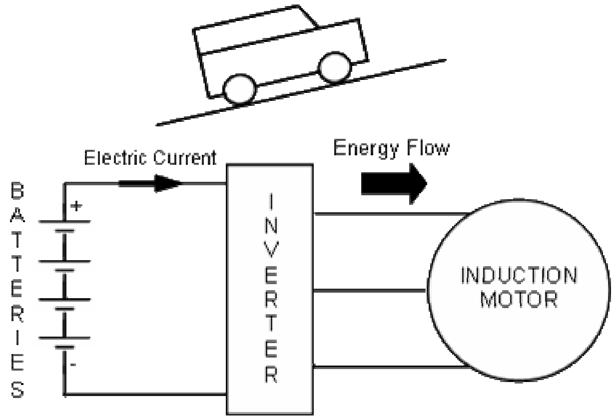

Figure 1. Vehicle in acceleration or keeping constant speed

Using a three-phase induction motor is a choice that concerns its better torque characteristics.

The project in hand is made with the purpose described above, and includes its features with a monitoring capability.

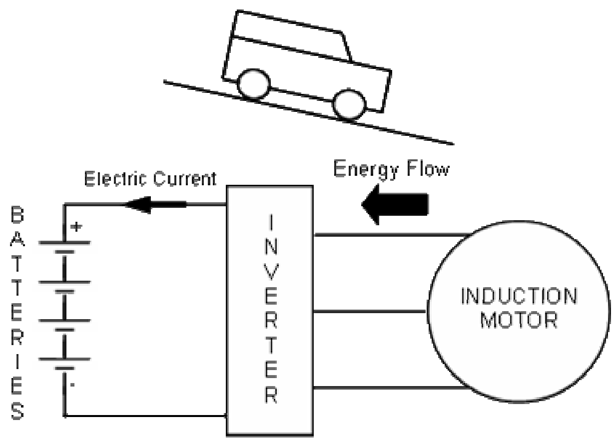

Figure 2. Vehicle braking or in downhill

When the vehicle is accelerating or maintaining speed, it requires power, which means that the batteries are feeding the motor. While braking, energy is being returned from the motor to the batteries. Because this energy flow is very fast, it can't happen directly from the inverter to the batteries. There has to be an element capable of charging in seconds or less such as capacitors or even ultra-capacitors.

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2. The controller

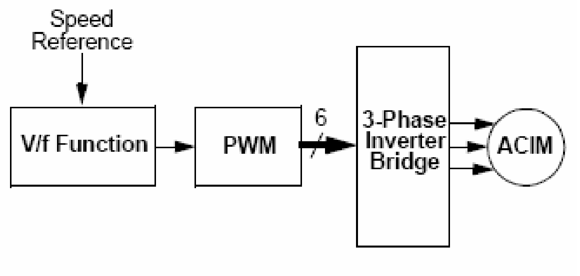

Figure 3. Block diagram

A three-phase induction motor has to be fed by three sine waves phase shifted of 120 degrees in time. In order to drive and control the motor, a velocity/frequency function has to be considered. As higher the frequency of the sine waves, the faster the motor will run, and as higher the amplitude of the sine waves, the higher will the torque be. This kind of control is created through a microcontroller generating PWM signals which are applied to an inverter bridge. These signals are used to synthesize three wave forms that approximate the sine wave shape.

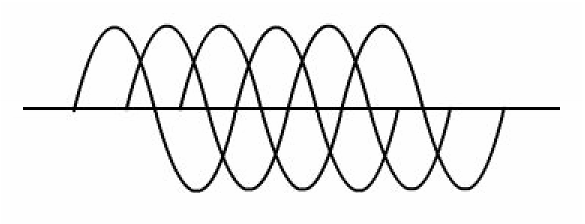

Figure 4. Three sine waves

The ability to change the frequency, amplitude and order of these sine waves, makes the controller able to change the speed and rotation direction of the motor, fitting this application to be used in a vehicle.

The rotating speed (N_s - in *RPM*) can be calculated having the number of the poles (*p*) of the motor used, and the frequency of the voltages applied to the motor windings (*f* – in *Hz*). Its value is given by equation (1).

$$Ns = 120 \times \frac{f}{p} \qquad (1)$$

3. Conclusions

This work intends to show a traction system prototype, which consists in a developed Power Electronics inverter with digital controller, designed to drive a three-phase induction motor, to be used in an electric vehicle. The inverter allows regenerative braking, in order to optimize the efficiency of the electric vehicle regarding its energy consumption.

4. Acknowledgements

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Discovering Electric Circuits. An Experimental Lesson

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Abstract. Most of children toys are battery-operated. Children are used to simple operations such as the change of dead batteries and very early they learn to relate the toys functioning with the presence of batteries. This knowledge can be the starting point for a deeper look on the functioning of electric devices. The concepts of electric circuit and conducting materials can be acquired from an experimental activity based on the use of common electric circuit elements such as batteries, lamps and electric cables.

Photo 1. Lighting fish balloons in a ring

The present experimental activity was planned for kindergarten children to discover the basic features of electricity and electric circuits. This activity was tested with children aged 4-5 in a class of Colégio D. Diogo de Sousa in Braga in 2004.

The experimental lesson began with the examination of a fish-balloon toy, which was lighted when the contact between two metallic tips was done with the fingers. The operation of this toy was explored making the electric contact by different ways, so that children could figure that the lamp lighting depended on the existence of a closed circuit and on the use of conducting materials. Thereafter children where asked to construct a circuit that could work in a similar way as the built-in the fish-balloon from a set of objects (batteries, lamps, electric cables and sticks of different materials). They easily recognized the lamp, battery and electric cables as needed to make the circuit. The incorporation of sticks of different materials, such as wood, rubber, plastic and metal was tested. These materials were classified as conducting and non-conducting materials.

Photo 2. Assembling an electric circuit with lamps and a battery

Photo 3. Incorporating conducting and non-conducting materials in the electric circuit

Keywords. Kindergarden, Electric circuits, Conducting and nonconducting materials.

Solubility: An Experimental Lesson

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Abstract. The benefits of experimentation are well known for young pupils. Therefore, science education in primary school should have an experimental approach as far as possible. Some subjects of the primary school programme are

particularly appealing for hands-on-science lessons, such as The study of solubility.
In this communication it is presented an experimental lesson planned for the study of solubility and developed with children aged 7-8, in a class of Colégio D. Diogo de Sousa, at Braga in 2006.

The main goals of this activity are:

- to develop basic investigative skills;
- to perform team work;
- to use of scientific vocabulary in the description of the properties of materials and experimental facts;
- to organize the results of experiments in the form of tables and graphic bars;
- to analyze and compare experimental data;
- to communicate the group conclusions to the class.

Photo 1. Observing the characteristics of the solids

The experimental activity consisted in i) the observation of liquid and solid chemical substances contained in small tubes, and ii) the addition of few drops of the liquids to the tubes containing each solid.

In the first part of the activity, children were asked to identify the properties of the chemical substances in the tubes in a time-sheet of multiple-choice answers and portray the different substances.

Thereafter the solubility essay, children should classify the solid substances as very soluble, soluble and non-soluble in a table.

At the end of this 2 hours activity, a child of each group communicated to the class the results of their solubility tests of a single solvent. The results of the class were collected in the blackboard and analyzed in a class debate. The qualitative information was converted to a quantitative scale: very soluble - 2; soluble - 1 and non-soluble - 0. The resulting scores for liquids and solids were used to build two graphic bars. The interpretation of these graphs allowed the evaluation of the better solvent and the most soluble solid. In this debate children also presented their previous knowledge on the solubility phenomena. One of the best-known facts was the solubility-temperature dependence.

Photo 2. Discussing results among the group

A Hands-on Water Drainage and Underground Water Contamination

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Abstract. This paper describes an activity with three investigations through which the students are introduced to scientific inquiry. During this process they are allowed to study the porosity and the permeability of ground soil and also they are encouraged to construct their own ground soil model. At the first investigation students measure the time that water needs to drain through different kinds of soil (ex. clay, sand and stony ground). At the second investigation students realise that both too much and too little water cannot preserve a plant. They seek out the appropriate soil combinations in order to

preserve plant's life. At the third investigation students realise how pollutants can travel through soil and they examine their suggestions about dealing with pollution through practicing.

Phases of investigations

No specific instructions are given to the students and they are expected to draw up by themselves the experimental process knowing only the objectives of the experiments and the given materials. The students discuss the ways of controlling the rate of the effusion, the appropriate methods which can prevent the pollutants entering the soil and the possible solutions for waste removal.

Finally the students are encouraged to discus within their group the functionality of their proposals in a local problem of their community.

Keywords. Contamination, Water drain.

Four Hands-on Activities Obeying the Inverse Square Law

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Abstract. The significant motive for this work constituted the following question: is it possible to find lab activities which bring out unification and a non piecemeal description of physical phenomena?
Point-like sources of gravitational forces, electric fields, light, sound and radiation obey the inverse square law. This geometrical law gives the ability of unifying educational approach of various cognitive subjects in all the educational levels.
During the last year we have been using engaging hands-on activities to help our students in order to understand the cohesion in Nature and to export conclusions from experimental data.

In this paper four activities are described, which were executed by students. These activities are concerning the electromagnetic radiation and the main goal is to confirm the inverse square law.

The educational methodology we propose, for this educational action is the "inquiringly evolving educational model". We used four activities entitled as: the geometrical origin of inverse square law, "verification of inverse square law –Simple photometer construction", "inverse square law in MBL with light and motion sensors" and "inverse square law with

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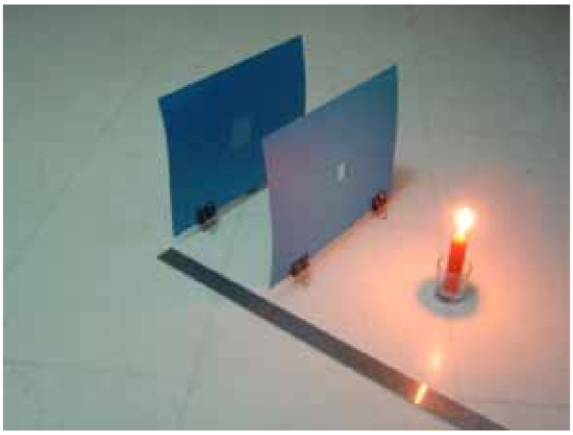
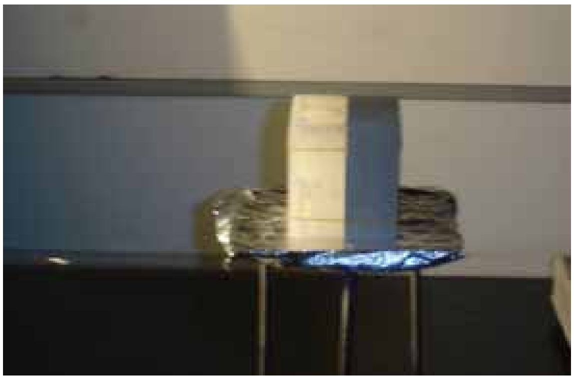
radioactive source and a Geiger - Miller sensor". The materials and apparatus students used for these activities are shown to the following images.



Activity 1. The geometrical origin of inverse square law



Activity 2. Verification of inverse square law – Simple photometer construction.

Activity 3. Inverse square law in MBL with light and motion sensors

Activity 4. Inverse square law with radioactive source and a Geiger - Miller sensor.

Keywords. Inverse square law, Photometer.

Estimating the Absolute Zero through Thermal Expansion of Air

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Abstract. In this paper we describe a hands-on activity made by students in order to estimate the absolute zero through the thermal expansion of air. The necessary materials for this activity are: a spherical bottle, a cap of a bottle, ice cubes, hot water, α syringe and a small thermometer. During the process the pressure remains constant. The small thermometer was placed into the spherical bottle and the syringe was settled through the small cap as the following images show.

The students during the process count the volume of the air at various temperatures starting from 0^0C. From the experimental data the students draw a volume-temperature graph with which graph they estimate the absolute zero.

Before the main activity in the laboratory the students have previously succeeded in a pre lab activity (with the form of a feel up sheet) in order to be ensured that the students have all the necessary basic knowledge to conclude the

experimental procedure achieving in parallel the better training result.

The experimental procedure

Keywords. Absolute zero, Thermal expansion.

Studying Thermal Equilibrium Using Temperature Sensors and a Film Canister

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Abstract. These Since 2004 all the students of Pedagogical Department execute hands-on experiments with the use of sensors. The experiment we present in this paper is characterized by the simplicity of the experimental procedure. The results from the implementation of these exercises are very encouraging.

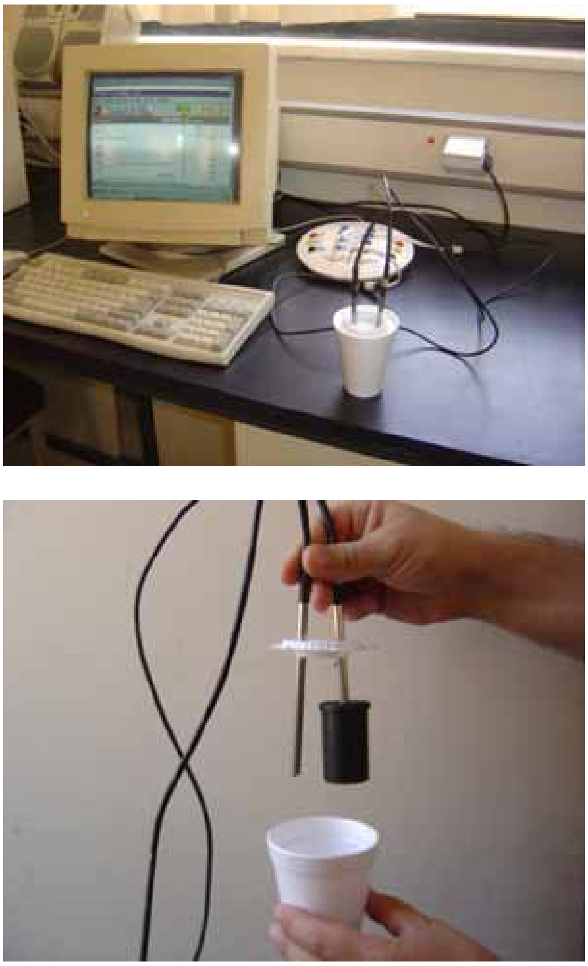

Figure 1. The thermal equilibrium experiment in M.B.L

In this exercise the students study the establishment of thermal equilibrium. They use hot water, 80 ^oC and cold water 15 ^oC. In this

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exercise hot water is placed into a film canister (because of its good thermal conductivity). A temperature sensor is placed into the canister (with hot water) and the canister is placed in a cup with cold water in which a second temperature sensor is placed, as it shown in the pictures below.

The exercise takes place in the laboratory with at least a PC with installed suitable software, such as CoachLab 5.0 (in our native language version), in combination with the console Coach Lab II and two temperature sensors.

The students are assessed not only with the report sheet of lab exercise but also by completing an observation sheet of team behaviour and a self-assessment form.

Keywords. Thermal equilibrium, MBL.

The Odyssey of a Plastic Bottle in the School Laboratory (Or How the Worthless Can Become Useful)

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Abstract. During the latest years an attempt has initiated in Greece in order to update the school science laboratories of secondary education, an attempt which is under development. Nevertheless, the use of simple materials in laboratory activities during science lessons is more or less a familiar practice and in many cases a one-way route for the teachers.

The reasons are many. Indicatively we mention the insufficient laboratory facilities, the familiarity of students with simple everyday materials, the more successful way of connecting theory and practice in this mode, the low cost of the materials and the grater safety of the students.

The Laboratorial Science Centre of Rethymno (EKFE) has started an attempt to record and videotape decades of experiments which can be conducted with simple and worthless (low cost) materials and has already published 2 CDs and 2 DVDs in the teaching units of fluids and heat.

The whole approach in the use of simple experimental devices starts with the choice of the necessary materials, which can also be assigned to students as a team work project. The materials will later constitute the contents of a small suitcase, which will be useful and easy to move around. (Reference to the materials).

It is rather impressive how the same object can be used in multiple experiments. Indicatively we mention the plastic water bottle, which can be the basic medium for more than 10 different experiments. An empty aluminium can be used in experiments from different teaching units such as static electricity, hydrostatics, heat, atmospheric pressure, energy and various chemical reactions. In a great number of experiments a lot of simple materials can be used such as a balloon, a coin, a mirror, etc. (Demonstrations, references to particular experiments).

The experiments with simple materials are resourceful for qualitative observation and verification of natural laws and they usually have the advantage of simplicity, they are completed in a short time, they can also be used in a front faced laboratory and they may demonstrate with clarity the teacher's objectives. They have disadvantages in the field of quantitative measurements and in the approach of natural laws through mathematical logic.

The experiment with simple materials must function in a complementary way and not substitute the measurement experiment or the experiment, which uses the modern laboratory facilities. It should be also used in the appropriate situation in a way that its "coefficient of teaching performance" should … tend to one!

Keywords. Hands-on experiments with simple materials, Suitcases of experiments.

Last years an effort of modernising Greek School Laboratories has begun and is still in process. The state, even after the usual delay, appears convinced about the necessity of experimental teaching in Physical Sciences. The "laboratorial state'' of Greek Lyceum has changed dramatically and the lack of material and technical infrastructure cannot provide an alibi anymore for the unwilling teacher to make experiments. Unfortunately the equipment of Laboratories in primary education and in High school, has not reached a good point. Insufficient equipment, in spatial rooms used as Laboratories,

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or –even worse – wardrobes which take their place, compose a picture that is not flattering for a European country which is called to face the challenges of the 21st century in the sector of education. Taking into consideration this vague and contradictory situation, the instructive method of "experiment" depends-once more on the consciousness of the teacher, the "basic ring in the educational chain". Under these circumstances, the use of simple materials by the schoolteacher in order to make experiments in the class constitutes a common instructive practice even in secondary school, and, sometimes, the only possible method of teaching. It is worth reminding the opinion of Piaget that ''knowledge is not the transmission of a picture, but always consists an energetic process that leads to a transformation of what is real''. Consequently Knowledge is inevitably connected with acting over objects that are with experimental instructive practice. With regard to the integration of simple materials of everyday life in experimental activities, a lot of questions and objections are rationally claimed. Does the systematic use of this type of activities "downgrade" the quality of experimental teaching and make the students disregard Physical Sciences? Are there cases when the teacher would be asked to make experiments with simple materials? In conclusion, which are the advantages and disadvantages of the experiment with simple materials of everyday life, and the one realised with typical laboratorial appliances?

Photo 1

It is doubtful, that in case that the School has insufficient laboratorial infrastructure, the experiment with simple means is a good choice. If the School Laboratory does not dispose of an appliance of connected containers, the latter principle can be understood by the students with a transparent flexible pipe, or with two glasses that communicate via this pipe, (Phot. 1, 2), or even through the application of this principle in artesian fountains. (Phot. 3)

A second reason, for which this instructive practice is proposed, is the gradual familiarization of students with materials of great utility of everyday life. Only a few Laboratories dispose of a generator of air. All the students, however, know a hair dryer, and they can understand via a spectacular experiment, that the flow of a fluid creates decreased pressure (Phot. 4). An ecological benefit of this teaching method is also that students will realise the multiple usefulness of various objects and that, finally, ''nothing is lost'' in our lives.

Photo 2

Photo 3

The low cost of these materials, constitutes a factor that will be particularly appreciated, especially from …School Headmasters, who do not affront with eagerness teachers' demands for

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laboratorial equipment. The Archimedes principle and the principle of pressure transmission in liquids can be approached experimentally with a lot of ways, one of which is the diachronic "Cartesian diver", which leads to a spectacular result with the minimum cost. (Phot.5,6)

Photo 4

Photo 5

The experiments with simple materials contribute considerably in a more successful connection between instructive theory and practise. With the experiment of reversed bottle from which the water is not poured (Phot.7), we will have the occasion to stress, that it is in this way that the automatic watering cans of birds and animals function. In this case the experiment functions as a marvellous way in order to "whisper" to the student: "You will need what you learn somewhere".

Photo 6

Photo 7

Furthermore, another advantage of experiments with simple materials is that as a rule they are harmless and in combination with their low cost they can be successfully used in ‘’frontal laboratory’’(=the one where every student has his personal seat to make an experiment on his own, in front of him, cont. to ‘’demonstrative laboratory’’ where the teacher is the only one to make the experiments and the students simply watch). It is easy to create, for laboratorial exercise, 8 boxes of materials necessary for the experiment that will serve to 8 teams of students (Phot. 7). In this point it is time

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we stressed that ''frontal laboratory'' undeniably surpasses any other laboratorial method, because it gives a space of initiative to the student, the lack of which "kills" his creativity.

Finally, in the advantages of experiments with materials of utility, belong their simplicity and their brevity. Either as experiments of demonstration, or in frontal laboratory, they are set up and completed in a few minutes. The experiment for the creation of static electricity with the empty refreshment tin and the electrified plastic rule is completed in 10 seconds with minimum cost. (Phot.8). It is impressive that the same object can be used in different experiments. For example, a plastic bottle of mineral water can constitute the basic auxiliary means for more than 10 different experiments. An empty box of aluminium can be used in experiments of different units, as, in the one of static electricity, hydrostatics, heat, atmospheric pressure, energy and in various chemical reactions. In a great number of experiments materials like a balloon, a currency, a mirror etc can be used.

Photo 8

Photo 9

However, the experiment with simple materials is at a disadvantage in the field of quantitative measurement and the approach of natural laws through mathematic logic. The verification of a Natural law is based on size measurement, on the exploitation of mathematic relations and on the report of experimental faults. But here are the chronometer, the tape measure, the electronic scales, the electronic oscillograph etc. The taking and evaluation of measurements is a very important part of experimental work and the teacher should not underestimate it. The demonstration of straight movement and the measurement of speed can be done in a simple way, with a rule and a chronometer and the movement of a bubble into a glass pipe that has been placed with a small bent on a headlight of transparencies (overhead) (Phot.9). Nevertheless, for the study of movements we should resort to the use of an electric chronometer, or air-path, and the sketching of graphics. It is obvious that even if the use of simple materials for experiments can be inserted in any level of education, their frequency of use should be decreased as we go up the educational ranks. In primary education the experiment with simple materials of everyday life should be the rule, while in secondary education it should constitute the exception.

Photo 10

With regard to the methodology and the better instructive exploitation of experiments with simple materials, the teacher should bare in mind the following points:

The whole approach in the instructive practice of the use of simple auxiliary means of teaching, begins with the choice of the necessary materials. It would be a good idea if the process of collection was assigned as homework to teams of students. The materials will constitute the content of a small suitcase, which will be functional and handy (Phot. 10,11). If the teacher is prompted to organise frontal laboratory, then he is supposed to create 8 – 10 similar collections in cartons. (ANNEX)

In experiments with simple materials it is preferable to set only one target, evident and easy to be presented, and to guide all our efforts to it. The experiment of the "Cartesian diver" for example, is one where a lot of laws and concepts of physics can be met, as the Archimedes principle, the distribution of pressures in liquids, the compressibility of gases, the difference of density between liquid and gas etc. The Teacher will set the target and let the experiment "speak" in his part. In the experiment that is presented in Photo 12, the main objective is to show that the hydrostatic pressure exercised in a certain part of a liquid is proportional with the depth of this part, and other parameters as the effect of atmospheric pressure in the flow of liquid are left aside. On the contrary, the experiment with the leaking bottle by which the water is not poured, shows very clearly the existence of exterior pressure (atmospheric) bigger than the hydrostatics pressure, which prevents the water to be poured from the holes of the bottle (Phot.13).

Photo 11

The experiments with simple materials are usually attractive, impressive and have-to a large extent- a character of "game". The teacher should exploit these elements in order to attract the attention of the students, but without stressing them excessively. In every case, the student should leave with the impression that he makes experiments in order to interpret natural phenomena or to verify natural laws and that he does not play. The schoolteacher of Physics should be aware of the "thin red line" that separates the "enjoyment of" the course from the "amusement".

Photo 12

Photo 13

The EKFE Rethimno has begun an effort of recording and videotaping the dozens of experiments that can be realised with simple materials. In the scope of this effort, it has already published two CDs and 2 DVDs with experiments concerning the units of fluid and heat that are already distributed to the teachers of Rethimno.

Finally, we consider that the experiment with simple materials constitutes a useful pedagogic practice, as far as it is used as a ‘’treatment’’. The moment when it should be prescribed and in its suitable doses. It should function additionally and not substitute the experiment of measurement, or the experiment that develops the modern laboratorial infrastructure. The object of the "schoolteacher of" physics should be that,

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through a rational use, the factor of his instructive output … approaches one!

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ANNEX
Content of box of experiments with simple materials.

3 small plastic bottles of water 0,5 L, a cut plastic bottle of refreshment 1,5 L, a small bottle of wine or beer, 2 small boxes of refreshment from aluminium, 2 cylindrical metal boxes, a small basin or plastic bowl preferable transparent, 2 glasses, a cup of coffee, a small ceramic dish, a sheet of waterproof paper or cardboard 3-4 pieces, 4-5 wooden rule from thin timber, plasticine, plastic straws, wooden straws, toothpicks, matches, 2 suckers with hooks, balloons (circular and cylindrical), glue tape, glue, thread, line and thicker thread, cotton, rubbers relatively fat, rubber of buckrams, handkerchief, napkins, black cloth of wool, a piece of rubber for hydraulic insulations, a lighter, cigarettes, 2-3 small candles with base from aluminum, 3 small mirrors, a small piece of glass, magnifying lens, crystal prism, coloured gelatins, 2 small balls of ping-pong, pencil, pen (BIC), ink or colour dissoluble in water, salt, vinegar, alcohol, baking soda, baking-powder, aspirin, HCl, sugar, flour, sulphur, lime, liquid soap, transparent plastic rubber, dropper, digital clock or calculator, small round magnets, 2 stick like magnets, metal strainer of tea, bullets, small springs, small lamp, small lamp LED, electric lens, fat wire of aluminium , thinner wires, two cylindrical pieces of iron, tinfoil, laminas from metal Zn or aluminium, laminas from coper, dust of iron, nails, pins, fasteners and screws, metal currencies of 0,5 euro, wooden pincers, plastic teaspoon, corks, ruler of plastic, protractor, transparent lid of box, comb, newspaper, hairdryer, battery of 4,5 V, small engine, cables, pliers, screwdriver, sandpaper, a small knife, a pair of scissors.

Observe, Ask and Do. Learning Guides. Exhibitions Exploration Tools

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Abstract. It's common knowledge that a static exhibition can be of little interest for children, moreover in a school context. How to make a group of students remain interested in an exhibition more than a few minutes? This question arose with the "Wildlife Photographer of the Year" exhibition, which is of acknowledged quality. As a Science Centre, Fábrica felt the urge to dynamize this exhibition and make it more interactive by conceiving a learning guide that would not resemble a school book. Proverbs, riddles and simple questions, always with a subtle touch of humour, were the tools employed to excite new feelings and perspectives, constantly having the photographs

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as background. The learning guide's scientific content was presented in a fun and apparently entertaining way.

From the activities suggested in the guide, several interactive and experimental exhibits were developed and integrated in the exhibition. They became the key to the success of this working tool.

The proposed activities could be accomplished individually or in group and led to a later research, outside of the Science Museum, in a school or familiar context.

The graphic image of the guide revealed to be fundamental to catch the target public's attention.

Incitement to new challenges and arise to new perspectives were the achieved goals.

Keywords. Learning guides, Hands-on.

The Programme of Fábrica and its Communication with the Exterior

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Abstract. With Fábrica – Centro Ciência Viva de Aveiro is an open space for different ways of communication to promote science and technological culture among the society.

Inside an University and integrated in a national net of sciences centres, Fábrica is a space of opportunity to create a relation with science or simply establish an informal contact with matters that are related to it.

Placed in an old flour mill, the science centre becomes a sign of life in the interior of a huge building, reflex of the expansive activity in the cereals range, developed lifelong the XX century. This building had become, in the last 10 years, a grey mark of abandonment, only alive in the memory of many people that have worked in there. The Fábrica – Centro Ciência Viva is raised inside this building adapting it, and being adapted by it, to be opened to the public and to invite all the people to come inside and benefit of the activities that are prepared for them. The building itself fits the opposite, which is the reflex of the ancient structural activity. The nature and diversity of the programme is the clue to approach the inside activity to the outside. Establishments with schools, social associations and enterprises are a step to involve all the society with this project.

Keywords. Public communication.

The Learner as a Co-creator through Collaborative Task-based Learning of a Hands-on Experimental Apparatus and Potential Media

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Abstract. We hereby present the results of a work assigned to student-groups of pedagogical and physics department of University of Athens. We set the students the task of designing an experiment in various thematic regions of physics. We also ask them to develop a proper video or movie for educational needs. The teacher had the role of companion in the transaction of assigned task. Some issues were:

1) The dependence from the pressure of water boiling point. Cold boil.
2) Simulate the function of a wing.
3) Setting up an experiment with simple materials to generalize the Bernoulli law in fluids.
4) Measuring the Poisson constant of the air.
5) Measuring the moment of inertia of a bar.
6) Pulley's moment of inertia measurement.

Here we report on the first three issues.

With the first issue worked on 3 teams of students. Group A drew an experiment with a sensor of pressure and a sensor of temperature.

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They created also supporting software. This software is characterized by his methodology. Croup B drew another experiment with a sensor of pressure and a sensor of temperature and moreover created a movie (flash format). Finally group G drew experiments with simple materials.

Figure 1. Frames of movie (flash format)

Figure 2. Video scene of an experimental process

The second issue is closely associated with the third, both concerning the Bernoulli law. Specifically, the second is concentrating in the function of the wing, trying to introduce students in the subject of Bernoulli law and conditions of flying. They are given a set of materials (a piece of paper, a couple of straws, a piece of plasticine and a hair drier) in small groups and they are asked to design, to make and to video the apparatus.

In the third issue, students are asked to generalize their assumptions about the Bernoulli law, in liquid flow. In this direction, they are given a glass with water and an egg floating in it. Then they pour water upon the egg and they are asked to describe what they see. Also, they are asked to repeat the activity changing the power of the water flow and draw a conclusion.

Keywords. Co-creation, Teacher as a companion, Boil, Bernoulli law.

Invent an ET ! An Interactive Strategy Regarding the Theme of Communication and the Five Senses

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Abstract. Efficiency and effectiveness of any interactive science exhibition is strongly dependent on ways to enhance visitor's hands-on, minds-on and hearts-on engagement with the various exhibits. In this communication, we will describe our experience related to the first thematic exhibition for travelling created by Exploratório, the Ciência Viva Centre of Coimbra, Portugal. The theme is communication and the five senses. Instead of a large number of simple exhibits, we chose to build only ten exhibits each one enabling more than one experiment/interaction, and organized in four islands: vision and light (all electromagnetic radiations), hearing and sound (and infra and ultrasound), tactile communication (including various codes) and taste and smell (chemical communication). It is expected that this approach will reduce the usual tendency, especially of young visitors, to run from one exhibit to another. Instructions are kept to a minimum and explanations are offered at three levels of depth, depending on the previous knowledge of each visitor. But the major strategy to engage visitors is the invitation made to each one to invent an extra-terrestrial, by using each experiment to enable a choice of the ET's sensorial characteristics. Appropriate software was designed and use is made of a touch screen, computer and printer to give each visitor the possibility of taking home an ID card of his/her ET, including picture and descriptive features.

A practical illustration will be made and the relations with school curricula explored. In addition, the preliminary results will be presented of a research project that aims at investigating the impact of these strategies on the motivation of the visitor, according to age and formal education level.

Keywords. Exhibition, Communication, Senses.

Scientific Toys and an Introduction to Scientific Concepts at Different Levels

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Abstract. Creation, transmission and appropriation of Science require effort, methodical work, persistence, … sometimes sacrifice, always triggered by curiosity or necessity, hence aiming at satisfaction and intellectual pleasure. However, much can be learned by playing throughout life. In particular, discovery by playing represents one of the first approaches to science in childhood. Indeed, toys can be an important source to be explored.

Some commercial scientific toys have been selected and studied in relation to basic scientific concepts. Interpretation leaflets were produced considering different levels of complexity. This approach is expected to be of great relevance to enhance interaction between children and parents, around science.

Keywords. Physcis, Mathematics, Chemistry.

Innovative Multivalent Kits on Optics and Astronomy

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Abstract. Two new kits will be presented for the teaching of optics and astronomy. One is about light, colour and vision, enabling the study of properties of light, the phenomenon of colour, an introduction to vision as well as an exploration of optical instruments. More than an optics bench, it was conceived as a means of overcoming alternative conceptions and usual learning difficulties. The other one, about astronomy, enables the simulation of the conjugate motions of the Sun, the Earth and the Moon, as well as their consequences (seasons, night and day, eclipses, …), in an rigorous and original manner. Written materials for teachers and pupils accompany the kits, following improved POE (prediction, observation, explanation) methodologies.

Keywords. Optics, Hands-on expereiments.

The Kitchen is a Laboratory

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Abstract. “Cozinha é um Laboratório” (“Kitchen is a Laboratory”) is an element of “Fábrica – Centro de Ciência Viva de Aveiro” (www.fabrica.ua.pt/cienciaviva) where the visitors can cook and explore topics related to food chemistry.

“Kitchen is a Laboratory” is not only a conventional kitchen, where one can prepare a complete meal, but also, a laboratory with plenty of experimental activities that help visitors to understand the biochemical, physical and chemical phenomena that take place when food is prepared.

The activities are organized in thematic topics that changes periodically. Examples of the activities are: “Do grão ao pão” (From grain to Bread), “Branco é, galinha o põe” (It is white and laid by the chicken), “O fantástico mundo do leite” (The fantastic world of milk), “A clara de Castelo do Chocolate” (The egg white from the chocolate castle), “Deste chá eu gosto” (I like this tee).

Each activity begins with a short introduction about the topic, product history and processing. Along the activity the chemical characteristic of the ingredients are mentioned and the main changes suffered by foodstuff components upon

cooking are explained. The information about each activity is consolidated in an illustrated brochure that is provided to the participants after the visit.

"From grain to bread", an example of the activities, begins with a short introduction about the story of bread and the transformation of cereal into flour. Afterwards everybody makes their own dough and while the dough ferments, parallel experiments are developed in order to explain the nature of gluten, and what happens to the dough during yeast fermentation. After the bread is cooked the visitor is invited to eat its own bread!

Our visitors are not only schools; we also have a considerable number of families that enjoy spending part of the day acting as scientific cookers. All the activities are hands-on oriented, visitors are always invited to take part of the activity. The larger part of the experiences uses common kitchen materials, and thus easy to implement. Our visitors are able to repeat them back to school or in their homes.

Keywords. Hands-on Chemistry.

Undergraduate Experiments with Sound Waves

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Abstract. The present work deals mainly with the way to increase the enjoyment in experimental activities at the lectures of Physical–Chemistry, among undergraduate students. Using simple and common equipments, the pupil will perform several kind of experiments, like (i) to distinguish between electromagnetic waves and mechanical ones; (ii) to use an oscilloscope as a measurement instrument, and to draw on some previous knowledge/concepts like sinusoidal wave, wavelength, frequency, period, angular frequency and group velocity; (iii) to analyze and to separate complex waves produced by different musical instruments and compare them with a pure sound produced by a tuning-fork; (iv) to perform a qualitative analysis of the characteristics of the sound waves, and to study the sound characteristics; (v) to determine the sound velocity in air; (vi) to evaluate the frequency of musical notes created by various instruments; (vii) to analyze the signals by an analytical approach Fourier analysis, using a software that allows the obtention of the Fourier transform for the different sound signals; The sounds analyzed are simple harmonic signals, produced by vibration of tuning-forks and some notes of a recorder, as well as more complex sounds, like guitar notes or violin ones.

Keywords. Hands-on experiments, Chemistry, Physics.

Superconductors as a Study Stimulus

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Abstract. Superconductors discovered in the 80's, based on the Y-Ba-Cu-O complex oxide system, could be used in classrooms at several levels and for different activities (Materials Science, Physics and Chemistry). For children, the Meissner effect, with a fog due to evaporating liquid nitrogen, and flying materials, can be a funny approach using the magical part of the science. For secondary school students, the synthesis of these oxides can be performed using common equipment and simple reagents in a low-cost way. Also, the conduction mechanisms in metals, superconductors and semiconductors, and the physics related with electronic conduction could be presented. Moreover, the chemistry dealing with the composition of the oxides and their oxidation numbers as well as the yield of a reaction performed at high temperature completes the approach at this level. At the University, the chemical reactions with sub-stoichiometry and the crystallographic structure of the superconductors based on perovskite structures can be introduced; while, in Physics, the concept of spin and basic notions of Cooper pairs, superfluidity, and Bose-Einstein condensation could be discussed.

Keywords. Hands-on experiments, Chemistry, Physics, Superconductor.

Hands-on Experiments in Physics in Primary School

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Abstract. In Basic Schools, at the 3º and 4º years of scholarship, the course titled "Study of the Environment" deals mainly with Science and Experiment. These classes are presented as a way to receive contributions, with concepts and methods, from different scientific areas, like History, Geography, Natural Sciences, Ethnography, among others, in order to allow a gradual understanding of the Nature and the Society. For the children development, the Portuguese Ministry of Education clearly identifies the necessity of a more experimental approach, since, according to the contents of the official programs of 3º and 4º years of Basic Schools, a set of experimental activities is assumed as part of the compulsory education. These experiments are detailed in the Part 5 of the booklet of "Study of the Environment", with the title "Discovering Materials and Objects". The experimental activities to be performed in the 3º year can be classified in four themes: Light, Magnetism, Equilibrium, Movements-Forces. The experiments at 4º year level are included in five wide subjects: Matter, Water, Air, Electricity and Sound.

Keywords. Hands-on experiments, Physics.

Glass Fusing: An Art and Science Connection

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Abstract. Glass technology can be used to introduce new methodologies in education and communication in science, especially associated with an existing relationship between Science and Art.

In the so-called arts of the fire, the use of glass fusing as a process of jewellery manufacturing, stained glasses and decorative objects represents an example of interconnection between art and science. Glass fusing is the process by which we can join two or more glasses with the purpose of elaborating an object. It is a generic term that puts together several techniques whose common characteristic consists of creating manufactured plain objects from the overlapping glass layers.

The physical-chemical qualities of the glass, such as the glass transition temperature, the reticular and structural properties, as well as the silica inversion, the composition, the colours, the raw materials, can be subject of research in order to improve the existing materials and create new materials with new properties.

Fig.1. Identification of the "float" glass stained surface with an infrared lamp

The "float glass" used in glass fusing is submitted to a controlled fusing temperature

allowing a new structural rearrangement. After cooling, a solid glass block is produced with new formal and aesthetic qualities. It can be observed that cooling time is determinant of the substance glass qualities. If the cooling time is too long crystallization can happen - ordering of molecules inside the solid structure.

Fig.2. Some examples of work to be done during the Science Fair. From top to bottom: glass beads, glass rods and glass fusing art objects

For centuries, the temperature control in the glass manufacture was a well kept secret, and a knowledge that could give rise to political and social power.

Fig.3. Glass after being submitted to high temperature

Nowadays, the technological evolution renders possible accurate and precise control of the atmosphere inside an oven allowing the efficient control of the temperature, and the maintenance of the properties.

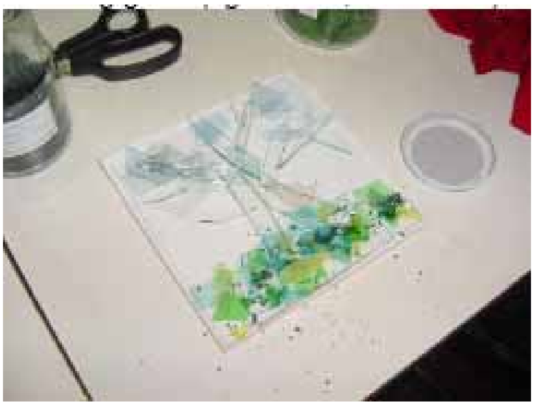

Fig.4. Glass materials prepared for fusing (pieces of broken glass, scales e glass beads of different densities)

During the Science Fair participants are invited to make some objects by means of the "glass fusing" method (figures 2 and 3) using commercial "float" glass (figure 1) combined with several kinds of other glass materials for intrusions (figure 2).

The main goal of the workshop is to learn about glass qualities, properties and its behaviour when submitted to melting temperatures. The participants are asked to produce glass objects exploring colours, textures and shapes.

Fig.5. Enamelled glass

Fig.6. Enamelled glass

During previous workshops it was possible to have groups of people with different levels of knowledge about glass technology, making beautiful objects of fusing glass (figures 2, and 3 to 6).

Keywords. Glass technology, Hands-on Experiments.

Van de Graaff Generator

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Abstract. It was designed and built a "table top" Van de Graaff Generator which can be used for didactical and entertainment proposals.

The Van de Graaff Generator was invented by Robert Jamison Van de Graaff, in the 19th. Giant Van de Graaff generators can produce millions of volts, while "table top" sized Van de Graff generators typically produce 100,000 V to 500,000 V.

Although we are dealing with high potential we can use the Van de Graaff generator without harming ourselves or other around us, but there are several safety measures that have to be taken in account. We will show same fun and didactical demonstrations that can be performed with this Van de Graaff generator.

Keywords. Physics, Hands-on experiment, Van de Graaff.

How Hands on Science Has Successfully Helped to Motivate and Improve English Levels in Our Secondary School

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Abstract. This work will show briefly how our experience can help you set up a Hands on science course in your school ,to improve the English levels of your students. Examples of some of the 500 experiments we have used will be shown.

One of our parents´ priorities is that their children will leave the school with a high level of English. In response to this our college implemented a Hands on Science course as an option for all secondary students. The number of students involved in this option has risen in the 4 years the course has been running from 40 to 204 students and next year the number will increase again. This proves students (and parents) are

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motivated to choose hands on science even when set against options like computer studies or technology.

The course is taught in English at students level.

The course is integrated with the science they learn in their theory lessons in their own language so as to reinforce their science understanding.

The course is in a logical order but flexible enough to respond to any changes in the curriculum.

Resources will be discussed, after 25 years of teaching experimental science and English language it is clear it is not what you spend on equipment but how you invest it.

A fair evaluation was done of all the students English levels between those who took science in English to those who did not. All students during each of the 4 years took the same ten English exams were compared the results clearly responds to what the parents wanted. For a college to expand it must respond to what the parents´ want .

Keywords. Hands-on experiments.

Electromagnet and Switchboard for Slewing Crane

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Abstract. This paper presents an electromagnet and a switchboard used on a science fair slewing crane described in a separate paper. The electromagnet can lift 50kg loads. The switchboard includes a transformer that powers the electromagnet. It also contains relays, contactors and inverters that allow the operation of the crane three-phase motors using a single-phase power supply. Crane slewing is limited to an 180º angle, for safety reasons. Pressing an emergency button switches off all command circuits. An 8051 microcontroller-based system determines the vertical position of the electromagnet, which cannot be switched off while being on a high position, not even if the emergency button is pressed.

Keywords. Electromagnet, Switchboard, Contactor, Inverter, 8051 Microcontroller.

1. Introduction

A science fair slewing crane described in a separate paper (Fig. 1) has an electromagnet and is controlled by a switchboard. Both devices are presented in this paper.

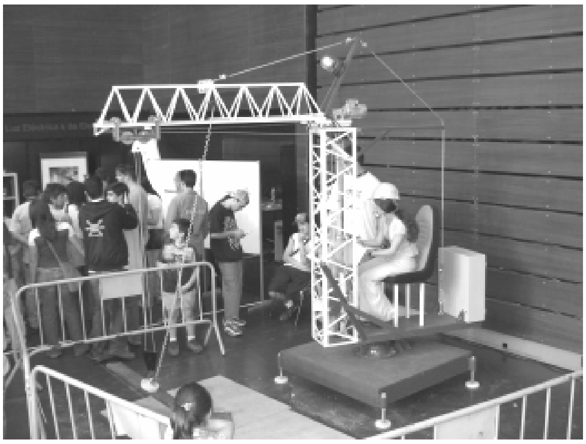

Figure 1. Slewing crane at *Robótica 2006* festival

The switchboard (Fig.2) receives command signals from a control panel (Fig. 3) and two limit switches. According to these signals, it switches the electromagnet (Fig. 4) on or off and controls three three-phase motors. One of the motors is responsible for slewing the crane right or left. The other two enable the electromagnet to move up, down, forward or backward.

2. Materials used

The following materials were used to build the switchboard and the control panel:

- 2 inverters;
- 1 power source;
- 1 remote control;
- 10 relays;
- 2 contactors;
- 1 transformer;
- 2 circuit breakers;
- 33 connectors;

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- 1 roll of 0.75mm^2 cable;
- 1 roll of 2.5mm^2 cable;
- 1 switchboard case;
- 1 emergency switch;
- 1 two-position joystick;
- 1 four-position joystick;
- 1 pushbutton;
- 4 limit switches.

The following materials were used to build the electromagnet:

- Varnished 0,25mm^2 copper wire.
- Cylindrical piece of iron with a diameter of 15cm and an height of 4cm.

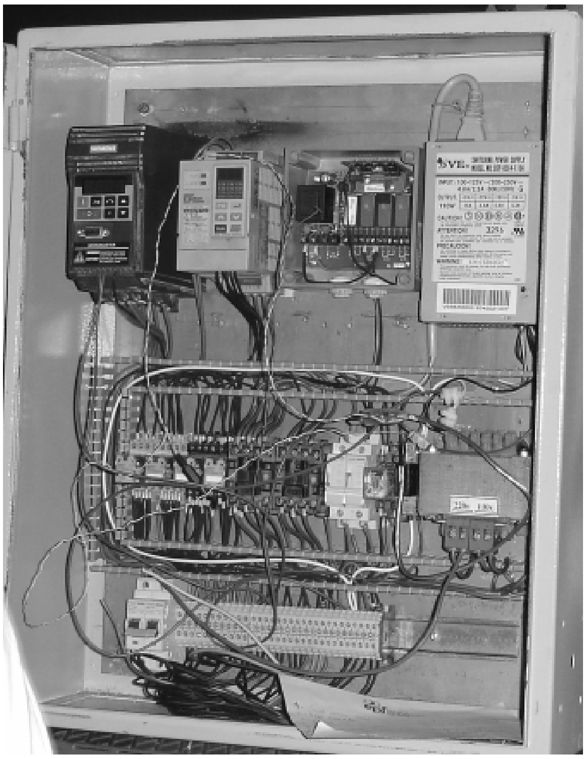

Figure 2. The switchboard

3. Switchboard operation

The switchboard contains several command circuits [1] that are active as long as Relay 6 (Fig. 5) is active. The control panel has an emergency button s1 (Fig. 5). Pressing this button switches off Relay 6. It is also possible to switch on or off Relay 6 using a remote control (Fig. 5).

In order to keep 230V mains voltage as the only power source of the crane, inverters were used to drive the three-phase motors. Fig. 6 depicts the command circuit of inverter 1, which drives the motor that moves the electromagnet up or down. The sense of motion is done according to the position of a two-position joystick s2, placed in the control panel. Pressing the emergency button stops the electromagnet movement.

Figure 3. A young visitor to *Robótica 2006* festival operating the control panel (the switchboard is behind the operator's seat)

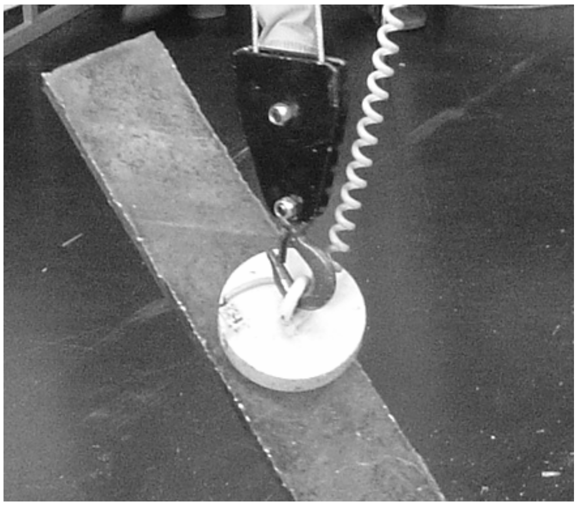

Figure 4. The electromagnet

Fig. 7 shows the command circuit of the relays used to command the inverters and to switch on and off the electromagnet. Two limit switches were used to ensure that the electromagnet stops when its forward or backward movements limits are reached. Two more limit switches were used to ensure that the crane only slews within an 180º angle.

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It is not possible to use limit switches to determine the vertical position of the electromagnet. So, a system based on an 8051 microcontroller (Fig.8) was developed [2, 3, 4, 5, 6]. An inductive sensor (Fig. 9) is placed near the reel of the cable that holds the electromagnet. For each reel turn, the sensor sends one signal to the microcontroller. Electromagnet height is determined by counting these turns.

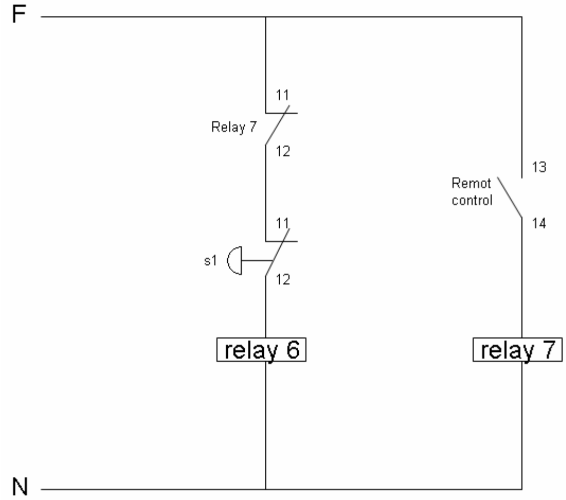


Figure 5. Emergency button and remote control function

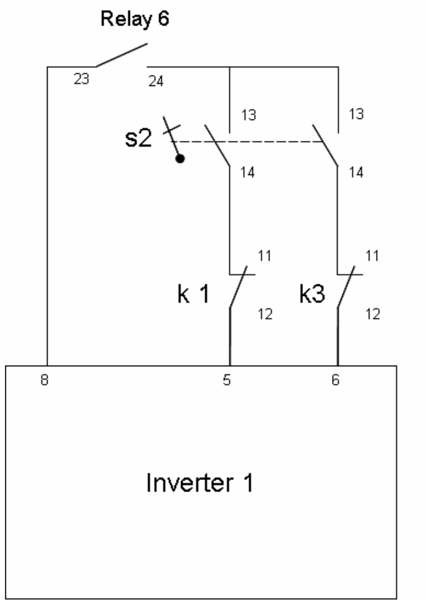
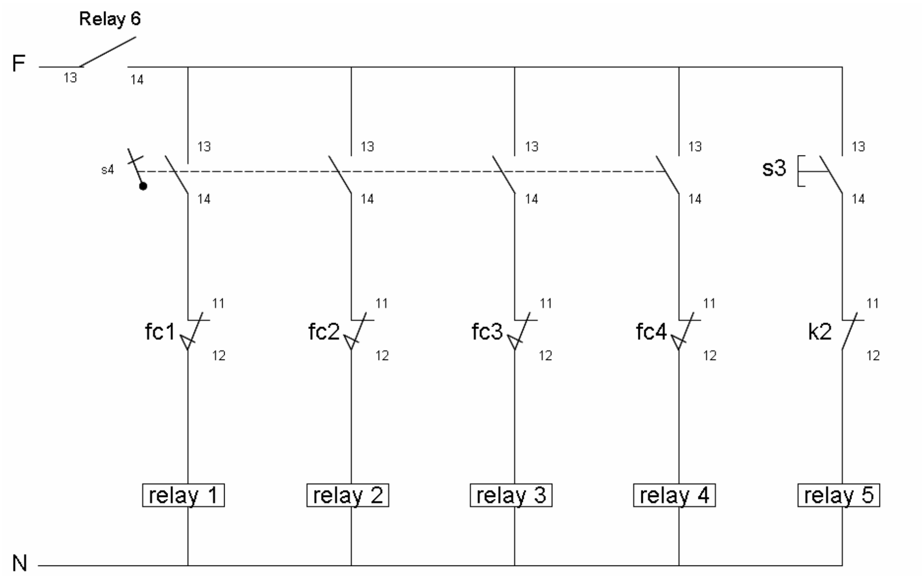


Figure 6. Command circuit of inverter 1

The electromagnet can be raised to a height of up to 2m from the ground. For safety reasons, an operator is not be able to switch off the electromagnet if it is above 0,50m level from the ground, not even if the emergency button is pressed.



s3	–	pushbutton that switches the electromagnet on or off.
s4	–	four-position joystick, which allows the operator to slew the crane right or left and move the electromagnet forward or backward.
fc1	–	left slewing limit switch.
fc2	–	right slewing limit switch.
fc3	–	forward movement limit switch.
fc4	–	backward movement limit switch.

Figure 7. Command circuit of the relays used to command the inverters and to switch on and off the electromagnet

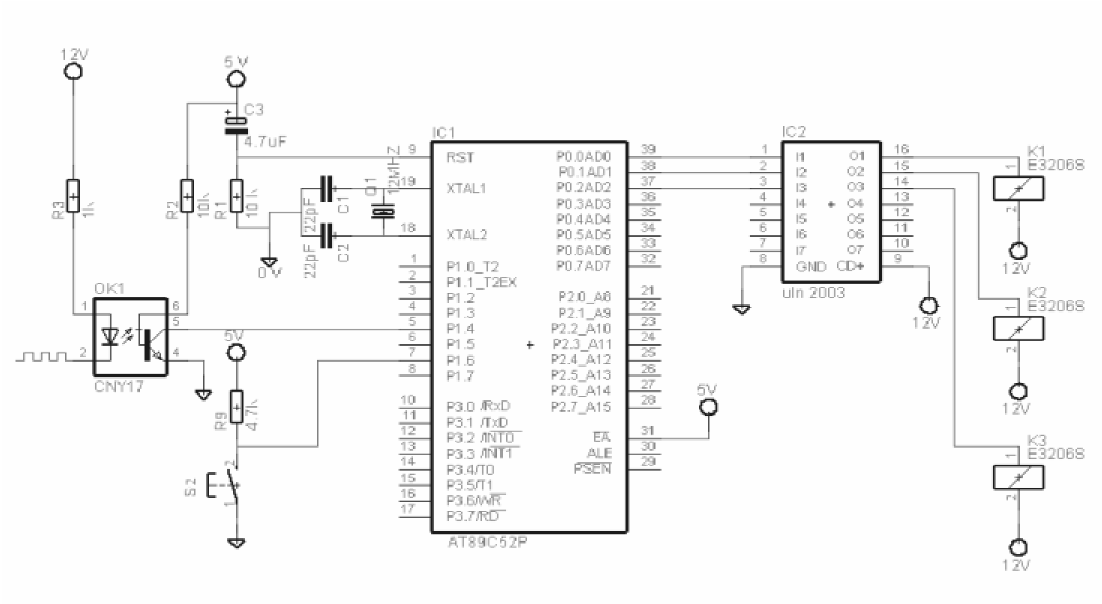


Figure 8. 8051 microcontroller circuit

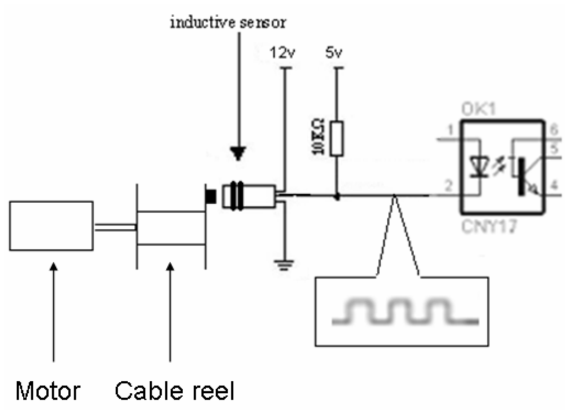


Figure 9. Connection of the inductive sensor to the microcontroller

Auxiliary relays were used to control inverter 2 (Fig. 10). This inverter drives both the motor that slews the crane and the motor that moves the electromagnet forward and backward. The two movements cannot occur at the same time. So, only one inverter was used, instead of two.

Two contactors (Fig. 11) were used to switch the motors on and off. The command of the contactors is done by a four-position joystick, which allows the operator to slew the crane right or left and move the electromagnet forward or backward. Since an operator is not able to select two different positions of the joystick at the same time, it is not possible to activate both motors at the same time.

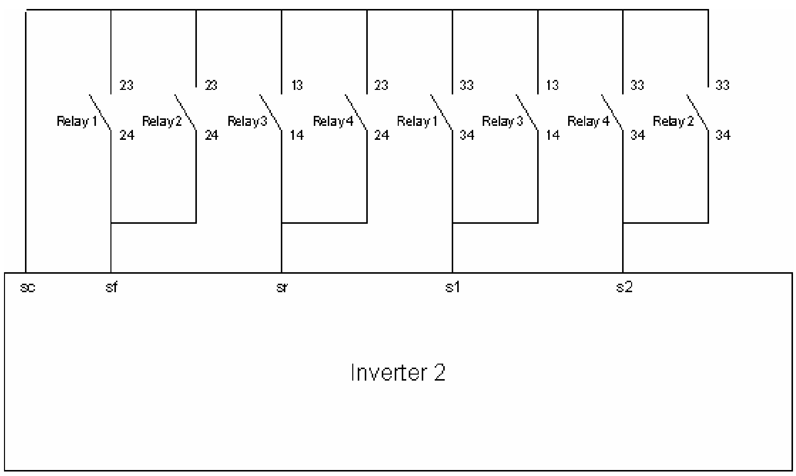


Figure 10. Command circuit of inverter 2

Each signal received from the four-position joystick activates a specific relay, which switches on one of the contactors. At the same time, the relay tells inverter 2 which motor should start and which is the sense of rotation of the rotor. Fig. 12 shows the power circuit, which

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includes a transformer that powers the electromagnet.

Whenever the emergency button is pressed, all command circuits stop functioning. However, if the electromagnet is switched on at that time, it will not be turned off.

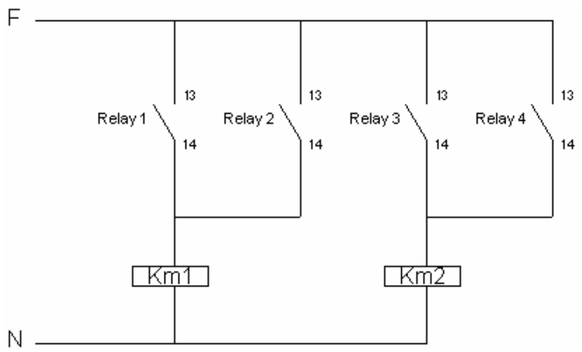

Figure 11. Command circuit of the contactors

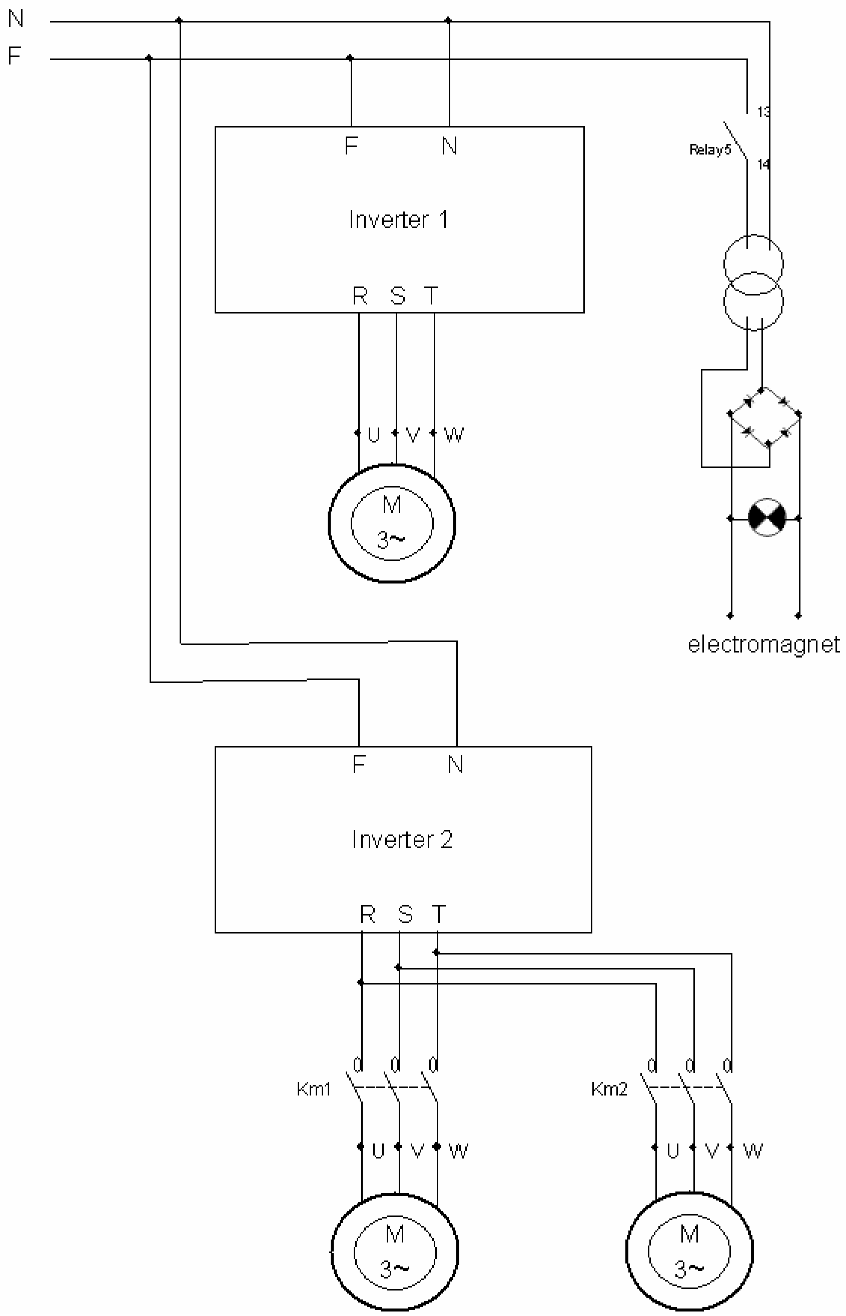

Figure 12. Power circuit

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4. Source code of the program installed in the 8051 microcontroller

This is the source code of the program used by the 8051 microcontroller to determine the vertical position of the electromagnet:

```
#include <REG51.H>
#include <portas.h>

int conta=0;

void actualiza(void)
{
    int i;
    if(P16==1)
    {
        for(i=0;i<=15000;i++);// To eliminate the bounce effect
        if(P16==1)
        conta=conta+1;// If  gate P1.6=1 increases the conta
    }
    if(P16==0)
    {
        for(i=0;i<=15000;i++);// To eliminate the bounce effect
        if(P16==0)
          conta=conta-1;// If  gate P16=0 decreases the conta
        }
}

// The function verifies the counter state and acts according the
conditions....//
void verifica(void)
{
    if(conta<=14&&conta>=10||conta==0)
    {
        if(conta==0)// If the counter goes " 0 " it turns off the
    ascent command
          P00=1;
        if(conta>=10)// When the counter is in the middle sends a
sign
          P01=1;
        if(conta==14)// If the counter goes " 0 " it turns off the
descent command
          P02=1;
     }
     else
     {
          P00=0;  P01=0;  P02=0;
     }
}
//.........................................................................//
int main()
{
    int i;
    while(1)
    {
         if(P14==1)
        {
             for(i=0;i<=15000;i++);//To eliminate the bounce
         effect
        if(P14==1)
          {
             actualiza();
              verifica();
          }
          }while(P14==1){}
     }
     return 0;
}
```

Remarks:

- Whenever gate P14 (Fig. 8) has a logical level 1 the program executes the *actualiza* instruction, which updates the *conta* variable. This updating depends on the logical level of gate P16 (Fig. 8).

- The *verifica* instruction has the purpose of verifying the state of the *conta* variable.

  - If *conta*=0 then gate P00=1 (Fig. 8). This disables the electrical circuit through the relay K1 (Fig. 8), which turns off the ascent circuit.

  - If the value of *conta* is between 10 and 14, gate P01 (Fig. 8) has a logical level 1. That will switch on relay K2 (Fig. 8).

  - If the value of *conta* is14, that means the electromagnet is at the ground level. Gate P02 (Fig. 8) stays at logical level 1. This activates relay K3 (Fig. 8), which shuts down the electrical circuit, allowing the electromagnet to go down.

6. Electromagnet construction and operation

The core of the electromagnet (Fig. 13) was made with a 15cm diameter cylindrical iron piece with a cavity.

A coil with 3500 turns of 0,25mm^2 varnished copper wire was placed inside this cavity. Fig. 13 shows an inside view of the device.

To activate the electromagnet, an 110V DC voltage is applied to the coil terminals. Then, a continuous current flows in the coil, producing a constant magnetic field [7, 8]. The electromagnet can lift 50kg loads.

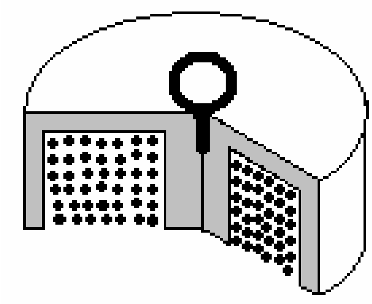

Figure 13. Electromagnet

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7. Conclusions

An electromagnet and a switchboard used on a slewing crane built for science fair events have been presented.

The constructed electromagnet is capable of lifting ferromagnetic loads of up to 50kg, which can be raised to a height of up to 2m from the ground.

The switchboard contains relays, contactors and inverters that allow the operation of the crane three-phase motors using a single-phase power supply.

The switchboard also includes a transformer that powers the electromagnet.

On a control panel, a two-position joystick allows the operator to move the electromagnet up or down. A four-position joystick allows the operator to slew the crane right or left and move the electromagnet forward or backward. Pressing an emergency button switches off all command circuits. It is also possible to switch on or off these circuits using a remote control

An 8051 microcontroller-based system was developed to determine the vertical position of the electromagnet, which cannot be switched off while being on a high position, not even if the emergency button is pressed.

8. Acknowledgements

The authors are grateful to Cátia Chamusca for the revising of this paper.

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Radio-driven in-door surveillance system

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Abstract. During the past years we can note a significant increase in the number of applications for the blimps. Not only are the traditional scientific applications foreseen but also applications in fields as different as publicity or the transport of heavy and sensitive materials.

We will present in this work a system for remote vigilance based in a blimp with a very special shape that gives him a very low aerodynamic coefficient. This was we get a blimp very more manoeuvrable and with great liberty of movements than a conventional blimp. The entire system, here purposed consists in a blimp with the shape of a UFO, his control and propulsion system and a console system with a TFT.

For the effect we have developed a generic board based on a microcontroller from Microchip: PIC18F870, as the control software and the control algorithms to help on the driving and stabilization of the blimp. A protocol of communication has been also developed to assure a communication channel free of errors.

The main functions that our system supports could be resumed in:

1. The system allows a very precise and proportional RF control of the blimp by the means of a joystick with a range of about 300 meters. The protocol of communication has a mechanism of error detection that gives some immunity to errors on the RF channel. The command console allows triggering some events on the blimp.
2. RF link 2.4GHz of reasonable quality between the blimp and the command console were is the receptor and a high quality TFT monitor.
3. Navigation help system that uses gyroscopes and accelerometers and a digital compass. These sensors with software specially developed for the

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effect allows any person even without any experience to control in an easy way the blimp.

Keywords. Radio controlled blimp, Surveillance, Communication protocol for blimps, Stabilization systems.

H_2 driven radio controlled car

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Abstract. We will present in this work a remote controlled car with a video camera. The great innovation is that use as power source Hydrogen. The hydrogen is converted in electricity using a type fuel cell knower as PEM – Proton Exchange Membrane developed in cooperation with the company SRE – Soluções Racionais de Energia.

For the effect we have developed a generic board based on a microcontroller from Microchip: PIC16F877A, as the control software and the control algorithms to implement the control and monitoring of the fuel cell and also the control of the car. A protocol of communication has been also developed to assure a communication channel free of errors.

Keywords. Remote controlled car, PEM.

The Verification of the Preservation of the Total Mechanical Impulse Law through the Impact of Objects in Plane Surfaces

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Abstract. Last year on Hands on Science program from Portugal, High School E. Lovinescu join with his club Inquisitive Mind. Since then, the students of the club organized workshops, experiments, took part in inter-highschool science conferences. They had the opportunity to exchange ideas with other clubs from Bucharest and Romania.

It is an experimental method which needs handy materials. The experimental determination can be seen by the students in their own home, not only in the lab.

Measuring with the slide-rule some distances and with the protractor some angles, they can verify one of the most important mechanical law – the preservation of the total mechanical impulse law. This paper was made in Power Point having a short-reel film which illustrates the making of the experiment. The results of the experiment verify and confirm the theoretic data.

Keywords. Hands-on Science, Impact, Impulse.

Hands-on Diffraction

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Abstract. Diffraction is an important topic for science education. It's a physics phenomenon related to optics, sound and other wave behaviour. Diffraction is a subject included in the curriculum of basic and secondary Portuguese schools, both on sound and optics context. Low cost and simple experimental activities for High School students will be presented. Main goals of this study are to promote the experimental teaching of optics and to promote physics education based on hands-on activities. The educational strategy will be presented with focus on materials, equipment, experimental configurations, measure techniques and simulations. Experiments developed and results obtained will be analysed and discussed. Results obtained point out that experimental work based on hands-on activities may be considered as an important teaching tool.

Keywords. Physics, Optics, Diffraction, Experimental work, Hands-on activities.

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Hands-on Sound

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Abstract. Sound is an important topic for science education. It's a physics phenomenon related to wave behaviour and present at everyday life. Sound is included in the curriculum of basic and secondary Portuguese schools. The development of experimental activities for school students will be presented. Main goals of this study are to promote the experimental teaching of sound and to promote physics education based on hands-on activities. The educational strategy will be presented with focus on materials, equipment, experimental configurations, measure techniques and computer simulations. Experiments developed and results obtained will be analysed and discussed. Results obtained point out that hands-on activities and sound-based strategies may be considered as an important teaching tool.

Keywords. Physics, sound, Experimental work, Hands-on activities.

Hands-on Holography

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Abstract. Holography is an advanced technology with important applications on everyday life. From displays to data storage, relating science, technology and society, holography can be a stimulating strategy for contextualized science education. Holography is based on wave physics and is used in different fields of knowledge, such as acoustics, optics and electromagnetic waves. The implementation and development of optical holography kits for use at schools will be presented. The main goal of this talk is to promote the experimental teaching of optics based on problem solving and hands-on activities. The educational strategy will be presented with focus on materials, equipment, experimental configurations, holographic techniques, chemical processing and problem solving situations. Experiments developed and results obtained will be analysed and discussed. Results obtained point out that hands-on activities and holography-based strategies may be considered as an important contextualized teaching tool.

Keywords. Physics, Optics, Holography, Experimental work, Hands-on activities.

Hovercraft: Science or Amusement?

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Abstract. This work intends to demonstrate the basic functioning of the hovercraft. It is important to refer that the material used becomes this project viable of being reproduced in schools for the pupils. The authors consider it pertinent in the boarding of concepts as "pressure", "atmospheric pressure" and "force". Its use can be also useful in the boarding of dynamics concepts with nominated "uniform and rectilinear movement" and "attrition".

The functioning of hovercraft is based on the air movement for pressure difference. In the interior of donut the pressure is raised due to air inlet, sufficiently superior to the pressure in the exterior - atmospheric pressure. Thus, air goes to tend to dislocate - from the interior of donut for the exterior passing later for underneath of the plastic. The air, when dislocating itself for the exterior, forms an air sheet between hovercraft and the surface, reducing visibly the attrition between the two.

Keywords. Hovercraft, Air pressure.

The Luminiscence of the Ultrasounds

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Abstract. Our project has two goals: to understand ultrasounds and performing an experiment. For the experiment, we used a device for producing ultrasounds and a transparent container filled with water and glycerine. We spot small sparks produced by the liquid in the container when it is crossed by ultrasounds. The experiment is recorded with the video camera.

Keywords. Physics, Ultrasound, Luminescence.

Measuring The Archimedic Force Through Scales Method

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Abstract. This presentation is a didactic film made in our laboratory about the measure of the force of Archimedes. We determine the volume of the object by sinking it in the container filled with water using: graded container filled with water, small empty container; another small container filled with water, object, scales, graded mass. Then we suspend the object on one of the scales' plane tree. On the same plane tree there is a small empty recipient. We balance the scales and introduce the object in a container with water which is placed underneath the plane tree. The scales will balance, while the object will be pushed upwards by the archimedic force. We compensate the archimedic force by pouring water in the container on the plane tree. We then pour this amount of water in the graded container, we can see that its volume equals the volume of the object. We can conclude the archimedic force equals the weight of the amount of water replace.

Keywords. Physics, Archimedes, Forces.

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A World to Discover, A Passion to Fulfil

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Abstract. Is it possible for secondary school pupils to learn mathematics? Is It also feasible to teach them high level mathematics? Is a fifteen or sixteen year-old pupil able to go into completely new mathematical worlds and to get good results at them?

Historically the “Pascal Triangle” is one of those paradigmatic examples of collective knowledge construction: Chinese, Indian, Arab and European people have taken part in the development of its properties and implementation and this is one of the studies we propose 14 to 16 year old students and that we are bringing now.

Students face it from different perspective. They induce properties, subject them to evidence, prove them, express them algebraically and put them into practice in different contexts from the ones supposed in their point of origin. The way from arithmetic to fractals is really original and, as for teachers, we are satisfied with it, the outcome is surprising and, as for scientists, we are pleased with it but above all, this make students grow and, as for educators, we are delighted with it.

When the Council of Europe talks about basic competence, it mentions in a veiled way the thinking autonomy students must develop to put their knowledge into practice in different contexts, so this proposal, which I call “A world to discover, a passion to satisfy”, is above all a methodological proposal.

Keywords. Combinatory numbers, Educational methodology, Fractals, Geometric numbers, mathematics, Pascal Triangle, History of mathematics, Numbers, Square numbers, Triangular numbers.

1. Some annoying questions

The Pythagoras’ theorem or the Pascal’s triangle are two matters which appear in the curriculum of secondary school in a recurrent way although they are just two strange tools with proper name. A teacher making interesting questions about them in class is very estrange. If we understand the word interesting as being able to wake up the interest and curiosity of students. Excuse me this arrogant frivolity in the beginning but I think this statement is not very arrogant, at least in my country.

Since we are devoting this dissertation to it, we take the Pascal’s Triangle like example. Textbooks are full of tedious binomial developments in which their authors choose, I expect without the intention of making still more tedious, for the Newton’s Binomial as a tool instead of the own Pascal’s Triangle. Beyond the anecdote of containing the coefficient of the different powers of the binomial and the different combinatory numbers, nothing else is said about it. Even to prove the properties of the combinatory numbers, factorial developments are used instead of their properties.

But… Why should Pascal´s triangle appear in scene? Where does its interest lie? Moreover, what do we know of it actually? Why is it called Pascal and not Chia Hsein (11th century), Omar Khayyam (12th century), Yang Hui (13th century), Ibn al-Banna (13th century), Chin Chiu Shao (13th century), Chu Shih Chieh (13th century), al-Farisi (14th century), al-Kashi (15th century), Pedro Apiano (1527), Michael Stifel (1544), Tartaglia (1556), Stevin (1625) or Herigone (1634)? Why denying the history? When we teach Mathematics, what do we want to teach? Or in other way what do we want our students to learn? In what do we want to train them? We could go on asking… What is doing mathematics? What kind of students do we want to educate after being in our classrooms? … I know, …, what the university demand… The questions are valid although we have enounced to our freedom of chair and, with it, to have an own criterion about our work. It is evident that it is possible to do other things but it is risky, this requires work and …. It is so comfortable repeat the old contents without having to answer questions so tiresome like these…! We aren’t paid to do it, then?

2. Adriana and Diana

This part actually is written by two students, they are fifteen. They aren’t of this kind of students, especially gifted at mathematics, who have their expectations put in this subject, on the contrary, their future professional is in the medicine, far, very far of this discipline. These aren’t excepctional cases. Today, just like that, we spoke about the Arithmetic’s Triangle and they are the main characters because Adriana Muñoz and Diana Lorente, with the project *"The imprecise border of a universe of irregular dimension",* obtained a praiseworthy third place in the 14th National Congress of young investigators.

They went to Pascal´s Trianglehim because they wanted to answer a question about figurative numbers, they were surprised of some curious behaviours of that numerical table that they didn't know[I], and I invited them to find fifty numerical different properties in in. Text-books usually bring forward three, like maximum. They could have looked for bibliography to answer to the proposal. This is what anyone expecting to find the answer in other would have done but, when students are used to make questions and to find the answers by themselves they prefer more interesting options and they leave the easy solutions for desperated times of lacking inspiration about maths.

They found many of the properties that Pascal obtained and some others that the French philosopher didn't discover. I have chosen, like a example, the ones that follow below, avoiding those that are obvious[II], and I am going to describe them in parallel with those that Pascal enunciated because I think it is necessary have a clear reference of the possibilities to make mathematics that a student of secondary school have.

3. Taking history as reference

Pascal enunciates like this the *second consequence*[III]*: Each cell is equal to the sum of all those of the preceding parallel rank covered from his perpendicular rank to the first inclusive.* The statement of the French philosopher results dark and difficult because don't have an effective synthetic notation. Much more teaching, by proximity historic, is the presentation of Adriana and Diana. They have a precise and synthetic notation when expressing their results.

♦ FORTH PROPERTY

1
1 1
1 2 1
1 +3 3 1
1 4 +6 4 1
1 5 10 +10 5 1
1 6 15 20 +15 6 1
1 7 21 35 = 35 21 7 1
1 8 28 56 70 56 28 8 1

$$\binom{n}{0}+\binom{n+1}{1}+\binom{n+2}{2}+\ldots+\binom{n+k}{k}=\binom{n+k+1}{k}$$

They used the developed factorials to get that irrefutable proof which Pascal talks about and that he bases on the previous properties of the triangle:

$$1+(n+1)+\frac{(n+2)(n+1)}{2}+\frac{(n+3)(n+2)(n+1)}{3\cdot 2}+\ldots$$
$$+\frac{(n+k)(n+k-1)\ldots(n+1)}{k!}-\frac{(n+k+1)(n+k)\ldots(n+2)}{k!}=0$$

If we extract common factor, we have between the two last members:

$$1+(n+1)+\frac{(n+2)(n+1)}{2}+\frac{(n+3)(n+2)(n+1)}{3\cdot 2}+\ldots$$
$$+\frac{(n+k)(n+k-1)\ldots(n+2)}{k!}\big((n+1)-(n+k+1)\big)=0$$

Then:

$$1+(n+1)+\frac{(n+2)(n+1)}{2}+\frac{(n+3)(n+2)(n+1)}{3\cdot 2}+\ldots$$
$$-\frac{(n+k)(n+k-1)\ldots(n+2)}{k!}k=0$$

that's to say:

$$1+(n+1)+\frac{(n+2)(n+1)}{2}+\frac{(n+3)(n+2)(n+1)}{3\cdot 2}+\ldots$$
$$+\frac{(n+k-1)(n+k-2)\ldots(n+1)}{(k-1)!}-\frac{(n+k)(n+k-1)\ldots(n+2)}{(k-1)!}=0$$

and if we repeat the same we obtain: 1-1= 0

The Pascal's third result is a copy of the previous: *Each cell is equal to the sum of all those of the preceding parallel rank covered from his perpendicular rank to the first inclusive.* Pascal could have avoided that statement in base on the symmetrical arrangement of the numbers in the Triangle. An evident distribution which, however, the French philosopher, enounce as the *fifth an sixth consequences* in spite of the self-demand which is already aforementioned of *arrange the propositions in the correct order.*

If we continue with the Adriana and Diana's model, which we are more usual, the forth conse-

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quence of the French philosopher Pascal would be like this:

+1
+1 +1
+1 +2 +1
1 +3 +3 +1
1 4 +6 +4 +1
1 5 10 +10 +5 1
1 6 15 20 +15 6 1
7 21 35 35 21 7 1
8 28 56 70 = 56-1 28 8 1

$$\binom{0}{0}+\binom{1}{0}+\ldots+\binom{n}{0}+\binom{1}{1}+\binom{2}{1}+\ldots+\binom{n+1}{1}+\ldots$$
$$+\binom{k}{k}+\binom{k+1}{k}+\ldots+\binom{n+k}{k}=\binom{n+k+2}{k+1}-1$$

Pascal, without appealing to the full induction method, nor combinatoria, do a reasoning of this kind: The sum of the cells of the first diagonal (those in which there are ones) is equal to five. The sum of the second is equal to 15 and the sum of the third is equal to 35 but, with the previous property 1+5+15+35=56 so 5+15+35=56-1

A perfectly general model, despite leans in a particular example. A kind of reasoning absolutely habitual in class, that we praise in Pascal and we censure hardly in class, demanding other more strict (algebraic, of course) and complete. We have to demand enough rigor and fitted to each age and moment, also the history used this criterion lax, because: who has the necessity of such mathematic formalism? Neither students nor teachers, we as human beings much less, then?... Yes, there is no doubt that the euclidiana tradition and burbakista generated such need. The tradition still maintains its validity.

Universities are engraved on our memories this model, that issued our degrees and they instructed us in the subject, we have been, as teachers, their loyal vassals, and we have converted it in the unique objective.

This fourth consequently of the French philosopher didn't appear in class and I have not found in the excellent book of D. Seymour [1986]. Maybe because its formulation appear with much more easily if we study an "Arithmetic Rectangle" like the one Pascal used, if we put the numbers in the Chu's triangular arrangement, or even in al-Karagi's or ibn Mun'im's[IV] and this is which Adriana and Diana use.

4. To Pascal guided by our students

To show the seventh, eighth and ninth consequents we use the presentation that Diana and Adriana make, in the third and tenth properties of their document "La imprecisa frontera de un universo de dimensión irregular".

♦ THIRD PROPERTY

1
1 1
1 2 1
1 3 3 1
1 +4 +6 +4 +1 2^4
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

$$\binom{n}{0}+\binom{n}{1}+\ldots+\binom{n}{n-1}+\binom{n}{n}=2^n$$

We analyse the Pascal's demonstration, and it says this: *The first is the unity, the second is the double of the first, so 2; the third is the double of the second, so 4; and so on to the infinite.* The students, however discover that each row is read like a unique number[V], is power of 11 (see the second property) and the result of multiplying a number by 11 is no other than the sum of its digits, two times[VI]. It is obvious that each row sum the double that the before and that sum has to be a power of two.

♦TENTH PROPERTY

1
+1 +1
+1 +2 +1
+1 +3 +3 +1 2^5-1
+1 +4 +6 +4 +1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

$$\binom{0}{0}+\binom{1}{0}+\binom{1}{1}+\ldots+\binom{n}{0}+\binom{n}{1}+\ldots+\binom{n}{n}=2^{n+1}-1$$

Here, the Adriana and Diana's exordium is the same as the Pascal's one. They say: *"the demonstration results evident because is the sum of the geometrical progression of the differents powers of 2 which were in the third property".*

Pascal also enounces a series of *consequents* which is worth reporting by his originality and they aren't presents in the work of the students. What Pascal enumerates as tenth (X) we could enumerate it like this[VII]: *If we take a number of consecutive cells of one row, from its beginning,* *its sum is equal to the double of the sum of same number of cells in the previous row, after resting the last.* In other words:

$$\binom{n}{0}+\binom{n}{1}+\ldots+\binom{n}{k}=$$
$$2\cdot\left(\binom{n-1}{0}+\binom{n-1}{1}+\ldots+\binom{n-1}{k}\right)-\binom{n-1}{k}$$

Thanks to a superficial analysis of the even rows, we observe that their central cells are all of them multiple of two. Pascal enounces this as *eleventh consequent*. The next properties are properties much more unrelated to our docent experience, because they refer to the quotients between different terms of the triangle. The *twelfth consequent,* express in combinatorial notation, says: $\dfrac{\binom{n}{k}}{\binom{n}{k+1}}=\dfrac{k+1}{n-k}$. *The thirtieth, fortieth and nineteenth consequents*, in combinatorial way, would be: $\dfrac{\binom{n}{k}}{\binom{n+1}{k}}=\dfrac{n-k+1}{n+1}$,

$$\frac{\binom{n}{k}}{\binom{n+1}{k+1}}=\frac{k+1}{n+1} \text{ and } \frac{4\cdot\binom{2n}{n}}{\binom{2n+2}{n+1}}=\frac{2n+2}{2n+1}$$

The ones with the numbers *XV*, *XVI*, *XVII* and *XVIII* are result of those others that appear with numbers *II and XII,* it is maybe because Pascal finish this description saying: *"you can obtain many other proportions that I don't write because everybody can obtain them easily, and you can find others more beautiful.* The eleventh property of the Adriana and Diana's work is a proof of his words.

♦ELEVENTH PROPERTY

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

If we divide tidily the alter numbers in blue we obtain the quotient of the consecutive numbers, in red so we have:

$\dfrac{\binom{n}{n-1}}{\binom{n+2}{n+1}}=\dfrac{\binom{n+1}{n-1}}{\binom{n+2}{n}}$ *It can be demonstrated because* $\dfrac{n}{n+2}=\dfrac{\frac{(n+1)n}{2}}{\frac{(n+2)(n+1)}{2}}$ *but, if we compare the rest of the rows then* ***¡¡¡oh surprise!!!****, between the second and the third also happen something similar:*

$$\frac{\binom{n}{n-2}}{\binom{n+3}{n+1}}=\frac{\binom{n+1}{n-2}}{\binom{n+3}{n}}$$

that it can be demonstrated by the same reasoning and, of general way, this tell us that: $\dfrac{\binom{n}{n-k}}{\binom{n+k+1}{n+1}}=\dfrac{\binom{n+1}{n-k}}{\binom{n+k+1}{n}}$. And, in fact, with their usual factorial method, they prove that this comes true.

We cannot know if that emotion that Adriana and Diana transmit were shared by the French studious; there is no doubts that Pascal, like a student getting closer to the Arithmetical Triangle, he might have found a limited number of properties and when he finds a new one he thinks that it is more beautiful than the last one. When he speaks about the different uses he warns us: *"...I leave much more than I give; It is an estrange thing, until what point this is fertile in properties. Everybody can practise them".*

If we follow him we will be in a great didactic adventure, which we can enjoy because textbooks have stolen us the properties on a systematic way. From each new way to come out you can find a huge amount of properties. We can see a beautiful collection of them in D. Seymur [1986] although here I prefer the Adriana and Diana's analysis.

♦ SECOND PROPERTY

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1 11^4
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

$\boldsymbol{(10+1)^n}$

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In other words: each row would contain the digits of a power of 11 if there were no "taken numbers": $11^0=1$; $11^1=11$; $11^2=121$; etc. Working in base 11 would be the numbers 1, 10, 100, etc.

♦FIFTH PROPERTY

1
-1 +1 = 0
-1 +2 -1 = 0
-1 +3 -3 +1 = 0
-1 +4 -6 +4 -1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

$$(1-1)^n = 0$$

♦SIXTH PROPERTY

Here we take the numbers from alternative rows, like if we looked to the hollows of the columns and rows like the figure shows. Each colour represents the result of this sight and all that you can see in the same line is summed. The result is the succession of Fibonacci.

1 1
1 1 2
1 1 3
1 2 1
1 3 3 1 5
1 4 6 4 1 8
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

♦SEVENTH PROPERTY

1
1 1
1^2 $+2^2$ $+1^2$
1 3 3 1
1 4 = 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

$$\binom{n}{0}^2+\binom{n}{1}^2+\ldots+\binom{n}{n}^2=\binom{2n}{n}$$

♦PROPIEDAD 8

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 x10 x10 5 1
1 6 x15 20 x15 6 1
1 7 21 x35 x35 21 7 1
8 28 56 70 56 28 8

$$\binom{n}{k}\cdot\binom{n}{k+1}\cdot\binom{n+1}{k}\cdot\binom{n+1}{k+2}\cdot\binom{n+2}{k+1}\cdot\binom{n+2}{k+2}$$

is perfet square

♦NINTH PROPERTY

1
1 1 4^2
1 2 1
1 +3 +3 1
1 +4 +6 4 1 7^2
1 5 10 10 5 1
1 +6 +15 20 15 6 1
1 +7 +21 35 35 21 7 1
1 8 28 56 70 56 28 8 1

$$\binom{n}{1}+\binom{n+1}{1}+\binom{n}{2}+\binom{n+1}{2}=$$
$$X_{n+1}=(n+1)^2=n^2+2n+1$$

Where X_{n+1} *is the (n+1)-th square number.*

The study of the geometrical numbers, or as Pascal would say *numeric orders,* was the first time that Adriana y Diana get in touch with the Pascal's Triangle but, I must clarify, the true interest which motivated Adriana and Diana for doing the investigation, (today they are students of medicine and physiotherapy), the key why they decided to continuous with it, was the fractal distribution, of the multiple of any number (for them a prime number or a power of a prime number). But, maybe, they won the prize because they had generated different Arithmetic Triangles and because they looked up into them the properties shared with Pascal's one, and about this we are talking now.

5. Other Arithmetic Triangles

The wick of the curiosity was setting light and the limits of the science are only in the barriers placed to our imagination. The lines of improvement are loyal to that initial reference to the figurate numbers but, the spirit to go further is alive and this will be when we can ask: what would happen if…?

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

Red : natural numbers Blue: triangular numbers

Yellow: tetrahedral numbers (3D)
Green: triangular numbers in 4D
Violet: triangular numbers in 5D

What would happen if in a ordinary Arithmetic Triangle in which, as you can see, its diagonals are respectively the unit, the natural numbers, triangular, tetrahedral in three dimensions, four, etc., would generate from the square numbers on, pentagonal, etc. keeping the criterion of formation?

To begin, we don't know if the diagonal of "ones" and the diagonal of the natural numbers would exist. But the first important decision is what square numbers are the in three, four, etc. dimensions. But that answer is easy if we take into account the first square number in three dimensions is 1 and that we maintain the same criterion sumatory to build the triangle.

1
4 1
9 5
16 14
25 30

That is enough to calculate the yellow diagonal out and all the rest. And the first term of the Triangle which could be 1 or 2 and is not determined. The numbers which appear with squares in other dimensions are in fact pyramided and no cubic ones.

2 1
2 3 1
2 5 4 1
2 7 9 5 1
2 9 16 14 6 1
2 11 25 30 20 7 1
2 13 36 55 50 27 8 1

In the same way we can build the triangle of pentagonal numbers

3 1
3 4 1
3 7 5 1
3 10 12 6 1
3 13 22 18 7 1
3 16 35 40 25 8 1
3 19 51 75 65 33 9 1

We could do the same with hexagonal numbers or numbers of any other kind but it is not very logic as the results we obtain seem to be easily generalized to any polygonal number.

Therefore, the three triangles have the same structure, so they would have to have the same characteristics or at least, a high number of them in common. Let's see if this is true or there are differences"

I am not going to go deep into this analysis, it is better proposing it as exercise. At last we are mathematicians and they not. But I will continuous with their conclusions so that we can see to what extension they are true or false. At this point, it is not much important; they were only doing an essay!!!! We cannot forget that. They concluded that with the necessary variants, some of which require to work in a numeration system of base 11, all the properties that are based in the sum or express relations with additions members are valid to be general, the rest not. It is a coherent conclusion because they have maintained the criterion of formation.

I don't want to talk in deep about the analysis that Ángel Velasco, Alberto Pérez, Javier Eced y Javier Adán (they are also fifteen years old), in *"Around of the Triangle",* did the Pascal's triangle in three dimensions, in other words they did a work in which they show the coefficients of the trinomial. The analysis of its properties and the comparison with those of the ordinary Arithmetic Triangle is an excellent problem of investigation for students of any level, even university.

I don't think that it is necessary to speak more about the details to establish the differences between what is today making mathematics in the school and what should be make Mathematics, neither I think that it is necessary answering the open questions that I have given at the beginning. But I proposed one in the abstract, and although all that I have written here is an answer I wouldn't like to leave any doubt about it. It was this: *is it possible to learn mathematics from the student of secondary school? Is it possible that these mathematics are of a high level? Can a student who is 15 or 16 years old go into the mathematics universe which is brand new for them and can they obtain important results?*

6. Fractal structures

At this moment I must clarify two things. The first one is that, the property of the fractal distribution of the multiple of any number in the

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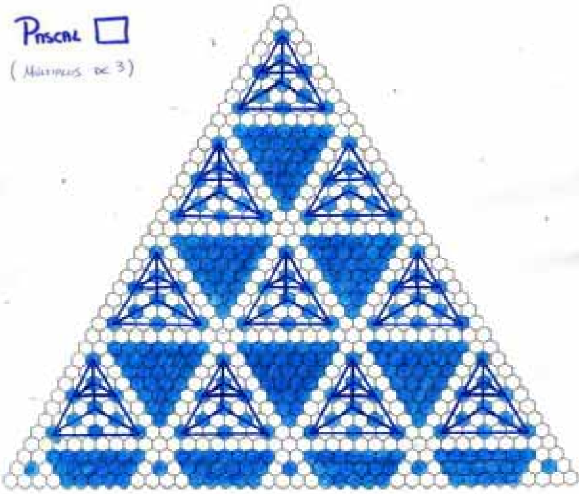
Arithmetic Triangle (for them, a prime number or prime power) was the key for Adriana and Diana to continue in their search. That and the possibility that their triangles carry this property out and, consequently, it is possible to find a Pascal Triangle for each pair of natural numbers.

Multiples of three in a square numbers Triangle



I include a part of the writing that they showed to see that it was a manual work. In those moments they did not have the possibility for using software tools which give an answer to the problem. But that should not be obstacle for to entry into an investigation process, on the contrary, it is a part of the process. In the presentation we are having the possibility to play with computer science. They played whit crayons and then they calculated the corresponding fractal dimensions. It is true that they found obstacles that they could not always solve. The limitations in their way of working were big. But it is not important. They had enough autonomy for thinking and security in their own capacities. They had discovered so much that they were not going to have any deception if they could not answer all questions. On the contrary they were going to enjoy to entry in a universe with all its ways to be discovered.

Investigating for pleasure; it would be an excellent objective. Build mathematics, above this process is also a challenge. When you allow freedom to guide the person who studies mathematics, the student can discover a great amount of possibilities, like a forest in which it is always easy find corners to surprise yourself. An unknown world to the student, and many times to the teacher in which our fears and his cautions are the unique reasons for a paralysis teaching, which has finished converting that common place to the delight in an enchanted forest in which students and teachers don't dare entry, and in all their lives they are able to stutter their matters growing algorithmic.

The fact that students need calculator to do easy operations of mathematics, and even the fact of being wrong to simplify a derivative or an algebraic expression… generates a huge crisis in teachers of Mathematics, and this is worst when we realized that it is in the majority of students… Huge efforts are dedicated to correct that "problem" although we know this is an unimportant problem for the most of professionals. Inclusively for the mathematicians and engineers because they prefer to resort to software, with the perspective that manual work is not guaranty of anything. However, nobody is worried about a student not having the opportunity to enjoy himself with the pleasure to discover, he is not able to face with any problem and he is not effective to investigate, when finishing the high school or university.

For centuries, there are people who think that the best way to learn is study, over the plain, the way that other people have rounded. Like this they guarantee that students arrive inevitability to the same places that other people arrived although they arrive in a virtual way. Other people like me propose investigation as a learning model. In this process map does not exist, the ways are not marked, the first steps are waved and the erratic and unpredictable route, but the results are so extraordinarily surprising that trusting the possibilities of students (all students) is worth.

I think it is time to make profitable the human ability. I think that it is the time to send algebraic calculations that a medium computer make in seconds to the algorithmic museum. It is the moment to guide the time that we spend training discipline and obedience towards the pleasure of discovering. It is the moment to grow imagination and divergent though. It is the moment in which we have to allow students to think about any question although they seem estrange with no complex, and we also have to allow students to give a solution suited to their possibilities, sensing the way to tackle in-depth.

As far as I am concerned, I apologise for the humility which I have not had in all the previous paragraphs. I simply would like to invite you to dissidence, but not even that, I am happy with a question: when the European Council talks about basic competences, it refers to the autonomy of

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though that students must develop to apply their knowledge to different contexts, are we going to be able to accept seriously that challenge?

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Footnotes

[I] In the deep meaning of the word "not to know", anteriority, it had been shown the combinatory numbers and their triangular disposition.

[II] They usually appear in text-books like combinatory numbers property.

[III] Pascal calls like this the result that he obtains: consequently *I*, *II*, *III*, etc. Adriana and Diana are using: *Property 1*, *2*, etc.

[IV] Ahmed Djebbar [2001].

[V] $1= 11^0$, $11= 11^1$, $121= 11^2$, $1331= 11^3$, etc.

[VI]
```
 1331
  x11
 1331
1331_
14641
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[VII] I have changed his redaction adapting to an expositive model much more actual.

Scalar and Vector Quantities

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Abstract. In physics, certain properties of matter are measured and the results examined to see if there is any mathematical relationship between them. It is important to grasp the true meaning of the equations we find in a physics book. They do not tell us what things are in themselves, but are simply a convenient way of expressing the laws governing their behavior. Most quantities measured in science are classed as either scalar or vector quantities.

Keywords. Vector, Physics, Mathematics, Scalar.

1. Introduction

In physics, certain properties of matter are measured and the results examined to see if there is any mathematical relationship between them. It is important to grasp the true meaning of the equations we find in a physics book. This is the main purpose of science, to seek out the laws of the Universe and, if possible, to express them in precise mathematical form.

Most quantities measured in science are classed as either scalar or vector quantities. A scalar quantity is one which has magnitude (or size) only. A vector quantity is one which has direction as well as magnitude. Thus when we say that a library contains 2000 books or a fuel thank contains 50 liters of petrol, we are dealing with scalar quantities. On the other hand, a good example of a vector quantity is force, since forces always have direction as well as magnitude.

Scalars are simply added by the ordinary rules of arithmetic: 5 kg added to 2 kg makes 7 kg; 25 books added to 10 books makes 35 books and so one.

The sum of two or more vectors is a single vector which is called their result. Vector quantities such as displacement, force and velocity, cannot be dealt with so simply unless they all act in the same or directly opposite directions. For example, a force of 5 N added to a force of 2 N can have a resultant of anything between 3 N and 7 N according to the directions in which this forces act.

2. Addition of displacements

Now, if we say that a motor-car travels a distance of 100 m, the expression “100 m” is a scalar quantity. But, if the car happens to be moving along a straight line and we mention the direction of travel, e.g. 100 m due east, we are now dealing with a vector quantity, and this is called the displacement of the car.

Displacement is defined as distance moved in a specified direction.

Suppose a man starts from a point A and walks as distance of 3 km in a direction due NE to a point B (Fig. 1).

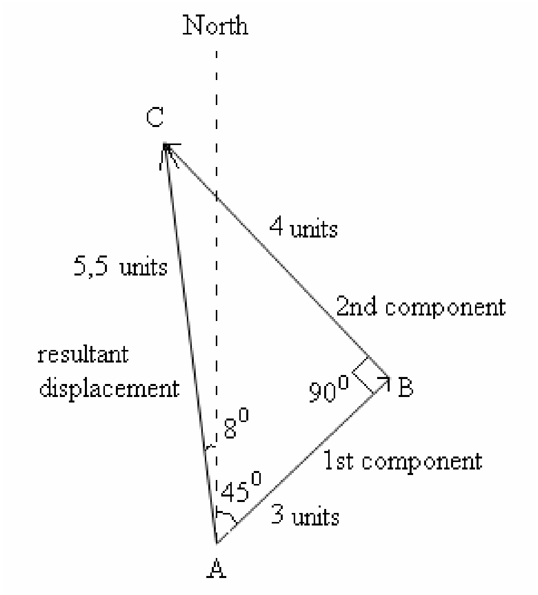

Figure 1. Addition of displacements

From B, he then walks 4 km NW ending at a point C. His resultant displacement is found as follows.

The first displacement is represented by a line AB, drawn 45^0 east of north, 3 units long and with an arrow on it to show the direction of travel. From a head of this line, we draw the second displacement BC as line 4 units long, 45^0 west of north, i.e. at right angles to AB.

Clearly the men could have reached his final destination by walking direct from A to C, provided there were no obstructions. Hence AC represents the resultant sum of the two vectors AB and BC both in magnitude and direction. Measurement shows that the resultant displacement is 5.5 km in a direction 8^0 west of north.

3. Polygon of vectors

A number of vectors which are added together or compounded to give a single resultant are called the components of the resultant. In the previous example, the rule we have used, namely, to draw each component vector in turn with the head of one starting from the tail of the previous one, can be extended to any numbers of vectors so that the diagram becomes a polygon instead of a triangle. Also, the order in which the vectors are taken does not matter provided they are drawn in the correct direction. Moreover, this method can be applied to any kind of vector: force, velocity, acceleration and so on. Figure 2 shows how the method could be use to find the resultant of four component forces of 2, 1.5, 3 and 2.5 N respectively acting on a body at a point A in the directions shown.

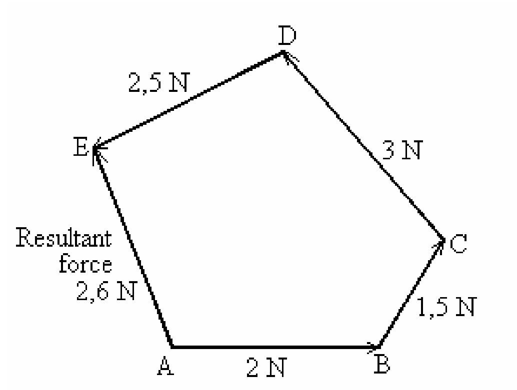

Figure 2. Polygon of vectors

4. Resultant force

We shall now apply the above rule to find the resultant force on an ocean liner which is being towed into harbor by two tugs, A and B, exerting forces of 2.5kN and 3.5kN, respectively and with their tow-ropes making an angle of 68^0 (Fig. 3).

A line LA 2.5 units long with an arrow on it is drawn to represent the pull of tug A. From A we now draw a line AB 3.5 units long parallel to the direction of a second tug (i. e. making an angle of 68^0 with the direction of LA) and also arrowed to represent the pull of tug B.

Measurements made on our vector diagram show that LB is 5.0 units long and make an angle of 40^0 with LA. Hence the resultant pull is 5.0 kN, making an angle of 40^0 with the tow-rope of tug A.Now, the addition of displacements by a vector diagram which we described earlier was

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fairly obvious, but we merely stated that the vector diagram gave the correct resultant when apply two vectors other than displacements. There is no formal proof: rather it is that we define the resultant in terms of the rule for constructing a vector diagram. The only real prove is an experimental one.

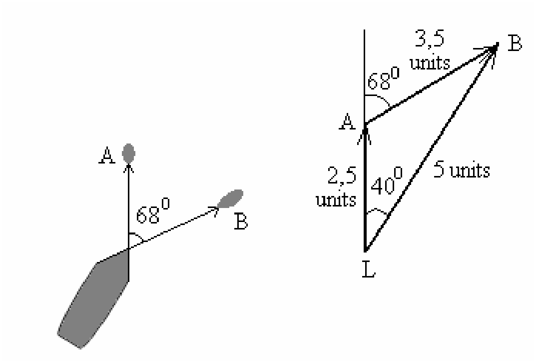

Figure 3. Resultant force

Another example:

A garden roller is pulled with a force of 200 N, acting in angle of 50^0 with ground level. Find the effective force pulling the roller along the ground.

As a rule, problems of this type may be solved either by scale diagram or else by calculation, so both methods will be explained here.

a) By vector diagram (Fig. 4)

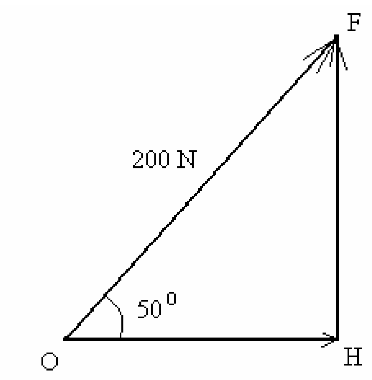

Figure 4. Components of a force

Using any suitable scale, the pull on the roller is represented by a line OF, 200 units long making an angle of 50^0 with the horizontal, OH.

If a perpendicular is now dropped from F on to OH, the sides OH and HF of the vector diagram OHF represent the horizontal and vertical components of OF respectively. Particularly, in the case of forces, it is very often necessary to convert a single force into two components. Of these the horizontal component OH represents the effective force which pulls the roller along the ground. Measurement shows that OH = 129 units long.

Hence the effective force = 129 N.

b) By calculation (Fig. 4)

$$\cos 50^0 = \frac{OH}{OF} \quad (1)$$

$$OH = OF \cdot \cos 50^0 \quad (2)$$

Replacing with numbers in equation (2), we have

$$OH = 200 \cdot 0{,}6428$$

$$OH = 129$$

Hence the effective force = 129 N.

Before leaving this problem, in it is of interest to consider the part played by the vertical force component HF. This acts against the weight of the roller, and therefore reduced the force which the roller exert on the ground. On the other hand, if the roller is pushed instead of being pulled, the vertical component increases its effective weight.

5. Addition of velocities

A passenger sitting in a railway carriage, which is traveling at constant speed along a straight section of track, simply has a velocity equal to that of the train. If he now gets up and walks across the carriage floor, his resultant velocity with respect to the track is made up of two components: his velocity OA across the carriage and the velocity AT of the train (Fig. 5).

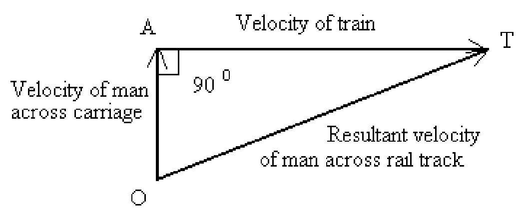

Figure 5. Resultant velocity

6. The parallelogram rule

All of the examples given so far for the additions of vectors have been based on methods involving the drawing of triangles, or where more than two components are concerned, by drawing vector polygons. However, there is another method which the reader may come across. This is the parallelogram rule.

In this method, the two components are represented by the adjacent sides of a parallelogram,

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in which case the resultant is given in magnitude and direction by the diagonal of the parallelogram drawn from the point of intersection of the two sides.

Figure 6 shows how our previous problem is solved by this method. Note that the parallelogram, in this case a rectangle, consists of two congruent triangles, either of which alone would have served equally well for finding the resultant velocity, since it does not matter in which order the component vectors are drawn. Note that the parallelogram rule can also be applied to forces.

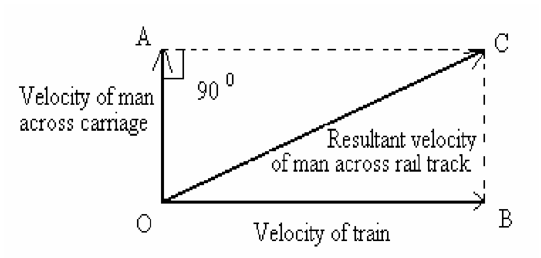

Figure 6. Resultant velocity using parallelogram rule

7. Worked examples

1. A man wishes to row a boat across a flowing river. The stream velocity is 2km/h and the velocity of the boat in still water is 6km/h.

Find the direction in which he must head the boat in order to make a course straight across the river.

Suppose the boat starts from point O (Fig. 7). It has two components velocities: its own velocity across the surface of the water which is the same whether the water is moving or not, and the velocity of the stream. These two components have a resultant velocity OA at right angles to the bank, which is given by completing the vector triangle OCA.

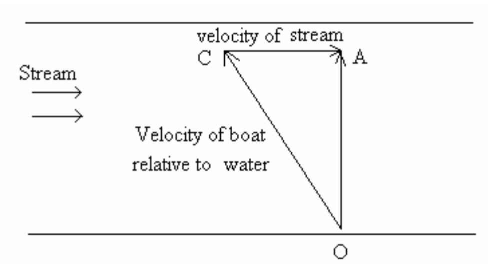

Figure 7

$$\sin \alpha = CA/OC$$
$$\sin \alpha = 2/6$$
$$\sin \alpha = 1/3$$
$$\sin \alpha = 0.3333$$
$$\alpha = 19^0$$
$$OA^2=OC^2 - AC^2$$
$$OA^2=36 - 4$$
$$OA^2=32$$
$$OA=5,65$$

Hence the prow of the boat must be pointed in the direction OC at an angle of 19^0 with the resultant velocity OA which is of magnitude 5,65 km/h.

2. We shall conclude by considering the vector diagram from three forces which are in equilibrium. If we now the magnitudes and directions of the forces, we should expect the vector diagram to form a closed triangle with the force arrows all following one another round in the same direction. The vector triangle will be closed since forces in equilibrium have zero result, so there can be no open side to represent it.

If, however, we have three forces known to be in equilibrium, but we know the magnitude of only one of them together with the directions it makes with the other two, we can find the value of these for a vector diagram.

Such a case is shown in Fig. 8.

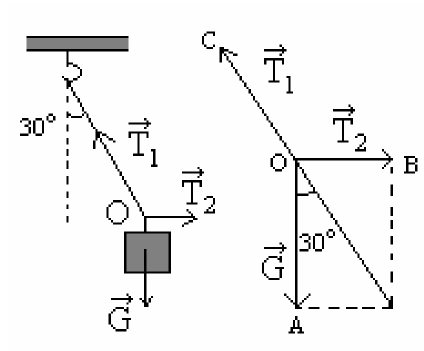

Figure 8. Three forces in equilibrium

Here we have a 15kg mass suspended from a hook, in the ceiling, which is pulled a side by a horizontal string until the supporting string makes an angle of 30^0 with the vertical. The three forces in equilibrium are the tensions T_1 and T_2, in the strings and the weight G, of the 15kg mass.

Using a scale of 1cm to represent a force of 10N, we draw a line OA, vertically downwards and 15cm long, to represent the weight G, of the 15kg mass. OB will represent the tension T_2 and CO, the tension T_1 in the strings. The resultant of the forces G and T_2 must be equal and opposite of the T_1. The three forces acting at O are in equilibrium, that is to say they exactly balance one another. If we have drawn the diagram accurately, we can find T_1 and T_2 by measurement. Otherwise, we can calculate the values by trigonometry:

$$\cos 30^0 = \frac{G}{T_1}$$

$$G = m \cdot g = 15 \cdot 10 = 150N$$

therefore $T_1 = \frac{150}{0{,}866} = 173N$.

Also, $\text{tg } 30^0 = \frac{T_2}{G}$

therefore $T_2 = 150 \cdot 0{,}577 = 87N$.

8. Acknowledgements

I would like to thank the “Hands on Science” coordinator Manuel Felipe Costa and the national coordinator Dr. Dan Sporea for their support and encouragements.

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An Adventure in the Web: “Escher Finding the Infinite”

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Abstract. According to the position acquired by the information and communication technology in the construction of high level thinking, critical opinions, organization ability, analysis, synthesis and evaluation, the webquest notion, its mentors and its components are presented. A webquest is an organized learning activity available in the web that applies to a variety of teaching situations and leads the students to a rich and powerful experience. It’s supported by the new potentials of collective and interpersonal communication that internet provides and allows cooperative work. It’s presented a small characterization of the webquest “Escher e a procura do infinito” related with its subject, class’s level, the type and structure. This approach involves students in asking questions and making observations in order to find answers and learn scientific concepts with a hands-on experiment. It was made a study about the efficacy of this mind tool in the extending and refining knowledge, in particular, the concept of infinite.

Keywords. Infinite, WebQuest.

1. Introduction

To deal with the constant technology evolution and unadaptation knowledge, the students most refine their thoughts, being able to solve problems, looking several solutions. It is with these hands-on construction materials that mind tools assume an important paper in student’s education. It is an apprenticeship by construction and never by memorization, exploring all the technology possibilities. Each individual is responsible by their own knowledge.

In this paper we are going to present one of the most powerful mind tools, designated webquest. It is an inquiry-oriented activity that uses the resources available in the internet. It must be developed with group activities, making use of the cooperative work. It is justified the use of the webquest in the learning of the infinite and how a 12º class reacted to it. In other words, we will explain what a webquest is, how is going to be applied and in what way students can learn more efficiently Mathematics using this kind of material, what is the advantage of analyzing Mathematics in this way.

2. Mathematics and technology

In our society, the school has a very important role, it allows that an individual acquires a lot of skills, develops critical thinking, constructs their own knowledge … and make us acquire a statute in society. In this way, we need to include informatics, communication technology in student’s curricula. The use of these tools allows a better access to the information and therefore a better performance in school and a stronger knowledge. The domain of technology is indispensable to the development of Mathematics.

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There are already thousands of schools connected with the internet, and the number is increasing every day. Through the web, the teacher invites the world to come inside is class room. It is a share of ideas. The use of these mind tools, allows the students to develop the abilities of research, organization, synthesis, analysis, critical opinions and evaluation.

Technology is an important vehicle for the mathematical communication. The materials that teacher uses are a start point for learning. For NCTM (1994: 168), "Mathematics as solving problems, as communication and as deduction is three connected perspectives" [5].

3. Infinite

The infinite has motivated philosophers, theologians, poets and mathematicians, through several centuries. It is not a simple question of logic, but something that has always needed some imagination. The distinction between potential and actual infinite remounts to Aristotle's and it was revived with the infinite set theory of Georg Cantor, in the XIX century.

Through times, there were some paradoxes connected to infinite. The most known are Zeno's. Actual infinite was only accepted as a mathematical object that needed study after some paradoxes were explained. Since 1869, with Cantor's work, the infinite is seen as a part of Mathematics. He was born in S. Petersburg, had his high degree in Berlin and through his set theory (*Mengenlehre*) or multiplicities theory (*Mannigfaltigkeitslehre*), he accepted the actual infinite and developed a new theory that explained the different infinite sets with the transfinite cardinal numbers. He considered that the numbers 1, 2, 3, 4 … do not allow us to count infinite sets, so he created a new type of number: the transfinite. To the numerable set he awards the smallest transfinite cardinal number $\aleph_0$ and to the continuum he awards a biggest transfinite number.

Cantor's theory revolutionized the Mathematics. Finally, the actual infinite was incorporated in Mathematics. According to Hilbert (1926: 236), "infinity's question has always disturbed human's emotions more deeply than any other problem, infinites idea stimulated and fecundated humans reason as any other" [4].

In spit of this revolutionary theory, there were discovered some contradictions that still are being solved in our days. Appeared some paradoxes in *Cantor's paradise*, because his discourse was very vast, containing certain contradictions, as the notion of set, for instances. But we should add that "is less important in Mathematics what sings are then the way they act to. Besides, even after it was reformulated in its bases by a new axiomatic (…) Cantor's theory standed up in most" (Oliveira, 1982: 120) [6].

The notion of infinite is explored along the learning program of a mathematician student. This notion comes with the study of sets, irrational numbers and functions in the 9º school year. At the end of this level, students acquire "the comprehension of functions notion and its representations like sets correspondence" (Abrantes, 2001: 67) [1].

In secondary school the notion of infinite is studied in a more formal way. In the 10º school year, functions are explored with rigor. In the 11º school year, limits, continuity, derivation, trigonometric functions and successions are studied. Finally, in the last year of this cycle, the notion of number is extended and limits are studied in a more formal way that students "should reach the concept of infinitely big, infinitely small and succession limit" (Silva, 2002: 9) [8].

4. WebQuest

The originator of the WebQuest concept was Bernie Dodge (1995) at the activities of EDTEC 596, "Interdisciplinary Teaching with Technology", and according to him (1997 [1995]), "a webquest is an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet, optionally supplemented with videoconferencing" [3]. Despite Dodge was the inventor of the webquest model, we should refer the enormous role of Tom March in the development of this mind tools. He was the first collaborator of Dodge in this field and now his one of the bests.

A webquest give students a task that allows them to use their imagination and problem-solving skills. They can explore issues and find their own answers. This mind tools are group activities and it can be developed with one or more subjects, depending the on what we want to analyse. These activities are always very motivating for students and must be developed with the use of internet, being a suggestion of the teacher to be solved by students.

A webquest should contain six building blocks: introduction, task, process, resources, evaluation and conclusion. It might be improved

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by wrapping motivational elements around the essential configuration by giving the learners a task to participate. There are at least to levels of webquests according to the goals complexity: long and short terms. A webquest is a group activity based in the Internet. The home page should contain the school year of the individuals that are going to do it, the authors, their contacts and when it was created.

If a teacher decides to develop one webquest, he mustn't forget three important aspects: the duration of the webquest according to the complexity of the subject, respect the structure stipulated by Dodge and proceed to the evaluation of this activity before it is available at the internet.

5. Escher finding the infinite

With the main goal, develop high thinking, it was elaborated the webquest "Escher finding the infinite" (Escher e a procura do infinito) available at the web through the URL: http://patisampaio.no.sapo.pt, were we can find some resources about Maurits Escher and the infinite, contributing, this way, to the construction of knowledge. According to the complexity of the subject and the controversy infinite history, the use of different resources allows a better comprehension of the past to try to respond for the future.

5.1. Theme

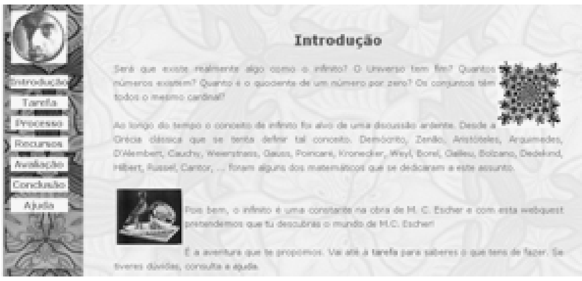

Figure 1. Introduction of "Escher finding the infinite" (Escher e a procura do infinito)

Such as the webquest refers to (figure 1), infinity's concept has always been controversy, suscitating several paradoxes. We decided to make a webquest about the infinite because it is a subject of the Mathematics school programme and is complex enough to originate high thinking. Trying to make a more attractive work, we decided to include the work of Maurits Escher, connecting this artist with the concept of infinite and therefore the title of the webquest: "Escher finding the infinite" (Escher e a procura do infinito).

5.2. Receivers

The notion of infinite is in the national curricula of Mathematics, but in a more expressive way in the Mathematics of the students from sciences. This is not an intuitive notion, it is a very complex one, therefore the webquest is for secondary students and not for the elementary ones. According to the national curricula of Mathematics, secondary "students must realize individual or group works about the calculus history" (Silva, 2002: 5) [9], intrinsically related to the infinite history.

5.3. Duration

According to the complexity of the theme and the students that is meant to be, this webquest is characterised as a long term. Students should analyse deeply a quantity of information, transforming it into new knowledge and being able to create something new. This way, this mind tool should be applied between one and four weeks.

5.4. Structure

We have already explained some characteristics of the webquest, but still is necessary to talk about its structure.

In the home page (figure 2), there is a teachers information that clarifies what is a webquest, who are there mentors, when it should be used, to whom it concerns and some bibliography of the subject.

Activating the link to go into this adventure, we reach to the introduction and to the menu that is always available at the left side of the screen. There we can find the six building blocks of any webquest: introduction, task, process, resources, evaluation and conclusion. Such as the students help.

In the introduction, we make a trouble question and invite the students to find out the world of Maurits Escher, being the infinite a constant of his work. In the task we explain that the work of this artist around the subject can be divided into three categories: cycles, tessellations and limits. They must do a poster with these categories. The task is accomplishable and leads to deep thought of the theme.

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A webquest is an organized learning activity available in the web that applies to the construction of high level thinking, critical opinions, organization ability, analysis, synthesis and evaluation.

Figure 2. Home page of "Escher finding the infinite" (Escher e a procura do infinito)

The process is described with simple words, in such a way students can understand exactly what is asked and they should answer to the task. So we elaborated a small table that divided the four elements of each group into the sub themes of the research (table 1). We should notice that each group could make their own distribution of the work.

Task		Students
Find about the infinite history		A, B
Understand the infinite concept		C, D
Find about Escher work		All
Connect Escher work with the infinite	Cycles	A, C
	Tessellations	B, D
	Limits	A, D
Choose the images		B, C
Elaborate the poster		All

Table 1. Fragment of the process of "Escher finding the infinite" (Escher e a procura do infinito)

Sometimes, the process is associated to the resources, as it is in this case. Each resource has is importance and it is connected to the subject. According to the sub themes, the resources were divided into four categories: infinite, M. C. Escher, images and tessellations. For each topic, there is a small description (table 2), followed of a enormous number of web sites in portuguese and in english.

The evaluation has qualitative and quantitative standards to analyse what students have learned, their group and individual work and the realization of the task. Finally, the conclusion indicates the advantages of making the webquest, challenging the students to do a new research.

Theme	Description
Infinite	Infinite debates were a constant of the greek school, but only in the XIX century, with Georg Cantor, actual infinite was accepted as a matter of study by Mathematicians.
M. C. Escher	Maurits Cornelis Escher was born in july 17, 1898, at Leeuwarden, Netherlands. The acknowledge of his work was not instantaneous, being only recognised at 1951! In a 1959 paper, Escher decided to write about limits.
Images	Escher's work represents a vision of Mathematics.
Tessellations	We live around tessellations and at 1936, through Escher's visit to Spain, he decided to dedicate part of his work to this subject.

Table 2. Fragment of the resources of "Escher finding the infinite" (Escher e a procura do infinito)

6. Research

The conception and implementation of "Escher finding the infinite" (Escher e a procura do infinito) is inserted in a research work that covers the use of webquests in the apprenticeship of the mathematician concept of infinite. The study has qualitative and quantitative data, because the concept of infinite is to complex to be studied it only with numbers.

In this paper we are going to present a first result of this activity that had it's beginning at april's 18 through may's 18. Participated 16 students of a 12º class. It was a convenient sample, because they were one of the investigator's classes.

In the first session, the students were informed of the research work that was going to be developed with them and they fulfilled a questionnaire about their infinity's notions. In the second session it was presented the webquest and through seven sessions, the students worked in groups to realize the activities. In the eight‘s session, they fulfilled another questionnaire about their infinity's notions.

The first group worked in a cooperative way, letting everyone participate in the group activities. They have shown a good research, getting enough information from the internet and organizing it in a proper way. The overall aesthetics of the poster is attractive, with colours and pictures well chosen. The language used is simple and objective. There is some creativity but they could do better. It messes the title. It corresponds to scientific standards but there are some fails. Some of the images chosen to represent tessellations aren't Escher's. In the other hand, the images chosen to represent cycles and limits are very good. The text in the poster is very curious and adequate. Concisely, we can evaluate this group positively and consider that the infinites notion was worked in a clarifying way.

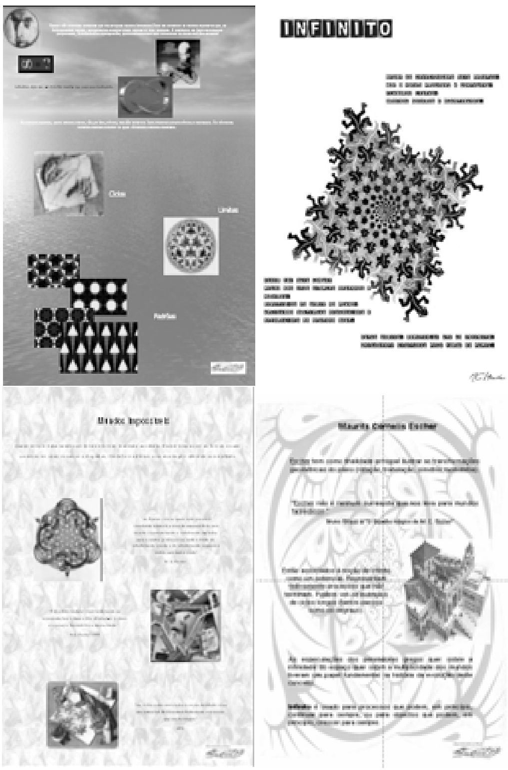

Figure3. The four posters realized by the students

The second group also worked in a collaborative way. Each element respected the opinion of the others and tried to discuss the subject every time they didn't agree. They made just the enough research to do the activity, not going farther. That was organised in consist way. They have chosen only one Escher's image, putting it in the centre of the poster. The background is white, making a good contrast with the big picture at the centre. This way, the overall aesthetics are very attractive. The language is simple and motivator, referring that since ancient times, humans have though about the infinite and Escher's showed another perspective with is pictures. There is creativity and achieves some scientific standards, but they could explore more the concept of infinite. They have answered to the task in a satisfactory way.

The third group respected the distribution of the sub themes and followed the suggestion made by the teacher in the process. They made some research to get the information needed to fulfil the task and organised in a coherent way. There is a harmony between the colour of the letters and the background of the poster, making overall aesthetics attractive. The language is adequate and the texts chosen are mostly Escher's citations. So we considered that they could be more original. The title has also Escher's hand: "Impossible worlds" (Mundos impossíveis). They reached the scientific standards because there was a connection between infinite and Escher's pictures, but infinity's history was not mentioned. This way, the understanding of infinites paradoxes was not accomplished.

Finally, the fourth group also respected the division proposed by the teacher in the process to proceed to the dynamic of the group. There was always a mutual respect between each element. They have shown a good research, getting enough information from the internet and organizing it in a proper way. The overall aesthetics of the poster could be more attractive, because there is a lack of colour. The language is simple and motivator. They could be more original. The scientific standards are achieved because there is a reference to the infinity's history, connecting it to Escher's work. Concisely, we can evaluate this group positively and consider that the infinites notion was worked in a clarifying way.

7. Conclusion

The mathematician speech has is foundations in the communication and in knowledge. So we should variety our speech, improving it with technology. Mind tools make the Mathematics learning more easily. As a teacher we should always look for new ways of teaching so that the students acquire more knowledge and develop high thinking.The webquest model was chosen because lets the student do their own research and has always the teacher to support him at any case. With this mind tool, we expect that critical opinions, organization ability, analysis, synthesis and evaluation are developed. In this actual case, four groups made a poster about the notion of infinite and mostly they have done their task with success. So we can say that the use of webquests in class contexts may improve the learning process and, in particular, may link the Mathematics to the technology and to the world.

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Formal and Informal Learning in Mathematics and Science

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Abstract. The lack of interest in young people towards scientific subjects studied at school is increasing, while students usually show curiosity and interest when they are visiting a Science Center or a natural environment.

The project aims to experiment teaching forms, in Mathematics and Science, based on the informal learning, characteristic of out of schools activities and centered on the direct and active students' involvement. The challenge is to explore ways for integrating the informal learning approach with the formal one, more sequential, structured and directive, typical of the school.

The project would have a wider educational purpose, because best practices in Mathematics and Science teaching are crucial in helping students to acquire knowledge and inquiry procedures which will allow the future citizens to critically evaluate the received information and to make conscious decisions in a world deeply influenced by Science and Technology. Aims:

- to build, through exchange of experiences among partners, learning environments suitable for motivating students, especially the less gifted ones, and for stimulating and raising their curiosity about the surrounding natural and technological world
- to take advantage of the comparison between different European school systems, to study and experiment learning ap-

proaches based on cooperation, interactivity, creativity, enhancement of different learning styles and rhythms

- to find ways of using the ICT not only as a means of developing knowledge and skills, but mostly to develop motivation and facilitate cooperation

Keywords. Informal learning, Quest.

Hands on Maths: Kits for Class and Home

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Abstract. Didactic kits can be devised so as to be useful not only in the context of the classroom –operational demonstration of abstracts concepts- but also at home in benefit of an enhanced family interaction regarding the appropriation of science concepts. New didactic kits on the Pythagorean theorem, the multiplication formulas for binomials, and the constant π − developed in collaboration between our science centre and a technological centre − will be presented, as well as the preliminary results of an evaluation which is being carrying out on their impact on the motivation and learning by both school children and adults.

Keywords. Mathematics.

Fractal Analysis of Histological Slides and Micro-relief Images of Skin Neoplasia

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Abstract. Fractal geometry is a tool to characterize irregularly shaped and complex figures by using numerical values among which the fractal dimension (Fd) has been extensively used. The objective of this work was to measure Fd values by means of image analysis of melanoma, melanocytic naevi, seborrheic keratoses and Basal cell carcinoma tissues, taking as control the normal skin of each patient. The Fd was evaluated by means of the Box counting method analysing histological slides and microtopography images. Results obtained showed that FD´s means of histologycal slides images (Fd_h) corresponding to some neoplasia is higher (1.334±0.072) than those for the healthy skin (1.091±0.082). There was a significant difference between the fractal dimensions of a neoplasia and healhty skin ($p \leq 0.001$). Even though the Fd's means of microtopography images (Fd_m) can distinguish between healthy and malignant tissue in general (2.277±0.070; 2.309±0.040), the Fd_m can not be used to identify among the different types of skin neoplasias. The Fd_h can be used to discriminate normal and pathological tissue. This work may constitute an approach to make a better a priori diagnostic tool to aid pathologist.

Keywords. Mathematics, Fractal.

Mathematics and affectivity

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Abstract. Some researchers on education had notice that there is a strong connexion between the learning of mathematics and the affectivity between the teacher and the learner. As the natural relation is made especially by words, the formal and informal language play a quite important role on the learning. But not only the words but also the "intonation" and " affect" of them. On our talk we will give examples of these aspects and also we will present some open problems to solve the question.

Keywords. Mathematics, Hands-on

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Physics and Creativity in Fluid Dynamics

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Abstract. The development of Physics not only from theoretical point of view but from practical one, made this matter an important element in all the domains of science and research, becoming a factor of progress. The study of Physics is based on the direct contact of the student with the reality, with the studied objects and phenomenons, on the producing and observing different experiments. In conclusion, the increase of the interest of the study of physics must be based on the experiment, on the creativity of the students. This work proposes to present an aerodynamics experiment which can increase the quality of instructive-educative process and can attract the students in the activity of scientific research.

Keywords. Creativity, Experiment, Fluid Dynamics, Scientific Research.

1. Theoretical notions and experimental dates

From the daily experience, the students observed the fact that the air is in opposition with the movement of objects. The resistance which the air opposes to the movement of the object presumes appears because of the friction and pression forces. If the mobile is moving in the air with the speed of 0.5 m/s (meters on the second), the fluctuations (turnovers) caused by the forces of pression aren't considerable. The movement is turned over (disturbed) by the forces of friction.

The forces of friction are caused by the viscosity of the air. These forces are tangent at the area of the object and admit a force of result which has as a line of support, the axis of symmetry of the mobile, named the resistance of friction. In this case, the resistance is proportional with the speed. The fluid slips along the walls of the object and the flow is laminar.

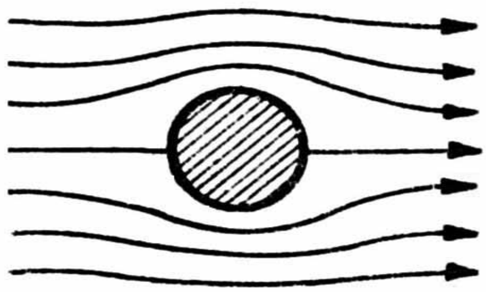

Figure 1. The flow is laminar

If the mobile is moving with a speed contained between 1m/s (meter on the second) and 280 m/s the resistance of friction caused by the viscosity of the air is small in proportion (comparative) with the resistance caused by the forces of pression. At this speed, in front of the mobile is producing an overpression zone and in the back of it a zone of low pressure, which gives birth at the vortex. In this case the resistance is caused by the difference between the front forces of pression and the back forces of pression. It is concluded the fact that the resistance at the advance in the air is proportional with:

- the square of the speed of the mobile;
- the density of the air in the conditions of the experiment;
- the S area of the surface obtained through the projection of the object (material) on a perpendicular plane on the vector of speed, named apparent outline (contour).

The resistance is in relation with the form of the object:

$$F=\frac{1}{2}CS\rho v^2$$

The ½ factor is included from theoretical considerations. The C proportionality factor depends on the form of the object and is named Form Factor in turbulence system.

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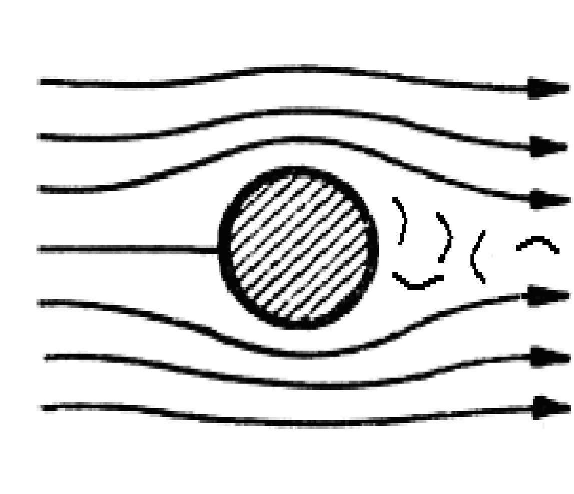

Figure 2. The flow is nonlaminar

The C values for some objects are presented in the following table:

		Coeficientul Reynolds $Re = UR/\nu$ U - viteza R - raza de curbura ν - viscozitatea cinematica	Coeficientul rezistiv c
	emisfere goale		0,34 1,33
	elipsoid de rotatie turtit 1:0,75 alungit 1:1,80	$\frac{UR}{\nu} < 2,5\cdot10^5$ $> 2,5\cdot10^5$ $\frac{UR}{\nu} > 10^6$	0,6 0,2 0,05 – 0,1
	con $\alpha=30°$ $\alpha=60°$		0,34 0,51
	cilindru $\frac{L}{R}=2$ 4 10 20 80 ∞	$\frac{UR}{\nu}=4,4\cdot10^4$	0,63 0,68 0,74 0,82 0,98 1,20
	cilindru $\frac{L}{R}=0$ 2 4 8 14		1,11 0,91 0,85 0,87 0,99
	profil aripa $\frac{l}{d}=2$ 3 5 10 20	$\frac{Ud}{\nu} > 10^6$	0,2 0,1 0,06 0,083 0,094

Table 1. The C values for some objects

Starting from these aspects we designed and constructed with the students a simple device which can allow the determination of the Form Factor in turbulence system and evidence the force of friction between the object and the air. Also, there can be established the speed of the air jet produced by a hair dryer or by any other system of the presented type (air blower type).

The scheme of the experimental device is presented in the figure number 5 and in reality is presented in the figures nr.3, 4 and nr.6.

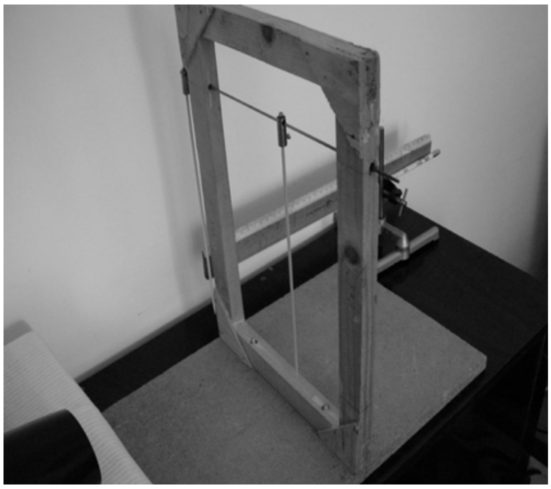

Figure 3. The experimental device

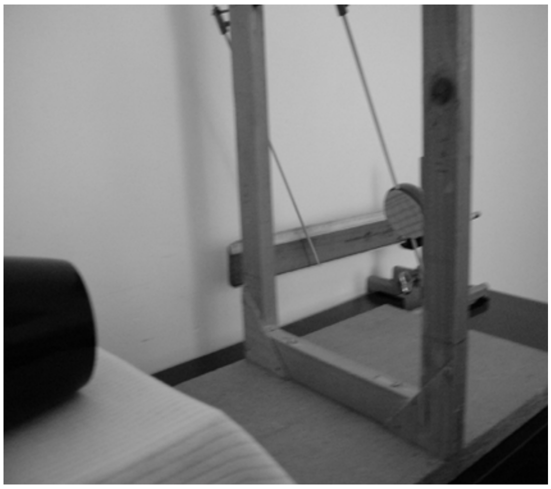

Figure 4. The experimental device

The object is fixed on a very easy bar (constructed from wood), connected with a horizontal axis which can move easy in a way in which the friction is minimal. The horizontal axis is structured in the exterior with an indicator which is moving in front of a horizontal ruler.

If on the object is straighten the air jet which comes from the hair dryer, it will move until the aerodynamic force of friction and the weight of the object and of the bar establishes a resultant force along the support bar. Measuring x, h and the mass of the object and of the bar we can establish the force of resistance which appears at the movement of the object through the air.

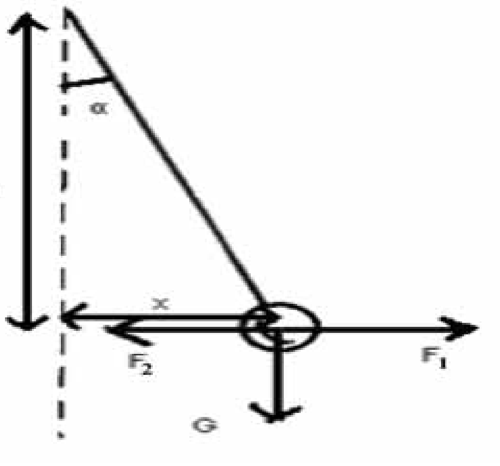

Figure 5. The scheme of the experimental setup

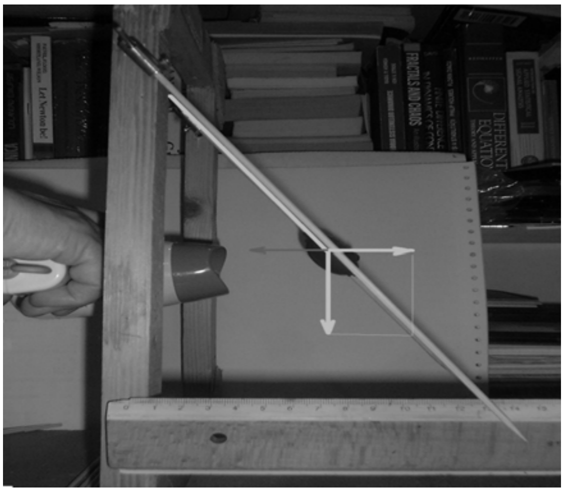

Figure 6. The experimental setup

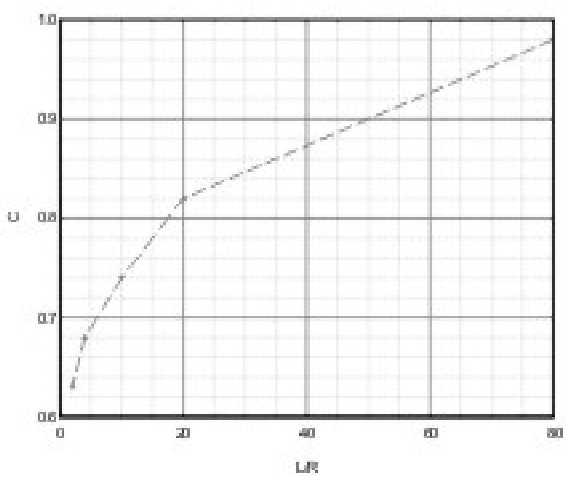

Figure 7. C=f(L/R) for the vertical cylinder

In accordance with the notes from the figure number 5; F_1 represents the hydrodynamic force, F_2 represents the resistance force, equal and of opposite sense with the hidrodynamic force, G represents the weight of the object, X represents the deviation read on the ruler, h- the distance on the vertical from the point of support to the position of the ruler. In this experiment it was selected: $\rho_{aer} = 1.2928 kg/m^3 \approx 1.3 kg/m^3$ and h=19cm.

The students have established the speed of the air current which came from the hair dryer for objects at which it was known the C value, and then for an object with irregular form they have established the C value. The experimental results obtained are presented in the table 2.

tgα=x/h=F/G
F=Gx/h=mgx/h
$(CS \rho v^2)/2 = mgx/h$
$v=[(2mgx)/(CS \rho h)]^{1/2}$
ρ_{aer}=1,2928Kg/m^3~1,3 Kg/m^3

The ray of the object-R=2cm
The transversal area of the object

$$S = \pi R^2 = 12.56 cm^2$$

$Mass_{bar}$=1.76 g
$Surface_{bar}$=1.5 cm^2

For the cylinder was established the C value from the graphic knowing that:

$$\frac{h}{R} = 3 = \frac{4.5cm}{1.5cm}.$$

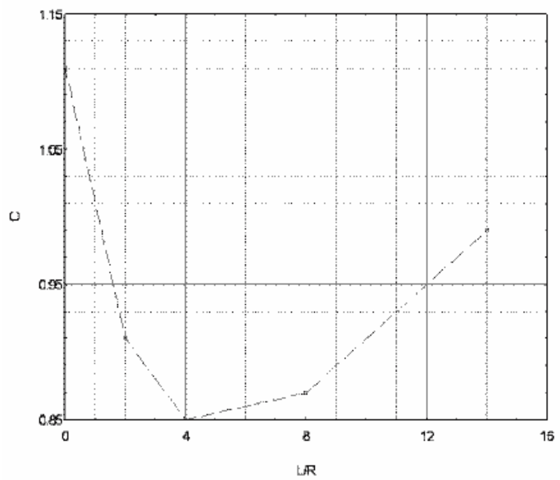

Figure 8. C=f(L/R) for the horizontal cylinder

The object is positioned in a way in which the air current, which comes from the hair dryer (of Brown type),1600 W electric power, positioned at 20 cm distance from the vertical line (the vertical line of the frame),falls down in the center of the object.

For realizing correct the experiment the students must understand the theoretical notions and make many different series of measurements. It was observed that the students had the tendency of calculating the area of each object, not considering the fact that in the calculation of the speed of the hair dryer, intervenes the transversal area, which in this case is the same for all the objects, besides the cylinder. Another frequent mistake made by the students was not calculating the mass of the stick which was fixed with the analysed object. Because the mass of the object is small, approached like value to the mass of the bar, the neglection of the mass of the stick leads to the appearance of some big errors. It was neglected the fact that the temperature, the humidity can modify the viscosity of the air.

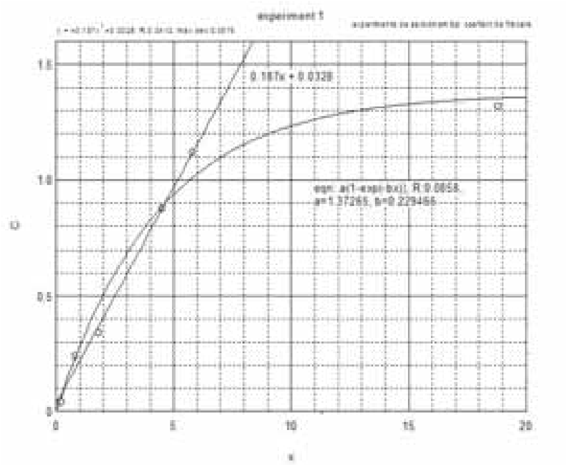

Figure 9. C=f(X)

Representing by graphic the C value in function of X with the help of the program (Editor) EassyPlot it can be concluded the fact that this dependence can be considerated a continous one on the initial section,the equation of line being of the following form:y=0.187x + 0.0328 or considering the dependence not in line or not continous (representation which can be observed in the figure number 10),the best function is of the following form:y=a(1- exp(-bx)) where a=1.373,b=0.229.From the graphic representation for an usual object, measuring x it can be established the C value,so this graphic represents the calibration of the constructed device.

2. Conclusions

Even though there were realized some mistakes, the process of this experiment has determined the development of practical and intellectual abilities of students, the development of creativity, skills of individual and group work.

Also, the students understood how they can realise a scientific step, that for creation you need work and tenaciously consciousness because the effort, the information stocking and the experience are decisive. Thomas Alva Edison said that:" the genius represents only 1% inspiration, 99% being perspiration". Also, the students observed that learning Physics they make a contribution at the development of the society, at the increase of life quality. They learned to value work and the effort deposited by our precursors and by our contemporaries. The active implication in the realising of the experiment and the interpretation of results determined them to learn Physics with pleasure and with interest!

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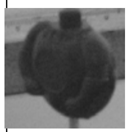
Object	Disk	Hemisphere	Hemisphere	Sphere	Aerodynam. Profile (*)	Irregular object	Cylinder vertical	Cylinder horizontal
	 v^2=0,6447mx/C	 v^2=0,6447 mx/C	 v^2=0,6447mx/C	 v^2=0,6447mx/C	 v^2=0,6447mx/C	 v^2=0,6447mx/C	L=4,5cm R=1,5cm L/R=3 C=0,65 v^2=1,146 mx/C	L=4,5cm R=1,5cm L/R=3 C=0,9 v^2=1,146 mx/C
h	19 cm	19 cm	19 cm	19 cm	19 cm	19 cm	19 cm	19 cm
Mass	1 g	6 g	6 g	10 g	6,5 g	6 g	5 g	5 g
X	18,8 cm	5,8 cm	1,8 cm	0,8 cm	0,2 cm	4,5 cm	2,1cm	2,9cm
V^2 without correction of the mass bar	9,182	20,031	20,478	21,490	20,953	18,427 C = 0,945	18,512	18,883
V^2 with correction of the mass bar**)	25,343	25,908	26,485	25,272	25,636	25,729 C = 0,875	25,0286	25,5297
C	1,32	1,12	0,34	0,24	0,04	0,875	0,65	0,88
R and S	2 cm 12,56 cm^2	2 cm 12,56 cm^2	2 cm 12,56 cm^2	2 cm 12,56 cm^2	2 cm 12,56 cm^2	2 cm 12,56 cm^2	1,5cm 7,065 cm^2	1,5cm 7,065 cm^2
Mass bar	1,76 g	1,76 g	1,76 g	1,76 g	1,76 g	1,76 g	1,76 g	1,76 g
Surface bar	1,5 cm^2	1,5 cm^2	1,5 cm^2	1,5 cm^2	1,5 cm^2	1,5 cm^2	1,5 cm^2	1,5 cm^2

Table 2. The experimental dates

(*) aerodynamic profile was achieved about paste one paper cone on the sphere (the length of the cone = 6 cm).
**) the correction of the mass bar $v^2 = [2(m_c + m_t)gx]/[C(S_c)\,\rho h]$

Historic Experiments on Internet. Trying to Find New Answers to Old Questions

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Abstract. The evolution of the ideas in Science is one of the answers, if the question is how the students will become serious in studying Science. Internet is the answer, if the question is where will students find the information. The only (?) question we, still, have to answer is how to present the evolution of the ideas on Internet. In this paper, we try to give an answer to this question.

We believe that the evolution of ideas is well illustrated, through the presentation of important experiments; experiments that contributed to the establishment of revolutionary theories and influenced the evolution of ideas in science and the society. Those experiments we call Historic Experiments. By presenting the Historic Experiments we refer to the history of Science and to the mechanisms as well; finding the proper balance between these two is essential for a good result.

We believe that the information around the Historic Experiments should include short reference to the main theories accepted at the time, the motives and the personalities of the researchers; it should describe in more detail the efforts of the researchers, the technical difficulties they had to overcome and the way they solved the breakthrough. Moreover, it must point out the modern applications and encourage the user to put “Hands on Science”, by giving practical instructions to reproduce the experiments; presenting variations of the original experiment appeals to the creative skills of students and teachers.

The educational material should be given in the form of multimedia; hypertext, static pictures, videos, animations, simulations, music and voice. It should include worksheets and tests. Moreover, it must be accessible by any school and in a later stage promote the discussion and collaboration among schools in reproducing and analyzing Historic Experiments.

Keywords. History of Science, Historic Experiments.

1. Introduction.

We started three years ago developing educational material about some Historic Experiments. The idea was to publish it on the Internet, so everybody has a free access to it; it is intended to serve a secondary level science class in its every day work.

Its main characteristics:

- Simple structure; the options of the main menu are in the form of direct questions. The text in each option is short, clear, written in plain English, so it is easily understood. There are links to detailed description and further explanation.
- The Historic Experiments are visualized through static pictures and animations.
- There are videos of experiments trying to reproduce the historic ones, using modern technology (e.g. sensors). There is information about the material used in the experiments and instructions how to build them up.
- There are lesson plans, questionnaires and worksheets to encourage the students study the material carefully and test their skills.

We tried to build up an easy to follow site; we also tried to give enough information around the Historic Experiments and the way they were carried out. We present, in short, the previous theories the droughts, the difficulties and the breakthrough for each one of them.
Following the exemplary line of reasoning followed by the scientists who introduced the Historic Experiments, we believe that we contribute to the better understanding of the physics’ laws.

2. What are the Historic Experiments?

Scientists who tried to test a hypothesis have introduced experiments. Some of them contributed to the establishment of revolutionary theories; in this way they have influenced the evolution of ideas in science and the society. Those are the Historic Experiments.

Historic Experiments to be are conducted as we speak, somewhere in the world. A collection of Historic Experiments should include modern experiments as well. It would be interesting to start up a discussion of which modern experiments will be considered as Historic Experiments 500 years from now.

3. Why to teach about Historic Experiments?

The idea of teaching in class elements from the History of Science and reproducing a number of simple Historic Experiments is a way to help students learn about the nature of scientific inquiry and to encourage school teams in working as “researchers” and discover the way of discovering (AAAS, Historical perspectives: 1993),.. More specifically:

- Pupils get familiar with real problems and with the way the pioneer researchers solved them.
- The pupils get an idea of all the difficulties and contradictions around a revolutionary theory At a later stage the students will find out that the scientists often don’t follow in their research the standard step of the scientific method as we teach them at

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the secondary level; their work includes the collection of phenomena of relevant evidence which in combination to logical assumptions and the intuition of the researcher lead to the scientific hypothesis.

- Dealing with real problems, the students learn the concept of controlled variables; if two or more parameters vary in an experiment then you cannot have clear results from the experimental data. It is difficult, in this case, to correlate specific changes to the relevant magnitudes. One should be careful in designing an experiment and selecting the devices, to avoid such complications (AAAS, The nature of science: 1993).
- The students get aware that the results of a research might be different than the expected ones. New ideas are often the product of such situations and they lead to new research (*T. Kuhn,1962)*.
- Students develop an understanding of modern science's historical roots in a way that emphasizes the hard work involved. We believe that young people are inspired by the pioneer experimentalists.
  Great scientists in the past believed in and promoted the study of the early theories…
  "…Schrödinger clearly believes that there is more to the study of ancient history than mere factual curiosity and a concern with the origins of present - day thinking… He is primarily concerned with the very nature of physical reality, the humanity's place in relation to this "reality" and with the historical question of how great thinkers of the past have come to terms with these issues. (Roger Penrose; Foreword at the book "Nature and the Greeks" and "Science and Humanism" Erwin Schrödinger)

4. Why to present some Historic Experiments on Internet?

Presenting Historic Experiments on the Internet has certain advantages:

- In a web site, detailed instructions can be given to school teams that want to reproduce a historic experiment, accompanied by simulations.
- It is possible to exchange ideas and present the work of teams who perform their version of the Historic Experiment
- It serves the Science teacher by providing him/her with material tailored to the needs of the Science lesson. Each presentation can be given in both a short form and a detailed one, which cannot be done in a book. Most science teachers will limit themselves to examining the short option. For someone who is more deeply interested in a certain part (e.g. the historical events, or the detailed description of the experimental data) there is the possibility to find out more about it by using the appropriate hyperlinks.

5. The authoring environment

We developed the educational material in HTML and Macromedia's Flash MX files; we believe that these tools can provide web pages of sufficient quality. In the Macromedia environment we used the Action Script to support the simulation models presented.

Some of the animated pictures are built by using an environment providing tools for image manipulation; in the program Animation Shop 3, we combined static pictures – frames, created under the program Paint Shop Pro 8, to get effects and animation.

The outcomes is available to schools that have access to the WWW; they can view and study the information presented; we hope in a later stage that educators and students will be enabled to actively participate in the process of exchanging ideas and providing additional information.

5. The authoring environment

A "complete" selection of Historic Experiments should involve about 50 - 60 experiments, from different historical periods. We should make it clear that the term "Historic Experiments" does not exclude modern experiments of our time. On the contrary, at a later stage we hope to have a process of on line "evaluation" and selection of experiments that are developed today in different countries.

The criteria for selecting some of the most important experiments of all times are:

- The experiment should be simple enough to be understood by pupils of the secondary level.
- The experiment should be included at the most European curricula. It should refer to

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concepts that are taught at the secondary level.

- The experiment should cover different topics in Science.
- The experiment should be possible to be reproduced in a school laboratory.

We could not avoid starting with the experiments that we like for some reason. They are simple and fascinating; they have made an influence to us since our school years.

At the moment four experiments are included in our small collection. Those are:

MECHANICS
Galileo Free Fall Experiments

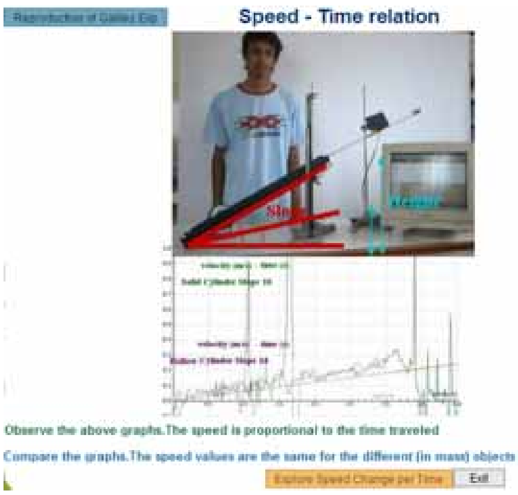

Figure 1. Galileo Free Fall Experiment

ELECTROMAGNETISM
Faraday Electromagnetic Induction Experiments

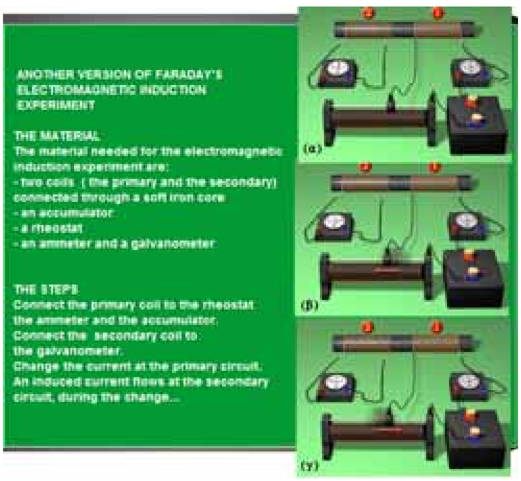

Figure 2. Faraday Electromagnetic Induction Experiment

WAVE - PARTICLES
De Broglie – Davisson/Germer Experiment

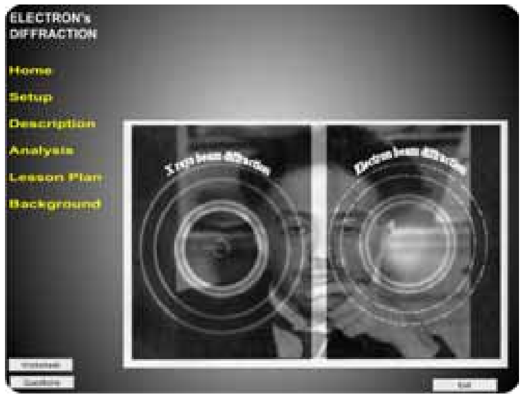

Figure 3. De Broglie Davisson/Germer Electron Diffruction

BIOLOGY
Beaumont – Digestion as Chemistry Experiment

Figure 4. Beaumont Digestion as Chemistry Experiment

The reason why the collection is yet small is:

- We try still to find our way of how to build up properly the educational site. We wish the material published to be used in class. For that reason we decided to proceed slowly.
- We are a small team of full time teachers; we hope to have some more support from other colleagues in the future

8. The topics – the structure

The structure of the menus for the experiments is similar. The options are referring to:

When, Where, by Whom and How a historic experiment was developed; it also refers briefly to the *Impact* of the experiment (and the relevant theory) to the evolution of ideas in Science.
More specifically:

For the Galileo Free Fall Experiments the menu options are:

- The Importance (of the Experiment)
- The Personality (Galileo's personality)
- The Determination (of Galileo)
- Aristotle's Theory (the previous theory)
- Doubts… (about Aristotle's theory)
- Galileo's Doubts (about Aristotle's theory)
- The Hypothesis
- The Experiment

The submenu "The Experiment" includes the options:

- The Breakthrough
- The Steps
- The Formulae
- Simulation Models
- Modern Experiments

For the Faraday Electromagnetic Induction Experiments the menu options are:

- *The Importance (of the Experiment)*
- *The Personality (Faraday's personality)*
- *The Determination*
- *Previous Theories*
- *The Inspiration (Oersted's Experiment)*
- *Faraday's Efforts (expectations)*
- *The Hypothesis*
- *The Experiment*

The submenu "The Experiment" includes the options:

- The Breakthrough
- Conduct Exp1
- Conduct Exp1
- The Formulae
- Your Experiments

For the De Broglie – Davisson/Germer Experiment the menu options are:

- Home (introduction)
- Setup (of the experiment)
- Description (of the experiment)
- Analysis (expectations – results)
- Lesson Plan
- Background

The submenu "Background" includes the options:

- Wave – Particle theory
- Peak Condition
- Historic Experiments
- Experimentalists

For the Beaumont – Digestion as Chemistry Experiment the menu options are:

- *The Importance*
- *The Personality (of Beaumont)*
- *Hippocrates' Theory*
- *Other Theories*
- *First Contact*
- *Second Contact*
- *Third Contact*
- *Alexis Martin (the patient)*

We tried to describe the Historic Experiments Step by Step. That is: A description of the experiment; the declaration of the variables, the collection of the experimental data, the variable dependence in the mathematical model (P. Dimitriadis 2002).

The menu options guide the user in following the standard steps of the Scientific Method. Moreover, it allows the teacher and the student to find easily what he/she is interested in.

The text is divided in small parts; it is simple and clear. In each page there are static pictures, animation or simulation, with some degree of interactivity.

There is enough information about the problems and the difficulties the pioneer scientists faced in carrying out the experiment.

The simulations are quite simple. They serve as tools to compare the previous and the new models; for the same reason we used also static pictures.

The reproductions of the Historic Experiments are presented in videos. We figured out that this is the best way to capture the interest of the student; from our experience in class we know that the students pay more attention to videos, which is "real", than to simulation, which many consider a game.

Ms Papatsiba designed a variation of the Historic Experiment of Electromagnetic induction in a Microcomputer based labs environment (including position, magnetic field and voltage sensors): a magnet is sliding down a gentle slope and induces Electromagnetic Induction to a coil at the bottom of the slope; in this way the acceleration of the magnet is relatively small, so the magnet can be traced by the position sensor.

The students can reproduce the experiments following the instructions and the pictures. They are encouraged to try to redesign the experiment under their teacher's supervision using probably modern measuring devices like sensors. We tried to encourage the users throughout the site, to try the experiment themselves in real life, because this is the best way to learn.

The results from the measurements of the reproduction of the Historic Experiments are compared to the conclusions of the initial hypothesis and of the accepted theory, today. The students are encouraged to observe the outcome graphs from the sensors, comment on the shape of the graph and read the values. Then, they work by inserting the values in Excel spreadsheets on line. We hope that this way the students get a better understanding in the relevant theory.

8. Students' participation

A team of 3 students of the 5th grade (15 years old) of the Greek Gymnasium Lyceum of Brussels studied Galileo experiments from the site and worked on reproducing one of the Free Fall Galileo experiments. The purpose was to compare the velocities of falling objects of different mass. They used gentle slopes and let a solid and a hollow cylinder roll down; the slope was placed at the edge of a table 0.80 cm above ground. After the cylinder reaches the bottom of the slope falls in a parabolic orbit. By measuring ONLY the horizontal range of the orbit for the two cylinders, the students reached the same conclusion as Galileo did ones: that the velocities of the cylinders at the bottom of the slope are practically the same. The student work includes videos, calculations and text; it is now a part of the site about the Historic Experiments. The project was submitted and took part at the competition of "Ideas for science fairs".

8. The plan further

- We wait for a detailed external evaluation of the educational material. Based on it, as well as on the remarks from teachers and students, we hope to be able to improve the content and the style of the site.
- At the home page of the site about the Historic Experiments, there is a global map; on top of the map the Historic Experiments are marked with different colours, depending on the historical period. The same idea could apply to a popular virtual globe program, a 3D global map representation of the earth, the Google Earth. A collection of points that represent Historic Experiments in different historical periods, could give in a glance a picture of the distribution of important experiments in place and time.
- The collection of the Historic Experiments should be extended. It should include more of the most important experiments, based on the same structure and style.
- At a later stage we hope to have a process of on line "evaluation" and selection of modern experiments. As it is already mentioned, it would be interesting to have a debate of which modern experiments will be considered as Historic Experiments 500 years from now.

9. The site

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Hands on Science Activities in Slatina

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Abstract. Our college is an associated member of the "Hands on Science" network from 2004. The paper describes our results obtained during 2005-2006. A diversity of activities were developed: the promotion of physics experiments based on training kits received during our participation in the network, as well as the set-up of a web site with our results, a secondary school contest "The web site of my class", an art exhibition organized by the best students of art classes, our participation on "Hands on Science" network's exhibition to the European Commission, activities of the biology club and of the chemistry club.

Keywords. Experiment, Physics, Science.

1. Introduction

During the second year from our participation in "Hands-on Science" project, we focused on the diversification of our activities and on the improving the visibility of the project achievements in our school and in our city. The impact of "Hands on Science" network on methods of Science's teaching and understanding was high. We organized the promotion of physics experiments based on training kits received during our participation in the network, as well as the set-up of a web site with our results, a secondary school contest "The web site of my class", an art exhibition organized by the best students of art classes, our participation on "Hands on Science" network's exhibition to the European Commission, activities of the biology club and of the chemistry club.

2. Physics by experiments

As a reward of our activities during 2004 into HSCI, we received two training kits for mechanics to assist our teachers and students in building real physics experiments.

Unfortunately, our Physics laboratory's endowment is very old and inadequate. Therefore, these training kits were welcomed. Teachers used them to introduce students into mechanics' secrets. I asked to my 15-16 years old students to group into teams of two and to choose an experiment for a presentation in front of their class (Fig. 1).

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Each team has to set the experiment up, explain it to the class, note the results and write a paper including the theoretical background, objective, needed materials, way of work, experimental results and conclusions.

Students are asked to evaluate their own work, and if the end result does not satisfy them they may decide that the process should be repeated.

Critical spirit and practical skills are considered essential for a modern citizen. In the process of doing so, students learn to collaborate with the co-worker of their team, to evaluate their own work and to make the best of the assets they have available. Students, therefore, learn to develop collaborative characteristics and social skills.

Figure 1. Adhesion force presented in front of class by high school students

The interest was major because the kits were easy to use, the competition was high (the same procedure was performed in parallel in different classes) and we tacked pictures and some experimental movies for a special web site [1] with our results.

Their work uploaded via the internet, will remain at school for other students to use it in order to learn and, because the web site's language is English, other schools from Hands on Science network may have access to it. Students can also visit this web site and show to their friends and relatives their own product.

I think the experimental approach combined with theoretical one is very advantageous and leads to a better understanding and interest for Science. Physics teaching and Science teaching in general, must develop creative spirit, imagination, logic reasoning, team spirit and practical skills. The "Hands on Science" network provides a frame to promote experimental teaching of Science as a way of improving in-school scientific education.

3. "The web site of my class"

On March 23, 2006 a team of enthusiastic teachers from our school organized a contest at secondary school level named "The web site of my class".

Each class was represented by a team of 2-4 students who collected the information, drew up the content, evaluate it, decide which the important points are and which ones have less importance, do photos, designed the web site and finally, uploaded it via internet [2-7]. As coordinator teacher, I only observed their work, supervised and encouraged them.

This approach encouraged me to use information and communication technologies as well as collaborative tools, in order to widen the students' opportunities while facilitating the interaction with each other and with distributed information resources. Activities were performed after the normal class hours, as an out-of-school activity, from September 2005 to March 2006.

All web sites had to contain some compulsory pages: "My city", "My school", "My class" and "Hands on Science" (Fig. 2).

Figure 2. The web site of VI C class, the winner team

The competition was very attractive. Students developed abilities such as judging their own work, collaborating in teams, assuming a responsibility as well as to practice self-learning techniques. The whole class was involved, even if only 2-4 students form the team.

Finally, students also acquired some technical expertise and had fun. They showed their work to teachers, other colleagues, friends and parents.

4. "Geometry applied to Art"

The bests students of high school art classes from our college took part to the circle "Geometry applied to Art" set up by Mrs. Marinela Preoteasa, teacher of mathematics. To the end of the school year, they presented their bests projects of houses, gardens and churches (Fig. 3).

But also secondary school students are very talented both in Math and Arts. For instance, student Arina Mihaela Pisica (12 years old) has special drawing skills (Fig. 4), she has already held three personal painting exhibitions and at the same time she studies hard Mathematics, she takes part in competitions and she had lots of prizes under the supervision of my colleague Ioana Simion.

Figure 3. A student from high school art classes presents his project of a house

Figure 4. A painting of Arina Pisica

Clara Diaconeasa (12 years old) and Andrada Oprea (12 years old) are very talented in music, they have been playing the piano for six years and they had many auditions and musical contests. All this did not prevent them from getting excellent results in Math as well. They have also taken part in different Math contests and, both national and international ones, where they got good results and prizes.

5. Exhibition to the European Commission

In order to support the network efforts and to promote its results we participated to an exhibition booth at the November 2005 Conference on communicating European Science to the European Commission. We presented our achievements beside others partners from "Hands on Science" network in various forms like: posters, multimedia presentations, experimental devices, photos and short experimental films.

6. Biology Club and Chemistry Club

From March to May 2006, secondary school students studied birds on Olt River, in the biology club coordinated by Pitu Iuliana (Fig. 5).

Figure 5. A paper about swans

Figure 6. Chemistry Club

Also, in the frame of Chemistry Club, young chemists coordinated by Butan Luminita and Guraliuc Carolina, build small experiments proving practical skills (Fig. 6).

7. Conclusions

We will use the results of students' work (devices manufactured by students, web sites, papers, paintings, projects, experimental movies, photos, etc.) like didactic material for classes of Physics, Computer Science, Mathematics, Biology and Chemistry so they be more attracted and interested to understand Science.

We enjoyed very much to work in "Hands on Science". The participation in this project of schools of various European countries gave the project a fundamental European dimension.

8. Acknowledgements

I would like to thank the "Hands on Science" coordinator Manuel Felipe Costa and the national coordinator Dr. Dan Sporea for their support and encouragements and for mechanics training kits from Cornelsen Experimenta.

I would also thank specially, to my students and colleagues for their enthusiastic work.

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The Coriolis Pinball

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Abstract. The Coriolis Pinball is a game that allows getting a feeling of the properties of the Coriolis acceleration, so important in geophysical fluid dynamics.

The game simulates on a computer screen an ordinary pinball, only set up on a rotating disc, where the player is also assumed to be located. Balls are shoot at variable speeds and directions, chosen by the player, and points are collected when discs on the playing field are hit.

Keywords. Coriolis, Inertial forces, Inertial accelerations.

1. Introduction

The Coriolis acceleration is a very important but rather anti-intuitive effect of the rotation of the Earth on geophysical movements with time scales of the order or the day or longer. The same effect appears for much quicker movements of systems with much reduced spatial scales, and this is used here to illustrate the planetary effects.

2. The Coriolis acceleration in a small-scale system

The system considered in this work is a rotating plate with radius R = 2 m. The plate is horizontal and rotates over its vertical symmetry axis with an angular velocity ω. Any observer placed on the disc will see on any movement referred to the plate the action of an acceleration perpendicular to the velocity vector, $\boldsymbol{v}$, and with modulus $a_C = 2\omega v$, known as the Coriolis acceleration. If the rotation of the plate is clockwise, the vector $\boldsymbol{a}_C$ acts to the left of the velocity vector, if the rotation is anti-clockwise it acts to the right of the velocity. In terms of vectors (bold type): $\boldsymbol{a}_C = -2\boldsymbol{\omega}\times\boldsymbol{v}$.

From a kinematical point of view there is no mistery in the Coriolis acceleration, and a first-year undergraduate should be able to obtain its mathematical expression. Still, some direct experience can considerably improve the perception and understanding of this phenomenon.

Simply walking on a rotating plate along a diameter takes some trying. Similarly, throwing a ball to a friend without it just flying away unexpectedly is trickier than it seems.

Throwing a small ball to hit several targets while sitting on a rotating plate is the aim of the game proposed here.

The plate is shown on a view from above with the player located at a point of its perimeter. The initial velocity is shown as a stick at the launching point; the subsequent trajectory, as well as the points collected, are calculated automatically. An accompanying board allows the introduction of numerical values for rotation and initial velocity.

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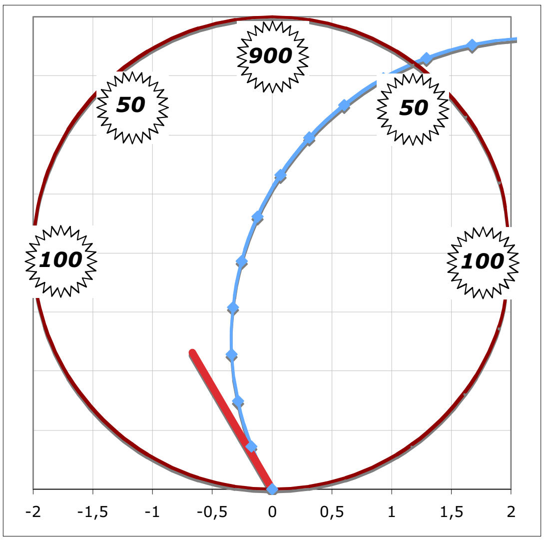

Figure 1. The playing field of the Coriolis Pinball

What happens is depicted as seen by an observer that looks from above and rotates along with the plate (and the targets). Movements are thus shown as referred to the plate, that appears as stationary.

The game is provided as an application file that can be launched on any computer.

Learning the Basics of Light and Optics. A Comenius 2 Project Proposal

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Abstract. In our emerging Society of Information, Light and Optics have a crucial importance not only in Science and Technology but also in the widest range of aspects of our every day life.

The proposed project is focused on the discussion establishment and promotion at European scale of new positive good practices on teaching the basics of optics and optics related technologies at primary schools by inducing the students to an active volunteer and committed participation in the teaching/learning process through practice and experimentation, making intensive use of the new instruments and resources of the Information Society.

Training courses will be prepared and delivered to teacher and educators. Available support educational material will be analyzed. Syllabus proposals will be made. Text and workbooks with electronic interactive versions will be produced in all languages of the countries involved. Interactive web sites and virtual simulation tools and labs easily addressable from any school will be established. Two international conferences will be held as well as a number of meetings, workshops and courses for schoolteachers and contests and activities for school students.

Keywords. Elementary Optics, Primary School.

Chladni Plates: A Hands-on Energy Activity

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Abstract. The effective learning of Science and Technology requires the use of many tools, being one's own observation and experimentation essential in any case. Both are the main features in current interactive museums and it seems appropriate to use the resources of this informal learning in the educational institutions itself in order to present new ways of seeing things. In this essay are shown the most important results of the set-up of an interactive museum in a teaching centre, which had about thirty specifically designed, manipulative and stimulating modules and in which the pupils/monitors carried out at the same time experiments and support tasks during the development of the planned visits. To illustrate the carrying-out process, one of these modules

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related to the well-known Chladni plates is analysed in detail.

Keywords. Chladni Plates, Hands-on Science, Science Education, Science Museum.

1. Introduction

The success of interactive Science and Technology museums from the end of the 20th century is made evident in the wide range currently available, the majority of them being the successors of the San Francisco Exploratorium [1], with one of their basic suppositions being that the visit should be a time of playful learning. The basically manipulative format of these centres fosters an interrelation between the series of concepts and ideas that are brought into play and the visitor, something that is not usually achieved in expository collections of traditional museums. The manipulative experience that interactive museums provide is essentially based on the appropriate combination of arousing curiosity and intrinsic motivation, the use of play and exploration, the use of different modes of learning (cognitive, psychomotor and emotional) and the support of the visitor's mental models and knowledge [2].

This interactive museum model can be brought into [3-4] the formal world of teaching taking advantage of the vast amount of information that currently exists concerning experiments that can be simply carried out [5], which allows for demonstrations and mini-experiments to be carried out in the classroom, during usual explanations or in a wider context, grouped as an interactive exhibition. The latter activities involve the students to a greater degree than during normal classes, thus reinforcing class work as it allows personal use of the concepts using every-day materials and relating them to usual technological applications [6]. In this case, the teachers and students were responsible for the tasks of designing, building, assembling, organization and the carrying out of the experiment, thus increasing collaboration and their creativity between them. This process, as in all scientific work, requires ample knowledge of the pre-existing ideas and the capacity to adapt, improve and modify them in varied ways, an essential role which is developed by the teacher [5]. On the other hand, the pupil on building his/her manipulative model gains a deeper and fuller knowledge of the concepts involved.

In this essay, we present the most noteworthy results obtained during this experiment at the Escolas Proval Secondary School of Nigrán (Spain). The benefits, potential and general difficulties associated to the process become evident through the detailed analysis of one of the manipulative modules.

2. Energy in your hands

As a natural continuation of the experiment previously carried out [7], the assembly hall of the Escolas Proval Secondary School of Nigrán (Spain) again turned into a small interactive museum [8] in which about thirty manipulative modules with their corresponding self-explanatory panel allowed the visitors to carry out activities, collect evidence, select options, form a conclusion or test their abilities [9], searching on the one hand for a balance between potential enjoyment and learning and on the other hand, combining the formal contents of a classroom with the exhibition itself. The materials used, which had not only qualitative but also quantitative aspects, were simple, inexpensive, accessible, easy to assemble, transportable and easy to handle, appropriate for all ages and any level of knowledge. The self-explanatory panels which accompanied each of the modules attempted to be visually attractive, with short/simple instructions/explanations which had the aim of guiding the previous knowledge of the visitor, prompting the visitor to explore for him/herself, to generate new questions, find the answers to those questions and to make more real the concepts involved.

This was accomplished by making the visit a multi-sensory experience, stimulating the understanding of the contents which were brought into play, providing the opportunity to not only participate with their hands but also with their senses and minds and relating the contents with previous experience, their daily life and the contents of formal learning. Several pupils also carried out monitoring tasks during the exhibition (in some cases due to security reasons) with the aim of guiding the visitor to achieve an enriching experience and to avoid mere compulsive manipulation or the visitors becoming a passive recipient of information.

Figure 1. Hands-on Energy exhibition

Figure 2. Hands-on Energy exhibition

As a connecting link for all the modules developed, the energy involved in different processes was adopted, possibly one of the most universal and interdisciplinary scientific concepts, which has an important role in numerous areas of Science and Technology and its properties explains to a large degree the world which surrounds us [10]. In this manner, the visitor could experiment, in combination with other concepts brought into play, with the energetic level of different processes (noises and decibels, radiometer, pressurized rockets, hydraulic lifts, lights and consumption…), analyze thermal properties of different materials (avoidance of burning paper, burning an almond, does metal burn?...), see several energetic relations (magnetic brake, bicycle wheel…), generate energy (human battery, electric motor, thermoelectric helicopter, lead battery, Van de Graaff…), use their energy to provoke perceptible changes (spring, sonorous tubes, resonant springs, chaotic pendulum…), etc…

3. An example: Chladni Plates.

The waves that surround us everywhere are at the same time a paradigm of energetic propagation in space. Its study is a fundamental basis of formal curriculum in a large number of scientific-technological subjects, in which the involved concepts are tackled from several perspectives and in differing depths. The Chladni plates [11-12], an ideal complement for traditional one-dimensional introductory experiments on strings and springs, allows the creation and experimentation with stable waves in two-dimensional mediums, making visible in a spectacular and comprehensible way that which is apparently invisible and thus avoiding a good many conceptual errors deeply rooted in the related contents [13]. Traditionally a metallic oscillating plate is used with its edge free and a fixed point onto which fine grains of sand or something similar is placed on areas of the plate that do not vibrate to create beautiful complex but symmetrical patterns, similar to those formed on percussion instruments of membrane. These stable patterns known as vibration modes and associated with an audible frequency, are explained as the interference of reflected and transmitted waves in which the distance between the node lines (which joins points without movement) are directly related to the length wave of the travelling wave on the plate.

Normally, the manual stimulation of the stable wave is carried out using the bow of a stringed-instrument (violin, violoncello, double bass,…) or a similar substitute (for example, a saw for metal in which the blade has been replaced by several nylon threads [14]) which requires certain skill and training. The delicate process can be made simpler if we replace human intervention with an electronic or acoustic stimulator [15], in which case patterns are achieved at any moment without hardly any previous practise, the range of frequencies can be used to create patterns and the transition between consecutive vibrating modes can be quantified. As a measure of precaution it is advisable to use earplugs as the most spectacular results are achieved with certain irritating tones.

Figure 3. Working with the Chladni plate

4. Experimental assembly and results

Today it is possible to do the same experiment with less effort by using an electronic generator of waves and a loudspeaker instead of a violin bow. Although there is commercial equipment with all the necessary material, including plates of different sizes and geometry [16], we have tried to use common and inexpensive elements which are easily accessible in any teaching centre, such as a sound amplifier and a loudspeaker sound box.

Our experimental setup consists on four main elements:

1. Signal generator. We used an electronic signal generator with the following characteristics: sine, square and triangular waves, adjustable output level (with attenuators to allow a wide range of levels), continuous adjustable frequency and different scales (10-100-1K-10KHz minimum), digital frequency meter. This element is very important, since an exact measurement is needed to find the resonance frequencies of plates and to be able to repeat the experiment again in the same conditions. This kind of signal generator, however, is very common in electronics and physics laboratories.

2. Sound amplifier. It could be used almost any available sound amplifier. We used a music amplifier with an output power in the range 20-50W.

3. Loudspeaker (acoustic box). We used an acoustic box with one loudspeaker covering the whole range of frequencies. It could be used a common acoustic box like those of hi-fi music systems, home cinema or similar. The loudspeakers should have a nominal power enough to be connected to the amplifier without risk of damage. It could be used only an speaker without acoustic box, but we preferred this by two reasons: the box itself can be used as an stand for the experiment and at low frequencies the front and back waves of a speaker can interfere, reducing the available power. In our experimental setup the acoustic box is placed in a horizontal position, and serves also as a fixing point for the Chladni plate. So it should be large enough to hold the plate and fixing elements.

4. Chladni plate. We used a square aluminium plate of 60x 60cm, with a thickness of 3mm.

The assembly can be made in two steps:

1. Electronic connection: the signal generator is connected to the power amplifier by a coaxial cable with a BNC connector in one side and a jack or RCA connector in the amplifier side. In some cases, this cable should be made if not available. The amplifier is connected to the loudspeaker by a two wire cable (this cable has no special requirements but a certain minimum diameter).
2. Mechanical assembly: This part is a little more difficult. The aluminium plate should be firmly kept in place over the acoustic box, but at the same time we can only fix it by a few points (typically only one in the centre of the plate). So it should be used a strong screw or piece of metal. In our case, we used as fixing point the grid that protects the loudspeaker, making sure the plate was exactly over the speaker to maximize the acoustical coupling between them. This kind of assembly is different from the most common ones, in which the central fixing

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point is attached to the speaker or mechanical vibrator. In our case the fixing point becomes a node instead of a vibrating point.

Another important difference is the way of energy transfer to the plate, in our case the transfer is by acoustical coupling (i.e. through the air) while the most common method is by mechanical transfer with a coupling element. This kind of coupling can result in a loud noise while making the experiment, what is a little disadvantage, but on the other hand the mounting is easier and more resistant, and there is no need to use a special (and expensive) mechanical vibrator. When all the elements were connected and assembled, we started making trials to locate the resonance frequencies of the plate and get different patterns. We had to adjust both frequency and sound level, since the overall response of the system (generator-amplifier-speaker-box-plate) widely varies with frequency. Every resonant frequency found was carefully registered to be able to repeat the experiment another day. We found many different patterns, from the simplest to very complex ones. For developing the patterns we used beach sand.

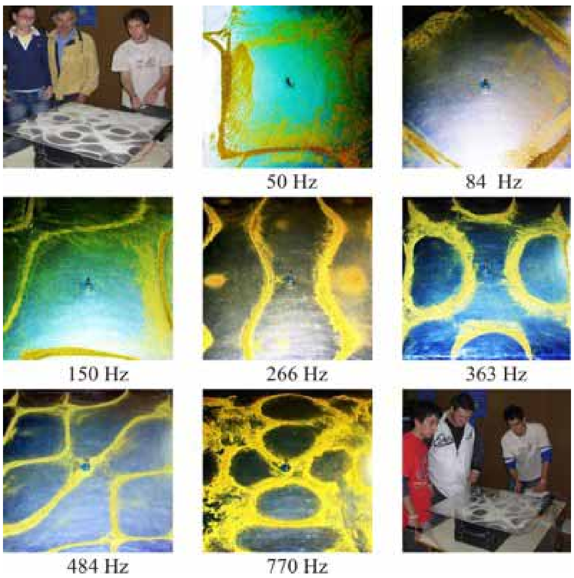

Figure 4. Chladni figures at different frequencies

The educational possibilities for widening the field of performance once the basic experimental assembly has been set up are numerous and varied as the vibration patterns depend on many variables. Thus, node lines can be forced in certain areas of the plate by direct contact by the experimenter or with a certain weight or by changing the support point; changing the materials (type, colour, size) used to see the nodes (including antinodes [17]) (sand, sugar, salt, small pieces of paper, aluminium powder, silica beds, talcum powder... [18]; or by varying the actual features of the oscillating plate (metallic or transparent [19], its thickness, geometry…).

5. Conclusions

The results obtained during the experiment of setting up a small interactive museum with the theme of energy are highly satisfactory: the exhibition received during the week that it was running over five hundred pupils from five secondary level teaching centres. This same exhibition was later set up in other centres of the immediate surroundings. At the same time, the experience has encouraged the pupil’s creativity and a reliable manipulative approximation towards Science and Technology in the pupils directly involved. The high level of involvement with the experiment is made apparent in their wish to carry out similar experiments a posteriori.

The experiment analyzed related to the Chladni plates demonstrates the potential and versatility of manipulative experiments as a learning tool. As improvement for this experiment we are planning to use a computer generated waveform to drive the sound amplifier. It could be done with a simple PC with a sound card and a program that we have already written to adjust frequency and level. This kind of program can also be found in several internet places, and eliminates the only element that some schools could not own, that is the signal generator. Finally, it is possible to make a specific amplifier for the experiment using common electronic circuits like TDA2050, whose schematics and PCB could also be found in internet.

6. Acknowledgements

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Density of Liquids by Measurements in Pressure Differences

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Abstract. A new procedure to measure liquids densities is presented. Assuming an equilibrium hydrostatic and ideal behaviour of the air closed in a tube connected to manometer, the method allows us to establish a linear relation between the closed air pressure difference with respect to the atmosphere and the vertical penetration depth of tube in liquid. In applying the procedure to water, density values are obtained at several temperatures.

Keywords. Liquids Densities, Manometer, Pressure Difference.

1. Introduction

We describe an experimental device allowing determinations of liquids densities. Under certain conditions, a linear dependence exists between the pressure difference in the air trapped in a tube connected to a manometer and the depth this tube is penetrated vertically in the liquid.

2. Materials and method

The manometric tube open at the bottom is placed vertically inside other jacketed tube, in order to study changes with temperature. The liquid whose density is required goes up inside the jacketed tube by means of a peristaltic pump. This pump must work slowly so only under this condition the hydrostatic equilibrium can exist. The heights of the liquid level inside this tube and the manomentric tube are denoted respectively by x and x′.

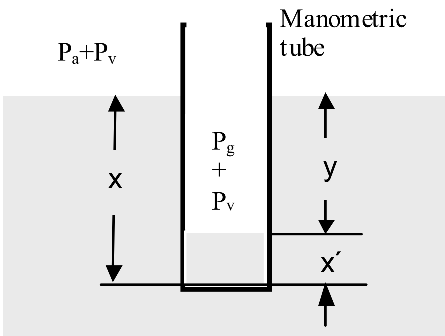

Figure 1. Liquid free levels

In the manometric tube the closed air is continuously compressed due to the rising of the liquid level and so a pressure difference ΔP with respect to ambient pressure (P_a) is generated. ΔP is measured by an electronic manometer provided with an analogical output. The pressure inside the manometric pipe is the sum of the dry air pressure (P_g) and the vapour pressure of liquid (P_v), at the considered temperature. Assuming an ideal behaviour for the closed air and given that the process is developed at constant temperature, from the Boyle´s law together with the fundamental equation in Statics of Fluids it follows

$$\Delta P - P_v = \Delta P^* = +\rho g\left[x + L\frac{P_v - \Delta P}{P_a + \Delta P}\right] \qquad (1)$$

where the liquid density is denoted by ρ and being *g* the acceleration due to gravity and L the length of the manometric tube. Introducing ΔP*= =ΔP-P_v and taken into account that P_a>>ΔP, the last equation reduces to

$$x = \left(\frac{1}{\rho g} + \frac{L}{P_a}\right)\Delta P^* = m\Delta P^* \qquad (2)$$

showing a linear dependence between x and ΔP^* and where *m* denotes the slope value, obtained from the fitting of experimental points [x, ΔP*]. From *m* we can reach ρ.

3. Results and conclusions

As an application of the above model, the water density was measured at different temperatures over the range [10,50] ºC. The analogical output of the manometer was connected to the multiplexed input of a Keithley 2700 multimeter, where a thermocouple probe was connected also for a thermally following of the process. Via a RS output the multimeter was connected to a PC for the data processing. In the considered range the linear relation (2) was accomplished. Table 1 illustrates the m values and the corresponding density values for the water. In all cases the correlation coefficient was above 0,9999. The results cited in literature [3] point out to a thermal derive, not foreseen in our model, being necessary its consideration if we wish useful results. With respect to reference values, it was estimated a subtractive four degree polynomial correction to improve results, giving values ρ* (Table 1) according with bibliography.

Table 1
Water density obtained at several temperatures
Pa= 756,9 mmHg, L=134,1 cm, g=981 cm/s²

Temp.±0,1 (ºC)	m ±2×10⁻³ (×10⁻³ cm²s²/g)	ρ ±0,002 (g/cm³)	ρ* ±0,002 (g/cm³)
50,0	1,165	0,985	0,988
40,0	1,142	1,007	0,992
30,0	1,120	1,030	0,995
20,0	1,100	1,051	0,998
10,0	1,090	1,062	0,999

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A Space Education Hands-on Experiment Using the Principle of Action and Reaction in Elementary School

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Abstract. This work explores results of a research involving elementary school students, aiming to motivate and use elements of space exploration with the purpose of helping the understanding of a specific physical principle and of contributing to the dissemination of knowledge on astronautical activities. Twelve students and two teachers of elementary public school participated in the experiment applying the hands-on methodology in the reconstruction of the Principle of Action and Reaction. The results allowed inferring that the realization of experiments in space education contributes to the teaching/learning process of concepts of science, technology and related fields in an interdisciplinary, meaningful and contextualized approach.

Keywords. Science teaching, space education, Astronautics.

1. Space exploration in Brazil and in the world

The dream of reaching the skies is one of the most ancient mankind's desires [1]. Astronautics, that is, the manned or unmanned exploration of outer space represents one of the most recent sciences and practices in the history of science and technology. Space Era has begun in the context of cold war between the United States and the former Soviet Union and it started when the first satellite constructed by man – the Sputnik I was launched by the former Soviet Union, in October 4, 1957. After that plenty of spaceships, probes, satellites, space stations, space telescopes and other artefacts have been launched to space with a wide range of purposes.

The benefits derived from space exploration are accounted in diverse areas: telecommunications, medicine, environment monitoring, general research in science and technology. According to Haggerty [2] the benefits resultant from space exploration, or spin-offs, are found in the development of rescue equipment, entertainment products, special clothing, prosthesis material, water purifiers, robotic, superconducting materials, optical fiber and other applications of great economic and social impact.

Being a continental-sized country with a large variety of natural resources, early Brazil became aware of the importance of developing national space products, processes and services for its socioeconomic progress, conducting since the 1960's space activities with the creation of the Aerospace Technical Center (CTA) in 1954, the National Space Research Institute (INPE) in 1971, and the Brazilian Space Agency (AEB) in 1994.

In 1993 it was launched the First Data Collecting Satellite (SCD1) by the American Pegasus rocket and Brazil became the 16th country in the world capable of designing, developing and operating a space platform [3]. Furthermore, Brazil and China are partners in the development of the series of remote sensing satellites CBERS (China-Brazil Earth Resource Satellite). Brazil has also the Alcantara Launch Center (CLA), a privileged center on the Atlantic coast outside of Sao Luis very close to the geographic and magnetic equator of Earth.

Recently, as part of the upcoming centennial year celebration of the flight of Santos Dumont in his 14 Bis, the first Brazilian astronaut and cosmonaut Marcos Cesar Pontes has gone into a space mission to the International Space Station (ISS) and there developed scientific and educative experiments.

2. Space Education

Space science and technology education consists of a singular nature tool capable of offering students an integrated and global understanding of scientific and technological facts and phenomena. It can represent the motivation of the curiosity and interest of the students on processes, products and services derived from space environment exploration so that offering an interdisciplinary understanding of science and technology along with the manner they affect daily life. In this perspective space education contributes with the teaching/learning process in science, mathematics and technology [4].

Space exploration and its outspreads are transformed in the axis from which it is presented scientific, mathematical and technological contents. This theme may be the starting or reaching point from which it is developed the pedagogical classroom work. Hence, space education has the potential to be helpful in the scientific literacy of elementary school students, taking into consideration the fact that in the first years of schooling the interest for sciences and technology is captured and it is consolidated the first scientific models and conceptions.

Space education somehow began when the professional staff – composed by doctors, masters, and specialists – necessary to the development of the first space activities were constituted.

Nevertheless, only in the 1990's it has been recognized the necessity of working knowledge and practices of space education among teachers, children and teenagers in elementary and secondary school, in spaces of formal and informal education, aiming to contribute to scientific and technological preparation of students as well as to disseminate the consolidated space programs, their careers and socioeconomic benefits.

On the other hand, presently there is a large variety of space education programs around the world. It can be mentioned countries such as the United States, Russia, Canada, Japan, France, Brazil, Israel and so on.

We can illustrate with the NASA's Program for Education [5], from the American space agency. It reaches great successes in offering activities and resources for both students and educators in formal and non-formal educative spaces for all educational levels. Courses for students and teachers on space subjects, workshops, lectures and visits to space centers, distribution of printed and on-line material are some actions of the Agency. NASA has also several links in its home page (http://www.nasa.gov) related to education.

Additionally, there are international initiatives such as the International Space Week (http://www.spaceweek.org), reaching space education organisms from over 50 countries, consisting in the largest public space event in the world, promoted by the United Nations since 1999. UNESCO by its turn has launched its space education program in the year 2002. There is also the Globe Program, a NASA initiative involving more than 100 countries, about 24 thousand teachers and 14 thousand schools consisting of a scientific education hands-on program for initial and intermediate level students, in which teachers go into training and students realize scientifically valid measurements and report it to scientists and international colleagues through internet.

In Brazil, there is a program named AEB School, which develops a series of activities and events aiming to spread the Brazilian space program and to motivate young students towards science and technology.

In 2004 and 2005, the Brazilian Ministry of Education (MEC) in partnership with the Brazilian Space Agency (AEB), in occasion of the National Week of Science and Technology promoted courses on "Remote sensing – the use of satellite images as didactic resource in secondary school" in five Brazilian capitals.

In accordance to these tendencies and initiatives, the United Nations Office for Outer Space Affairs emphasized on occasion of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), realized in Vienna, 1999, the importance of working space sciences and technology education in schools as development factor for the nations, hence, according to the conference papers, "Education and training in space science and technology can provide many developing countries with opportunities to modernize and pursue a more dynamic development" [6]. Space education has been regarded as a vehicle of approaching children and teenagers from careers in science and technology.

3. Some basic notions on Astronautics

Astronautics is the science and practice of extra-atmospheric or outer space exploration by manned or unmanned artefacts developed by human beings. Following it is presented some concepts and basic notions of Astronautics present in the astronaut's life in outer space.

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3.1. The outer space environment

Outer space is the space surrounding the uppermost reaches of the atmosphere of Earth and where we can find all objects of the Universe [7].

Although being a void this space can be thought as an environment through which it pass freely radiation and objects. For many reasons, it is an inhospitable environment for human life. One of its characteristics is the nearly complete absence of molecules so that density is so reduced that they can be inconsiderable. On Earth the atmosphere exerts pressure in all directions. At sea level pressure is of 101 kilopascals whereas in space it is nearly zero.

The temperature range in space is also one of the main constraints for human life in such environment. In space, at an Earth's distance from the Sun the sunlit side of the objects can climb to over 120º Celsius whereas the shaded side can plummet to lower than minus 100º Celsius [7].

Other factors encountered in space environment include weightlessness, electromagnetic radiation that is not filtered by atmosphere (as the ultraviolet), meteoroids and debris from previous space missions.

3.2. Working in space

One of the characteristics of space environment is weightlessness experimented by astronauts and objects carried inside the spaceship. This weightlessness can be explained by the fact that as rigorously we do not have "sensors" which allow us to evaluate the weigh force we perceive it through the inner efforts we face in daily life.

For instance, we can imagine ourselves on feet in a bus stop. Earth's gravitational field exerts a force named weigh on all particles that constitute our body. As we are stopped over a resistant surface we do not submerge in the direction of the center of Earth, but our body is comprised, which causes an inner effort of compression equivalent to our weight, which gives us a null resulting acceleration. So we have the perception of this compression that has the same value of our weight, so that we can feel it.

Hence whether we consider an individual moving under the action of its own weight only (without any inner effort) he will feel "zero weight" This happens during freefall or during a trajectory as the one described by the projectiles or in any orbit described by space vehicles.

Here on Earth, to lift or move an object, one should be with their feet firm on the floor and need to subdue the gravitational force which acts on the object in order to develop the task. In space, due to the sensation of imponderability the objects can be easily moved but the astronaut must have a platform capable of offering him enough resistance to overcome the inertia of the object to be moved.

Figure 1. Astronauts working in space

Also on Earth surface, boxes placed on over another present friction caused by compression of their surfaces of contact which must be subdued for that they can be moved one in relation to the others. In the environment of a space vehicle, these same boxes do not comprise and the friction does not have to be subdued to move them. Certainly their inertia will not change but due to the absence of friction, it is quite easy to push them softly in the space environment.

As a result and considering that in space it is also valid the principles of quantity of energy and movement, and in spite of the weight an object presents on Earth, when in orbit, one single crewmember can move and position it easily provided that he has a stable platform from which to work, with enough inertia and capable of offering the necessary support for the execution of the tasks. On the other hand, the apparent imponderability can also make it difficult the astronaut activities, depending on the inertia of the platform to which he is connected.

Hence, standing on a platform such as a spaceship – of great mass and inertia – the astronaut can realize tasks impossible to be realized on Earth, because of the weight of the objects involved. Nevertheless, if the astronaut is not on a stable platform of reasonable mass and inertia, such as a space shuttle, to push an object provokes the flotation of object and crewmember in opposite directions [7].

Therefore, considering that in his activities the astronaut does not always have a stable platform to stand on, simple tasks, such as using a tool or pushing a glass, in space, can become complex, for both the tool and the glass and the astronaut can undesirably move, fact that demands him exhaustive trainings for that with complex and combined movements he is capable of transmitting the desired moves to the objects and tools.

4. Actions and reaction and astronautic activities

The experiment in space education has been applied in an elementary school classroom (fifth grade students), with the purpose of applying and explaining Newton's Third Law, the Principle of Action and Reaction and of establishing a connection with work and life of astronauts in space. It has been adapted from a study topic named *Spinning Chair* which refers to movement in space, as described in the activity NASA book *Suited for Spacewalking* [7] a didactic manual published by NASA which deals with concepts and experiments related to space activities and involving contents in sciences, technology and related fields, based on the activities developed by astronauts in outer space. The experiment has been divided into two activities aiming to reconstruct the Principle of Action and Reaction.

The materials used in the first activity were the following:

a) 01 spinning chair without back;
b) 02 objects for hands (sandbags), about 2 kg each.

Initially, students have been accommodated in a circle with the chair at the center, with a space left for that the students could move with the chair.

Figure 2. Student realizing the spinning chair experiment

The teacher explained that they should attempt to move in the inner of the circle and in circular movement but without stepping on the floor neither upholding on the wall. For that they should produce with the body movements that could cause locomotion. In the sequence students have been asked individually to develop the activity and received two objects two kilograms each to help them achieve some movement. After some attempts they have realized that a certain pendulum movement allowed the circular movement.

Figure 3. Student tosses the bags to move

The second activity had the purpose of consolidating knowledge explored in the preceding activity and has been realized as follows: students individually received a rubber balloon, filled it with air and after that they had been oriented to release it and notice the movement realized by the balloon and by the air inside of it. In order to illustrate the Principle, the teacher filled one balloon with air and explained that as the air inside the balloon exerts a force against its inner surface this surface also exerts one force that maintains

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the air compressed inside of it. Hence, when the balloon is released, the air pushes the balloon and it pushed the air, simultaneously.

Figure 4. Student doing the balloon activity

In the sequence it has been conducted explanation on the daily astronaut activities in space, with presentation of pictures allusive to the work of these professionals to better illustrate the theme.

To conclude and record some of the results of the experiment, each student presented by means of a previously elaborated questionnaire for collecting data their impression about the activities: comprehension, facility, meaning, satisfaction, interest, and so on. Besides it has been realized and recorded an interview with two persons involved in the experiment: one teacher and one student.

5. Results

Considering classroom observation and the collected answers, generally speaking, it has been realized that the participating students felt difficulty during the prescribed and experimented locomotion. Furthermore, although they had received some notion about the Principle of Action and Reaction they thought it a little strange the fact that as they were pushing the wall, it would be pushing them too; that as they jump on the floor, so that exerting a force in direction of the center of Earth, the planet would be pushing them in the opposite direction, with a force of the same intensity.

It has been also verified that the majority of the students involved in the experiment were not familiarized with space thematic, since according to students' reports, such subjects have not been presented in any scholar subject. In the fifth grade students studied some concepts and theories in astronomy but the thematic of space exploration was not discussed.

Considering the twelve questionnaires answered by the students and the two interviews realized it has been possible to infer that students had satisfaction in realizing the experiments and they could establish relation among them and the space activity, demonstrating understanding in various levels of the physical concepts involved. From the sample researched, half the students supplied reasonable explanation for the Principle of Action and Reaction, that is, spontaneous deductive explanation related to sensorial perception and to visualization as in the case of the balloon activity. Additionally, it has been evidenced that for these students it has been more difficult to understand the fact that as one jumps on the floor, Earth exerts a force of the same intensity but opposite direction.

Figure 5. Students fill in the questionnaires

ITEMS	ANSWERS (%)			
	Yes	No	No Answer	Other
Facility	84	8	8	0
Comprehension of the principle of action and reaction	75	8	17	0
Importance	67	0	25	8

Table 1. Student's answers to the questionnaire. Source: Table elaborated from questionnaires applied in Paraná State public school (Brazil)

Additionally, 75% of the students stated that the activity was viable and easy to realize. Some student's reports:

"Is has been good";
"Because you just needed to give the impulse";
"You just need to toss the objects back and then you have the impulse".

About the utility, 75% stated that the experiment has helped in the understanding of the principle under study and from this number, 16% gave a justification for their answer. It has been asked that students related what they liked the most in the experiment. Some answers:

"To push the chair",
"To move backward and forward the objects",
"To release the balloon and explode it".

When asked about what they did not appreciate in the activity, they referred to the moments of pushing the objects. According to the teacher interviewed, Brazil has much yet to do about space matters in classroom and students do not have the opportunity of thinking beyond their immediate world. One of the difficulties pointed out by the teacher on the completion of the experiment by the students has been motor coordination question.

The report of the student interviewed has confirmed that her greatest difficulty has been to move by the impulse of the objects. She stated she had never studied space exploration in some school discipline but considered the subject important and interesting.

6. Conclusions

Activities in space education can be characterized as experiences rich in meaning and which contribute to the process of learning and teaching of contents in science, technology and related subjects. The experiment developed has privileged the ludicity and interactivity, to that motivating the study and active students' participation along the activity, possibilitating that the Principle of Action and Reaction could be experimented and would have good receptivity by the involved people.

The option to realize one experiment related to Astronautics, besides facilitating the assimilation of the Principle of Action and Reaction, has allowed the realization of a discussion on subjects correlated to space exploration such as the astronaut career and the Brazilian space activities. It has been realized that the space thematic although seemed strange at first glance fascinates students who, among other factors, find out that there are people living and working outside the Planet in reduced scale ecosystems that are spaceships or space stations.

Finally, this hands-on experiment contributed indirectly in the demystification of space careers such as the ones of astronauts, scientists and other professionals of space field opening up the possibility of awareness about the activities of the Brazilian space program.

7. Acknowledgements

The authors are thankful to the critical reading and suggestions presented by Professor Pedro Sérgio Baldessar, from Federal Technological University of Paraná (UTFPR).

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Particle Physics Goes to School

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Abstract. With the Hands on CERN project students can approach the physics frontline in the classroom. They can interactively explore the building blocks and the fundamental forces in nature using real data from the DELPHI experiment at CERN, the European particle physics laboratory, and get close to a modern scientific experiment using the same scientific information as the scientists. Hands on CERN has been translated to 15 European languages including the two original languages, Swedish and English, and has become a European-wide used education project.

Close to 60 European particle physics institutes and altogether 6000 students from18 countries participated in the successful European Masterclasses 2005 and 2006. Most of the participating groups used Hands on CERN to explore the fundamental particles and processes of microcosm in this genuine European-wide physics education event.

The hands on CERN project demonstrates an innovative way of introducing particle physics in the classroom. Combined with classical school experiments it can form an attractive course in modern particle physics.
Keywords. Particle physics, House of Science, Masterclasses, ATLAS.

1. Introduction

Particle physics is dominated by large accelerators, kilometres in circumference, and detectors large as multi-storey buildings, making particle physics experimentation in the class room very difficult. The web based Hands on CERN education project tries to remedy this by making particle collisions from the Large Electron Positron Collider available at school. With the Hands on CERN project [1,2], using digitised scientific data transmitted via Internet, schools can approach the physics frontline in the classroom. Students and teachers are able to explore the same scientific information as the scientists. The primary aim is to explore quarks and leptons, the fundamental building blocks of nature, and the fundamental forces in nature embedded in the Standard Model of microcosm.

2. Experiment and particle collisions

The particle collisions are used to explore quarks and leptons. Some of these only existed naturally at the very beginning of the Universe, but are now produced in high energy collisions at a few large physics laboratories. The experimental data are from the DELPHI experiment [3] at the Large Electron Positron Collider (LEP) at CERN, the European particle physics laboratory [4]. With the 1500 events, quarks, leptons and gluons, the mediator of the strong intereaction, and the decay of the heavy Z^0 and W particles, the mediators of the electroweak interaction, can be studied.

3. The Education material

The education material is composed of the 1500 events and the 3D event display of particle collisions, and background material about the Standard Model of microcosm and accelerator and detector information. In addition there is a program with which one can interactively play with quarks to construct particles and compose Feynman diagrams [5].

4. The particle events

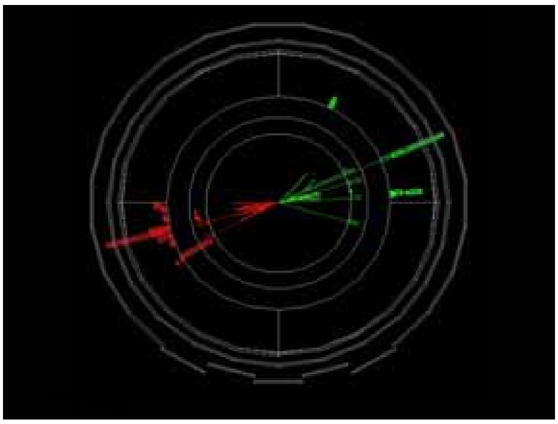

Figure 1 Two-jet event. The production of a Z^0 particle decaying into a quark and an antiquark giving rise to two jets of particles deposing their energy in the calorimeters (rectangles)

At a collision energy of 91 GeV a Z^0 particle is produced. It rapidly transforms

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/decays/ into a quark and an anti-quark or a lepton and an anti-lepton, where the lepton is an electron, a muon or a tauon. The quark gives rise to a jet of particles (Fig. 1). One of the quarks can radiate a gluon, the mediator of the strong interaction, and give rise to a third jet of particles. The probability for this to happen is proportional to the strong coupling constant, α_s. The two-jet and three-jet events are used to determine the value of the α_s. At a collision energy exceeding 160 GeV two W particles can be produced. The decay of these particles give rise to rather complex events.

5. Projects for students and teachers

Several research projects have been organised for students and teachers using the Hands on CERN education package. At school the education project can be used from about an hour (study a few events and learn about quarks and leptons) to a day (explore a large number of events, study the Standard Model, determine the strong coupling constant and use the Fireworks of particle physics to construct particles. It has also been used in research schools for students at Science Laboratory and House of Science (Fig. 2) [6, 7] and the European Masterclasses 2005 and 2006.

Figure 2 Research class students at House of Science working with Hands on CERN

5.1 Research schools

During a two week course in astronomy and particle physics the 17 – 18 year old secondary school students studied the intricacies of high energy particle collisions and the origin of Universe [6]. Examples of the different type of events are shown in Fig. 1. The first task was to classify the material according to the type of event that had taken place: Z^0 decaying into leptons or into quarks. If the event was identified as a lepton event they determined if it was an electron, a muon or tauon event. The quark events were classified according to the number of particle jets. The dynamics of Standard Model were discussed and from the experimental data they could determine the strong coupling constant and compare it with electromagnetic and gravitational interactions.

5.2 Masterclasses 2005 and 2006

Close to 60 European particle physics institutes and 3000 students participated in the one day European Masterclasses 2005 [8] (Fig. 3).

Figure 3. Students at the National Technical University of Athens taking part in the 2005 Masterclasses

Many of the participating groups used Hands on CERN to explore quarks, leptons and the Standard Model of microcosm. For this event the Hands on CERN was translated to several new languages, and it now exists in 15 languages. During a Masterclass event, high school students visit one of the participating universities or research centres for one day, they attend lectures on particle physics and perform measurements on real data from particle physics experiments. The computer work was sometimes complemented by experimental work exploring the properties of the electron and studying cosmic radiation using scintillator detectors or cloud chambers. The participants also got the opportunity to visit the research groups and experience the research environment at the universities. The evaluation of the Masterclass event showed that an overwhelming majority (over 80%) of the participants liked the Masterclasses, and that between 75 and 85% of the participants learned a lot about quarks and leptons, particle detectors, general particle physics and particle accelerators. Because of the successful event in 2005 the Masterclasses were repeated in 2006 with the same number of participating institutes and students, also including a US laboratory.

6. International recognition

Hands on CERN now exists in 15 languages[1] including the two original languages (Swedish and English). In 2004 Hands on CERN has was selected a winner of the Scientific American Science and Technology Web award [9], and in 2005 it received the prestigious Webby Award in the Science category [10].

7. LHC and ATLAS

In the tunnel that housed the LEP collider until 2000 a new collider for accelerated protons is being installed – the LHC (the Large Hadron Collider). One of the large LHC detectors is the ATLAS experiment [11]. ATLAS will explore the fundamental nature of matter and search for new discoveries in the head on collisions of 7 TeV protons. ATLAS is a large collaborative effort by 1700 physicists including 400 students from more than 150 universities and laboratories in 34 countries (Fig. 4).

Figure 4 The ATLAS detector under construction at CERN. The man at the bottom of the photo indicates the scale of the detector

The website [11] describes ATLAS and makes a tour to the theory of particle physics, the accelerator and the detector. Web cameras situated in the ATLAS cavern, accessed from the front page of the web site, show the status of the detector installation. ATLAS information material like brochures, films and posters have been translated to different languages by members of the ATLAS collaboration. A variety of information material can be obtained via the website.

The ATLAS Student Event Challenge will use ATLAS data and build on the best practise of the successful QuarkNet [12] and Hands on CERN education projects. The ATLAS Student Event Challenge will be an innovative education project to enhance student education and will provide them with access to real and simulated data and the opportunity to participate in a real particle physics experiment.

8. Summary

With Hands on CERN students at schools and universities explore particle collision data from the DELPHI experiment. Hands on CERN complements the traditional way of teaching physics and introduces a normally rather inaccessible experimental subject at school. Combined with classical electron experiments and explorations of the cosmic radiation it forms an attractive course in modern particle physics. The attention that Hands on CERN and the Masterclass events have received, shows that unconventional teaching methods can be very appreciated and that today's scientific experiments like the ATLAS experiment and other experiments at the future LHC collider have a role to play also at school.

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Development of a Low Cost Digital Energy Meter

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Abstract. This paper presents a versatile low cost equipment that allows simultaneous display of usually required measurements in electric circuits, like true RMS (Root Mean Square) values of mains voltage and current, line frequency, power factor, active, reactive and apparent power, and energy.

The equipment is based on a microcontroller that interfaces current and voltage transducers through 16 bits sigma-delta ADCs (Analog to Digital Converters). The microcontroller controls the periodic acquisition of the measured signal waveforms, makes the respective calculations and presents the results on an alphanumeric display. The equipment also provides a serial port that enables the communication with other devices allowing the interface through a SCADA (Supervisory Control and Data Acquisition) system.

Keywords. Power and Energy Measurement, RMS Voltage and Current Measurement, Digital Measurement.

1. Introduction

Traditionally, in AC systems, electric voltage signals have sinusoidal waveforms that can be mathematically expressed as (1), where $v(t)$ is the instantaneous value at a time instant, t, V is the peak value of the voltage (voltage amplitude) and w is the angular frequency. The electric current represented by (2) is also a sinusoidal signal with an initial phase shift φ in respect to the voltage signal. The equation (3) expresses the relation between the angular frequency and the frequency, f, of the signal.

$$v(t) = V \sin(wt) \tag{1}$$

$$i(t) = I \sin(wt - \varphi) \tag{2}$$

$$w = 2\pi f \tag{3}$$

The line cycle period, T, is the inverse of the frequency (4).

$$T = \frac{1}{f} \tag{4}$$

Figure 1 shows a graphical representation of sinusoidal voltage and current signals with a $\pi/4$ phase shift between them. In this figure it is possible to see the amplitude and the period designated in boldface. In this figure Δt is the time shift between voltage and current signals and is directly proportional to the phase shift (φ). The relation between the time and phase shifts is given by the expression (5).

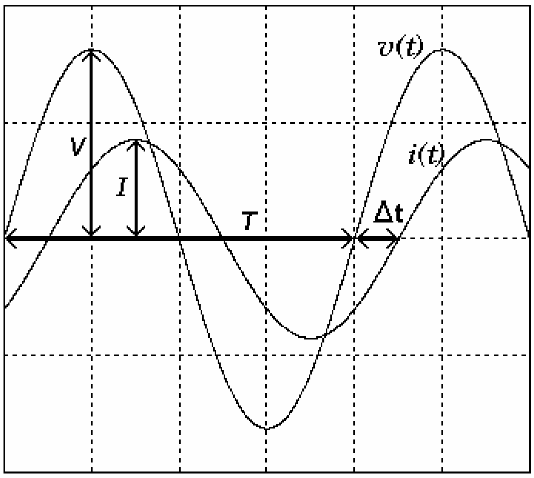

Figure 1. Voltage and current waveforms

$$\varphi = \frac{\Delta t}{T} \cdot 2\pi \tag{5}$$

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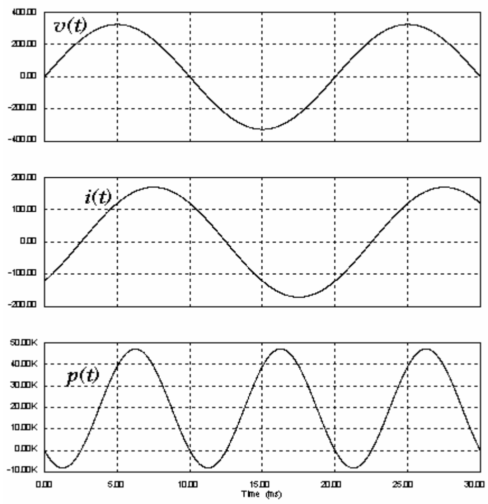

Figure 2. Instantaneous power

Electric power (6) is defined as the rate of energy flow from the source to the load at every instant of time [1] and is calculated by the product of the instantaneous values of voltage and current.

$$p(t) = v(t) \cdot i(t) \qquad (6)$$

Figure 2 shows the resulting power waveform for the voltage and current waveforms presented in the same figure, where $\varphi = \pi/4$.

According to the definition of electric power, the energy (7) can be achieved by the integration of power with respect to time [1].

$$E = \int p(t) \cdot dt \qquad (7)$$

Usually when dealing with electric signals, RMS and average values are used in detriment of instantaneous values. By definition, the RMS value of an AC electric signal corresponds to the average value that causes the same heat dissipation in a fixed resistor. The RMS values of voltage and current are calculated by (8) and (9).

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt} \qquad (8)$$

$$I_{RMS} = \sqrt{\frac{1}{T}\int_0^T i^2(t)dt} \qquad (9)$$

In Figure 3 it is represented the instantaneous value of a sinusoidal voltage and its correspondent RMS value, which is equal to the sinusoidal peak value (V) divided by $\sqrt{2}$.

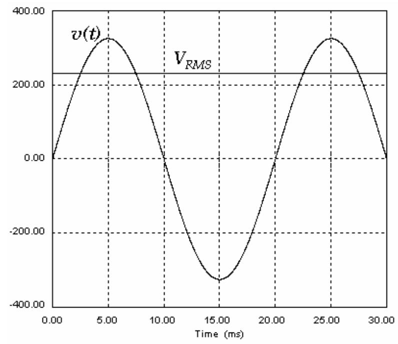

Figure 3. Instantaneous and RMS signals

The active power P corresponds to the average value of *p(t)* and is achieved by the expression (10). This parameter can be rewritten in terms of RMS values as (11). The reactive power Q is calculated by (12) [1].

$$P = \frac{1}{T}\int_0^T p(t)dt \qquad (10)$$

$$P = V_{RMS}.I_{RMS}\cos(\varphi) \qquad (11)$$

$$Q = V_{RMS}.I_{RMS}\sin(\varphi) \qquad (12)$$

The apparent power, S, is the product of the RMS voltage by the RMS current (13) and can be written in terms of the active and reactive power as (14). The quotient between active and apparent power gives the power factor (15).

$$S = V_{RMS}.I_{RMS} \qquad (13)$$

$$S^2 = P^2 + Q^2 \qquad (14)$$

$$PF = \frac{P}{S} = \cos(\varphi) \qquad (15)$$

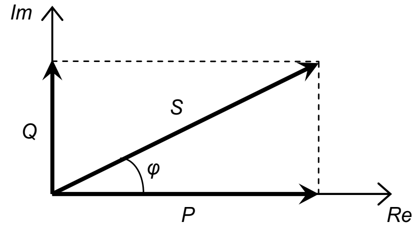

Figure 4. Electric power phasor diagram

In order to simplify electric circuit analysis, a graphical approach based on vectorial representation of the electrical signals can be used. Figure 4 shows the representation of electric power signals in a phasor diagram.

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2. Operation theory

In the previous heading, the relations between the presented electric parameters were introduced according to the IEEE standard definitions for the measurement of electric power quantities under sinusoidal conditions. In order to develop digital equipment, the analog electrical signals must be sensed, discretized and converted to digital values [2]. This operation is of most importance and requires some precautions. The equipment performance is very dependent on the accuracy of the voltage and current transducers.

In respect to voltage transducers there are two main solutions: resistive voltage dividers and voltage transformers. The first solution is usually the cheapest and with a correct selection of the employed resistors it presents better results. The second solution has the advantage of electrical isolation between the circuit under test and the equipment. The electrical isolation is an important factor for safe measurement of high voltages.

Concerning current transducers there are many options: current shunts are cheap and present good results; current transformers are a good solution that allow electrical isolation and enable the measurement of high current values with low power losses, but do not measure mean component values; Hall effect current transducers are very similar to current transformers with the advantage that they can be used in DC circuits; Rogowski coils also present electrical isolation and they are a good solution to a very large range of currents measurement, but are more expensive.

Normally the transducer prices increase directly with their accuracy. To make the choice of the correct transducer, parameters like the final equipment price, the equipment performance and the application range must be considered.

The equipment performance is also very dependent on the analog to digital conversion. The signal provided by the transducers is continuous in time and it is necessary to convert this to a flow of digital values. The resolution of the converter indicates the number of different discrete values that can be produced over the range of input values. A high resolution conversion means that the digital values are very similar to the analog values at the sample instant. The sampling rate defines the rate at which new digital values are sampled from the analog signal. In Figure 5a) it is possible to see the relation between the original analog signal *v(t)* and the acquired digital signal *v(n)*. In Figure 5b) the same analog signal is acquired with a sampling rate ten times higher. The result is that the digital signal acquired at a higher sampling rate is more similar to the analog signal.

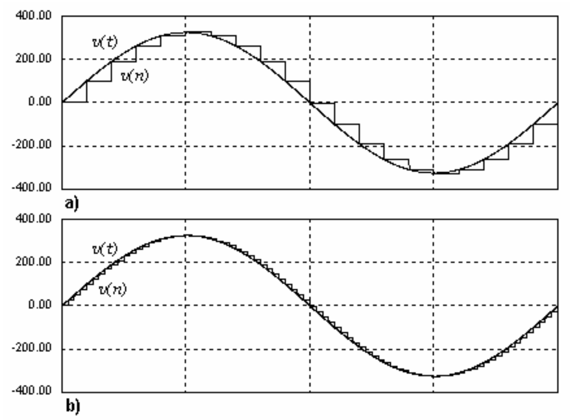

Figure 5. Effects of the ADC sampling rate: a) 1.000 samples/s b) 10.000 samples/s

To get a good performance, it is very important to use a high resolution ADC operating at high sampling rates.

Based on the acquired signals, the involved integral calculations presented in (8) and (9), are substituted by digital summations, according to the signal sampling rate. Therefore, the RMS values of voltage and current are now obtained by expressions (16) and (17).

$$V_{RMS} = \sqrt{\frac{1}{m}\sum_{n=1}^{m} v^2(n)} \qquad (16)$$

$$I_{RMS} = \sqrt{\frac{1}{m}\sum_{n=1}^{m} i^2(n)} \qquad (17)$$

According to previous introduced definitions, the instantaneous power corresponds to the product of the instantaneous values of voltage and current (18). The apparent power is achieved by multiplying the RMS values of voltage and current. Active energy and reactive “energy” are obtained by the continuous accumulation of the respective power signals.

$$p(n) = v(n) \cdot i(n) \qquad (18)$$

The line cycle period is achieved by measuring the time between consecutive zero cross detections.

3. Developed equipment

In Figure 6 it is possible to see a photo of the laboratorial prototype of the developed equipment.

The main device of the equipment is the microcontroller. It is responsible for the coordination of all other components. First the microcontroller executes the operations that allow the acquisition of the electrical signals to be measured. To perform this operation two high speed sigma-delta 16 bits ADCs are used to convert the signals obtained by the voltage and current transducers. After this operation, the microcontroller executes the necessary calculations to obtain the desired parameters, and finally performs the numeric to character data transformations to place the results in the LCD (Liquid Crystal Display) display. In Figure 7 it is possible to see a photo with the parameters that are presented in the LCD during normal operation.

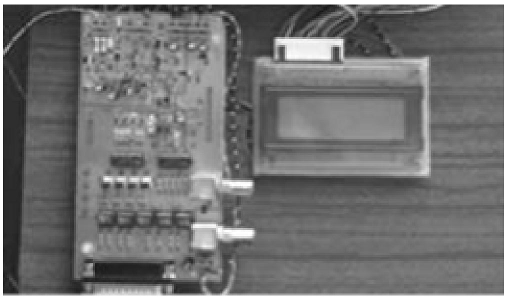

Figure 6. Digital energy meter prototype

Figure 7. Data presented in the display

In order to allow the interconnection with other computerized devices the equipment has a serial communications port. The implemented communication protocol allows two main operations: a calibration procedure and data polling. When in calibration mode, the microcontroller disables the normal operation of the equipment and allows read and write operations to the calibration registers. These registers are physically implemented in an internal EEPROM and allow the non volatile storage of gains, offsets and other constants necessary to normal operation mode.

When in normal operation, if the equipment receives a data request, an interruption is generated and the microcontroller responds immediately with the requested data. In Figure 8 is represented a communication frame according to the implemented protocol.

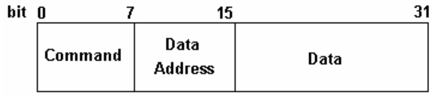

Figure 8. Communication frame

The field "Command" is used to indicate the operation that the microcontroller must execute. The field "Data Address" is used to select the parameter that is involved in the operation. Finally the field "Data" contains the information that affects the selected parameter. The "Data" field is ignored if no data is requested by the "Command" operation.

4. Conclusions

This paper presents a low cost Digital Energy Meter that allows the measurement of Power, Energy and RMS values of voltage and current. The equipment is based on a microcontroller that controls the signal acquisition and presents the measured parameters through an LCD display. In order to allow initial calibration and communication with other computerized devices the equipment has an available serial port.

In comparison to other measurement instruments the developed meter shows good results.

5. Acknowledgements

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On the Feasibility to Include Contemporary Science Concepts in the Primary School Curricula. A Retrospection into Two Case Studies

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Abstract. In contemporary knowledge conscious societies, the effective Science and Technology teaching is of paramount importance. One very significant parameter of an effective Science and Technology teaching is the actual syllabus involved in the school curricula. In general, the syllabus reflects the Science of the previous century. Very important Science advances like relativity, quantum mechanics, statistical physics, systems, etc are at most given a short simplistic description if not omitted at all. The reason usually quoted is that these issues are complicated and require advanced mathematics consequently they are beyond the capabilities of the students. We have challenged this widely apprehended doctrine by trying to teach the basic concepts of relativity and of systems to 5th and 6th grade students (ages 11-12 years). The results from these test cases were encouraging and have been already presented in the Hands on Science 2005 International Conference. In this work, we examine the two test cases from the viewpoint of the feasibility of a large-scale inclusion of contemporary Science concepts in the Primary school curricula.

Keywords. Science teaching, Primary school curriculum, Primary education.

1. Introduction

The contents of the Science syllabus in school curricula have a significant impact on the effectiveness of Science and Technology Literacy which is of paramount importance to the contemporary knowledge conscious societies [1]. For an adequate Science and Technology Literacy knowledge on contemporary Science concepts is necessary [2]. However, concepts like quantum mechanics, relativity of space-time, statistical physics, elementary particles and cosmology, materials science and solid state physics, radioactivity - even more traditional topics like (micro) electronics - and other recent developments are missing from school curricula although many of them are (more than) a century old.

One often quoted reason for this omission is the statement that these concepts are very abstract and difficult to understand, thus they are not appropriate for the Science syllabus in schools. . In this work we examine the validity of this statement which is (to our opinion) a widely accepted belief rather than an empirical fact

2. Methodology.

In order to test the feasibility of teaching contemporary Science concepts to students of the compulsory education we proceed as follows:

1. The basic notions from a selected contemporary Science topic were located and analysed. It is understood that the objective, for the compulsory education at least, is to teach the understanding of the basic notions of the selected topics and not the full functioning of the model with all the (complicated) mathematics.
2. A class (grade) from the compulsory education level was chosen as a test case for the teaching of the basic concepts located in the previous step. Grades 5 (age

10 to 11 years) to grade 7 (age 12 to 13 years) were thought appropriate. The reasons are: a/in a Piagetian context the students are old enough to be at the stage (or approaching the stage) of formal logic, b/they, usually, have not exposed to a systematic (analytical) Science course consequently they have not any representation related to the concepts to be taught (presumably – see next step).

3. The basic steps for a teaching intervention were planned.
4. Before the teaching intervention was actually delivered, a questionnaire was given to the prospective students. Its purpose was to locate the students' relative (pre) concepts on the subject to be taught and adapt appropriately the details of the teaching intervention. Possible influences of the society (in a Vygotsky's context) could also be traced.
5. The teaching intervention was delivered. This included at least two sessions of 1 or 2 teaching hours each separated by an interval of one or more weeks. At the last session a questionnaire was again given to the students.
6. For every one of the Science topics selected at the first step, a report with the outcomes from the questionnaires together with the comments of the teacher who delivered the teaching intervention (action research) was prepared.
7. The reports prepared at the previous step were analyzed by the authors of this work who had also been involved during the planning of the teaching intervention as 'councillors' on the didactics and on the subject matter of the topics selected.

3. Implementation

The whole work was organized within the degree dissertation course of the Department for Primary Education of The University of Crete. The choice of Grades 5 and 6 (ages 10 to 12 – primary school in Greece) as the classes for the test cases was a consequence. The reports prepared became (part of) the graduate dissertation of the students involved. Two specific topics were selected, their selection influenced by the students – researchers who actually delivered the teaching.

3.1 Systems and Systemic thinking

The 1st topic selected was on the concept of 'system'. The student researcher was already a teacher in primary education schools with a diploma from academy attending further education courses at the Department for Primary Education of The University of Crete in order to obtain a primary teacher's University degree. The basic concepts located for this topic were the system as a complex concept consisting of entities (subsystems) with direct links (dependencies) between them. The skill to recognize a system with its various constituents and the deduction by the school students of indirect links (dependencies) of the type ***constituent a*** *is linked to (depends on)* ***constituent b***, ***constituent b*** *is linked to (depends on)* ***constituent c*** *consequently* ***constituent a*** *is linked to (depends on)* ***constituent c*** were among the aims of the teaching intervention [3]. Characteristics of systems, e.g. relations between different parts of a system, are included as factual knowledge in the school syllabus, for example (some) relations between constituents of an ecosystem. Consequently the students, who, in a Piagetian context, are entering or approaching the stage of formal logic, are not faced with a concept totally abstract to them. However, these basic concepts are mentioned in a fragmented way mostly as (direct) dependencies between parts of an ecosystem and although the word system with its everyday meaning is mentioned quite often in the textbooks, the concept of '*system*' as a technical term of systemic theory is missing [4]. The planned teaching was delivered to students of the 5th and 6th grade (ages 10 to 12) of the classes the student researcher was teaching. It should be noted that the word system is a commonly used word in many expressions of everyday life and many preconceptions from the students are expected. As a result, a successful teaching intervention will show clearly, even with a relatively small sample.

Some of the results obtained from the experimental teaching of the topics selected are [6]:

1. The pre-test indicated that students perceived 'system' as something repetitive (e.g. clock) or something planned (e.g. homework reading) or something involving human action (e.g. irrigation) or humans themselves (e.g. the human body).

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Even 'system' as a complex or corporate notion (e.g. a tree or a tree wood) was not perceived clearly as a system. The post-test carried out one month after the teaching intervention showed a remarkable improvement on the perception of system. Not only they exhibit a working knowledge definition of 'system' but they can also justify it by indicating interrelations between its parts.
2. The pre-test indicated that all students stayed within the direct one to one relations. At the post-test 5 out of the 20 students were able to immediately indicate also indirect relations (dependencies). Although this number is rather low it is very encouraging in view of [3]. This is further supported by the observation that during the discussion following the post-test [7] almost all the students were able, in a two step process, to perceive also indirect relations which they had not indicated at first so that a more thoroughly planned teaching intervention may have had better results. The fact that of the 5 students who showed a clear evidence of advance towards a systemic thinking the 4 were girls (who mature earlier) combined with Vygotsky's context of the Zone of Proximal Development reinforces our statement.

3.2. Einstein's Theory of Relativity

The 2nd topic selected was on Einstein's theory of relativity. The student researcher was a final year student at the Department for Primary Education of The University of Crete whose most of the graduates of the Department work as primary school teachers. The basic concepts located for this topic were the meaning of simultaneity and the time – space dependence on the state of motion of the observer (relativity of space and time). As it was discovered that *speed of light*, *black holes*, etc are words familiar to school students through comics, science fiction, mass media, etc their meaning were also included to the teaching plan. On this topic nothing is explicitly included in the school curricula although the phrasing of the textbooks suggests an absolute (Galilean) space-time continuum [5]. This is in dissimilarity to the previous 1st topic selected and should be taken into account in comparing the results. The planned teaching was delivered in a 6th grade class (age 11to 12) of a primary school where the student researcher was doing his 4th level school practice undergraduate course.

For this 2nd topic selected the implementation was done using a primary school class of 6th grade (ages 11-12 years) [8]. There were 16 students in the class 12 of which attended all 5 meetings. The student researcher had 5 meetings with the class. The 1st meeting was to familiarize with the students and collect the pre-test questionnaire. In the 2nd, 3rd and 4th meeting the teaching intervention was made in 3 separate days about one week after the 1st meeting. At the end of every teaching a questionnaire was completed on formative assessment purposes. The final (5th) meeting was done about one week after the last teaching took place and the post-test questionnaire was collected. The main results are:

1. The pre-test indicated that the students knew that distance time and mass are measured in (kilo)meters, hours (seconds), (kilo)grams, that an object weight is due to earth's gravity and it would be less in the moon. They also had heard about galaxies and black holes, presumably an influence of (science)fiction through TV, comics and DVD's.
2. In the 1st teaching hour the concepts of motion, of the speed of light and of the dependence of the weight of an object upon the gravitational attraction of the earth were introduced. Clarifications on the students' understandings on galaxies and stars were also provided. At the end of this teaching, the students were able to infer that an object in moon should appear lighter and, if left to fall, it will need more time to reach the ground than the time needed in a similar situation on earth.
3. In the 2nd teaching hour the students were introduced to the concepts of the speed of light (as constant in all frames and as an upper limit for any material body), of the dependency between the speed and the mass of an object and of the relativity of space (time dilatation - space contraction) within the context of Einstein's theory of relativity. At the end of this teaching, the majority (>60%) of the students answered correctly the questions on the speed of light as an upper limit and on time dilatation. On the other issues the correct

answers were: for the speed of light constancy 4/10, for space contraction 3/10 and for the mass dependency 4/10 with another 2/10 answering 'do not know' [9].

4. In the 3rd teaching students were exposed to a presentation on the shapes of galaxies, the expansion of the Universe and the evolution of stars [10]. Their attention was also drawn on the observable perception that 'their weight seems to change in accelerating (decelerating) situations, e.g. at the start (stop) of an elevator on the take off (landing) on an aeroplane, cornering (braking) of a car, etc.' as an introduction to the concept of equivalence between the inertia and the gravitational mass. At the end of this teaching, all the students answered correctly the questions about the shape of the galaxy and those relating acceleration to gravity. Again, about 1/3 of the students answered correctly the question of a more advanced character.
5. One week after the last teaching a 'post-test' questionnaire was collected. In this the majority of the students (>70%) answered correctly. Although the time elapsed is short, the questionnaire indicates an effective teaching of the corresponding subjects. The increase of the correct answers in comparison with the questionnaires completed at the end of the teachings is under investigation. Possibly this is due: a/to a better phrasing of the questions of the final questionnaire, b/to an informal peer discussion between the students after the teachings and the completion of the questionnaires. The fact that the 'do not know' answers have diminished may support this view.

4. Commentary

From the previous two (small scale) test-cases it is evident that 5th and 6th grade (ages 10-12 years) primary school students:

- are capable to conceive the basic concepts of '*system*' and of the relativity of space and time.
- are, to a significant percentage at least, capable to comprehend more advanced notions like '*systemic thinking*' or the relation of weight to acceleration.
- the difficulties on some advanced concepts may be considered as similar to the difficulties in understanding other topics and, with a more carefully planned teaching (e.g. based on individual teaching approaches) may improve the situation.

We may, consequently, expect reasonably that the same results will show up also with other topics as mentioned earlier in **1. Introduction**. Thus, the issue of updating the school Science syllabus acquires a new perspective. Towards this end we briefly indicate some remarks based on our experience from these test cases and, also, from discussions with other colleagues, teachers (including the students – researchers) and students.

a) For every topic the basic concepts should be located and an appropriate teaching strategy should be adopted. This teaching should focus not on the detailed processes and functioning (a scope outside the objectives of the compulsory education) but on the conceptual modelling (representation) of the natural world. The teaching should also try to relate the (new) concepts to other topics and, also, to everyday phenomena.
b) The topics selected should be presented in a coherent way and not as separate unrelated add on modules.
c) There are no previous experiences on the preconceptions of the students and this implies more effort from the teacher.
d) The previous teaching implies a similar mode of initial education for the Science teacher. Science teacher education is usually along two extreme lines, as a specialist training and as a general teacher. The first is usually the case for the secondary and for the technical vocational education. These teachers usually tend to occupy their students with details on data, processes, mathematical formulas etc paying little attention to the general model for the natural world. The second is usually the case for primary education. These teachers usually tend to repeat the textbooks and teach Science as a collection of (unrelated) data and observations. Neither of these seems appropriate for the context under discussion where the teacher should possess and be able to teach e.g. scientific inquiry skills. Further study towards the development of complex cognitive skills and reasoning should always accompany even declarative

teaching, which sometimes seems unavoidable. Only this way the 'dogmatic approach' of an 'absolute scientific truth' (similar to indoctrination in a religious class) will be avoided. Otherwise, confusion between science advances and the religious dogma will appear as has repeatedly been observed [11].

e) In both cases the students - researchers observed that the students were approaching the (new) ideas with a 'fresh and innovative' way they had not anticipated. This helped them (the teachers) to clarify their understanding of the subject they were teaching. It unearthed however the real problem, according to us, on the introduction of contemporary Science concepts to the school curricula, i.e. the teachers' competence and their lack of a conceptual understanding of Science. In these two test cases the students researchers did not had a specialist's training in Science [12]. This resulted in extensive consultancy with the authors of this work. As they commented later, they used this experience of theirs to anticipate children's' behaviour and adapt the teaching strategy adopted although in many occasions children surprised them with the (usually simpler) interpretations they assigned to the new concepts taught.

5. Epilogue

Our basic objective that we should put under the test of empirical evidence the general belief that 'children are not able to understand new concepts which scientists have spent a lot of time to understand' has been validated. Children are capable of assimilating contemporary Science concepts. Consequently, a total reform of the school Science curriculum must be done. In view of the comments made in **4. Commentary** this reform should be tested on its different parameters to ensure an efficient contemporary Science literacy, the most critical parameter being the Science teacher (initial) training.

6. Acknowledgements

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[2] For the necessity on the modernisation of the Science curriculum see George Kalkanis 'Which (and How) Science and Technology Education for Future Citizens?', pp. 199-214 of Vol. II of the proceedings of the University of Cyprus, '1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens', Paralimni-Cyprus 29/4-2/5 2001.

[3] It should be noted that in a Piagetian context, the students in this age are mostly in the concrete (and towards the formal) operational stage able (mostly) to one parameter (direct, one to one) relations. Consequently, the expectations here should be limited.

[4] In systemic theory the term 'system' is used to denote a way of organizing our thoughts about reality. It may refer to (material) things (e.g. a machine) or a corporate organization. Although related concepts may be traced back to the works of Norbert Wiener on Cybernetics and of Edward Lorenz (a meteorologist) on Chaos systemic theory, especially applied to understanding and solve complex problems has only recently emerged as a, more or less distinct, scientific branch. For a particular viewpoint see Daniel Aronson, Overview of Systems Thinking (Visited on 13-Jun-2006) in http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf.

[5] This is true also for the textbooks in middle and high schools. In most of the University level textbooks the same attitude is also observed.

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[7] The pre- and post- test questionnaires were complimented by discussions with the students in order to ascertain the validity of their answers. This was triggered by the observation that the students understood the meaning of relation as one sided. For example they understood the word influence as having the meaning of diminishing (in numbers) or of a negative (on values) notion.

[8] Antonis Tsalapakis, 'The Theory of Relativity in Primary Education', proceedings pp. 408-410 of the 2nd International Conference on Hands on Science Hsci2005 – Science in a Changing Education, July 13-16, 2005 – Greece, The University of Crete campus at Rethimno (http://www.clab.edc.uoc.gr/2nd/). A more detailed report may be found in; Antonis Tsalapakis, 'The Theory of Relativity in Primary Education', Rethimno 2006, degree dissertation, Department for Primary Education, The University of Crete (in Greek).

[9] Although these figures seem low, in view of the comments made in point 2 of **3.1 Systems and Systemic thinking**, they rather encouraging.

[10] This was done mainly following (provoked?) students questions on the subject. The inexperienced zest of the student researcher played also a role.

[11] It was also observed by the student researcher of the second test case when, answering students questions he entered to recite current views on the origin and evolution of the universe. Many students reacted intensely on reason that it was contrary to what they had learned in the religious class (the bible in this case).

[12] This was rather an advantage because: a/ they were willing to learn without any second thoughts about their image as 'Knowledge sources', b/based on our teaching -training experience, secondary education Science teachers (specialist's training) usually have strong conceptions on what Science is and how it should be taught and very rarely they endeavour to try a different teaching style.

Introduction to Fiber Optics and Telecommunications

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Abstract. The importance of teleco-mmunications and fiber optics in modern societies is remarkable. In this communication we will present an introductory educational kit aimed to present by hands-on experimentation the basics of fiber optics and telecommunications to primary and secondary school students. It includes a set of investigative experiences with increasing level of exigency covering the basic generic and specific knowledge in this domain. It focus on the development of observation sense, critical reasoning, and creativity, promoting an active committed volunteer and autonomous engagement of the pupils in the analysis and learning process of problems and situations in science and technology highly relevant to their every day life.

Keywords. Physics, Optics, Optic Fibers, Telecommunications, Scientific Method.

1. Introduction and principles

The evolution of technology and the development of new solutions that directly affects our everyday life demand the establishment of a sound scientific and technological literacy in our societies. From early ages our youngsters and pupils should have an enduring and efficient knowledge update especially in what concerns key proficiency and aptitudes. It is so important to promote the pedagogical conception development and production of new materials and equipment that may allow the introduction, in-school but also in informal learning environments, to basic concepts of recently developed high-tech including the underlying scientific theories.

In our days, in our Information (or better Knowledge based) Society, telecommunications play a fundamental, crucial, role. With the massive increase of the amount of information that needs to be exchange, virtually in real time, between all the points of the globe, all the telecommunications system had to be redesigned and renewed in the last decades. At present, optical fibers are at the foundation of all modern telecommunications system. It was its sprouting and development which allowed telecommunications development to the level that we now observe and to what is already foreseen in a near future. Thus optical fibers and waveguides are surely our day's one of the most important domains of physics and of Science and Technology in general.

The light propagation phenomenon in optic fibers, or waveguides in general, apart from being amply inquisitive and intriguing for the layperson (and the young are especially receptive to the solving of such strange and vanguard type "enigmas"), can be explained, on a first approach, with the use of some basic and fundamental rules of geometric optic. Hence, its study may not only serve as a way to motivate and stimulate pupils for the study of Physics and Sciences in general but also to contribute to the learning process of some concepts and basic competencies of the higher importance in physics in general and optics in particular, that are often even included in the natural sciences and physics curriculum of most of our primary and secondary EU schools.

In this perspective, the development of an introductory kit intended to the experimental study of wave guidance optical fibers and telecommunications, was considered essential to the scenery of almost total absence, as far as we know, of this type of pedagogical materials in Portugal.

The kit which consists on an integrated and coherent set of materials, equipment and introductory activities' manuals to Optical Fibers and Telecommunications, was developed in the frames of the Hands-on Science Network based on the authors' previous work supported by the former Instituto de Inovação Educacional.

This experimental kit to Optic Fibers and Telecommunications introduction enrolls itself in the hands-on experimental approach to Science and Technology teaching/learning process that we advocate [1-3]. The use of this sort of material in the different levels of education, to whom it is intended to, will contribute to a more effective prosecution of the established specific objectives of learning in terms of acquired knowledge, but also on what concerns the development of critical spirit, observation capability, creativity and on pupils active and autonomous engagement in the critical analysis of problems and situations. Furthermore it may become an important motivational factor for the study of physics and natural sciences.

In a systematic way we could enumerate the pursuing set of objectives [1-9] with this type of activities: to establish a basic knowledge in the field and make it possible for pupils to acquire aptitudes and elementary competencies in a modern top importance domain as optical fibers and telecommunications is by hands-on experimental practice; to contribute to the development of the active study of sciences by means of hands-on experimentation; to contribute for teachers knowledge update concerning wave guidance optical fibers and telecommunications but also on essential aspects of optics; to enhance pupils commitment on physics and natural sciences study as earlier as at elementary school up to secondary vocational training and even higher education level; to encourage the use of experiments execution as essential science learning tool; to familiarize (/introduce) pupils to the scientific method, developing critical spirit and observation abilities as tools essential to all science related activities; to stimulate creativity; to stimulate pupils active and autonomous engagement on critical analysis of problems and simple situations in science & technology fields; ultimately inducing the recognition of the usefulness of physics and science in general in the every day life [8].

2. Brief introduction to optical fibers and its use on telecommunications

Light (electromagnetic radiation) propagation in waveguides and optical fibers [10,11] is a process indubitably fascinating however of complex explanation. Yet, the basic process is simple and well-known for a long time. It is all about total reflection or, if you prefer, total internal reflection of light. When light in its path finds a surface of separation (diopter) between two mediums of different optical properties, part of the light is transmitted (refracted) and part of it is reflected. When the transition occurs from a more optically dense material to one with lower refractive index the transmitted light is shifted away from the normal to the diopter in the light' incidence point. Increasing the inclination of the incident light impinging onto the diopter, at a certain point, the light will "go out" perpendicularly to the diopters' normal not being transmitted. Above a certain angle limit of incidence only reflection will occur: the total reflection. The process is easily envisioned in a transparent recipient with water. As well also the process of successive multiple total reflections where light bounces inside a material, as it happens in optic fibers, in a pipe or glass plate, or, simply … in a block of gelatin!

The properties and characteristics of different types of optical fibers readily available allow the replacement of conventional materials in wide range of situations such as in illumination and decoration, on several medical applications, artwork cleaning, in different types of sensors and … in telecommunications.

In this domain (of outstanding importance in nowadays life) the importance of optical fibers became unsurpassable and was the introduction of fiber optics that lead to the current level of development in the telecommunications area. As an example: a 5 mm diameter optic fiber cable can replace a 7,5cm diameter copper cable employed some years ago. It is 25 times lighter and lasts 2 to 4 times more. The cables can be longer - 20 km (even 40km) - than copper cables which demand repeaters from 1 to 1km. The major drawback is still the costs involved. Fiber optics are made of a rather pure glass - 1km of this glass is as or more transparent than a normal window' glass (5mm thick). But... while a normal telephone line (2 copper wires) allows the transmission of 24 simultaneous calls, with a pair of fibers 24,000 or even 100,000 to 150,000 simultaneous communications can be established. The profits in transmission capacity will be still more noticeable in the transmission of TV signals. While with UHF modulation it is allowed the transmission of 10 channels, with an optical-fiber cable system this number raises to 100,000 channels. Digital signals transmission capacities superior to 200 superior Tbit/s.km are commonly obtained.

The market' demand for optical fibers is ever increasing been the telecommunications area responsible for almost half of it. Application on long distance communications (transoceanic submarine cables) increased significantly in the 90's. Cable television (CATV) is now one of the main applications of optical fibers. Annually the world-wide optic fiber market puts into motion over 10.000 million Euros with a steady growth.

Among the advantages of optical fibers uses we can summarize the following: low loss in transmission; immunity to noise and electromagnetic interference; high broadband width (nowadays massive amounts of information need to be transmitted between distant places all over the world); information transmission security; is made of insulator material; small dimension and low weight; high flexibility (when coated) and resistance to temperature and chemical agents; and low cost. The disadvantages are: fragility of non-coated fibers; difficulty to execute derivations; delicate connection between fibers and other components; and sensitivity to cosmic radiation.

3. Fiber optics and telecommunications introductory kit

So as to reach the proposed objectives, it was planned and established an integrated and logical set of experiments' guides materials and equipments (as simple and low-priced as possible) which allows the accomplishment of simple and attractive experimental hands-on activities of introduction to Optical Fibers and Telecommunications.

A set of 15 experimental works was prepared, with increasingly complexity in order to promote the improvement of our youngsters critical and autonomous engagement along this learning process. First it starts with light guidance' observation in solids (glass blocks, prisms...) and liquids (tap water flow...) and, eventually, light guides made of eatable gelatin (for pupils of elementary and pre-school). Thereafter we move forward to the observation and study of different types of optical fibers (always plastic ones or strongly protected in order to prevent accidents) including fibers for ionizing radiation detection, the concept and use of remote illumination and image manipulation, fiber cables use on monitors and on rudimentary scanners. The preparation of fibers and cables as well as with its connections will be followed by the study of light propagation on different types of fibers and with diverse constraints. Light sources and detectors will be studied and a direct voice communication system (energy conversion: sound-electric-luminous-electric-sound) is to be set-up and used. Finally it will be assembled an elementary telecommunication system using optical fibers introducing also a first approach to the information codification problem.

In what concern the manuals/guides, it was intended to cover all sort of doubts and questions that pupils may have, with an intuitive structure and simple and direct explanations as complete as possible, always appealing to the student's critical active intervention.

The protocols are simple and formative just pointing the student/group towards the execution of their work'. Frequent appeal is made towards critical reasoning and careful observation. Attention is drawn to some situations that should be observed and critically analyzed in a more diligent manner. In general, the teacher or monitor will be responsible for this task and will also have to raise some questions (whenever possible making use of comments, questions or commentaries pupils will make along the process) of informative and formative nature leading the student to raise questions and open new insights. Whenever possible it is suggested that pupils should be allowed to establish the way and steps of execution of their experiments and also project new, their own, experiences.

The carrying out of all experiments, in the proposed order, will be relatively time consuming and require the learning process to be consolidated. Thus the kit may be used in succeeding years from the first to the last years of school.

4. Conclusion

The goal of the physicist is to discover understand and explain the physical world which surrounds us.

To observe (seeing critically) is the first and essential step in this process. Then doubts and problems should be raised and critically analyzed. New situations and sceneries are to be foreseen and constructed. Always in an active and engaged way.

The students should observe discuss convey and criticize their own conclusions and, as possible as it can be, establish/decide what to do next… constructing their own knowledge. Making Science...

The enhancement of student's specific knowledge is important but Science demands work responsibility and Method. It is precisely in this direction that the teacher/educator first efforts must focus.

The exposure to knowledge or the access to its sources is not a sufficient condition so that the learning occurs!

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Bringing the heavens closer: Astronomy and astrophysics from seven up

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Abstract. There has been recently an increased interest in tackling the frequent common misconceptions -or alternative conceptions- about astronomical notions found both in elementary school students and in their teachers. Research in many countries has shown that basic astronomical concepts like night-and-day cycle, lunar phases, meteors, seasons, etc, are by far not completely acquired by neither of the two groups. We have recently presented a series of astronomy books aimed at helping both children aged seven years and up, and their teachers, in subjects covering a wide range of topics, all introduced with carefully chosen words and images that young children can understand.

Keywords. Astronomy, Misconceptions, Elementary school teaching, Support material.

1. Introduction

Astronomy in many countries is just a nice way to spend a night below the stars contemplating the universe, but has not found its proper place in basic education. The result is that often, children do not find answers to the many questions that genuinely come to their minds while reading or making observations. More often than not they learn (or have to accept) what older people -e.g., parents and teachers- tell them, even if the new notions unconfortably find their place side by side with their previous ideas about the subject.

Recently, an increased interest in tackling the most frequent alternative conceptions about astronomical notions has surfaced. This so-called "unscientific knowledge" was found both in elementary school students and in their teachers. While there have not been many studies in Argentina about this, research collaborations in other countries have shown that the most basic astronomical concepts are incorporated neither by students nor by elementary school teachers. The subjects tested included the night-and-day cycle, lunar phases, seasons, the nature of planets and stars, meteors and meteorites, among many others.

In our country, science programs for primary school level include the chapter "Planet Earth and the Universe", and in there one finds topics in physics and astronomy spanning from Galileo to beyond Einstein, in a clearly ambitious schedule.

2. Astronomical material

We have recently presented a series of astronomy books aimed at helping both children aged seven years and up, and their teachers, in subjects ranging from basic atmospheric phenomena like rainbows and sun-pillars -observable during the day- and the scintillation of remote stars at night, to the relevance played by gravity in the inner functioning of the Sun, and how to think and apprehend the infinite space of our universe.

Figure 1. Stars falling on Earth?

Topics like those and many more: the constellations -including Ophiuchus-, locating Sirius and Canopus in the sky -guided by a short story-, eclipses, comets and meteors, Kuiper belt objects, the Oort cloud, extrasolar planets, galaxies -and their collisions-, supernova events -and their remnants-, the curvature of space, gravitational lensing, and a long etcetera, are all introduced with carefully chosen words that young children can understand, with new concepts and definitions signaled by different fonts and colors [1].

Moreover, in each book the text is limited to a maximum of roughly 120 words for double-page and so a main effort was made to condense the most appropriate words to succeed in communicating the precise scientific content.

At an equal footing with the text, the images were conceived by an illustrator working side by side with the scientist. The depth of the illustrations together with the extraordinary mastering of colors and the usage of real images for some *collages*, make these brief books extremely attractive for children.

3. Falling stars or meteors?

Just to give the reader a flavor of the subjects and drawings involved, let us concentrate on meteor showers (unfortunately, we have no space for considering many of the other topics mentioned above). Children grow up knowing these objects as "falling stars" (Fig.1) and many times the result is that they have difficulty in connecting meteors with comets. With easy words and attractive images, one can explain that it is in fact due to the dust left by comets in their travel around the solar system that, once this dust enters the Earth atmosphere and disintegrate in seconds by friction, we are able to appreciate the astronomical show. (Actually, one knows that it is the Earth that crashes the dust head-on in its annual motion around the solar system.) This show repeats itself every year (for each relevant comet) while our planet travels through nearly the same position of its orbit.

But this is not all. If the dust particles happen to be a bit too big, meteorites can reach the surface of the Earth. This possibility has an interesting connection with the preservation (or extinction) of life on our planet, and the following double-page (Fig.2) shows a situation in which dinosaurs eventually disappear due to one of these astronomical hazards.

Figure 2. Meteorites and massive extinctions

4. Outlook

In spite of the fact that the books were published less than a year ago, we have received positive feedback from educators who used this material in their science courses. Parents with an eye in astronomy also communicated their delight with the new tool to convey correct notions to their children.

It is well-known that young students arrive in science courses with pre-constructed and consistent models of the physical world surrounding them, and this is particularly true also with astronomy. It is the aim of my exposition in the HSCI2006 conference to present these didactic books, show which alternative conceptions they can help to alleviate, and explain how to introduce to children many other astronomical and cosmological notions in a simple and cheerful way.

For the time being the books are available only in Spanish, but projects for translating them to English cannot be discarded.

5. Acknowledgements

I would like here to thank my collaborators, Paula Bombara and Viviana Bilotti. Working with them was lots of fun. I also acknowledge useful discussions on science education with María Iglesias and Alicia Kriner. Financial support was provided by Conicet and by the University of Buenos Aires.

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Forty Sho(r)ts on Einstein: A Film Contest

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Abstract. The aim of the "Einstein's minute"; contest was to challenge all those who practise the art of image and sound to produce a short movie (animation, video, multimedia or other) about the life and/or work of Albert Einstein, the inspirer of the 2005 World Year of Physics. 40 films from Portugal and Brazil met the requirements and were accepted for the contest.

An international Jury awarded the Grand Prix of 1500 € to a film explaining the theory of the special relativity in less than one minute in a dynamic and entertaining way. Several honorific mentions were also awarded. A multimedia prize of 500 € was awarded after an internet poll among nine of the films that were produced under the special requirements imposed for the films being viewed in the internet. The films were first exhibited within the framework of the "Scientific Documentary Festival", that was held in November 2005 in Arcos de Valdevez, Portugal. Since then, some of the films have been selected to be shown in public sessions in Paris, France, at the "Institut de cinématographie scientifique". The 14th edition of ENCONTR´ARTES, in Paredes, Portugal, has hosted an installation of 37 of the films as a nuclear part of 2006 theme: "Universos da genialidade, galáxias de estrelas". Einstein, Shakespeare, Mozart and Camões were the stars of this arts festival. The making of the films and their exhibition has offered the authors, the organizers and the public different perspectives on the Einstein's revolution as well as the influence of physics advances on our daily lives.

Keywords. Physics, Einstein, Films.

Undergraduate Experiments on Electromagnetism

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Abstract. With this project, the authors intend to carry out the implementation and the development, in the classroom, of a set of experimental activities related with the topic "Electromagnetism", presented during the 9th year of school formation, i.e. to 15-16 years-old pupils. So, these young students will perform several experiments in electricity, magnetism and electromagnetism, using simple equipments.

The here-proposed experiments include: (i) The magnetization and the demagnetization of materials; (ii) The 3D visualization of a constant magnetic field; (ii) The magnetic field induced by electric currents (in a straight conducting wire and in a solenoid); (iv) The construction of an electromagnet; (v) The verification of the Oersted's experiment; (vi) The assembly of an electric bell as an example of practical application of electromagnetism; (vii) The realization of the Faraday's experimentation.

Keywords. Physics, Hands-on experiments, Electromagnetism.

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A Web Site about Historic Experiments: Following Faraday's Steps Using Microcomputer Based Labs (MBL)

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Abstract. The conventional didactic approach to the Electromagnetic Induction phenomenon, is to present the experiment and Faraday's formulae in a superficial way; the students don't realize the relations between the rate of change of the magnetic flux and the voltage induced.

We believe that the proper didactic approach should include elements of the History of Science and analyze the relations between the physical quantities. To accomplish that we need to use the New Technologies. More specifically the use of position, voltage and magnetic field sensors enables us to:

- Take measurements of physical magnitudes that are difficult to measure by using conventional means, like the intensity of the magnetic field.
- Easily compare the measurements (e.g. of the intensity of the magnetic field and the voltage) all presented in diagrams on the computer screen.

In this way the students discover the relations between the selected magnitudes.

The use of MBL in Mechanics' applications is nowadays quite extensive; on the other hand, its use in Electromagnetic experiments is rather limited, up to now. We consider the MBL an effective tool for the development of a good conceptual understanding of the Electromagnetic Induction.

We designed two variations to the historic experiment of the Electromagnetic Induction in an MBL environment:

1st: Magnet sliding down a gentle slope induces EMF in a coil

2nd: The change of the current in a circuit with a solenoid, induces current at a second circuit with a solenoid attached to the first one

Our objectives are that the students:

- Understand that, although the two experiments appear different, they are in a way similar
- Understand what triggers the induced voltage in the two experiments
- Understand Lenz's Law

Keywords. Electromagnetic Induction, Microcomputer based labs, MBL.

1. Introduction

The Electromagnetic Induction phenomenon has a central position with respect to the evolution of the classical Physics theory of Electromagnetism, as well as the technological development that led to the electrical energy production of today.

The Electromagnetic Induction phenomenon is related to the electric current which arises due to varying magnetic fields. The students must try to understand the relations among the physical quantities, as well as the mechanism in the several applications of the phenomenon; that means that the students should be in a position to understand how devices like the generators, motors, transformers and speedometers operate.

The traditional didactic approach of the phenomenon of Electromagnetic Induction is essentially limited to the repetition of the experiments that Michael Faraday και Joseph Henry have been conducted, back in the 19th century. They write down the mathematical expression of the Electromagnetic Induction Law which relates the induced voltage at a solenoid with the rate of change of the magnetic flux passing through it. The students are not, of course, in a position to follow the exemplary line of reasoning of Faraday; they just memorize the law without really understanding the phenomenon itself or its applications [1].

The new information technologies can create a more productive educational environment for physics teaching. In this paper we describe the use of microcomputer based labs (MBL) for the studying of electromagnetic induction. In MBL labs, the students - by participating in hands on experiments - have the opportunity to measure, directly and simultaneously, the physical quantities that are involved in the induction phenomenon.

Some physical quantities are difficult to measure; in particular, the use of sensors for the direct measurement of the strength of the magnetic field, it is something especially difficult to be done with the use of traditional devices.

The induced voltage and their simultaneous display on the computer screen, in the form of a diagram, give the possibility:

- Of the comparison between the change of the strength of the magnetic field and the induced voltage.
- To determine from the position – time graph, the velocity – time diagram and compare it to the induced voltage – time one.
- To focus the students' attention on the phenomenon, and relieve them of the "dull" process (as they perceive it) of taking measurements and creating the relevant diagrams.

Our objective is to detect the students' preconceptions as well as to develop Socratic dialogues between the teacher and the students during the experiment [2].

2. Design and procedure

We designed two experiments with respect to the Electromagnetic Induction phenomenon in the school laboratory; we made use of the New Technologies by taking measurements with sensors connected to a computer through an interface. We used a position (DT020 - sonic ranger), a voltage differential (DT001) and a magnetic field (DT028 - Teslameter-Vernier) sensor [4].

The experiments are variations of the classical experiments conducted by Faraday and Henry.

In the experiments, we used a solenoid of 24000 coils and a bar magnet that move relative to it on an inclined plane.

The solenoid is steady at the lower part of the plane. The magnet is attached to a Fletcher's trolley which can slide down a slope. Fletcher's trolley is the classical experiment apparatus for investigating linear translational motions. The trolleys are guided on a rail consisting stainless – steel profile by means of two low friction wheels [3]. By varying the gradient we can control the acceleration of the magnet motion. The monitoring system used is the Multilog and the software for the data analysis is the DB – lab.

We let the trolley free at the highest point of the plane; the friction between the trolley and the plane is relatively small. Thus, the motion of the magnet is linear uniformly accelerated; the motion is caused by its weight's (plus the trolley's weight) vertical coordinate. The motion of the magnet is monitored by the position sensor (the red line in Figure 1) while the magnetic field and the voltage differential sensors, connected to the solenoid, take also measurements (the blue and green line respectively, in Figure 1). As the magnet moves the students can observe the set of measurements as the magnet approaches the solenoid, as it goes through the solenoid and when it moves away from it.

Figure 1: Position – time, Electromotive force – time and the Strength of the Magnetic Field - time graphs

Experiment 1

The experiment is designed to be part of the didactic procedure in the 6th grade of the secondary level (age group 15 – 16 years old)

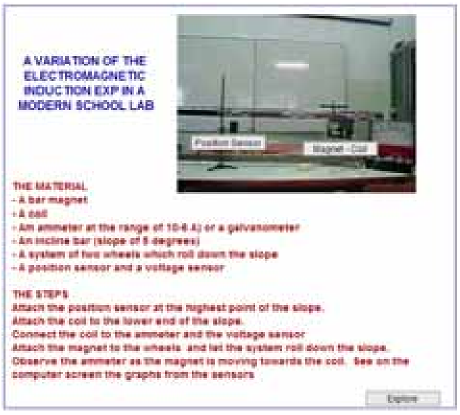

Figure 2: Moving magnet – Steady solenoid

With the use of a voltage and a magnetic field sensor, we obtain a real time collection of the corresponding data and a graphical display of their change with time at the computer screen. By the position sensor the program creates a position – time graph on the computer screen.

As a first learning outcome we expect that the students to realize that an induced voltage in the solenoid occurs only during the movement of the magnet (figure 1).

Second the students can observe that the polarity of the voltage depends on the direction of the magnet's movement, whereas, with the magnet inverted, the changes of the induced voltage with time vary accordingly (Figure 1). From all the above, we hope that the students will come to the conclusion that polarity is determined by the absolute value of the magnetic field change.

Third the students should start wondering about the factors that determine the magnitude of the induced voltage Electromotive Force (e.m.f.) and concluded that does not depend simply from the change of the strength of the magnetic field, but from its *rate* of change. Using the graphs Electromotive Force (e.m.f.) – time and the strength of the magnetic field – time (figure 2) we can determine dB/dt – time graph.

Next, students should determine the ratio of Electromotive Force (e.m.f.) to (dB/dt) and realized that this ratio remains constant or that the induced voltage is proportional to the rate of change of the magnetic field strength, i.e. with the rate of change of the magnetic flux.

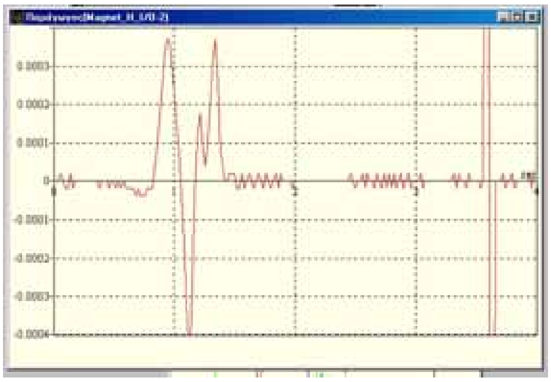

Figure 3: dB/dt – time graph

The next activity for the students is to use the computer software in order to study the magnet's motion. First they should derive from the position – time graph, the velocity – time graph; second they should compare the velocity – time graph with the Electromotive force - time graph. Because of the similarities of the two graphs, we expect that they will come to the conclusion that the Electromotive Force (e.m.f.) is proportional to the velocity of the magnet; in this way they can understand better the way the speedometer operates. (Figure 5)

More observations and analysis on the graphs could be achieved, depending on the class:

As the bar magnet moves in relation to the solenoid the students make observations: area 1 of the diagram in Figure1 corresponds to the time as the magnet enters in the solenoid; area 2 of Figure1 corresponds to the time as it exits.

We can ask the students to notice when the induced voltage gets zero; it is quite clear that this happened when the magnet is passing through the centre of the solenoid.

Another observation is that the maximum of the Electromotive Force (e.m.f.) value as the magnet exits the solenoid is greater than its maximum value at its entrance. We can ask the students to comment on this; it is interesting to find out how many of the students will be able to correlate the phenomenon to the velocity of the magnet which is greater after.

We can also ask them to comment on the change of the polarity of the Electromotive Force (e.m.f.) in relation to the Lenz's rule.

<u>Experiment 2</u>

Figure 4: Moving solenoid – Steady magnet

In this experiment we attach the solenoid to the moving trolley, keeping the magnet steady. We repeated the steps of the experiment 1. The students observe the graphs as the first experiment; we hope that they will discover that the Electromotive Force (e.m.f.) is induced by the relative motion magnet – solenoid, no matter which one is in motion.

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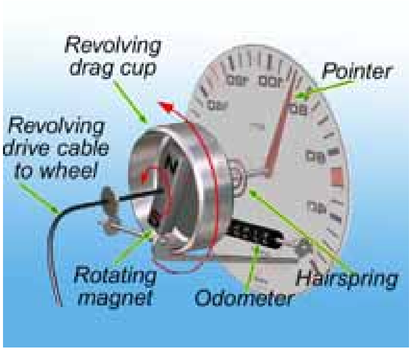

Figure 5: This is a speedometer. As the wheels of the car turn, the flexible cable turns and the magnet at its end rapidly revolves. That produces a tug on the drug cup that tries to follow the magnet but is held back by the spring. The pointer is attached to the cup and turns with it.

3. Discussion

In spite of the extensive implementation of MBL – programs in the teaching of Mechanics, the relevant literature about their application in the study of electromagnetic phenomena is very limited and it is characterized only by the indirect verification of Faraday's law of induction. We believe that MBL - labs, serves as an effective tool for the development of a good conceptual understanding of the electromagnetic induction; we also believe that the utilization of MBL - labs assists students' ability to describe, understand and predict the development of physical phenomena. Similar conclusions have been reached from the implementation of MBL-labs for the teaching of other content areas in junior and high school students.

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Virtual Laboratories on the Subject "Abortion and Emission of Radiation"

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Abstract. The Nowadays it is evident the influence of the Internet in our students. In this context, it is essential to implement web contents and e-learning activities to stimulate the study and the acquisition of knowledge by the students. To associate the web to the experimental work and the related theoretical concepts to its implementation seem to be also very relevant.
This work reports the development of the project "Virtual Laboratories". The main issues of the present project are:
- increase the accessibility of the necessary concepts to the development of certain experimental work and
- present in a virtual way the most relevant experimental activities, which will allow the experimentation beyond the laboratory room

In particular, areas such as Thermodynamic show a deficit of virtual laboratories at an international level. In this way this subject with less available material are the first for which

scientific content and virtual laboratories have been created.

In this presentation, the one simulation related to the absorption of radiation by different surfaces, known as “Leslie´s Cube”, will be shown. The experimental activity will be presented together with supporting material that will allow the student to acquire the necessary concepts to understand the experiment as well as to test this knowledge and to explore more about related issues.

The authors thank the support of the EU "Hands-on Science" project (110157-CP-1-2003-1-PTCOMENIUS-C3).

Keywords. Virtual laboratories.

Data Acquisition Experiments for Earth Science Lessons

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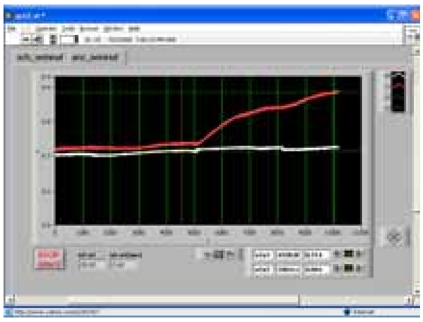
Abstract. Our study is developed in the framework of the Comenius “Hands on Science” Project. We intended to find the right way to show how the Nature works to our students. We have used a data acquisition system: a computer, a data acquisition board NIDAQ 6013 and sensors for light, temperature, microphones to record sounds, humidity, pressure and more. The software for the signals registration and analyzing was developed in LabVIEW.

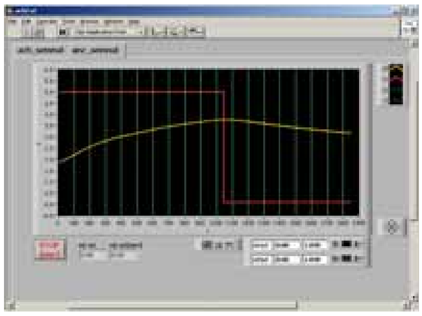
Experimental set-up for studying the effect of the CO_2 emissions on the atmosphere

One of the experiments we have developed allows the students to compare the thermal properties of carbon dioxide with that of air. An increase in the earth's temperature due to the use of fossil fuels and other industrial processes has lead to a buildup of greenhouse gases in the atmosphere. So the increasing levels of carbon dioxide in the atmosphere over the last century will lead to elevated global temperatures, which could result in coastal flooding and major climatic changes and have serious implications for agricultural productivity. In another experiment, we have used a Humidity/Temperature Sensor to measure air temperature and relative humidity in a plant terrarium.



Data acquisition signals from the temperature probes

Experimental set-up for studying the aparition of the seasons



Data acquisition signals from the temperature and light sensors

We have also used a light sensor for monitoring the solar light on the windowsill of our laboratory. In the last experiment we have used an Earth globe, a temperature and a light sensor to simulate the apparition of the seasons.

Keywords. Data acquisition experiments.

Using Narrative Stories in Teaching Science

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Abstract. This study emerged from an effort to explore narrative – based pedagogic discourses as a means of making science relevant, meaningful and accessible to young learners, aged six to twelve. Reform documents in contemporary science education criticize the way science has been portrayed and taught in schools. The dominant picture of science, mysterious and opaque, estranges students because it is disconnected from their everyday experience. It portrays science as a set of objective truths and absolute realities to be approached – abstracted, disembodied and decontextualized. Narratives, as in stories, are a vehicle through which experiences and events are communicated among people. Researchers have contended that stories have an influence on people's understandings and beliefs, promoting societal and cultural changes. We have carried out a case study of the implementation of a unit on waste recycling in a 2^{nd} grade classroom. We have used "discourse analysis" as both a theoretical and methodological approach. The aim of the latter is to characterize the nature of discourse of teacher - student interactions in a narrative - based science lesson and furthermore, to encourage the use of dialogue as a tool of thinking, learning and interacting. Our research questions; what is the nature of participant's (teacher – learners) conversations in a narrative-based science lesson? Do the narrative – based activities engage children in the use of problem solving and thinking strategies? We collected classroom video data, student transcripts and teacher plans. The data analysis illustrates the complex ways in which stories can scaffold science learning. Our findings suggest new ways of moving towards meaningful science learning at the elementary school and have implications on the development of curriculum materials that make appropriate use of stories.

Keywords. Dialogue, Discourse analysis, Narrative–based science lesson, Stories.

Teaching Physics Using Students Previous Ideas and Experimentation

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Abstract. The investigation on education has shown and proved the existence of intuitive ideas on the part of the students, built upon their own experience, observation, reflection and conclusions, not always coincident with those scientifically accepted. This work refers to the way children see and learn Science in a specific area-Physics. We had in mind not only the previously stated but also facts such as the noticeable lack of scientific knowledge in some subject areas such as Physics, on the part of Primary school teachers, and the students' big difficulties in what concerns the notions of "Electric Circuits" and "Heat", being these topics central issues in the learning of Physics. In an attempt to help overcome those difficulties, this project was intended:

- to identify the 4th year pupils' notions related to the concepts of electric circuits and heat;
- to propose, develop and apply a teaching-learning methodology of these concepts;
- to evaluate the effectiveness of the methodology;
- to analyse the effects of the teaching of Science (Physics) with everyday life examples.

In order to develop the study, which involved 40 pupils of the 4^{th} year, belonging to two

different classes of a primary school, we have used as a research tool a questionnaire applied as pre- and post-test, worksheets (consolidation exercise worksheets) and the development of experimental activities which were complemented, in some situations, with interviews.

The operating process of the study was done in two moments. Firstly, the pre-test was given, the pupils' answers were studied and the data to be used in the planning of teaching units were grouped. Secondly, the teaching units were devised and presented to the pupils; everyone involved has participated, experimented and presented the conclusions of the contents of the planned lessons.

Despite the limitations of this study, the results allow us to infer that the proposed teaching-learning methodology has proved itself effective in the promotion of the students' conceptual evolution.

The achieved results support our conviction that the improvement of the quality of teaching implies the valuing of "my ideas", by the use of teaching strategies which allow their reorganization, making them more articulate with what is scientifically accepted, combined with the creation of a space which allows children in their first years of schooling to be taught Science respecting their "inner and outer environment", that is to say, the children's skills and background.

The authors thank the support of the EU "Hands-on Science" project (110157-CP-1-2003-1-PT-COMENIUS-C3).

Keywords. Physics, Hands-on experiments.

Hands-on Experiences for High School Students

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Abstract. As laboratory work has been included in the Physics and Chemistry syllabus in Portuguese Secondary schools for tenth grade students, it proves essential an adequate development of experimental activities. Two main themes of the syllabus where students have problems are the evolution of the Universe and thermodynamics, as these subjects are either a source of confusion or regarded as too difficult by them. One possible reason for such confusion and disappointment by students, concerns the traditional emphasis on teaching by resorting solely to theory, instead of a hands on type approach.

To help overcome difficulties of conceptual learning regarding the abovementioned themes, we focus on two phenomena, namely, heat transfer and the Doppler effect. Regarding the former, we intend to present experimental activities to help students understand energy transfer in the form of heat, the notion of heat capacity, specific heat, latent heat (of fusion), using simple experiments. Regarding the Doppler effect, the students will study simple experiments involving water surface waves, and extrapolate the same concept to sound, and light waves. Regarding the latter case, these experimental studies allow them to better understand the notion of redshift and blueshit of light arriving from Galaxies by making it less abstract and also offer a unifying perspective of the effect.

In conclusion, by making these simple experiments of heat transfer and the Doppler effect, we argue that it can become an easy and fun way for students to effectively grasp abstract concepts.

Keywords. Hands on experiments, Doppler effect, Specific heat, Heat transfer.

Two Names Definitely Entered in the History: Hiroshima and Nagasaki

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Abstract. This paper contains very interesting things about the two atomic bombs: 'Little Boy' and 'Fat man' which were launched at Hiroshima and Nagasaki. They are very important for Chemistry, concerning the composition of them, for Physics, concerning the phenomenon of reaction, and History, concerning the importance of them and the circumstances under which they

were detonated. But all of these cannot be compared with the pain and the fear of the people remained alive after the explosion of the atomic bomb. This is the reason for the paper draws the alarm signal about the danger of the nuclear arms.

Keywords. The atomic bomb, “Little Boy”, “Fat Man”.

1. Introduction

The atomic bomb marked the history of many cities causing a lot of material, human and moral damages. Hiroshima, Nagasaki … Two names definitely entered in the history. Their sad celebrity is explained through the fact that they were the first targets of an atomic assault.

Figure 1. The explosion of the atomic bomb

The Nagasaki and Hiroshima cities, like the hall planet, remained astonished and grieved after the American attacks. The pain and the fear of the people remained alive cannot be translated into words.

This subject can be treated from many points of view: chemically- the composition of the atomic bomb; physically- the nuclear reactions which are produced; historically- the importance of the events and the circumstances in which the bombs were launched; psychologically- the determined impact on the people; biologically- the diseases generated and the transformations produced by the radiations in the normal function of the alive organisms.

The project contains astonishing and dreadful information regarding the followings of these entropic hazards, recordings from the planes from which there were thrown the bombs (precisely from Enola Gay, the “Little Boy” Bomb; and from the plane of type B-29, the “Fat Man” Bomb), pictures and images with the Enola Gay Plane and with the destroyed areas, the presentation of the function of these two types of bombs, and statistic dates (information) regarding the number of injured and dead people, and the type of the diseases appeared after the detonations.

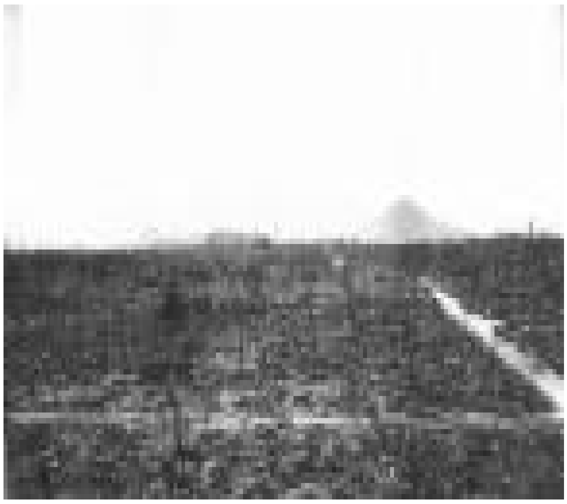

Figure 2. The destroyed areas after the explosion of the atomic bomb

2. The history of the atomic bomb

During the years 1932-1933 the atomic physics made a long road of important steps. At the Cavendish laboratory from Cambridge, the Cockcroft and Walton physicians develop the experience of their professor, Rutherford and attack the lithium nucleus with protons artificially generated, succeeding in disintegrating and transferring them in the helium nucleus.

In 1933, London, the Hungarian physician Leo Szilard makes an intuition of the possibility of using military purposes of the huge nuclear energy. But this is only an intuition, because the physics domain is far from possessing, even from theoretical point of view, the key of conquering the atomic energy.

In 1939 the start of the Second World War interrupted the silent "voyage to the unknown": the science and technique are mobilized for being tools for destructive purposes.

In the same year three of the physicians who immigrated in America, Szilard, Wigner and Fermi, send with the help of Einstein, a letter to the president of America, Franklin Delano Roosevelt, through which they communicate the discoveries made in the last period (a big amount of Uranium can determine a continuous reaction, this reaction developing a huge quantity of energy, and this new phenomena can lead to the construction of some extremely powerful bombs), they make an appeal to the president that the German people already know these things and probably they plan constructing such type of bombs, representing in this way a danger for the hall world, and they demand the approve of constructing (creating) an atomic arm, hoping to realize the same thing before the Germans do. In the same year the president gives an accord to the physicians for starting the action, all the plans and the operations become strictly secret, but only from 1941 they enter in the concrete faze of realizing the atomic bomb. This operation was named "The Manhattan Project" and was conducted by the general Leslei Richard Groves. For realizing this project there were spent approximately three billion dollars, but after two years, almost 150 thousand persons work as secretly as possible at this project. This secret wasn't known even by Einstein, who received the information of the existence of the atomic bomb after the explosion from Hiroshima, when the event appeared in the newspapers.

After the breakout (defeat) of Hitler's army, there was concluded the fact that the progresses made by the German physicians in the direction of constructing the atomic bomb were more reduced than they thought in America. The construction of the atomic bomb was in this way, useless, and people without scruples were preparing to experiment it on the Japanese cities. In March, the year 1945, Albert Einstein sends a new letter to the president Roosevelt, demanding him to renounce using the atomic bomb because of the danger at which it was exposed the human development. President Roosevelt dies without knowing about this letter, and his successor, Truman listens to the voices of the reaction circles. Numerous letters and memorandums of the physicians remained without answer. The atomic bomb threatens the human kind…

At the date of 16th of July 1945 in the desert of Alamagordo, the state of New Mexico took place the first experimental explosion of an atomic bomb, but things were just getting started.

3. "Little Boy"

Figure 3. The photos with "Enola Gay" plane

"Little Boy", how was named the first atomic bomb, the one launched at Hiroshima, in the morning of 6th of August 1945. It was 4.25 meters high, 1.5 in the diameter and had a weight of approximately 4 500 kilograms. “Little Boy” had also a heart, a little part of fissionable uranium, which Oppenheimer said that is looks like “a small diamante placed in a big tampon of wool “, because it represented only 0.5 % (per cent) of the total weight of the bomb. The bomb has, also, chronometric devices, set to function immediately after the launch, for stopping the explosion in the next 15 seconds.

3. “Fat Man”

On the date of August 1945 (hour: 15 and 49 minutes) in the morning, another plane of B-29 type, conduced by the Sweeney major, gets off the aerodrome from Tinian, having on board a bomb with plutonium of 5 tones, named “Fat Man”. It’s power of destruction is of 20.000 tones of trinitrotoluene. There were stabilized two objectives: Kokura and Nagasaki, at the free choice of Sweeney. Reaching the South of Kokura, the major observes that the city is covered with clouds. He heads back to Nagasaki, in front of which he arrives at 11 past 2, he launches the bomb from an altitude of 9000 meters.

4. The followings of the attack with nuclear arms

On the date of 22nd of January 1954 the sailors of the “Fukuriumarii no.5” ship noticed unusual phenomena, the globe of fire of the thermonuclear explosion from the Bikini atoll. As a result all the members of the team and the caught fish were affected by the radioactive ash not only at the surface but in the interior of the organism.

Other following of this explosion was the fall of the radioactive rains in the month of May of the same year, the radioactivity being maintained at a measurable level until September 1954.

In 1956 there were already in the evidence of the hospitals 6000 people ill at Hiroshima and 3000 at Nagasaki with followings after the irradiation, which needed different treatments.

For 1000 years the lands which are under the nuclear radiation cannot be used by people, and after 200-250 years it can be said that the radiation reduces at half its proportion.

	Hiroshima	Nagasaki
Dead	78.150	23.753
Missing	13.983	2.942
Injured	37.425	23.345
Burned	235.650	89.025

The disasters appear from the following causes:

-the intense heat from the explosion;

-the pressures at the wave of shock created by the explosion;

-the radiations;

-the radioactive cloud;

The problems which appear from the cause of these effects:

-the illness, the vomit, the diarrhea;

-the fall of the hair;

-the loose of cells from blood;

These symptoms grow the risk of the apparition:

-Leukemia;

-The cancer;

-The infertility;

-The malformations;

Because of the fact that there were used this type of arms, dangerous for the entire Globe, “the fight” between the Americans and the Japans was named the “Cold War”.

5. Conclusions

The work treats this subject because it has a major importance in forming the personality of the teenagers. In this way they will stop only for a few minutes from being selfish and rude with the people around, because, as Francois Mauriac said, in the date of 10th of August 1945, after the announce of the events from Hiroshima- “the World knows that the matter can disappear in the day in which a man, maybe a single one, will take by himself such a decision”.

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Biohazard's Solar System 2.0

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Abstract. The "Biohazard's Solar System 2.0" project was started soon after the local success of its predecessor. The aim is to give the user a chance to explore the wonders of our universe in a 3D virtual, interactive environment that is rendered real-time and can run on a medium performance PC. Using the built in scripting language you can create cinematic and/or interactive tours with minimum effort. Customizing is simple and effective: solar systems are files generated by the editor provided in the package. Copy such a file in the appropriate folder and it will be automatically loaded by the program. Same goes with tours, textures, fonts and sounds. Designed so anyone can do it. Now all that remains for the user to do is to get comfortable, get a cup of coffee and become the ultimate virtual traveler.

Keywords. Biohazard's Solar System 2.0, 3D Environment, Solar Systems, Interactive Tours.

1. Introduction

It is sad to see that many of the developers these days cripple the concept of edutainment and e-learning with products of questionable quality. Being a student, I have quite a lot of contact with edutainment software and e-learning platforms and, to be honest, I am disappointed with them.

Edutainment was born from the entertainment business. Weather we like it or not, edutainment exists because of video games. Still, while the gaming industry is rapidly evolving (which is a good thing and a bad thing at the same time), edutainment remains the shy, undeveloped child, put in the corner by other money making opportunities.

What we should understand is that developing edutainment software is not an easy task: it is at least as hard as developing video games. The users in the target group are younger, the purpose is more complex and the financial motivation is low. Adding these up we get low quality products.

2. Concepts

The first step I took when I started this project was to analyze the flaws in "Biohazard's Solar System Advanced" as well as other software, and try to figure out a way to correct them. I wrote down things that bothered me at edutainment software and noticed that all issues could be classified in four categories.

2.1. Interactivity

The first and most important concept in video games is also present in the case of edutainment. Unfortunately, it isn't given much importance and quite a lot of products end up being a slide show with a few clicks here and there. I consider the lack of interactivity the ultimate mistake an edutainment developer could make. And it is made so often …

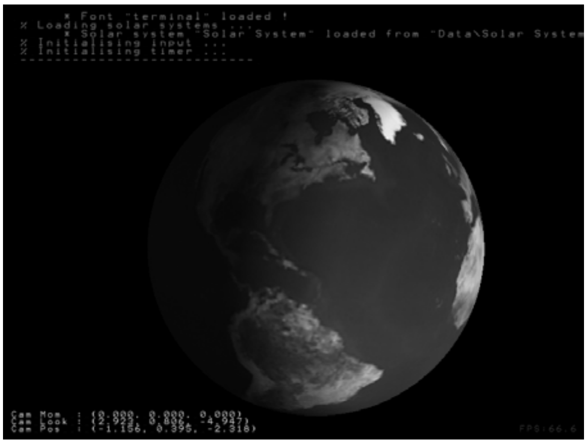

Figure 1. BhSS 2.0 in development

The solution I adopted (considering the nature of my project) is the same one used in most of the games these days: the scripting system. A virtual machine with access to the camera, HUD, graphics, input, sound and timing subsystems, bodies in the solar systems etc will run scripts written in a Pascal dialect (the reason is evident: powerful yet close to the English language). This gives the user the possibility to create his own "tours" (scripts) so he can share his knowledge with others in a custom way.

2.2. Customization

Another issue on the list was the lack of customization possibilities. No matter how good a product is, the information it provides is limited. Sooner or later the user will lose interest and abandon it.

To maximize the time a user is interested in BhSS 2.0, I chose to allow adding new textures, fonts, sounds, solar systems and tours. Everyone will be able to share their work, knowledge or even vision over the universe with other users, encouraging communities to form.

2.3. Appearance

Edutainment software, unlike video games, should have simple, stylish graphics and sound. At no moment the user should pay more attention to the graphic/sound FX than to the information presented. Eye candy means loosing the user and therefore not accomplishing the goal of the product.

I have seen many cases where graphics were plain ugly or stuffed with so much animation that you couldn't concentrate for more than 10 seconds. Dynamic backgrounds and strident colours are the most common pitfalls and, sadly, the most common type of eye candy.

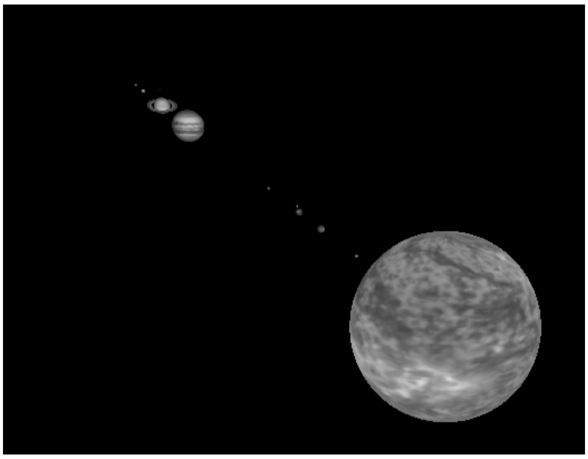

Figure 2. The solar system in BhSS 1.0

In order to avoid the negative effects of superfluous graphics, I cut down the number of FX to the minimum, eliminating anything that "felt" other than natural. This also helps keep the hardware requirements to a medium level, allowing more users to have access to the product.

2.4. Educational content

"What is the target group of users for my product?" should be a question every developer asks himself before starting a project.

This is the most important part of the edutainment software. It doesn't matter how good you are as a developer or artist, but as a teacher. The major pitfalls here are difficulty (too easy and the user will loose interest; too hard and stress will affect him) and bad teaching methods (too monotone and it gets boring; too lively and it just … sounds pathetic).

Figure 3. Cinematic angle in BhSS 1.0

Another issue is whether the content can be learned with or without a teacher. Excluding the teacher from the learning process is very hard to accomplish without side effects (like misunderstanding) but can widen the target group.

When designing a new tour, I always use as much interactivity as possible, plus a few tricks to keep the audience interested (small jokes, surprises etc). The tours can be followed with or without a teacher, although some are specially made for classroom learning.

3. Technical description

I chose Delphi 7 as the environment to develop BhSS 2.0 in, over Visual C++ 6.0 and C# 2005. It compiles faster than both the other, it has tidy code structure (unlike C++), it combines OOP with function oriented very well and doesn't use .NET (which is not the case for C#).

3.1. The engine

The engine used for BhSS 2.0 is developed in-house from scratch. I decided to adopt a modular design after looking back on the BhSS 1.0 code, which was awful to read and understand. As a test, I intend to use it for a strategy PC game that I will start in the summer, to see how far the concept can go.

The engine is divided into several subsystems that communicate with each other. These main subsystems are:

3.1.1. The Display subsystem

Since I'm not using VCL, I had to code the window creation/destruction routines and respond to messages manually. This gives better handling over the window and a noticeable increase in speed.

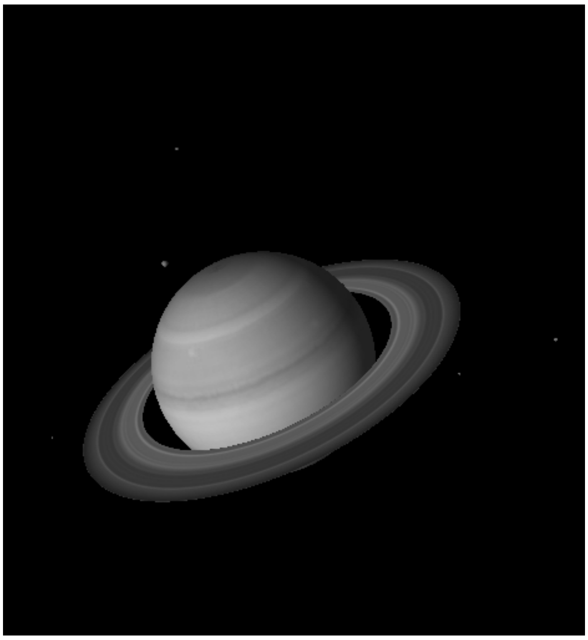

Figure 4. Saturn and its satellites in BhSS 1.0

Also, it simplifies the problem of maximizing the FPS count. When working with VCL, you need to use a whole bag of dirty tricks that, when added up, significantly reduces performance.

Overall, the engine works 20-25% better than a VCL version.

3.1.2. The Input subsystem

It contains low level routines for input detection. It handles key and mouse events (click and drag) and makes sure every other subsystem is notified.

In case of porting BhSS 2.0 to another platform, this and the display subsystem are the only that require major modification.

3.1.3. The Graphics subsystem

I chose OpenGL for real time rendering of the scene because of many reasons. Firstly, OpenGL is very easy to use, with few types, routines etc. Secondly, it is really fast and gives great results with few lines of code. And as a bonus, it is cross-platform so I might consider porting BhSS 2.0 to Linux or Mac.

The first step in rendering a scene is to determine which bodies appear on screen. After this, it comes the LOD processing that calculates the level of detail for each body (if Smart LOD is activated from the setup utility). Then each body is rendered with its properties (atmosphere props, glow props, shadows, transformations etc). If dynamic lighting is enabled, each body projects realistic shadows on the others. This is clearly visible during an eclipse, when each satellite casts a shadow on its parent body.

Then it comes the HUD rendering. The head up display is divided into several sections, some of them being "system output sections" (like the menu, FPS counter, console etc) and some defined specially for the virtual machine to handle.

The most important element of the HUD is the "bubble". It can move around the screen, point to different locations, display output and receive input (from edit boxes, radio buttons, checkboxes etc). Being under the control of the scripting subsystem, the bubble makes BhSS 2.0 interactive.

3.1.4. The Camera subsystem

Moving around in BhSS 2.0 is as easy as in any shooter video game. Turning is done by pressing the left mouse button and moving the cursor around (mouse dragging). The "W" and "S" keys are used by default to move forward and backward and "A" and "D" for strafing left and right.

Also, the camera has smooth movement and can focus on an object (very useful in tours) in order to rotate around it.

3.1.5. The Sound subsystem

For playing sounds, BhSS 2.0 uses the BASS library. There are two types of sound files: the effects (found in Data\Sounds\Effects folder) that are automatically loaded in the memory when the program starts and are used often, and the music

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files (found in the Data\Sounds\Music folder) which are loaded on request.

There are two channels for playing music and two for sound effects, so that they can overlap.

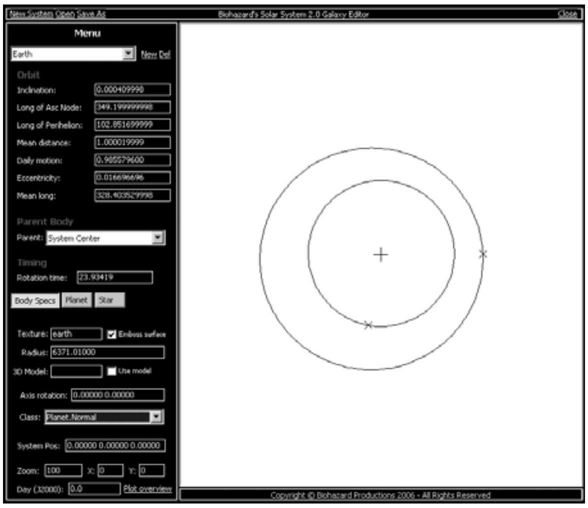

Figure 5. The Solar System editor – Mars and Earth orbits plotted

3.1.6. The Data Containers

The data containers or data libraries give BhSS 2.0 its customization possibilities. They load textures, sounds, models, fonts and solar systems in memory and get them ready for usage. Each library has routines for loading, deleting, retrieving and modifying resources.

3.1.7. The Configuration subsystem

A very important role is played by the Configuration subsystem. When BhSS 2.0 is started, this is the first subsystem that fires up. It then loads settings from the INI file (like resolution, colour depth, HUD colours, camera settings etc) and posts them to the other subsystems. When each subsystem is started, it has all the necessary settings to run without error.

3.1.8. The Scripting subsystem

The scripting language will be a Pascal dialect, with fewer types and routines. Work on it hasn't started yet, but my firs idea would be to have only two types (string and integer) as well as arrays of these types. The code is compiled into a simple language similar to assembler.

The virtual machine will manage the code, variables and external routines. These routines will link the VM code to the rest of the engine, giving the script control over the entire environment.

3.1.9. The Timer subsystem

This subsystem plays two roles. The first is to calculate the time between frames, count the FPS and advance the virtual date.

The second role is to convert between Julian calendar and J2000 epoch calendar (which counts the days since the date of the elements). The latter is used for computing realistic planetary positions.

3.1.10. The Console subsystem

It makes debugging and bug reporting much easier by logging all the actions that took place during the last session. Errors and warnings can be spotted without running any debugger.

Unlike video game consoles, I decided not to let users execute commands, which could cause the program to crash or disturb the script if not used carefully.

3.2. Tools

Customizing is very easy with this set of tools provided with BhSS 2.0. Create your own solar system, tours and modify the appearance of the program. Clean and easy!

3.2.1. Solar System editor

The Solar System editor provides an easy way to create new solar systems for the galaxy or edit the existing ones. Every solar system is divided in bodies, each body having its own properties and a parent body it orbits around.

Orbits are defined by a set of seven orbital elements: inclination, longitude of ascending node, longitude of perihelion, mean distance, daily motion, eccentricity and mean longitude at date of elements. Given these values, BhSS 2.0 is able to calculate the exact 3D position of the bodies at any date.

Properties of the body are divided into three sections: general (texture, embossed surface, radius, 3D model, axis transformation, revolution time and class), planet (if it is a planet – atmosphere, atmosphere size, atmosphere colour, rings, ring size, ring texture, ring alpha) and star (if it's a star – glow colour, glow strength).

Also, a set of three coordinates indicate the position of the solar system in the galaxy. All distances use the AU as a measuring unit.

On the right side of the window, the system is plotted so users can see an overview of the systems they are designing.

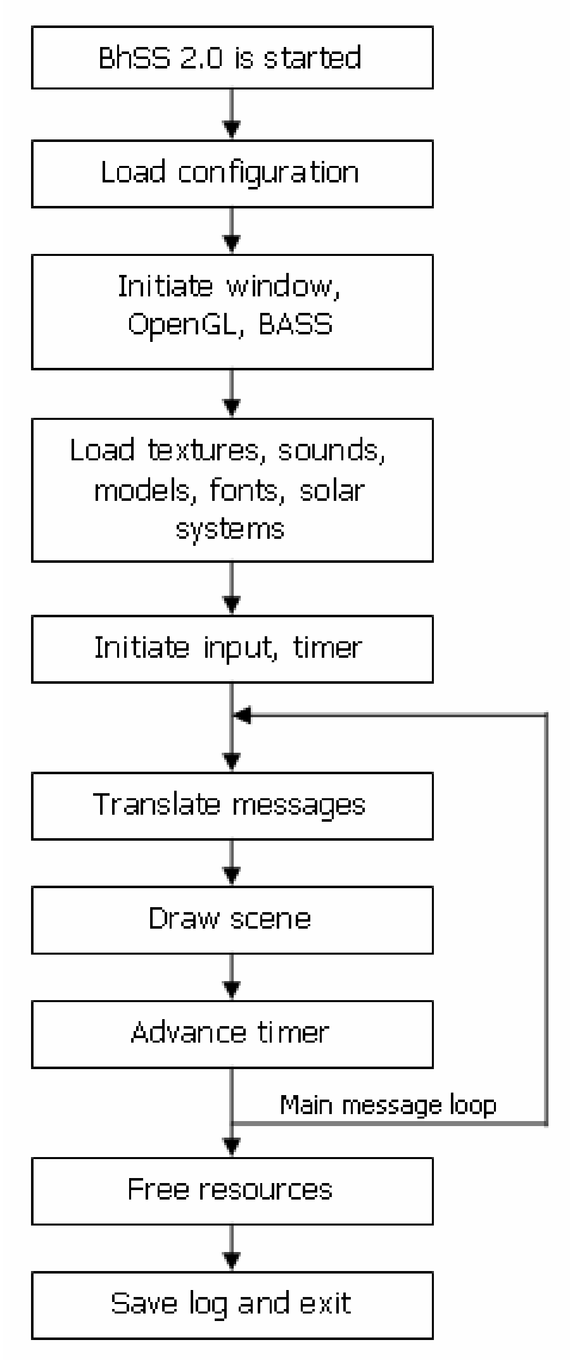

Figure 6. BhSS 2.0 from start to exit

3.2.2. Script editor

The script editor and compiler transform the code from the Pascal dialect to an assembler-like language that the virtual machine understands.

It features a friendly IDE and fast compiler with a simple timeline tool for cinematic tours.

3.2.3. Configuration editor

The configuration editor is a simple tool that modifies the "solar.ini" file, so you don't have to do it manually and risk corrupting it. You can choose the resolution, colour depth, screen state (full screen/windowed), camera properties, HUD colours, controls and many others.

4. Conclusion

Today, the edutainment business is undeveloped and offers low financial opportunities. The only way to promote it is to release more high quality products and the only way to do that is to put passion in developing such software.

Biohazard's Solar System 2.0 is freeware, and will be publicly available for download. I hope that my small contribution will mean something and will encourage other students like myself to develop quality edutainment software.

For the dev diary of BhSS 2.0, go to http://bhss2.blogspot.com

Figure 7. BhSS 2.0 Logo

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Kit and Method for Experiments in Physics/Mechanics

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Abstract. This paper presents a laboratory kit and its correlated method, which have been applied for almost forty years at the State University of Rio de Janeiro. The kit is very simple, resistant and quite cheap. It was idealized to teach Physics/Mechanics. Nevertheless, the ideas supporting kit can be easily transferred to other Physics topics. The method includes students' thorough application in order to mount, understand and explain the experiment, the associated theory and related topics. A complete written report and oral tests about theoretical and experimental aspects are also required by students to pass for. Some old and current problems that method and kit present are also discussed.

Keywords. Kit for experiments, Mechanics, Physics teaching, Teaching method.

1. Introduction

In 1960, after almost ten years working with high schools and university students in Brazil A. Dias Tavares (born 27/February/1917 died 26/February/1988) published a booklet entitled The teaching of Physics ("O Ensino da Física") [1]. In that booklet he appealed to Dewey, Lewin, Battig, Mating, Vandell Kersh and others' ideas [2 -13] to consolidate a teaching method which he tentatively called "Teaching by Guided Rediscovery". From these references we infer that Tavares's method is a constructivist one and we are going to demonstrate his quite original constructivist work by describing his method and practices.

As the constructivism accent is on the learner rather than on the teacher a serious problem originates: how can the student learns at his/her own rhythm using laboratory equipments to interact with and gaining an understanding of the involved matters? So at first, any one interested in using these theories would be able to furnish experimental tools to every single student in order to accomplish the aims of subject learning. But in general this is a too much expensive to be accomplish. Therefore, the development of a kit of experiments was one of the necessary steps of Tavares work.

In this paper we discuss not only the well established work of Tavares, but also some changes he made but does not describe in his constructivist based method, when applying it at State University of Rio de Janeiro from 1970 until 1987. We can anticipate that his very original method accents again the teacher, but now as a kind of master which has the mission to deconstruct [14-16] the so called common sense of student. In this way teacher makes the knowledge construction easier to student and shortening the delay necessary to do that.

2. Theory and the Guided Rediscovery

The method essence as long as it was formulated can be quite well described in the following explanation to the students conceived by Tavares [1]: *We are going to try teaching Physics to you, through a highly efficient method, the most efficient, since you do rigorously the things you are asked to do, since you study with persistence and work in fact.*

Perhaps you think that in such a manner it is not interesting and argue: if we would not have need to study and work to learn then we would have indeed a highly advantageous method. Unfortunately, we do not know any process able to do one learn without studying. We can anticipate meanwhile that the way we are going to try teaching you Physics perhaps is very near of this ideal if you soon fill enthusiastic by it to the point of thinking on it as an entertainment, a diversion.

You are not going to acquire knowledge, you are just going to use your brains to extract knowledge from observation and experiments, therefore you will use hands and tools with which will mount apparatus for your experiments and you will learn to interpret them. In your experiments you will see and understand the limitations that you will be exposed to. You will rediscover a large part of what mankind has discovered in hundreds of years; for this aim you will not use the same methods but some more efficient others; you will be easily driven or

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guided to the conclusions in the experiments we suggest.

Afterwards, all that you have learnt by direct experiment you will retain and boost with graduated drills and problems. The next step is doing your patrimony or acquired knowledge to grow like an alive organism in which all its components parts are functionally interconnected.

We want that your knowledge to be not yours but you; we want to form your personality in such a way that you react to every situation in life which require the knowledge obtained here; we want, and this is our main objective, that you acquire the capacity of studying and solving new problems, inventing if necessary new methods and processes of research and investigation.

In short, what we intend to teach you is a mode to act, to think, to work, to investigate, to research on Physics, and not only an amount of knowledge which is a by-product of the real learning we intend to teach you.

These words can be seen as a summary of the method Tavares has conceived. At this point there were two major problems to implement this teaching method: the teachers who should work with it and the equipments for doing the experiments. Indeed, these two problems are still among the recurrent problems in teaching Physics.

In Tavares's work with high school students he recommended the construction of necessary material by students themselves (*...we look for another solution since was quite evident that it was not possible in our high schools to obtain an individual practice class for every student. The encountered solution was to leave it to the own student and to subject to his/her own enterprise the realization of basic experiments with apparatus that himself would construct with little or no expense at all.* [1]).

Tavares soon perceived that it was not very operational as long as not all the students had the same abilities to make the adequate material. In this way, a teacher must also train the students who do not have the required abilities in them to detriment of Physics learning. So he idealized a very simple set of basic materials with which it would be possible to mount a succession of experiments.

At this point we should comment that the current training of high school teachers at our university involves making the necessary materials. In these courses we are very succeed but one part of training is to teach how to do the apparatus for the experiments.

The method as Tavares and some followers after him have applied can be described as strong activities in Laboratory or somewhere in which students have to mount a series of experiments (about 20 in fifteen weeks of lessons) at their own learning rate. The laboratory remained open a large periods for those students interested in use it out of lessons period. At every experiment the student had to do a report in a notebook and pass over the report correction. Afterwards student must pass over an oral examination about the theory and its experimental implications. Then, the student could pass to the next experiment. The grade attributed after this process was always the highest (10.0) because those conditions were satisfied only and only if the student had learnt completely the theoretical and experimental subjects involved in that experiment. It was very difficult to most students to reach the end of experiments list. The laboratory final grade (sum of all grades obtained divided by the total number of practices) almost ever was lesser than 10.0.

At the end of the course there was an experimental test based on those preceding practices and its grade was summed with that from practices to give an experimental grade. There was still a theoretical grade from theory lessons and with both grades one could reach that of the discipline.

However, the oral tests in laboratory are the most important part and this makes all the difference. There, the concepts are learned and their transference to real situations is evaluated. Besides that is the opportunity professor has to deconstruct the wrong concepts and misinterpretations of theory, experiments and real life situations. In some cases the student submitted to the oral test becomes very stressed because he or she cannot understands the reasons of his/her errors and then they begin to think there is some kind of persecution by the professor. Sometimes this process can be very difficult and unfortunately it is a part of the student transformation process [14-16]. The professor must have a very good preparation in order to meet with the requirements this work imposes. The number of students is also important but we have the experience of one professor and his assistant to attend fifty students in one group.

3. Hands on kit and experimental training

The first efforts to elaborate a set of materials able to mount some experiments of Mechanics used a few little wood boards, some nails, a hammer, a tin cover, an scale or a piece of one, a needle or pin, twine etc. That is enough to mount an experiment to relate a rod deflection with the weight causing it [1]. Besides that a lot of knowledge can be constructed about the weight of bodies, elasticity and so on. Fig. 1 shows a scheme of the assembly and materials.

Some questions should be made about these set of materials: Would be possible to convert these quite raw materials in something more durable maintaining the simplicity of the mounting showed hereinabove? Would be possible doing simple experiments with simple components and still so obtaining a little experimental error? Could these components be used to a number of experiments in Mechanics? Will these apparatus serve to develop the abilities in the student? Could it be such small in order?

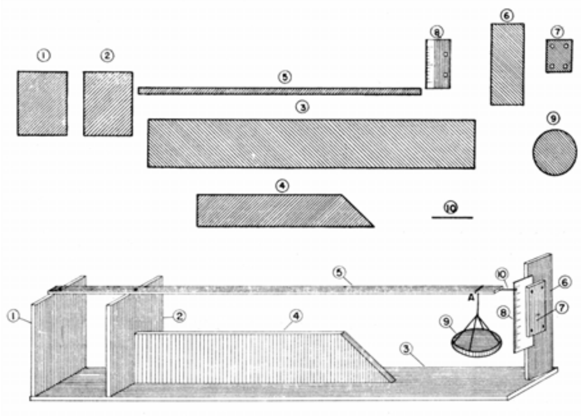

Figure 1 – A simple materials mounted experiment (component parts shown in upper side generate the apparatus below)

a student carry it about like a book? Could be it so cheap that an interested but not rich student was able to buy one? Tavares tried to answer these questions constructing a more durable kit (Fig. 2) all in metal accompanied by a few booklets [17] explaining introductive practices and associated theory. As can be seen in Fig. 2 the number of kit components is not excessive and it is made in stainless steel and brass, except the rule and protractor. In spite of a quite small number of components a fair large number of experiments can be done with it on Equilibrium, Motion, Friction, Rigid Bodies, Angular Momentum Elasticity, Harmonic Motion etc. One of the most important pieces of this apparatus is shown in Fig. 3, it is a coil spring. That coil is transformed in a dynamometer after a convenient calibration and will be used to exert the forces in the practices (Fig. 4).

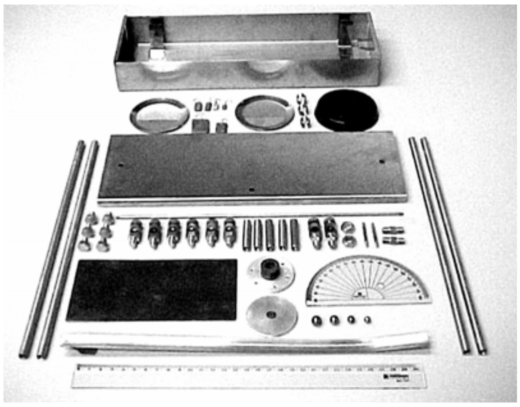

Figure 2. Photography of kit

Therefore, one of the first practices, or the one of the first actions to operate the kit is turning the three furnished coil springs in calibrated dynamometers using the weights (0.5, 1, 2, 2, 5, 10 and 20 g) and scale (30 cm) in the kit. The student has to make a graphic for each one of the springs, and he/she will use these graphs for all experiments using the dynamometers. It seems very easy but actually it doesn't as long as median student are not quite able to make delicate handwork. So, there is a lot of training for the student contained in these very simple apparatus.

In Fig. 4 we can see an experiment of three forces in equilibrium. The student must measure forces in coil springs by measuring their deformation; afterwards he/she measures the angles with protractor. With experimental data students make the

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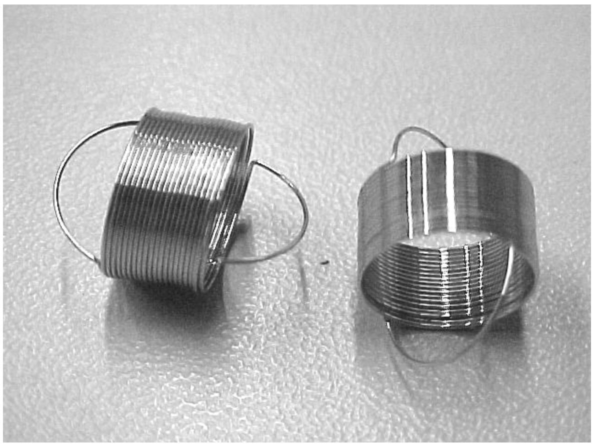

Figure 3. "Dynamometers"

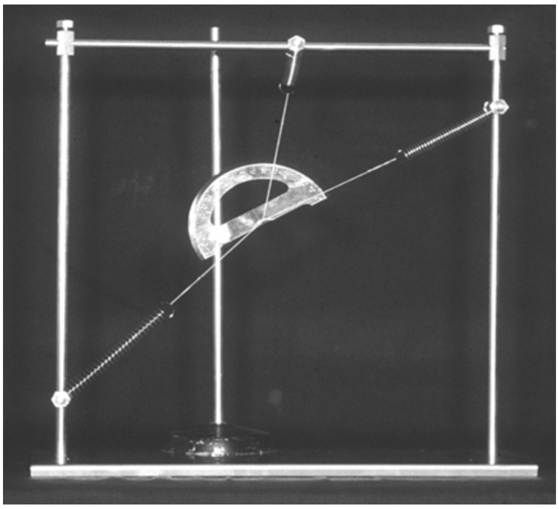

Figure 4. Equilibrium of three forces applied in a point

calculations in order to obtain the error between data and theory. It is quite evident the point of forces application is static so the vector sum of measured forces must be null. In behalf of brevity it is convenient not extend too much this description and we pass to a list of the most common experiments which can be performed with apparatus:

1. Forces – 9 experiments;
2. Momentum – 6 experiments;
3. Balances – 7 experiments;
4. Friction – 2 experiments;
5. Atwood machine - 3 experiments;
6. Rigid bodies – 7 experiments;
7. Moment of Inertia - 5 experiments;
8. Elasticity - 3 experiments;
9. Hydrostatics and Surface Tension - 3 experiments;
10. Harmonic Motion – 5 experiments.

So, it is possible to do at least fifty (50) fundamental experiments in Mechanics with this simple kit.

4. Discussion and Conclusions

We are going to discuss first of all if the questions posed in the preceding section may be answered by this kind of kit or apparatus.

It is quite evident we can convert some more or less raw materials in a simple apparatus. We may say that experiments like the one in Fig. 4 can be mounted with simpler materials. In that case the kit will serve as model to help different mountings of the same experiment (one student might use a wood frame and rubber bands and discover rubber doesn't follow Hooke's law).

Experiments like that in Fig. 4 present a very little error, in general 1% or better. The error in this case is evaluated comparing forces measured with the dynamometers with those calculated to obtain equilibrium condition with those angles.

From the list of possible experiments presented hereinabove we conclude that it is possible to mount a lot of experiments with this simple apparatus. We can add some more experiments in Hydrostatics, for example, adding a little graduated vase.

Figure 5. Student at work (1976)

We consider that this kit can develop not only experimental abilities in students but also other abilities like improving transference between theory and real situations. The abilities of observation, registration of data, the searching for better results, the analysis of experiments looking for improving them, etc, are all extremely profitable for the students.

The all in metal kit dimensions are 33.5 cm long, 11.7 cm wide and 4.8 cm thick, cf. Fig. 5. It weights less than 3 kg, which is comparable to a notebook weight. So one can say it is very portable and can be carried about without great difficulties. In fact, at the first times (from 1970 to 1980) all the students entering the Physics course had their own individual kit. University lent the kits to the students and they could take along the kit and do the experiments at home.

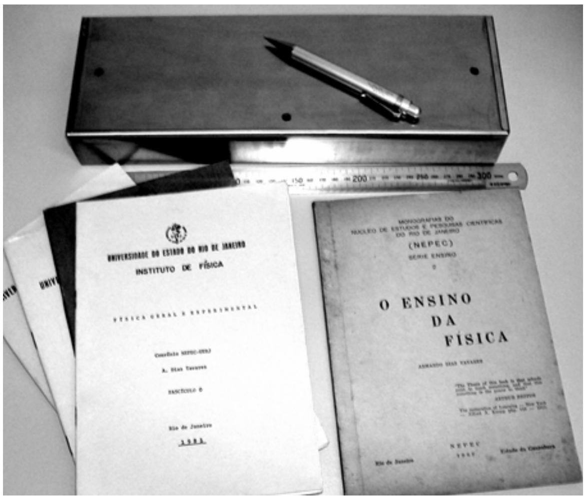

Figure 6. Kit closed for transportation

The materials used to construct the kit showed in Figs 2 to 5 are very resistant, stainless steel and nickel plated brass but we must say these kit have resisted for thirty years or more being used for thousands of students. They have stand very well with some repairs, spring coils (the most sensitive parts) substitution and other little services.

However, if the kit doesn't have to pass over such heavy-duty applications much cheaper materials like plastics and so on can be used. The prices also depend on the fabrication scale, the precision of results one wants to obtain from experiments etc, therefore it is quite true these that kits could be very cheap and within the financial resources of individuals and schools.

The important problem we can point out for teaching using this kit and the method "Guided Rediscovery" is the training of those teachers who will work with the students. If the teachers are not convinced of method advantages and they are not ready to assume a quite tiring routine of work, it is very difficult the method to succeed. It is necessary to have teachers very well prepared in both theoretical and experimental aspects of the discipline and they have to work hardly with this simple equipment to obtain better figures from the experiments and to learn the little tricks of each experiments. So, we have to emphasize the importance of teachers' training, from our experience in our University.

We can summarize reproducing the Arthur Bestor's sentence [18] which Tavares applied in his booklet [1] front cover: *The thesis of this book is that schools exist to teach something, and that this something is the power to think.*

5. Acknowledgements

We would like to thank very much: to FAPERJ by the financial support to preserve A. D. Tavares legacy; to Prof. Dr. A. R. R. Papa for many suggestions and corrections to this paper; to the Congress organizers by the logistic support received and, last but not least, to A. Dias Tavares whose hard work as a scientist and professor has influenced generations of physicists, engineers and others, including us.

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Hands-on Activities with LEDs and Light

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Abstract. In this paper we describe a few hands-on activities with Light Emitting Diodes (LEDs). The experimental procedure consists of measurements with digital voltmeter and spectrometer. The voltmeter is used to measure the voltage across the leads of the LED. The spectrometer is used to estimate the wavelength corresponding to the maximum intensity of the light emitted from the LED. With only these two measurements we are able to calculate two basic constants of physics and nature: Planck's constant h and electron's charge e. We also can find the energy required to light the LED, the frequency of light emitting from the LED and investigate the relation between the frequency and the energy of light emitted by the LED.
Light Emitting Diode (LED) is a special diode that emits light when connected in a circuit and biased in the forward direction. The phenomenon which takes place is the spontaneous emission of radiation in the visible and infrared regions of the spectrum from a forward biased p-n junction. The normally empty conduction band of the semiconductor is populated by electrons injected into it by the forward current through the junction, and light is generated when these electrons recombine with holes in the valence band to emit a photon.

Keywords: Light, LED (Light Emitting Diode), Photon, Frequency, Voltmeter, Spectrometer.

1. Introduction

A serious motive for this work constituted the following questions. Is it possible to execute simple hands-on experiments with LEDs in order to find Planck's constant, electron's charge, the energy required to light the LED, the frequency of light emitting from the LED and to investigate the relation between the frequency and the energy of light emitted by the LED.

For this reason an experimental process was designed and the results was very encouraging. The activity is also proposed for the students of High school that have been taught the nature of light and basic elements of Quantum Physics (photons, Planck's constant etc). Nevertheless it is necessary a theoretical framework as an introductory fundamental lesson-material for LEDs and their way of light emission.

2. Theoretical framework

Light Emitting Diode (LED) is a special diode that emits light when connected in a circuit and biased in the forward direction. Otherwise it is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased

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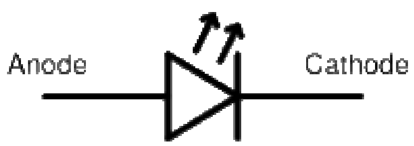
in the forward direction. This effect is a form of electroluminescence. The color of the emitted light depends on the chemical composition of the semiconducting material used, and can be near-ultraviolet, visible or infrared.

An LED is a special type of semiconductor diode. Like a normal diode, it consists of a chip of semiconducting material impregnated, or *doped*, with impurities to create a structure called a *p-n junction*. As in other diodes, current flows easily from the p-side, or anode to the n-side, or cathode, but not in the reverse direction. Charge-carriers - electrons and electron holes flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon as it does so. LEDs will only light with positive electrical polarity. When the voltage across the *p-n junction* is in the correct direction, a significant current flows and the device is said to be *forward-biased*. If the voltage is of the wrong polarity, the device is said to be *reverse biased*, very little current flows, and no light is emitted. LEDs can be operated on an alternating current voltage, but they will only light with positive voltage, causing the LED to turn on and off at the frequency of the AC supply.

Fig 1. LED schematic symbol



The wavelength of the light emitted, and therefore its color, depends on the band gap energy of the materials forming the *p-n junction*. In silicon or germanium diodes, the electrons and holes recombine by a *non-radiative transition* which produces no optical emission, because these are indirect bandgap materials. The materials used for an LED have a direct band gap with energies corresponding to near-infrared, visible or near-ultraviolet light.

LED development began with infrared and red devices made with gallium arsenide. Advances in materials science have made possible the production of devices with ever shorter wavelengths, producing light in a variety of colors. The refractive index of the package material should match the index of the semiconductor, otherwise the produced light gets partially reflected back into the semiconductor, where it gets absorbed and turns into additional heat.

In nonradiative recombination the energy released is dissipated in the form of lattice vibrations and thus heat. However, in band to band radiative recombination the energy is released with the creation of aphoton with a frequency following equation E=hf whre the energy is approximately equal to the bandgap energy E=hf=hc/λ where c is the velocity of light in a vacuum and λ is the optical wavelength.

This spontaneous emission of light from within the diode structure is known as electroluminescence. The light is emitted at the site of carrier recombination which is primarily close to junction, although recombination may take place through hole diode structure as carriers diffuse away from the junction region. However, the amount of radioactive recombination and the emission area within the structure is dependent upon the semiconductor materials used and the fabrication of device.

When sufficient voltage is applied to the chip across the leads of the LED, electrons can move easily in only one direction across the *junction* between the *p* and *n* regions. In the *p region* there are many more positive than negative charges. In the *n region* the electrons are more numerous than the positive electric charges. When a voltage is applied and the current starts to flow, electrons in the *n region* have sufficient energy to move across the junction into the *p region*. Once in the *p region* the electrons are immediately attracted to the positive charges due to the mutual Coulomb forces of attraction between opposite electric charges. When an electron moves sufficiently close to a positive charge in the *p region*, the two charges "re-combine".

Each time an electron *recombines* with a positive charge, electric potential energy is converted into electromagnetic energy. For each recombination of a negative and a positive charge, a quantum of electromagnetic energy is emitted in the form of a photon of light with a frequency characteristic of the semi-conductor material (usually a combination of the chemical elements gallium, arsenic and phosphorus). Only photons in a very narrow frequency range can be emitted by any material. LED's that emit different colors are made of different semiconductor materials, and require different energies to light them.

The electric energy is proportional to the voltage V needed to cause electrons to flow across the p-n junction. The energy E of the light emitted by an LED is related to the electric charge e of an electron and the voltage required to light the LED by the expression: $E = eV$.

3. Materials

1. battery 4,5 V
2. breadboard
3. cables
4. digital voltmeter
5. spectrometer
6. resistor 220Ω
7. five LEDs : red, orange, yellow, green, blue.

4. Experimental procedure

4.1. Implementation–design of the circuit

The circuit is shown in Figures 2, 3, 4 and 5. We used battery V = 4.5 Volt, resistor R= 220Ω (1/4 Watt) and five LEDs of different colors (red, orange, yellow, green, blue). The resistor is to protect the LED from too much current and to minimize the amount of current and voltage available to the LED. So we built five different circuits as we changed the LED D.

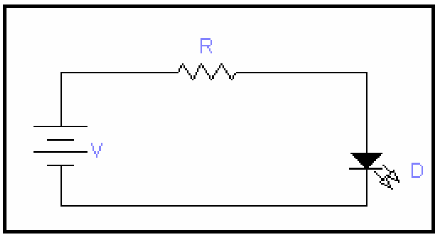


Figure 2

We select the value of R equal to 220Ω. This is a proper value. In Figure 2, when the forward voltage drop of an consequently

$$R = (V - V_{LED}) / I$$

We suppose V_{LED} = 1.9Volt and I = 12 mA. LEDs operate at relative low voltages between about 1 and 4 volts, and draw currents between about 10 and 40 *milli*amperes. Voltages and currents substantially above these values can melt a LED chip. So

$$R = (4.5-1.9)/ 12 \times 10^{-3} = 216.7\ \Omega.$$

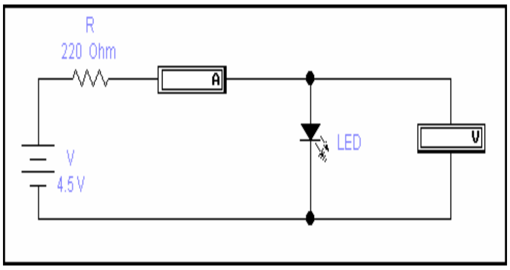


Figure 3

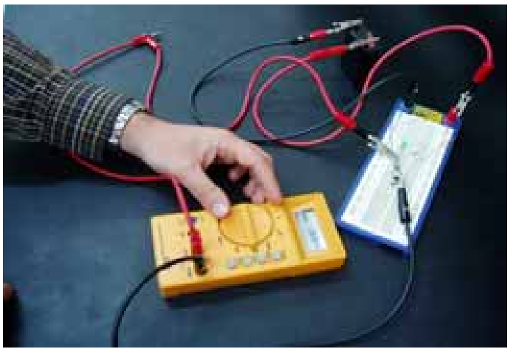


Figure 4. The experiment

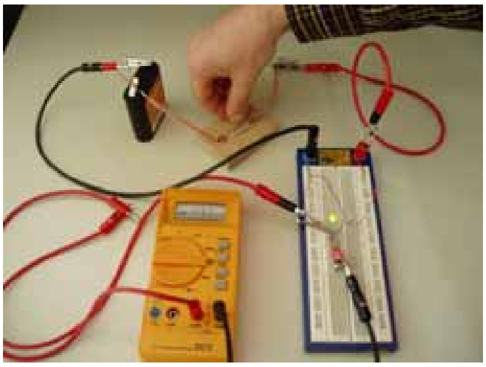


Figure 5. The experiment

4.2. Measurements of voltage across LED

We measured, with the voltimeter, the voltage across the leads of the LED. We turned on the digital voltmeter, connected the probes of the voltmeter across leads of the LED's and recorded the potential difference in volts across each of the LEDs. We constructed a data table (table 1).

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LED color	Voltage ac. LED (V)	Energy (eV)	Energy (*x 10^{-19}* Joule)
Red	1.77	1.77	2.83
Orange	1.81	1.81	2.90
Yellow	1.91	1.91	3.06
Green	2.03	2.03	3.25
Blue	3.05	3.05	4.88

Table 1

4.3. Finding the energy (an LED emit) from the voltage

LED color	Voltage across LED (V)
Red	1.77
Orange	1.81
Yellow	1.91
Green	2.03
Blue	3.05

Table 2

The electric energy is proportional to the voltage needed to cause electrons to flow across the p-n junction. The different colored LEDs emit predominantly light of a single color. The energy of the light emitted by an LED is related to the electric charge of an electron and the voltage required to light the LED by the expression: $E = eV$ Joules. The constant e is the electric charge of a single electron and has absolute value 1.6 x 10^{-19} *Coulomb*.

4.4. Estimation of wavelength with use of spectrometer and calculation of the corresponding frequency

LED color	Wavelength λ (nm)	Frequency f (x 10^{14} Hz)
Red	680	4.41
Orange	620	4.84
Yellow	580	5.17
Green	540	5.56
Blue	440	6.82

Table 3

The spectrometer can be used to examine the light from the LED, and to estimate the peak wavelength of the light emitted by the LED.

Figure 6

Suppose we observe the red LED through the spectrometer, and we find that the LED emits a range in colors with maximum intensity corresponding to a wavelength as read from the spectrometer of λ = 680 nm or 680 x 10^{-9} m. The wavelength is related to the frequency f of light and the speed c of light (c=3 x 10^{8} m/s) with the equation $c = \lambda f$. So we have $f = c / \lambda$ and for the red LED is f = 4.41 x 10^{14} Hz.

We repeat the procedure for the four other LEDs.

4.5. Making plot of frequency against voltage.

Table 4

LED color	Voltage across LED (V)	Frequency f (x 10^{14} Hz)
Red	1.77	4.41
Orange	1.81	4.84
Yellow	1.91	5.17
Green	2.03	5.56
Blue	3.05	6.82

With use of data of table 4 we are able to plot frequency against voltage and make a prediction of mathematical function between them.

4.6.Calculation of Planck's constant

We calculate Planck's constant if take as granted that e = 1.6 x 10^{-19} *Cb*

We have hf = eV so h = eV / f

Table 5

LED color	Voltage across LED (V)	Frequency f (x 10^{14}Hz)	Plank's constant h (x 10^{-34} Jsec)
Red	1.77	4.41	6.42
Orange	1.81	4.84	5.98
Yellow	1.91	5.17	5.91
Green	2.03	5.56	5.84
Blue	3.05	6.82	7.16

4.7. Calculation of electron's charge

We calculate electron's charge if take as granted that *h = 6.63 x 10^{-34}* J s

We have hf = eV so e = hf /V

Table 6

LED color	Voltage across LED (V)	Freq. f (x 10^{14} Hz)	Electron's charge e (x 10^{-19} C)
Red	1.77	4.41	1.65
Orange	1.81	4.84	1.77
Yellow	1.91	5.17	1.79
Green	2.03	5.56	1.81
Blue	3.05	6.82	1.48

4.8. Verification

We take e = 1.6 x 10^{-19} *Cb* and
h = 6.63 x 10^{-34} J s

With use of V measurements we calculate the frequencies

Table 7

LED color	Voltage across LED (V)	Frequency f (x 10^{14} Hz)
Red	1.71	4.13
Orange	1.74	4.20
Yellow	1.85	4.46
Green	1.94	4.68
Blue	2.96	7.14

The results are very close to the experimental values.

5. Conclusion

The experiments are successful because the experimental values and the correlated results are very close to the theoretical values. Also these experiments are very simple hands-on experiments that can be executed by students.

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New Technologies Applied to Science Learning Methods

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Abstract. During the last years we have seen more technological changes all over the world than ever. The influence that it causes in a large variety of sectors is remarkable. In Natural Sciences we have seen a great increase of

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possibilities with the use of powerful computers acquiring data, controlling process and analyzing data graphically or numerically. Therefore the use of those technologies in Natural Science basics courses is becoming so important and should be more and more used worldwide.

Nowadays all the scientific research is computer based, so that is very important that the future scientists get closer contact with computers and analyzing techniques as early as possible. For this reason PHYWE is offering more and more experiments with computational tools, where the students can do the experiments and understand better the scientific theories behind and at the same time learn important computational tools and methods. These tools make also available a much better understanding for the students, because of the powerful graphical analysis, reports formatting and other facilities. With that they can spend their time only to the important steps of the experiments and concentrate their selves much more on it.

It is very important to emphasize that just using computational tools is not the same as simulation. The students are still doing real experiments with their own hands. If they make mistakes they will still be "burning resistances" and see why it happened, so that they would never forget this important theoretical topics and basis.

As the technology are changing very quickly, it is important that the Scientists for tomorrow have already a good background not only about the theories behind their topics, but also about the tools they have to use to performance good experiments in this domain and obtain the best results.

The present session allows to know a litle of the systems TESS + PHYCON + InterTESS, made by Phywe Systeme GmbH. The main goals are:

- The computational tools;
- Graphical analysis;
- Quick, easy and better reports;
- No simulations, but real experiments;
- Easy evaluation from results

Keywords. Experiments, Didactic Material, Phywe, MTBrandão.

Charging and Discharging of a Capacitor (Using TESS with the PHYCON Computer Interface)

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Abstract. This experiment, "Charging and Discharging of a Capacitor using the PHYCON Computer Interface", is identical with TESS experiment "Electricity and Electronics 4.2" (P1373500) - except for the use of the PHYCON computer interface instead of the multimeters and by replacing the power supply with a standard 1.5 V battery.

The main goals are: determine voltage changes during the charging and discharging of a capacitor and determine the time constants involved in the charging and discharging of this capacitor and their dependences on the values of the capacitor and resistor used.

Keywords. Phywe, Physics, Didactic Material, Experiments, Computer Interface.

Alternative Introduction of the Basic Concepts of Special Relativity

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Abstract. We propose an alternative approach to introduce the basic concepts of Special Relativity. In particular, we shall derive Lorentz Transformations making use of a law of electro-magneto-statics and of invariance of electrical charge. The proposed derivation does not require the assumption of regularity conditions of the transformations, as linearity and continuity, required by other derivations. The level of the

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needed mathematics and physical concepts makes the proposed derivation suitable for Secondary School.

Keywords. Lorentz Transformations, Physics Education, Special Relativity.

1. Introduction

Students of secondary schools are fascinated by the suggestive concepts of Relativity, as lengths contraction and time dilation. But their attempt of attaining a clear understanding of the conceptual development of the theory immediately finds an obstacle: to understand why Lorentz Transformations must replace Galileo Transformations. Usually, Lorentz Transformations are derived by assuming that the velocity of light is the same in all inertial reference frames. Then the derivation proceeds by mathematical elaboration, introducing further assumptions of mathematical regularity of the searched transformations, as linearity and continuity. The motivations of these assumptions cannot be well understood by students with the typical mathematical background of secondary schools or of undergraduate university. The invariance of the speed of light is motivated arguing that the solutions of Maxwell equations in empty space are electro-magnetic waves which propagate with a velocity which depends only on universal constants. The full comprehension of this motivation requires to solve partial differential equations. This determines an obstacle, from a pedagogical point of view, to a deep understanding of Special Relativity. In this paper we propose a new derivation of Lorentz Transformations without imposing *ab initio* the invariance of velocity of light which can be obtained as a consequence of the theory.

In deriving the Lorentz Transformations we start from physical principles which allow of avoiding the above cited assumptions. One of them is the fact that electrical charge does not change with velocity, empirically justified by a quite familiar experience: if a solid body, with no (net) charge is heated, then its (net) charge remains zero. Since the increase of the temperature corresponds to an increase of the average kinetic energy of the particles constituting the body, i.e. electrons and nuclei, their velocity becomes much larger than the velocity of nuclei. If the charge was dependent on the velocity, the change of charge due to electrons should overcome the change due to nuclei, and the body would acquire a (net) electrical charge. But this phenomenon has never been observed. We make use of the Principle of Relativity stating that physical laws are the same in all inertial reference frames. It is possible to avoid any assumption of regularity for the transformations, just by imposing an empirical implication of elementary electro-magneto-statics is valid as a physical law in all inertial frames, in agreement with the principle of relativity. The deduction of this empirical implication is obtained by means of conceptual reasoning based on symmetry and reciprocity rather than on mathematical technicalities.

It is not necessary to make any assumption about the way the values of a physical magnitude with respect to different inertial frames are related with each other.

Our derivation consists of the following steps:

1. to show the invariance of lengths transversal to the relative motion;
2. to formulate two consequences of electro-magneto-statics law by using ideal experiments;
3. to show how lengths parallel to the relative motion transform (Lorentz Contraction);
4. to derive Lorentz Transformations.

2. First step: invariance of lengths transversal to the relative motion

Let us consider two inertial frames Σ_1 and Σ_2, with the x axes oriented as in Figure 1 and with relative constant velocity $\mathbf{v} = (v;0;0)$. This vector $\mathbf{v}$ represents the velocity of Σ_2 with respect to Σ_1 but also the velocity of Σ_1 with respect to Σ_2. Let us suppose that two material rectilinear wires are parallel to the direction of the relative motion, and that one wire is at rest with respect to Σ_1, while the other is at rest with respect to Σ_2. By r_1 and r_2 we denote the distances between the two wires with respect to Σ_1 and Σ_2, respectively. Between these distances, which are the measures of lengths orthogonal to the direction of the relative motion, the equation $r_1 = r_2$ must hold.

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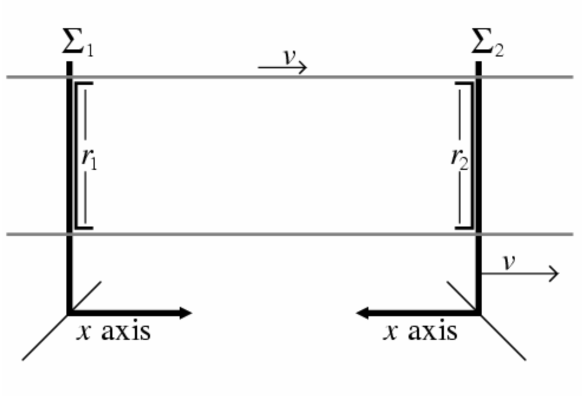

Figure 1. $r_1 \le r_2$ **or** $r_2 \le r_1$ **?**

Indeed, suppose that for an observer at rest in Σ_1 the inequality $r_1 \le r_2$ holds. Another observer at rest in Σ_2 sees a physical situation identical to that seen by the observer in Σ_1, with the roles of r_1 and r_2 exchanged (Figure 2). Therefore $r_1 \le r_2$ should hold and $r_1 = r_2$.

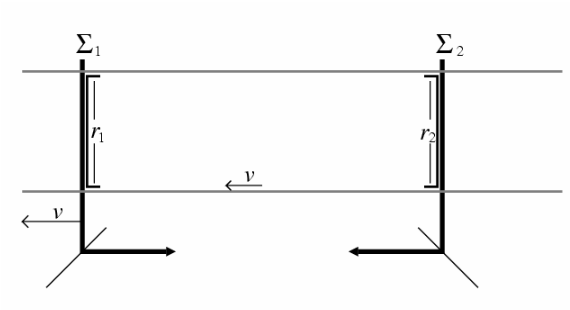

Figure 2. $r_1 = r_2$

3. Consequences of Electro-Magneto-statics

3.1. A first consequence

We consider two parallel rectilinear wires which carry a constant electrical current i and an uniform charge density λ, placed at distance r from each other. Let D be a device consisting of an uniform distribution of identical springs in the plane of the wires, each of them acting perpendicularly on both wires (Figure 3). Let the springs be chosen in such a way that their action establishes equilibrium between the wires. If we change the values of λ or i, the equilibrium is broken, in general. However, if these values are changed into suitable ones $\hat{\lambda}$, $\hat{i}$ equilibrium is kept.

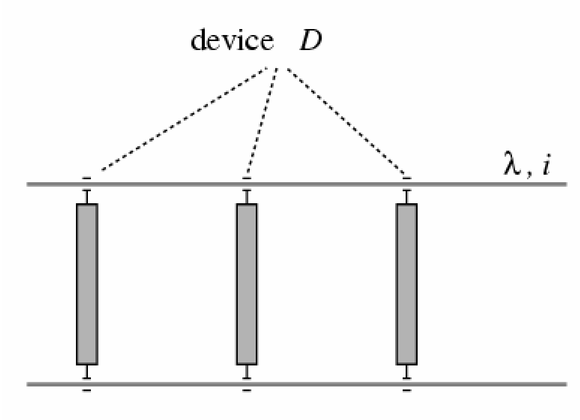

Figure 3. Device D yields equilibrium

The problem of finding the pairs $\hat{\lambda}$, $\hat{i}$ which do not perturb equilibrium is solved by introducing a function

$$\phi(\lambda, i) = \frac{\lambda^2}{2\pi\varepsilon_0 r} - \frac{\mu_0 i^2}{2\pi r} \tag{1}$$

According to the classical Electro-magnetostatics:

(L.1) If the action of device D yields equilibrium for both the two pairs of values λ, i and $\hat{\lambda}$, $\hat{i}$, then

$$\phi(\hat{\lambda}, \hat{i}) = \phi(\lambda, i)$$

As a consequence of the Principle of Relativity, law **(L.1)** must hold in all inertial frames. Usually function ϕ is interpreted as the density of the force acting on each wire as an effect of the Electromagnetic fields produced by he charge and the current on the wires. We emphasize that in our formulation the interpretation of ϕ in terms of force is not necessary, because it plays the role of a tool for ruling over equilibrium in this particular experimental situation. The empirical validity of **(L.1)** can be experimentally verified without making reference to any underlying theory. In so doing, we follow Ampére's philosophy: “The main advantage of the formulas so established [...] is that of remaining independent of the hypotheses, both of those used by their authors in the research of the formulas, and also of the hypotheses that replace the former in the future. [...] Whatever the physical cause one wants attribute to the phenomena produced by such an [electro-dynamical] action, the formula obtained by my-self will be always the expression of real facts. [...] The adopted [method] which led me to the desired results [...] consists in verifying, by means of experience, that an electrical conductor remains in equilibrium under equal forces [...]"[1]

3.2. Another consequence

Let Σ be a frame where the wires are at rest and let Σ' be another frame which moves with a constant velocity v in the direction parallel to the wires, with respect to Σ. We show that device D in **(L.1)** can be replaced by an invariant device I, without affecting the validity of the law. By invariance of I we mean that it appears to Σ physically indistinguishable from how it appears to Σ'.

Our device I consists of two distributions of springs, D_1 and D_2. The first one, D_1, is made up of identical springs uniformly distributed at rest with respect to frame Σ. Each spring acts on both wires. The second distribution, D_2, is made up of identical springs uniformly distributed at rest with respect to Σ'. Let ρ_1, ρ_2 the densities of the springs of D_1 and D_2 with respect to Σ. Hence, with respect to Σ device I consists of a distribution at rest with density ρ_1 and another distribution with density ρ_2 which moves with velocity v (Figure 4).

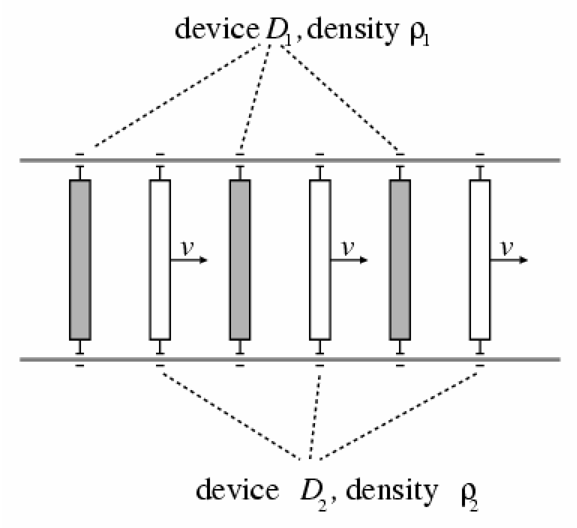

Figure 4. **Device I with respect to Σ**

Let ρ_1' and ρ_2' denote the values of these densities with respect to Σ'. If the density of D_2 is chosen in such a way that $\rho_2' = \rho_1'$, this implies that $\rho_1' = \rho_2$ by reciprocity (Figure 5).

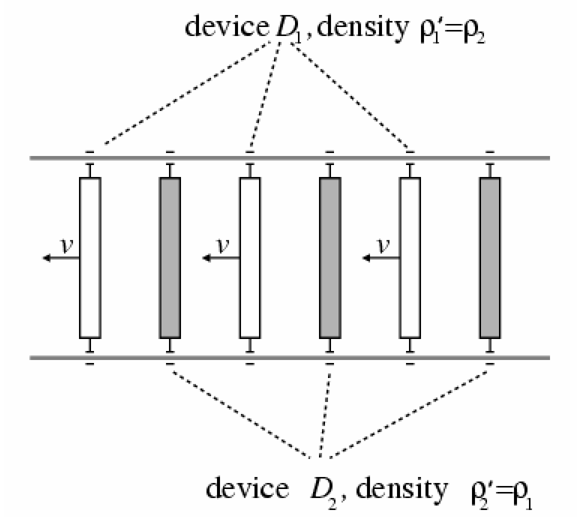

Figure 5. Device I with respect to Σ'

Therefore, as regards to the densities, device I composed by D_1 and D_2 appears to Σ identical to that seen by Σ', apart from an exchange of the roles of D_1 and D_2. How we have done with the densities, the value of any other physical magnitude of D_2, which determines its action on the wires, can be chosen in such a way that device $I = D_1 + D_2$ appears to Σ' identical to that seen by Σ, after an exchange in the roles of D_1 and D_2.

The invariance of I is completed by the fact that the distance r between the wires is invariant, as proved in the first step.

Now we state the following law **(L.2)**, obtained from **(L.1)** by replacing device D by our invariant device I.

(L.2) If the action of the invariant device I yields equilibrium for both λ, i and $\hat{\lambda}$, $\hat{i}$, then

$$\phi(\hat{\lambda},\hat{i}) = \phi(\lambda,i)$$

4. Third Step: Lorentz Contraction

Law **(L.2)** holds also in the case that of charges are at rest in Σ, so that $i = 0$. In Σ' the current is produced by the motion of the wires, therefore $i' = \lambda' v$, where λ' is the charge density with respecp to Σ'. If I realizes the equilibrium in Σ with the values λ, i, such an equilibrium must hold also in Σ'. Since I is invariant, **(L.2)** applies and thus

$$\phi(\lambda', i') = \phi(\lambda, i) . \quad (2)$$

By (1), (2) becomes

$$\frac{\lambda^2}{2\pi\varepsilon_0 r} = \frac{\lambda'^2}{2\pi\varepsilon_0 r} - \frac{\mu_0}{2\pi}\frac{(\lambda' v)^2}{r}$$

which implies $\lambda^2 = \lambda'(1-\varepsilon_0\mu_0 v^2)$; therefore, if we set $\varepsilon_0\mu_0 = \frac{1}{c^2}$, we have

$$\lambda = \lambda'\sqrt{1-\frac{v^2}{c_2}} \quad (3)$$

Hence, the charge density is not invariant. Now we consider a piece of wire of length L carrying a charge δQ with respect to Σ. With respect to Σ', this same piece of wire has a length L' and carries a charge $\delta Q' = \delta Q$. Then $\lambda = \frac{\delta Q}{L}$ and $\lambda' = \frac{\delta Q'}{L'} = \frac{\delta Q}{L'}$

Therefore, (3) becomes

$$\frac{\delta Q}{L} = \frac{\delta Q}{L'}\sqrt{1-\frac{v^2}{c^2}}$$

which leads to

$$L' = L\sqrt{1-\frac{v^2}{c^2}} \quad (4)$$

This relation is known as Contraction of Lorentz.

5. Fourth step: Lorentz Transformations

Lorentz Transformations can be now derived through three sub-steps:

Sub-step (a): we consider the case in which particle P is at rest in Σ on the x axis and we use Lorentz Contraction to derive its law of motion in Σ';

Sub-step (b): we extend (a) to a particle at rest in any spatial point of Σ;

Sub-step (c): by means of the results of (b), we derive the law of motion in Σ' when the particle moves in Σ according to any known law, i.e. we get Lorentz Transformations.

(a). If particle P is at rest in the point of coordinate x of the x axis with respect to Σ, its motion with respect to Σ' is described by the "world line" $(t', x'(t'))$, where $x'(t')$ is the x coordinate of the particle at time t' with respect to Σ'. The particle moves with respect to Σ' with a velocity $-v$. The value x represents the length l of the segment $[0, x]$ on the spatial x axis of Σ. This length l must be related to the length l' of this same segment with respect to Σ' just by Lorentz Contraction

$$l' = l\sqrt{1-\frac{v^2}{c^2}} \quad (5)$$

But l' is also the difference between the coordinates of P and of the origin of Σ with respect to Σ', which are $x'(t')$ and $-vt'$:

$$l' = x'(t') - (-vt') = x'(t') + vt' \qquad \forall t' \quad (6)$$

Therefore, by equating (5) and (6) we get

$$x'(t') = x'\sqrt{1-\frac{v^2}{c^2}} - vt' \;, \forall t' \quad (7)$$

This relation is the law of motion with respect to Σ' in the case (a). The same argument can be used to show that if a particle is at rest in point t' with respect to Σ' then its world line $(t, x(t))$ with respect to Σ is given by

$$x(t) = x'\sqrt{1-\frac{v^2}{c^2}} + vt \;, \forall t \quad (8)$$

(b). Now we consider a particle P at rest in the point of spatial coordinates (x, y, z), with respect to Σ. Our aim is to find the world line $(t', x'(t'), y'(t'), z'(t'))$ with respect to Σ'. Let us imagine a parallelepiped at rest in Σ with a vertex in the origin of Σ, the three edges from this vertex lying along the axes x, y, z and particle P in the vertex with the greatest distance from the origin. With respect to Σ' the coordinates $(x'(t'), y'(t'), z'(t'))$ of P at time t' coincide with those of this last vertex. The coordinates $y'(t')$ and $z'(t')$ are the lengths of the edges of the parallelepiped orthogonal to the relative motion, and therefore are invariant. For the x coordinate, we can repeat the argument of step (a); thus, with respect to Σ', particle P moves according to

$$x'(t') = x\sqrt{1-\frac{v^2}{c^2}} - vt'$$
$$y'(t') = y$$
$$z'(t') = z \qquad (9)$$

(x, y, z are constant!).

Reciprocally, if a particle is at rest in the point (x', y', z') with respect to Σ', then its law of motion with respect to Σ is

$$x(t) = x'\sqrt{1-\frac{v^2}{c^2}} + vt$$
$$y(t) = y'$$
$$z(t) = z' \qquad (10)$$

(x', y', z' are constant!).

(c). If particle P moves in an arbitrary way with respect to Σ, at time t_0 it is in a point (x_0, y_0, z_0). Let us introduce an imaginary particle A at rest with respect to Σ and another particle B at rest in Σ', such that both A and B collide with particle P just in the space-time point (t_0, x_0, y_0, z_0). Our assumption is simply that this threefold collision must occur also in Σ' in a space-time point denoted by (t_0', x_0', y_0', z_0') (Figure 6).

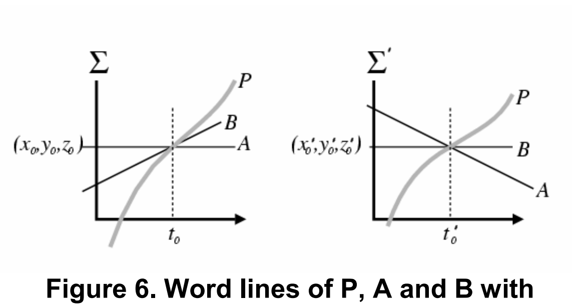

Figure 6. Word lines of P, A and B with respect to the different frames

Since B is at rest in Σ' its position is just the location of the impact, i.e. (x_0', y_0', z_0'). The space-time point of the collision must belong to the world line of particle A in Σ'. Therefore by (9) we have

$$x_0' = x_0\sqrt{1-\frac{v^2}{c^2}} - vt_0'$$
$$y_0' = y_0$$
$$z_0' = z_0 \qquad (11)$$

where (x_0, y_0, z_0) are the constant coordinates of A with respect to Σ.

Reciprocally, the space-time point of the impact with respect to Σ must belong to the world line of B in Σ. By (10)

$$x_0 = x_0'\sqrt{1-\frac{v^2}{c^2}} + vt_0$$
$$y_0 = y_0'$$
$$z_0 = z_0' \qquad (12)$$

where (x_0', y_0', z_0') are the constant coordinates of B with respect to Σ'.

By rewriting (11) and (12) in explicit form, we get the usual form of Lorentz Transformations:

$$x_0' = \frac{x - vt_0}{\sqrt{1-\frac{v^2}{c^2}}}$$
$$y_0' = y_0$$
$$z_0' = z_0$$
$$t_0' = \frac{t_0 - \frac{v}{c^2}x}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (13)$$

6. Conclusions

A difficulty in introducing students to Special Relativity by starting from Lorentz Transformations is that they are short of the mathematical knowledge to follow the usually derivations of the transformation based on the invariance of velocity of light. Many authors propose new approaches to Relativity *without light* [2], [5], [4] highlighting the pedagogical advantages. However, these approaches entail an higher level of mathematics, hence they is unavailable for a first introduction of Relativity. Interesting proposal avoid the Lorentz

Transformations at all, exploiting particular examples of the relativistic phenomenology [3].

In our opinion because of the counter-intuitive character of the predictions of Relativity, a pedagogically effective way of developing the topic would be the deductive one by starting just from Lorentz Transformations. Our derivation is based on physical concepts well known to students; it does not require assumption difficult to motivate and it is free of mathematical complications. In particular: it does not require assumptions of regularity of the transformations, differently from the other approaches [4]; the needed mathematics is elementary algebra; the needed physical concepts stop at elementary Electro-magneto-statics.

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Modern Art and Physics. A Didactic Experiment

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Abstract. The work "Cubism and Modern Physics - a Didactic Experiment" presents the attempt, involving young pupils (14 - 15 years old), to approach scientific knowledge through an unconventional method: the transposition of Physics concepts into graphic

Images. The experiment emphasized the capacity of these young pupils to analyze, to synthesize and to abstract. I also verified the way this course having a trans-disciplinary character (Physics – Art) can widen the cultural universe of the collegian and their possibilities to understand abstract concepts of Physics.

"The wise Ancient Times taught us the Muses are sisters. Knowledge is but one : languages, literature, history, physics, mathematics, philosophy, branches of learning which seem distant are actually very close, or better said, they combine in order to create a system which, due to our own limits, we perceive in sequences, as distinct parts. But there will come a day when we'll try to perceive the impressive harmony of knowledge. This is, in fact, the meaning of the human knowledge progress: first of all science, then science and yet again science." (Jules Michelet – "Discourse on the Unity of Sciences" – 1825)

I have chosen this quote for the idea it renders, but also in order to underline the fact that since ever educated people have concerned themselves with achieving an integration of the various forms of knowledge, as the representative of the industrial era – Jules Michelet puts it, an era dominated by a very clearly divided educational system. The means through which we, as teachers, succeed in integrating knowledge from various areas are the inter-disciplinary and trans-disciplinary approaches.

The fundamental advantage of the inter-disciplinary approach is rendered by the achievement of the transfer of knowledge from one area into another. The false frontiers between various school subjects fall down, and the child receives a general perspective on the world. As to the trans-disciplinary perspective, the essential advantage thereof consists in the global presentation of the phenomenon, which makes it possible to be anchored within reality.

In the following I shall present an experiment which I carried out together with 27 students aged between 14-15 years old

During several classes of my optional course – "Physics and Aesthetics", I tried to revive certain experiments made by cubist artists that were finally translated into works of art. The steps of my experiment were as follows:

1st stage : students initially received information suitable for their age concerning scientific aspects – the concepts of space and time were presented from the perspectives of classic and relativist Physics;

2nd stage : students elaborated short (scientific) essays focused on their knowledge concerning the problem of relativity in Physics (this stage had the role to verify the understanding of the concepts previously presented);

3rd stage : students made an artistic transposition of their knowledge concerning Einstein's relativity by presenting little works of art they produced(drawings, paintings, collages);

4th stage : students were presented with the cubist phenomenon – the directions of the theorists of this trend and the aesthetic achievements of the artists (works of art and literature);

5th stage : students could compare their own products and their ways of illustrating the approached scientific ideas with the ones of the great cubist artists.

The last stage of the experiment was necessary in order to help the students to better understand the cubist phenomenon and its particular expressive forms as opposed to classic art. The discussions I had with my students attempted to underline several aspects:

The novelty of Einstein's theory towards the classic theory of Newton;

The innovating character of the cubist trend especially in modern painting and sculpture

The opening of the 20th century artists towards the new scientific theories;

The existence of a permanent change of ideas and experience between the two ways of approaching knowledge – scientific and artistic knowledge.

I reiterated this type of experiment within all the topics the above mentioned optional course approached, a course which included various concepts in Physics:

Interactions and fields in Physics and Arts;

Gravity field in Physics and Arts;

Central field in Physics and Arts;

Space, time, movement in Physics and Arts;

Equilibrium in Physics and Arts;

Continuity and discontinuity in Physics and Arts;

Colour and sound in Physics and Arts;

Conclusions

The direct results which could be observed were relatively gratifying, as the students approached notions that were unknown to them and quite difficult to understand for young people aged 14-15. The students showed enthusiasm and interest for the new concepts, and thus a real trans-disciplinary approach was achieved. Despite the students' age, I noticed how easily they assimilated concepts relatively difficult to approach even for older students. A special role was played by the eagerness for novelty which is specific to their age. However, what should be emphasized is the students' ability to illustrate in an abstract way the approached concept – "multidimensional space", ability which could be compared, in my opinion, to the one available to adults. Out of the 27 pictures only one had a rather naturalist character, all the other displaying a strong abstract character.

Proportionately speaking, it could be stated that the students re-created a moment from the history of human knowledge, that had been unknown to them until that moment. Together with my young students, I reiterated the cubist experiment, which underlined yet another time the fact that the age between 14-15 years old is favourable to abstracting and also to dreaming of unknown universes. Through "playing" (in this case painting) the young student receives a smoother grasp on the abstractions of science, even if the rigours of science are unknown to him/her. However, what is really important for the future experience of the students involved in the experiment is the moment of authentic creation which was trigerred by a scientific theory on whose force lines they had been informed.

I dare say that this approach of Physics manages to stimulate such intellectual operations as : analysis, synthesis, abstracting, at the same time forming a foundation for the development of the student's creativity. Teenage time is the period of building intelectual awareness which strengthens the foundation of solid education. It is why I believe that the designing of optional courses having a trans-disciplinary cultural character is absolutely necessary, if not compulsory.

Each chapter of the "Physics and Aesthetics" course was concluded with the organizing of a mini-exhibition displaying students' works,

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which reinforced the information concerning Physics. Obviously, I was not interested in the artistic achievement of the students' works, but mainly in the methodological approach targeted at the understanding, however superficial, of a difficult theory of Physics by young students.

Another conclusion of the experiment refers to the students' artistic abilities to express ideas and concepts even in the absence of special training. Having these concepts as a starting point, both the students and the 20th century artists demonstrated the same type of plastic abstracting and expressing abilities, since their works had ideatic similarities. The only difference could be found in their pictorial techniques.

To conclude with, I consider that the didactic experiment I designed and conducted was a successful one and this is why I want to share it with other teachers of Physics.

Keywords. Physics, Art.

2005 The International Year of Physics Reflected in a Poster Exhibition

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Abstract. Nowadays studying a subject like Physics may seem a venturesome choice, to say the least, if not absurd. When financial success is the main criterion in choosing a career, it is rather unlikely that a high school graduate might wish to opt for a science subject such as Physics. In the last years, within the Romanian educational system, the study of sciences has probably fallen not on the second level, but on the tenth one, which is understandable since the lack of perspectives for the scientist on the labour market is adjoined by a total lack of publicity that, nevertheless, certain institutions could provide for this area of training.

In such a context, little favourable for the study of science domains, one could still discover certain grains of interest on behalf of our students only when the teacher succeeds in transmitting the student some enthusiasm which is, at times, rather disproportionate towards the subsequent results of the latter. More often than not, participating in school competitions or in any other structure meant to examine students' knowledge in Physics is viewed if not with complete lack of interest, then at least with lack of trust, due to the fact that teenagers' attention is not drawn towards this field by anything special, despite the existence of the Internet and publications targeting at popularization of science (since the access to such means of information is not affordable for the average man). Under such circumstances we, as high school teachers, can only orientate students' attention towards studying sciences through alternative methods which should be pleasurable and stimulate their interest. In the last fifteen years we have used various unconventional methods in studying Physics, out of which we can mention:

- Plays written by teachers ("Lesson of the Colors") or by students ("Light from the Depths") which were staged in our high school with the help of our students as actors. The accumulated material necessary for the writing of the plays was based on the students' portfolios concerning certain topics.
- Optional classes oriented towards bordering areas : "Physics and Aesthetics", "Inventing".

In order to celebrate the International Year of Physics we decided to organize a competition involving students and teachers from our school to promote Physics as a study field through advertising posters. The posters were either designed on computers or produced with the help of more traditional techniques. The best posters were granted awards, as the competition benefited by sponsorship.

All the posters were exhibited in the large hall of our school so that they should be seen by anyone wishing to. The jury who selected the awarded posters was made up of non-competing students and teachers of Physics.

The entire event was concluded with a mini-exhibition, and the awarded posters participated in the national level of the competition (also organized and hosted by our school). Subsequently, the entire exhibition was displayed in the hall of the Faculty for Physics from Bucharest as part of a series of activities celebrating the International Year of Physics organized by the Faculty together with the French Institute.

The "International Year of Physics through Posters" was carried out within the European programme "Hands on Science".

Keywords. Physcis, Hands-on Science.

Exploring Children's Spontaneous Ideas of Magnetic and Gravitational Fields Hands on Exhibits

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Abstract. Key points in motion are fields, action at a distance, field lines and the trajectory of an object in a field. Children's (age 5-9) intuitive ideas about gravitational and magnetic fields were explored in the informal context of scientific culture diffusion. The inquiry uses several instruments: oral questions based on a written questionnaire, discussion with some part of Rogers' dialogues and children's drawings (sketch and icons). The analysis begins by considering first static situations and then dynamic situations. In magnetic fields, children's previsions of trajectories of a steel ball were probed. Children's reasoning are of great interest because they help in the construction of learning proposals for teaching and learning the field as a unifying concept.

Keywords. Alternative Ideas, Children's ideas, Fields, Motion, Trajectories.

1, Introduction

Scientific and technological learning has a local nature, partly tacit, and cannot occur only through written or verbal communications [1,2]. Physics is a formalized experimental science and the relationship with phenomena represents both object and methodology in the learning process. The connection with phenomenology cannot be reduced to an experimental activity in predisposed contexts [3] and so needs an epistemological reference which gives meaning to actions [4].

Scholastic didactic activity is mainly organized in such a way as to not predict the overcoming of individuality in the learning process [5] and the comparison of hypotheses and heterogeneous models, knowledge and differentiated experience [6,7].

The missing connection between daily experience and scientific knowledge taught at school creates learning difficulties [8] which play at an interpretative level inhibiting the process of models generalization. These are once again the result of a teaching method which does not focus attention on the way in which individual items build up knowledge, on cognitive and learning problems, on the practical, working and intellectual involvement of all subjects in didactic activity [9,10,11,12]. Recent studies [13] have shown how many learning problems are determined by the teaching of physics which pays scant attention to methodology and the subsequent tendencies to generate 'inert tendencies of knowledge' [14] not fruitful outside the scholastic environment.

Literature on everyday cognition [15,16,17] has highlighted a contextual character, sensible and often tacit [18] of informal knowledge which is acquired interacting with other subjects and taking an active and practical part in daily life. In our research, over a number of years, we have dealt with the study of ways to build up the ability to mediate between different types of knowledge and learning [19,20,21] with the aim of giving a contribution in the specific area of disciplinary and learning knots, in an informal context [22-29]. Particular attention was paid to the ways of formulating a new understanding of the world, based on the theoretical generalization [30]. Learners are encouraged to use key concepts to identify connections which are not distinguishable from mere observation, in the context of our Games Experiments Ideas (GEI): a hands-on exhibits whose main characteristic is to be maked with simple everyday materials which can be used for experimental explorations [26]. In this context the proposals are those of "discussion by doing something", in order to highlight conceptual relationships and to study how individuals put their acquisitions inside what Bakhurst [32] calls 'reasoning space': how theoretical concepts are used to mediate understanding of experiments and how the latter are used to re-think theoretical concepts. The informal context allows us to confront one of the

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principle challenges: how to cross the borders between instruction and using instruction [32].

The exploration of reasoning in an informal context is carried out by means of semi-structured interviews, worked out with reference to the definition of competence stated by [33], moving from a situation, through means of the suggestion of interpretative elements of the theory, in order to gather together different operations, which constitute complex actions carried out in different fields of activity [34, 35] The degree to which individuals can re-situate knowledge and ability is a central problem to research [21]. Attention on "re-situating" enables us to distinguish between the application of knowledge and ability in at least two different types of border crossings: a) taking a known activity to a new context; b) using the problems which arise during the carrying out of a task to develop a new plan of activity in a new context.

Among the pupils' learning knots [36] there are often the ones ([1]) that scientists encountered in the process of building physics theories: they have a privileged position in offering different and partial representations, which are presented in an alternative and separate way to the physical meaning of the entity.

The concept of field is one of these. It has an autonomous nature in mathematics. In physics, it is re-interpreted with a role of synthesis and generalization, referring to different types of field and a complex nature respect to various phenomenologies. It is a typical physical entity[2], object of interest also from the point of view of disciplinary foundations. Considered by physicists themselves only a formal (mathematic) object, an object /physics entity (for example the electromagnetic field), property of a physical system (for example the field of the velocity in a fluid) or as a property of space or a structure or a tool for describing interaction [37}, it occupies a privileged position among the basic concepts for the building of a physics education.

In didactic tradition it is used as an example of the formalised analogical process. Its phenomenological aspects and its characteristics of time and space are only partially described for the various types of field, mixing the descriptive and interpretational levels[3]. The local characters are never discussed with the general ones and properties are presented depending on the type of field, without giving a role to the compared physical meaning of formal entities, which have the unifying power (field lines, potential, flux).

As happens for other abstract and/or general concepts[4], which recall the human toil required to acquire familiarity with their representative power, many ignore it or consider it in a reductive way in school didactics, while even younger children have intuitions that allow to deal with the physical meaning at a high level of abstraction and symbolic representation [38].

In this article we present an experimental research carried out in an informal operative context, to study in depth some learning problems mentioned in literature and single out the reasoning and conceptual organisations of children facing interpretative problems, in emblematic situations. Formal and objective analogies have been studied for this specific research, and also the proposed situations and the work protocol. This allows identifying the results which are useful to didactic action, even though they are obviously partial compared to the ample subject dealt with.

2. The Research Questions

Research on learning problems has shown the following main problems:

1) action at a distance [39,40,41]*)*: the conviction that a medium is necessary for the transmission of interaction, associated to the idea of field as a definite space region and therefore as a support (structure).
2) the representation of field and the role of field lines*:* interpretation of field representation by field lines, objectualization of field lines by students, difficulties in recognizing differences and in integrating alternative representations of fields (field lines, equipotential surfaces,..) [41-45].

[1] The difficulties children meet obviously are not only the historical interpretative knots or those unifying concepts which single out new physical entities: there are also various cognitive aspects, which complicate the problem.

[2] The nature of the concept of field summarises physics' modalities in interpretative processes.

[3] The confusion between the descriptive and interpretative levels is a typical problem of formal didactics and a lot of proof may be found in research on learning processes (Bosio et al 1997)

[4] The case of fractions in maths is famous: though handled with ease by primary school children, they are a complex learning problem at the ages of 14-16

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3) the identification of the trajectory of a moving object, within a field, with field lines.
4) the dissociation between the weight, the free-fall of bodies and the gravitational field *[46-49]*.
5) Earth shape and its gravitational field, the relationship between children's concept of the Earth and the direction of the gravitational field
6) the different way of looking at static and dynamic conditions
7) the loss of meaning of force concept and the difficulty in recognizing that interaction is reciprocal (third law of dynamics) in the different fields: the gravitational one [39,48,49,50] the magnetic and electromagnetic one [40, 51,52].
8) the connection between gravity and magnetism: many students identify gravitational effects with magnetic ones, considering gravitational attraction as a magnetic one. They also connect gravity and magnetism on the Earth, considering *gravity* as necessary for a magnetic field on the Earth (uniqueness of Earth system).

In all these researches different methodologies have been used (questionnaires, open or closed interviews, drawings, ...) and on different subjects of different groups of ages (pre-school level (4-6), elementary (6-11), secondary (11-18) and university). Therefore, each of these researches has a partial value and cannot be directly compared with the others, even if – notwithstanding the methodological and set-up differences – each one has encountered the same conceptual knots; all this is a further reason to consider and study the problem.

In the last three years we carried out a preliminary study through cognitive laboratories CLOE [27] on magnetic and electromagnetic phenomena, with semi-structured interviews, starting from a series of proposed situations. We collected special aspects on the observations and characteristic traits of the interpretative reasoning on the interaction of magnets with other systems (magnetic, ferromagnetic and inert), which have laid the foundations of this work, in which the problems that have been particularly investigated are the following:

- ***properties of space***: are there special situations to recognize the existence of properties of the surrounding space that manifest themselves through interactions? How can interactions and/or the properties of the points in space be recognized?

- ***conceptual connections*** on the disciplinary level: how can a more general view of force be retrieved?

- ***connection between phenomenology and interpretative models***: which reasoning are associated to local and/or global contexts and which have a descriptive nature with regard to the interpretative one?

- ***analogies:*** can the analogy between common characters of different fields be activated spontaneously? In which ways?

- ***representation of the field and trajectories***: which informal modalities activate the conceptual re-elaboration that distinguishes the two representations?

- ***generalities and particular cases***: is the global vision obtained as an *a posteriori* thought or is it a conceptual instrument at the base of recognizing events and similar properties in an operative context?

- ***objectual models***: can the role of mediation between global and local representation be facilitated by a concrete analogical model? What role does it play? How is it perceived?

- ***relations between concepts***: what relationship are created towards other concepts in the spontaneous exploration of gravitational and magnetic phenomena? (idea of space, of field, of potential, of interaction).

In this work the exploration of reasoning has been carried out for the cases of the gravitational and magnetic fields. For the gravitational case it still starts from a situation, through the suggestion of an object analogical model, which in this context represents the element of theory. For the magnetic case it starts from the representation of the magnetic field's force lines, built up using of different explorational elements (compass, iron filings, steel ball) in the space surrounding the magnet.

A compared analysis of the outcomes of the semi-structured interviews and of the written and

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graphical products, related to a definite exploration procedure in an operative context (situated) in the two cases, indicates potentialities and ways for analogical comparisons able to produce a more general and organic vision of the concept of field, both gravitational and magnetic. The purpose is to find the essential elements and the secondary ones that help the child in the building of the concept of magnetic and gravitational field.

3. Methodology of Research

The work has been prepared following these steps: first analyse and compare studies in literature about the learning of the topics, then single out historical, cognitive and common sense conceptual knots pointed out in the literature, then prepare the protocol and materials.

Children's (age from 5 to 10) spontaneous ideas have been explored: 12 primary school classes have participated in an activity in the informal context of the diffusion of scientific culture, which includes the interactive exhibition GEI [26], organized every year for schools from the suburbs. The two groups of 74 children who participated in this activity were randomly selected from all the participants (258 children).

Three inquiry instruments were used: 1) conversation with stimulating questions about the conceptual knots considered and some parts of Rogers dialogues [53] in order to explore learning sequences, 2) a written questionnaire based on graphs and icons, in order to explore children's intuitive ideas about Earth's gravitational attraction, gravitational and magnetic field lines, 3) gravitational field model proposed by Eddington, consisting of a big rectangular box covered with a tight elastic cloth: when a heavy sphere, representing the Earth, is put on the membrane, it deforms, creating a hyperbolic curve; quiet or moving masses, with different velocities, are put on that surface .

The following aspects of daily life are analysed: the contexts within which the subject is able to act and the activities carried out, the outcomes of the activities and the instruments used to obtain them. The primary objective is to express the ideas, the reasoning and the interpretative relations to make them visible and recognizable [54], because they do not fall within the rules foreseeable a priori and they are a reference for re-elaboration.

From the cognitive point of view we proceed with analogical modalities, the ways through which people – by building symbolic representations of the experiences lived - establish relations which allow them to make comparisons and understand similarities and differences from which they can take action [34].

The analysis begins considering experiments first in static situations: reflections on falling bodies, gravitational and magnetic force are proposed by interviews and drawings of the experiments observed with small groups of 3-7 children. Magnetic field lines are constructed observing the interaction between the magnet and several field probes (iron filings, compass, steel ball), while drawings are used to represent gravitational phenomena (free-fall of object all around the Earth). Then, considering dynamic situations, we explore the interpretative prediction of moving objects behaviour in the part of the fields represented: in the case of the gravitational one an analogical objectual model [figure 6] helps this prediction, while in the magnetic one we explored children's prediction of trajectories of a steel ball moving in the sphere of action of a magnet.

Children are asked first to predict the behaviour of the system that interacts with the field in both cases (gravitational and magnetic) and in both situations: static (free-fall on the Earth, interaction between the magnet and field probes) and dynamic ones (use of Eddington model, steel ball moving in the sphere of action of a magnet).

Then children observe the behaviour of the system considered, they compare it with their predictions by discussing in group and with the interviewer, and they give motivations for this behaviour (gravitational/magnetic force or field).

The inquiry, from a chronological point of view, was carried out following these steps for both fields: 1) oral questions according to Rogers dialogue; 2) children's drawings on the shape of Earth and on the trajectory of objects that fall on the Earth's surface / observation of the magnetic field's lines using different field probes and discussion in group; 3) oral questions on the prediction of the movement of objects in a state of rest or in movement within the field (gravitational / magnetic) considered; 4) use of the model of gravitational field / steel ball moving in the sphere of magnet action.

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4. Data analysis and main results

In the informal context of exploring children's spontaneous ideas, the way in which pupils sometimes use language or drawings to understand real events is decisive, for example to make a real event symbolic through the use of a metaphor, which could allow them to attribute to this event a more ample meaning, connecting it to an abstract image of the process.

From the analysis of children's predictions, observations and motivations of the behaviour of the systems considered, the main result observed is that in the process of attraction they recognize more easily the source of magnetic force or field than the gravitational one.

In fact it appears that this is the case concerning magnets most of the pupils (94%) interpret correctly the role of the magnet and recognize it as a source of magnetic force or field, while the situation is not so clear in the case of gravitational phenomena. not sustained either by themselves *"we let / do not hold them"*, or by something *"air doesn't support them"*, or by gravity itself (the concept of "*reverse gravity*") [39-41, 47]; 2) the context, that can be local (*Earth attracts objects*) or global (*the interaction of two masses*); 3) the properties versus the system, frequently children associate the system with system properties they have recognized *("gravitational force* ***is*** (instead of being produced by) *a sort of big magnet that glues our feet to Earth").*

Table 1: *Children's interpretations of magnetic interaction*

Magnet as **source of magnetic field** or magnetism as energy **42%**	*"There is a magnetic field"* *"There is an energy, magnetism"* *"There are magnetic waves"*
Magnet as **source of force 54 %**	*"The force comes from the magnet"* *"The force comes from the metal"*
The air as a medium of magnetic interaction **4%**	*"It is the air which is moving them"*

Table 2: Children's Interpretation of free-fall on the Earth

A) Contingent cause: 61,0%	*A1 Because you let it 43,5* *A2 Because it's heavy 11,0%* *A3 Because it can fall down / because it is the nature of the ball ! 6,5 %*
B) Lack of local properties 19,6% (idea of equilibrium)	*Because there isn't magnetism / Because there isn't the magnet* *Because there isn't gravitational force*
C1) 4,3 % gravity *animate* entity **C2) 6,5 % gravitational force *animate* entity**	C1: *Because gravity attracts objects with smaller mass.* C2: *Because gravitational force attracts all things*
D) Property of a specific system 6,5%	*Because Earth attracts objects*
E) Interaction between masses 2,2 %	*Because the bigger mass attracts the small one*

From Table 1 we can see that 42 % of children consider the magnet as the source of magnetic field, while 54% as the source of force.

On the other hand, in the interpretation of free-fall pupils in general do not have a complete comprehension of the process (figure 2): in fact 10,8% of children explain free-fall considering "gravity" or gravitational force or the Earth as the source of these phenomena, 2% consider the interaction between masses, while 61% use only contingent cause *(things fall down because we let them*).

From the analysis of pupils' motivation of free fall we observed three aspects: 1) causality, that is contingent rather than efficient: in fact, according to them, objects fall because they are

The first mention of magnetic field appears when 94% of children recognize the magnet as the agent of the iron filings distribution (guide function of the magnet "*They follow it as if guided*"). Moreover a primary idea of field concept for children can be the idea of power: "*this force is so powerful that it can go through objects*." Analysing the table in figure 2 we can observe that 61% interpret the process considering the contingent cause, about 20% of children explain the falling of the objects on the basis of the absence of local properties (magnetic or gravitational) that are considered necessary for the system's equilibrium; while 6,5% refer to a property of a specific system (uniqueness of Earth system); 10,8% to the gravity or gravitational force as "*animate* entities"; finally only 2% of the children mention interaction between two masses. However, even in the last case, it can be observed that the interaction is intended in only one direction, that is from the bigger to the smaller object, and not in both directions.

Gravitational force or *gravity* according to children

During the interviews the child was asked to explain the falling of the objects, but, only if he/she himself/herself mentioned "gravity" or the force of gravity, more details were asked. In most cases children avoided giving a meaning to the term, preferring one of the following solutions: a) explaining the situation, describing what happens in the presence of "gravity", b) attributing to the Earth this specific property (the uniqueness of that system), c) attributing the meaning to the interaction between two masses (rarely). Generally they associate to the concept of gravity that of force, and to the concept of force that of "action", or they associate "gravity" to the effects it produces; sometimes it is intended as an "*animated*" object capable of attracting (figure 2, category C), or is considered as an intrinsic property of the bodies ("*the ball has a force of gravity").*

From table 3 it can be observed that 34% relate the force of gravity to the Earth, which has a certain property or the capacity of doing something, while 12% compare it to a "*giant magnet that glues our feet to the Earth*" or to "*a magnet that attracts all the things to the centre of the Earth*". It is interesting to notice that children understand the analogical phenomenology and connect the force of gravity to magnetism, even though they often associate the system with its properties.

A 10% demonstrate a primitive concept of force linked to pulling, pushing,… however, putting in relation phenomenology to this only action, without specifying its efficient or contingent cause, they are not able to go beyond the attraction recognised only as pulling. The interaction between masses (also in this case recognised only in one direction) is found in only 7% of cases, such as a primitive concept of field intended as a property of space or as a sphere of action. From various studies (39,41,47]] what emerges is that children consider air as a way to transmit gravitational force, in our analysis we encountered its use with a meaning of physical space or of a region of space.

Table 3: Children's Explanations of gravity/gravitational force

1) leading character of the Earth 34% (that do or has something)	*Earth attracts objects down.* *It's the force on the Earth that allows us to keep our feet on the ground..*
2) Balancing element 16% (*reverse gravity)*	*It's something that supports the world!* *It's the thing that supports everything on space… also planets!*
3) Atmosphere's property 14%	The atmosphere as the limit for gravitational action
4) magnetic property (magnet) 12%	*Gravitational force is (instead of being produced by) a sort of big magnet that takes our feet glued on the Earth.* *Gravity is a strong magnet that attracts everything towards the centre of the Earth.*
5) primitive concept of force 10%	*It's something that attracts / It's something that pulls.*
6) interaction between masses 7%	*It's the capacity to attract objects with a smaller mass* *It's the attractive force between two masses*
7) primitive concept of field 7% (space property)	*It's the thing that holds objects up in the air* *Gravitational force is something like air*

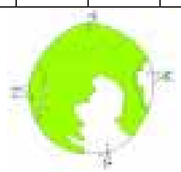
As shown by literature [39, 48,57,59]the concept that there is no gravity in space is frequent, in fact 15% consider atmosphere as the limit within which the gravitational force acts.

Instead, in the case of the magnetic field, as already said, children demonstrate a more clear and complete understanding of the process, also in the observation of the iron filings distribution, in the presence of a magnet; in fact it is interesting to see how 5% of the children spontaneously consider the phenomenology in movement ("*If you move the magnet they move*"). On this point, on the specific request of foreseeing the arrangement of the steel filings in case of a variation (this time suggested by the interviewer) of the magnet's position, most of the children (94%) recognise the "guiding" role of the magnet ("*They follow it as if it were a guide*").

Analysis of the children's drawings

Table 4: Children's drawings of the Earth's shape and free-falling

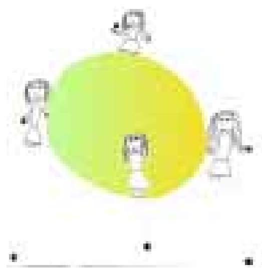
Age	All %	9-10 %	7-8 %	5-6 %
1) radial symmetry	**49**	64	50	29,2
2) exportation of local point	**23**	-	30	37
3) Local representation in the global system	**20**	16	20	29
4) kinematic view of the process	**8**	20	-	-
5) Flat Earth ([5])	**13**	-	-	37,5



Picture 1 <u>Radial Symmetry</u> 49%

Most of the children (44,6%) represent the free-fall interpreting the interaction between the ball and Earth in a geometry in which radial symmetry is recognized as a property of the system (of the interaction ball - Earth). Such symmetry is applied to four critical cases that imply the ball's movement towards the Earth's surface, with 4,1% of cases in which the dotted trajectory, with regard to the direction of the fall, implies an interpretative element that shows the centre of the Earth as a reference for the balls' trajectories from the various points where they are dropped. A small percentage 2,7 % highlight the causal interpretative aspect of the centre of the Earth as a centre of attraction, to the point of making it become a phenomenological consequence that makes the ball drop not onto the surface, but in the centre (this was explained by children when asked for clarifications, but, following a discussion they changed their opinion).

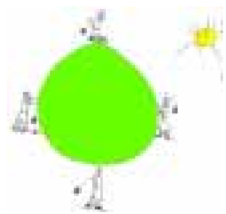
Therefore, a first element is given by recognizing a spherical symmetry geometry, while a second is given by recognizing an interpretative role to the point of falling.



Picture 2: <u>Completely local point of view</u> 23%

This is the completely local point of view and it corresponds to the lowest level of abstraction: all the system's elements are considered as elements of the piece of paper: Earth, the children and the free-fall.

It should be noticed that this interpretation is given not only by the younger children (5-6 years old) but also by a certain number of 7 year olds (37,5% of the ones who drew this picture); it would have been interesting to ask the children if they thought that Earth itself could fall down.



<u>Picture 3: Representation of local aspects in a global context 20 %</u>

The phenomenon of free-fall is seen as identical in all points of the Earth, but every event is translated in local terms. Therefore there is an automatic change of reference system in relation to the one used to represent Earth, given by the need to represent the fall of bodies as it presents itself at the local level.

[5] With the children who drew Earth as a completely flat surface a group discussion was held until the conclusion was reached that it was merely a local vision of Earth, then the group agreed to draw Earth as if looked at from a distance, and they were given another sheet of paper to draw another picture. Therefore category 5 is not included in the count of 100% of children.

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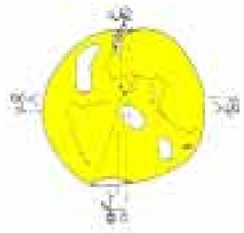


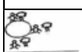
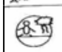
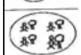
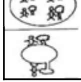
Picture 4: **<u>Kinematic vision of the process</u>** **8 %**

The kinematic aspect is privileged assuming Earth as a reference system (for everyone with a global vision) in the representation of free-fall, but trajectories are always parallel to the axis of the human body, and the object maintains its trajectory whether passing through the Earth or not. Earth itself does not appear to have a role in the phenomenon of the fall, but is passed through assuming only a role as reference for the human beings represented.

Most of the children who drew this picture then showed changes when they were asked to relate with experience (they were asked if, on the basis of their representation, it was possible to play with the ball and throw it to children on the other side of the globe, a question to which all answered negatively and, after some thought, they concluded that the ball should stop on Earth's surface).

Therefore children show a high capacity of abstraction and modelling of descriptive and interpretative aspects, what limits it is the comparison and relation to experience. They have in fact a limited experience and are uncertain about the feasibility of phenomena.

Table 5: Comparison with the results in literature about Earth conception of children 9-10

Children's conception	Nussabum 10 age Israele	Vosniadou Grade 3/5 USA	Baxter 9/10 age England	Merle 9/10 age France	E.Masclet 9-10 age France	**F.B.,M.M. 9-10 Italy**
	50 %	7,5 %	17 %	8,5 %	26%	**16%**
	12 %	25 %	-	-	-	-
	20 %	7,5 %	83 %	47 %	40%	-
	18 %	50 %	-	44 %	33%	**84%**

Picture 5: **<u>the flat Earth</u>** 13 %

A small percentage (12 %) of the younger children (5-6 years old) when asked to draw the Earth came up with the picture of a flat surface. In this case the various drawings were compared and the differences discussed, so that the children could understand that it was only the points of view that were different: a local one (from near) and the global one (as if the Earth were looked at from far away, from space) and reached the agreement to draw it all in the same way, that is, round.

In table 4 we compare the results in literature with our results about children's (9-10 years old) Earth conception and the disposition of human figure all around the planet.

The analogical model of the gravitational field

The group of 3-7 children can observe immediately the model from the beginning of the activity, that starts with stimulating questions about free-fall on the Earth and the presence of gravitational force on the Moon or on other planets. Finally children are asked to predict the behaviour of quite and moving objects in the region of the field considered. Children's drawing are made individually before using the model.

The analogical *objectual* model of gravitational field was carried out following Einstein's suggestion for the representation of space, picked up by Eddington (Eddington), with a big rectangular box covered with an elastic tissue: when a heavy sphere, representing Earth, is put on the membrane, it deforms the elastic tissue creating an hyperboloid; on the surface of which masses – still or moving with different velocity – are put.

It is also proposed as a connection between the local vision of Earth's gravity and the one linked to the gravitational properties of any mass that interacts with another. For children this model represents space in two different ways: a first more local level refers to space at a small distance from Earth (free fall of bodies), while a second planetary level considers interaction between any mass. When the behaviour of moving objects is analysed in the region of field considered, we pass from the local to the global vision.

The characteristics of the children's interpretative prediction with regard to the behaviour of both moving and still objects in the region of the gravitational field represented by the model are also considered important to sound out its representative potentialities and to analyse the capacity to discriminate the role of the initial conditions of the interacting systems.

Dynamic situation and trajectories

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In the dynamic situation in both cases (magnetic and gravitational) pupils are able to recognize the following: interaction, source (the magnet, the elastic tissue), interactors (the ball).

In the gravitational case we asked children to find, using the analogical model, the possible "routes" (the trajectories, in physics terms) of a ball thrown on the elastic tissue. The children tried all the possible ways of throwing the ball, until finding three modes of trajectory: 1) the ball falls on the Earth, 2) the ball is deviated by the Earth but "runs away", 3) the ball can go round the Earth with elliptic or semi-circular orbits. Thanks to practical experience and group discussions the children were able to recognise that by varying its velocity and direction, the ball could only either deviate its trajectory (if the velocity is sufficient and the direction is right) and run away or fall on Earth, either go around the Earth. The use of the model turned out to be particularly interesting and fruitful to aid the understanding (often spontaneous) of the satellites' motion around Earth, and of the fact that, if they were still, they would fall on Earth.

CHILDREN'S INTERPRETATION OF THE MODEL OF GRAVITATIONAL FIELD

Situation:

T: So we have seen that the Earth attracts all objects in space towards itself.
If now we wanted to put a ball in space where it cannot fall on Earth, what should we do?
C1: Throw it in the air and catch it
C2: Throw it with more strength
C3: Make it turn
T: And to make it turn what do you do? Do you throw with more or less strength?
C: Less strength
(The children try and discover that the ball can either fall on Earth, or be deviated and run away, or turn around Earth).
T: What rotates around the Earth?
C1: Planets
C2: The moon
C3: The stars
T: And closer?
C1: Satellites
T: If the satellite were still what would happen?
C: It would fall

Some children thought of a fourth possible trajectory, on the corners of the model, with it not being infinitely extended:

T: So how many motions have you found?
C1: one when the ball rotates
C2: one when we throw the ball and it runs away
C3: one when we throw the ball and it lands on Earth
C4: one when the ball ends on the corners
T: Yes. Actually the latter is the same as the second, because space has no corners, and this is only a model.

Children's intuitive models are sometimes in conflict with the one suggested, but the informal context allows to discuss which is the best interpretation of the situations examined, and to implicitly recognize that the model considered offers an interpretative representation, because it examines the conditions that make predictions possible.

For example, this child would not accept the model as realistic because he considered gravity as a force existing only near Earth and not around it:

C: But the force of gravity is only near the Earth and not around it!!
T: It isn't around it? And up to where do you think it reaches?
C: … up to the Earth's surface
T: And if I'm on a plane and the engines suddenly switch off what happens?
C: It falls
T2: But the plane is not near the surface, it is far…
C: yes but … the force of gravity reaches up to the sky
T: and where does the sky end?
C: it is the border of the universe

Table categorizes children's predictions on the trajectories of a ball with a non-zero initial velocity in a magnetic field generated by a magnet put in a position orthogonal to the direction of the slide (figure 7): we can observe that 68% of pupils identify magnetic field lines with trajectories.

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Table 6: Prediction of the ball's trajectories in a magnetic field.

Field lines = trajectories 68%	*"It follows the line up to here (the magnet's pole),…*
Rectilinear trajectories or curvilinear trajectories that do not follow the field lines 21%	*"The magnet attracts the ball and the ball attaches itself to the magnet. It goes straight when the ball is close enough to the magnet and the magnet has enough strength to attract the ball …"* *"It attaches itself to the magnet with a curve but not following the lines.*
The magnet deviates the trajectory of the ball (considers both the magnetic field and the initial velocity) 7%	*"The ball falls with velocity: The magnet attracts it but it keeps going on"*
The magnet repels the ball 3%	
The magnet does not influence the trajectory 1%	. *".... it goes down parallel to the adhesive tape.*

5. Conclusions and implications

In the informal context, with discussions on operative comparisons, in the presence of a tutor and among groups of children belonging to a network of different classes, it was found that the dimension of individual or small group operativity (practical and conceptual) acquires a pre-eminent role in triggering and directing an explicit progressive reflection on interpretative questions, which otherwise see children passive towards a solution. An evolution in the way of facing problems occurs, as well as a resonance between cognitive dynamics and the disciplinary structures.

With regard to the specific disciplinary problems, rather than searching for learning errors, attention was focused on trying to find the knowledge that can be possessed also by children in terms of symbolic culture, ways of exploring experience (operativity) and reading its meanings, interpretative patterns and links between elements of experience and knowledge, to identify the type of learning, which proves to be the source of many acquisitions that cannot be ascribed to activities intended for learning.

With regard to each problem found in the research, the data collected allows us to conclude the following:

- with regard to action at a distance, many studies reveal that children considered air as the medium that allows gravitational force action. In our analysis we found that children used air also as a reference of a physic space or a space region, while we confirm the children's concept of the limited sphere of action concerning the gravitational field.

- the magnetic phenomenology facilitates the representation of the field and the role of the field's lines, since the children interpret correctly the process by recognizing the magnet as the source of magnetic force or field.

- instead, in the case of the gravitational field the situation is not so clear: more than half of the children interpret the process considering the contingent cause (*we let go of things so they fall*). Also in the interpretation of gravity or of the gravitational force some of them attribute a leading character to the Earth, others refer to "magical" magnetic properties ("*gravity is a strong magnet that attracts everything towards the centre of the Earth")*, while not many refer to the interaction between two masses and nobody in any case considers the reciprocity of interaction (third principle of thermodynamics).

- with regard to the shape of the Earth and to its gravitational field this study confirms that pupils show no serious difficulty with the spherical shape of the Earth "seen from outside", and only some young children (age 5-6) draw the Earth flat. Also about half of the pupils represent correctly the free-fall of the ball around the Earth, a percentage which is much higher than what was found by previous researches about this aspect [18, 38].

- Finally the study confirms the pupils' difficulty in distinguishing the concept of trajectory from that of field lines in the case of the magnetic field, while the use of the gravitational model still has to be explored, besides as a connection with intuitive elements, also in order to give a more clear idea of space or of the gravitational field, or of the gravitational potential.

In the informal context this research allowed us to study the cognitive processes and to find some basic elements of possible learning paths to build the concept of field, in particular magnetic and gravitational:

1) magnetic phenomena can allow pupils to recognize that the space on the surroundings of a magnet has some properties that can be detected by the interactions with field probes.

2) these interactions are easily recognizable with a property of space since they are different in every point, and they can carry out the function of connecting the concept of free-fall (outcome of gravitational interaction or product of the force of interaction).

3) the magnetic field is useful to recognize the process of interaction in static situations, while the gravitational one lends itself to understand the role of initial conditions (in the magnetic field, that is rotational, there is the problem of recognizing the dynamics associated to the presence of couple of forces).

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Hands-on Universe–Europe

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Abstract. The EU-HOU project aims at re-awakening the interest for science trough astronomy and new technologies, by challenging middle and high schools pupils. It relies on real observations acquired trough an internet-based network of robotic optical and radio telescopes or with didactical tools such as web cams. Pupils manipulate and measure images in the classroom environment, using the specifically designed software SalsaJ, within pedagogical trans-disciplinary resources constructed in close collaboration between researchers and teachers. Gathering eight European countries coordinated in France, EU-HOU is partly funded through the Socrates-Minerva Action. All its outputs are freely available on the web, in English and the other languages involved. A European network of teachers is being developed trough training sessions.

Keywords. Physics, Web.

How Solving Physics Problems May Help Inducing Experimental Abilities in Pupils

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Abstract. Solving problems in Physics is, usually, considered an applied theoretical activity, aiming to improve the knowledge of the basic symbolic and numeric relationships between physical quantities. Just following the teaching of a basic relationship, introduced experimentally or theoretically, one or more problems, using that relationship, are solved, in class (supervised) and/or, as homework (by the trainee alone).

Keywords: Problem-Solving, Experimental Abilities, Laboratory Competences, Errors Compounding, Dimensional Calculus.

Many "Problems in Physics" books, introduce the statement of a problem (input & output data), give, frequently, hints how to solve, symbolically, the problem; offer, sometimes, a symbolic solution and usually, give the expected result - the value of the physical quantity to be found, asked in the statement, as amount and unit. Constants are given in the statements or/and in the Annexes of the book.

Sometimes, in statements, there are introduced data in other systems of units than the International System of Units, the solving of the problem implying the transformation of data and of their use, in only one coherent system of units, preferably in the legal I S U.

The use of the ISU standardised multiplying prefixes is frequent. Usually, the statement of the problem do not mention that the given values are, only, average values and disregards the precision reached in the actual process of measuring the values of the physical quantities implied. The errors on data are not, explicitly, given. Rarely, the errors are given, realistically, but implicitly.

There are neither requested the absolute and the relative errors of the output (to be found) quantities, nor the evaluation, in the final result, of the nature and relative importance of the errors introduced by each input data and each constant.

Rarely, there are requested the dimensional check of the homogeneity of some of the relationships used or established during solving a problem and the identification of the symmetries existing in the considered system.

Because the symmetries, dimensions and errors are extremely important in educating a student or a trainer, in making her/him able to understand and solve other problems, in helping him to be prepared to develop experimental abilities, to conveniently conduct an experiment for training or, later on, for research, the author has been using the following format in stating and solving problems in the student class tutorial or requested for student homework.

At the beginning of tutorials(if not in the course lectures) there are to be introduced notions about: symmetries, dimensional calculus, processing of experimental data, errors, absolute and relative, on directed measured quantities, compounding of such errors to find the errors on indirectly determined quantities, how to find data on Internet and in books on the quantities implied in the to be solved problem, analysis of the type (random, systematic, rough) and the relative importance of the sources of errors.

There is, gradually, introduced the format for solving a problem, the student being advised to:

- organise the problem solving as to be easily distinguished in the report on the solution: the statement, the symmetries, the symbolic solution for the average values of quantities to be found; the symbolic solution for the compounded errors, the dimensional check of the homogeneity of physical relationships used the numerical solution for the average value (s) to be found, the numerical solution(s) for the absolute/relative errors on results, comparison with the literature, the analysis of the nature of the errors and of their relative importance, suggestions for improvement;
- make the distinction between input data, constants (eventually, to be found by the solver) and output data (the requested results, to be obtained, by introducing in the program for the symbolic solution, the input data), when summarising the statement;
- transform the input data and the constants and express the output data (the results) in, only, one system of units;
- identify the average values and the errors, absolute and/or relative, expressed explicitly or implicitly in the statement, before starting to find a symbolical or numerical solution;
- `- check, from the very beginning, before trying to get the symbolic solution, the existing symmetries in the system (mechanical, concerning the form, the structure, . . ., up to matter – antimatter characteristics of symmetry) and chose a reference system for the solution such as to make the maximum profit of the existing symmetries;
- find the requested physical quantities as both average values and their errors (relative and/or absolute), this implying the knowledge and the use of the compounding of errors procedures (to find the error for the output quantities requested and for self-evaluation). Thus, the usual symbolic problem solving, which is oriented to look for a solution for the average values of the quantities to be found has to be supplemented with a solving process implying knowledge and use of the

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compounding of errors, solving process oriented too, to find the error for the output quantities requested and to offer an insight in experimental work, without actually doing it;

- check, dimensionally, the homogeneity of all physical relationships used to find the answer;
- express the results in one or eventually, in all the systems of units used in the statement;
- analyse the relative contribution of each input datum and constant to the error of the final result and to compare the interval of values found by him with the possible values to be found in the literature (hard or soft) corresponding to the result of his computations, to identify eventual systematic errors and correct the result;
- suggest ways for judging the different approaches in solving that problem and for improving the precision of the requested result.

In the statement of a problem, the professor or the teacher is to give the input data and constants (and in the annexes of the book, too, but with different precision), not only as average values but, also, accompanied with explicit and/or implicit errors, relatively e or absolute, expressed, sometimes, with prefixes and/or in different systems of units.

The constants introduced in the Annexes to the Problem Book are to be given with variable relative errors, and different with respect to the values given in the statements of different problems to be solved, as the trainee have a choice in choosing an error for a constant given directly in the statement of the current problem or in tables.

Eventually, the students are asked explicitly to observe the format of solving, above presented.

The working time necessary to find symmetries, dimensions and errors besides average values may be longer than for solving a problem only for the average values, but the knowledge and education values would be much higher and the area of application of the acquired competencies would be much larger and deeper.

Experimental abilities of the trainee, the conduct of an experiment for training, technical application of science or research and the European Tuning' would take much profit of such a methodology of problem-solving.

This new methodology has been introduced, by the author, to some classes of General Physics for Engineering students of the University "POLITEHNICA" in Bucharest and has proved to be accessible for the students implied and efficient to get deeper and extended competencies in solving theoretical and experimental problems, not only in Physics but in other quantitative scientific and technical fields and even in social and economic applications.

For school pupils, the format has to be introduced gradually, without general formulae, using compounding of errors for typical types of relationships: summation, product, of quantities at different power, trigonometric relations, exponential or logarithmic relationships. This new learning methodology in solving problems may be used at all ages and education stages. To this end, teachers are to be trained adequately during their yearly updating courses.

During the presentation, there will be produced samples of homework of the author' students consisting in solutions of problems using this new methodology. The author may offer programs in training in such a problem-solving methodology, in English or in French, at the University "POLITEHNICA" in Bucharest, eventually through a HSCI Program to be established or even, at a training course in Braga.

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The Physical Experiments through Smil Technology

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Abstract. The authors introduce the smil technology, one of the modern web based technologies, suitable for the presentation of

school demonstration experiments on the websites. The physical interpretation of the presented experiments is based on active learning student's approach to the question solving that is divided into small problems. The conceptual understanding of the physical principles is the main goal of these activities. The fundamentals and the structure of the instructional materials development for high school students are presented in the contribution. The selected nontraditional physical experiments, compiled using the smile technology, are accessible on the public video server.

Key words. Smil technology, Physical concepts understanding, School demonstration experiment.

1. Introduction

The use of physical experiment in the classroom is primarily oriented to the students´ understanding of the demonstrated physical phenomenon. Demonstration is an art and, like every art, it develops from year to year [1]. There is a wide range of experiments available for the classroom demonstration. The teacher's choice is usually affected by the experiment attractiveness, surprising result, practical applications that can be demonstrated with the help of experiment or the possibility to present it under different conditions. From the methodological point of view the possible experiment demonstration goes through several phases from the student primal knowledge concerning the presented phenomenon to interactive feedback and active student interference into the experiment realization and presentation. Nowadays there are modern information and communication technologies available that enables the experiment processing into the electronic form.

One of the possible ways is to use the web smil technology that integrates image, real video and the presentation into a unit accessible on the web.

2. Physical school experiments presentation on the web

There are many portals [2] on the web that are oriented on the physical school experiments. The presentation is usually realized in the form of instructions how to realize the experiment, what tools are needed, the picture of the experimental setup and there is usually a short explanation of the demonstrated physical phenomenon. On the web we can find a wide offer of physical experiments aimed at different physical topics that can be used in the classroom. Some of the experiments are provided by a videoclip of the experiment that can be a great advantage for the potential user and the possible experiment demonstrator.

The mentioned experiment web presentation supposes the spontaneous students interest in the presented problems. However, students often lack the motivation to study. This fact can also be partially caused by the way the presentation is prepared. It is sometimes prepared the way that is understandable only for the high-level students while the students with poorer level of knowledge can hardly understand the experiment's meaning. The presentations usually do not contain any questions, additional problems to think about or any feedback to check the understanding. We consider these factors essential for the meaningful use of experiments in education. The modern web technologies can be a good help in this field.

Figure 1. Example of the Smil presentation

The reasonable integration of technologies with the attractive experiments respecting the methodological principles can bring a positive effect on the presentation aiming to student's motivation and better understanding.

3. Smil technology

SMIL (Synchronized Multimedia Integration Language) enables to create multimedial presentations containing video, music, images and texts . SMIL arose from XML language (eXtensible Markup Language) as another

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standard of W3C consortium [3]. SMIL serves neither for the direct video nor for images creation. It integrates multimedial objects into the static HTML or XML documents. It works with the complete multimedial and text objects, it inserts them into the documents and it specifies a certain space for them. The SMIL 2.0 implementation enables to create an interactive applications and animations. The most important advantages of the SMIL language are:

- The precise definition of the visual form of the presentation,
- The precise location and size of the inserted objects,
- The presentation timing,
- The use of hypertext references,
- The use of interactive elements in the presentation,
- The condition testing.

The SMIL document supports different forms of media:

- Images – GIF, PNG, JPEG, ...
- Text – txt, XHTML, …
- Audio – WAV, MP3, AU, …
- Video – MPG, AVI, MOV, ...

Considering the fact that the communication with the internet browsers is not available for the present the presentation is realized with the help of other different programs, e.g.:

- Real One Player
- Apple Quick Time Player
- Java Applets – XMILES
- SOJA – SMIL Ouput in Java Applet

4. The possible procedure of the physical school experiment presentation with the help of SMIL technology

The presentation of the physical experiment with the help of the SMIL technology can be realized in the following steps:

- The physical problem introduction (a new problem with the attractive or surprising result – an important motivational aspect to attract the students attention),
- The experiment conditions analysis (the student describes the physical content included in the presentation and finds the most important physical factors influencing the physical problem solving),
- The summary of the physical facts known by the students,
- The prediction expressed by the students about the possible problem solving (students´ proposal in the form of graphical or textual presentation, discussion about the possible interpretation),
- The experiment explanation divided into small parts complemented with the continuous students feedback,
- The result analysis (comparison with the prediction),
- Discussion (the practical use of the presented phenomenon, possible further observations, other problems arising from the experiment).

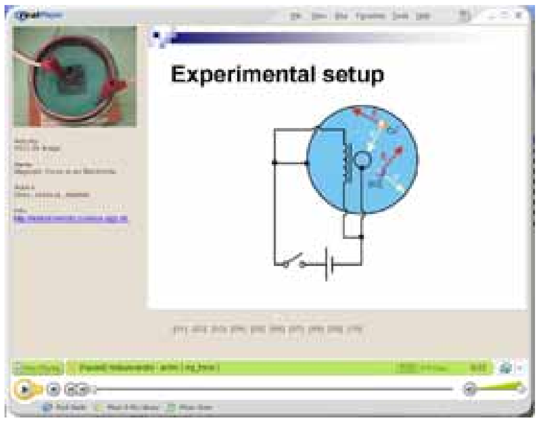

Figure 2. Smil presentation: Magnetic Force in an Electrolyte

5. The examples of experiments presented with the help of SMIL technology

5.1. Magnetic Force in an Electrolyte

All you need for experiment to demonstrate the magnetic force in an electrolyte is a glass dish, two ring electrodes, a coil with an iron core, dc power source, saturated solution of copper vitriol, connecting wires and an overhead projector eventually.

Two ring copper electrodes of different radius are inserted into a glass dish. Smaller electrode is in the centre of the dish and the bigger one is close to the outer border. Electrodes are adapted for the electric wire connection. A 1200 turns solenoid coil with an iron core (can be replaced by a permanent magnet) is placed vertically with the glass dish on the top. The glass dish with the electrodes is filled with saturated solution of copper vitriol. The coil is connected to a dc power source of up to 15 V and the electrodes are connected in parallel with the coil.

The electric field between the electrodes initiates the motion of positive (negative) ions towards the cathode (anode). In this case the radial motion from the centre to the border and from the border to the centre of the dish is produced. The magnetic field of the coil perpendicularly penetrates the plane of the glass dish with the electrodes and the solution containing Cu^{+2}, SO_4^{-2} ions. The ions are moving perpendicularly to the magnetic field lines of the coil. Therefore they are forced to move along a circular arc. Since the positive and the negative ions are moving in opposite direction, the magnetic force acting on both of them has the same direction. As a result the rotational motion in the solution can be observed after short time (app. 10 s). In fact, there are still some of crystals of copper vitriol present in the solution that are drifted by the ions visualizing their motion.

If we change the direction of electric current between the electrodes or the direction of the magnetic field of the coil, the direction of the rotational motion will change.

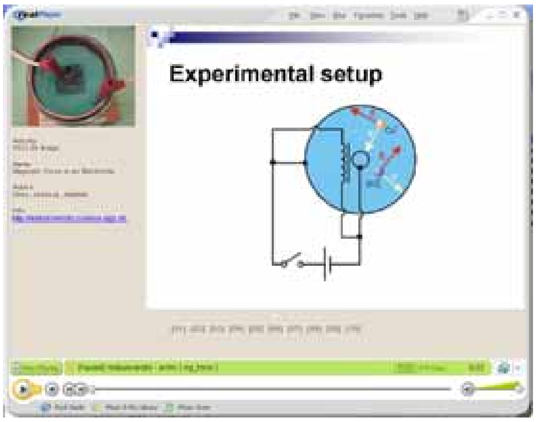

Figure 2. Smil presentation: Magnetic Force in an Electrolyte

5.2. The boiling of cold water

If the boiling of the water should occur, the pressure in the bubble must slightly overrun the outside atmospheric pressure having effect on the surface. By the lower outside atmospheric pressure the lower pressure in the bubble is also needed that can be achieved at the lower temperature. With the decreasing of the outside atmospheric pressure the temperature of the water boiling falls down, too [4]. We can carry out the following experiment.

The glass bottle filled half a volume of it with the cold water is hermetically closed. Through the cover the thermometer is inserted inside that determines the temperature of the water boiling. The bottle and the exhauster pump are connected through the side outlet. The thermometer shows the temperature of the water (e.g. 20°C). We activate the exhauster pump. The abrupt decreasing of the air pressure calls causes the nearly instantaneous boiling of the water, even if its temperature is only 20°C. Being also not confident with such a decreasing of the temperature of the boiling point, we can fill the bottle with the mixture of ice cubes and the water with the temperature something above 0°C. After the exhauster pump is activated again, we can observe in a while the boiling of the water. In the bottle the ice cubes are floating in the boiling water!

Figure 3. Smil presentation: The boiling of cold water

We can accomplish the boiling of the cold water even simpler. The injection squirt with an easy moveable piston will do the work. Let us submerge squirt into the vessel with cold water in a such way that its narrow part will be fully under the surface. It is obvious we can not suck the air into the squirt when filling it with the water. It is necessary to pull the piston intensely. The syringe is still submerged in the water. Because of the fact that the water comes into the squirt through the narrow opening it can not follow the movement of the piston. The more markedly effect of delayed water movement after the piston can be achieved when there is a needle on the squirt. The under pressure towards the atmospheric pressure occurs under the piston as well as over the water surface. On the base of these conditions the water is boiling in the squirt. The leaving bubbles can be observed.

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After performing of these experiments we should change our attitude towards looking on the water boiling itself.

5. Conclusion

In the future we plan to create a wider database of the experiments processed with the help of SMIL technology. The experiments prepared in the mentioned way will be situated on the web server [5] available for the wide use. We are persuaded that this technology can be a good contribution to the physical experiments presentation in order to help students in better understanding. It can also be a good help for teachers in the classroom when the tools for demonstration are not available and consequently the students do not have a chance to see the physical phenomenon demonstrated. This web technology can also bring into these classrooms the experiments that are very demanding, dangerous or hard to realize in the classroom conditions. The additional advantage is that the students can study the phenomenon individually since the experiment is prepared for the interactive students´ learning. The next step in the use of this technology will be the experiments verification in the process of education in order to get feedback from students and teachers – potential users of this technology.

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Hands-on Experiments in Physics in Secondary School

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Abstract. The main purpose of this project is to develop the students' enthusiasm for experimental activities, in the area of Physics and Chemistry, in Portuguese secondary schools. Using simple equipments, the students will perform several kinds of experiments, according to the line guides issued from the Education Ministry, for this school level. These practical works are divided in five themes such as Light, Equilibrium, Forces, Electricity and Electronics. The Light subject consists on the construction of a periscope and on the realization of several experiments using the light refraction's phenomenon.

The Equilibrium theme includes experiments using the gravity centre position of several bodies. Two activities deal with the Forces theme: First, the students achieve some experiments dealing with pressure force in solids and liquids; and then, they perform a set-up showing the friction forces between solids and liquids surfaces, measuring their intensity with a dynamometer. In the Electricity and Electronic topics, the selected experiments are: (i) the creation of an electroscope; (ii) the construction of a "rabbit game", that is a simple electronic circuit, with the purpose of demonstrating the switch's function principle; (iii) the production of a bright board "Happy Easter", that consists on the association of some electric and electronic components in a circuit, as an application of basic concepts on electromagnetism.

Keywords. Physics, Hands-on experiments.

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'Laboratory of Educational Robotics'. An undergraduate course for Primary Education Teacher-Students

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Abstract. In the Information Technology dependant current societies, the Science and Technology Literacy (STL) are crucial. It is necessary to the prosperity and the further development of the society but, also, it is a prerequisite for the existence of the democratic society of citizens (a democratic right according to UNESCO). Because of the rapid developments in the field, the vast majority of people are not literate in modern Science and Technology (especially in Information Technology). Consequently, the social interaction of the citizens cannot contribute significantly to STL. Only through a systematic education, an adequate STL may be effected. In this aspect, the compulsory education, whose focus is on the preparation of the future citizens, acquires special importance. An effective STL through education presupposes appropriately trained teachers. In this work, we present the design of an undergraduate course to the Department for Primary Education teachers at The University of Crete. The course is titled 'Laboratory of Educational Robotics'. Its syllabus includes the assembly and (simple) programming of different modules towards the construction of a robot performing specified (simple) tasks. The course objectives include the familiarization with the notion of robots and the development of cognitive skills.

Keywords. Laboratory, Robotics, Robolab, Primary education.

1. Introduction

Learning new technologies constitutes a priority in a constantly developing society. The European Union encourages the learning of new technologies aiming at accelerating the formation of a high quality substructure with logical cost, promoting digital training and the universal digital knowledge [1]. On the same lines, UNESCO [2] supports Science and Technology education courses. Science and Technology Literacy may be considered as a right to democracy [3].

The rapid advances in Science and Technology do not allow sufficient time for their assimilation and the formation of a corresponding 'social culture'. Consequently:

- The Science and Technology culture has to be achieved mainly through education,
- Misconceptions, alternate conceptions and other teaching deficiencies are more frequent in Science and Technology than in the other school subjects where some, at least, of the teaching deficiencies either do not appear or may be counter effected by the society environment [4].

Science and Technology Education and Literacy are usually considered within the scope of developing technical and vocational skills and dexterities, implying that the corresponding emphasis is addressed towards the Secondary Education, the Technical Vocational Education and the (initial and continuing) Training. To our opinion however Primary education is more important in view of the following (see also [4]):

- In all countries, primary education is the longest component of the compulsory education which aims at that personal development which will allow the students (future citizens) their active participation to the society of tomorrow.
- Students in primary education are at the age where their character and cognitive skill capabilities are being formed. Misconceptions at this age are difficult to correct later.
- An efficient and correct understanding of the basic concepts in Primary education may heighten considerably the efficiency of the teaching at a later stage.

Only an efficient teacher may successfully deal with the hindrances exposed in 0 above. Consequently, an emerging crucial point is the issue of the competence of the Science and Technology School Teacher and, in view of 0 above, of the Primary school teacher.

There are numerous studies on the characteristics of an efficient teacher [5]. Although most studies are dealing with a particular parameter i.e. the subject matter knowledge, the teaching approaches adopted,

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their communication skill with the students, etc. it seems that it is the total profile of the teacher that matters and not the predominance of a single characteristic [6]. However, in view of 0 and 0 above, the knowledge of the subject matter and the teaching approaches adopted are of special importance for the Science and Technology school teacher.

Another aspect of the teachers' subject matter knowledge on Science and Technology is what can be considered as a good and sound knowledge. The specialist's education or training, although it might help, it does not offer a solution, especially for the Science and Technology teacher. presenting the following disadvantages:

- Due to the rapid advances any education or initial training, however good it would be, it will soon be outdated.
- Training actions necessary to keep the teachers' knowledge in pace with the advances of the field, are limited by the constraints of time, of cost and of the lack of appropriate trainers. The same is true (perhaps to a lesser extent) for the initial education or training.
- Specialist's training is impossible for the primary school teacher (who teaches all school subjects). To some extent this is also true for the secondary school teacher when he (she) assumes the responsibility to teach a subject he (she) is not a graduate of.
- There is always the problem to transform the (scientific) knowledge that the Science and Technology teacher posses to successful teaching actions. This is a serious concern for the modern topics of Science and Technology where there is little previous experience if any at all. For the same reason, teaching experience cannot be expected to improve with time, if not accompanied by other measures.

Another characteristic to be considered for the Science and Technology school teacher is the general lack of technical support observed in many schools especially in rural areas and in primary education. Consequentially the Science and technology teacher should be able to maintain, repair or, even, construct the equipment and instruments that are necessary to Science and Technology teaching.

In many cases with modern Science and Technology subjects, especially in Informatics, (some) students, quite often, have more skills and, even, (technical) knowledge in the use of computers than their teachers. This upsets the traditional school equilibrium and needs special attention.

The background of Primary education teachers is oriented towards humanities. Many of them have a negative attitude towards Science and Technology. Consequently:

- Special actions should be taken in order to develop their self esteem and a positive attitude, prerequisites for an efficient training in Science and Technology teaching.
- In primary schools there is, in general, a culture towards humanities which may improve the efficiency of teaching in humanities, e.g. through informal peer discussions with fellow teachers. Such culture for Science and Technology is, in general, missing from primary education and from many secondary education schools.

The education or initial training of teachers in Science and Technology subjects is done by experts in the field. Although they (mostly) deliver a scientifically valid teaching, they are inclined towards the teaching of factual knowledge (i.e. data, procedures, techniques …) and consequently:

- The Science and Technology subjects are considered as difficult subjects [7] because of the extensive use of higher Mathematics.
- The problem to transform the (scientific) knowledge that the Science and Technology teacher posses to successful teaching actions still remains.

The education and the subsequent training of the Science and Technology teacher fall traditionally along two extreme lines:

- Training focused to the curriculum in force. It is based to specific teaching approaches, e.g. through the study of 'model teachings' of specific issues from the school curriculum. It has the advantage of a 'rapid focused' training. Its shortage is that skills to adapt the teaching (e.g. to changes to school curriculum, to the specific class conditions …) are not developed directly.
- Specialist's education based to sound training in pedagogy (general and focused to specific subjects), psychology (of the learner) and subject matter. Its characteristic is that, in principle, the teacher has learned the skills to adapt his (her) teaching to the actual classroom conditions. Empirical evidence however is controversial [8]. When this form

is adopted the curriculum combines subject matter and its didactic in interdisciplinary studies.

2. Training for the S & T teacher

The issues raised previously imply that the education and the subsequent training of the Science and Technology teacher should be examined on a different approach within the following axis:

1. Subject matter knowledge should not be factual (i.e. based on data, procedures, techniques, mathematical manipulation …). Instead it should be based on basic principles and methodology (e.g. conceptual Physics) with a sound understanding on the possibilities and implications of the Science and Technology advances. Detailed teaching on specific topics should be exceptional and only if supporting the previous aim. On simple words it should be on know how rather than on techniques.
2. The issues discussed under the teachers' subject matter knowledge should be appropriate for the previous aim (teachers' development). The issues should, also, be in a form to be used in school with little, if any, adaptation. Polymorphic teaching is a relevant choice [9].
3. The teaching approach adopted for teachers' education should be appropriate for the objectives exposed in 1 and 2 above. It should also serve as an apprentice practice towards teachers self training on the subject. Project assignments, in which inquiry and problem solving are encompassed seems an obvious choice. When mastered by teachers and used in schools may provide a solution for the teaching of new (and possibly unknown to the teachers) subjects. This type of teaching in schools permits the self training of the teacher and eliminates the possible drawback of the students knowing more than their teacher as was mentioned earlier (Introduction point 0).
4. In this inquiry, the use of digital information as the one available on the INTERNET may prove as a valuable resort.

3. Course description

The principles described earlier have been used successfully in implementing several actions for the education or the training of the Science and Technology teacher in the Department for Primary Education of The University of Crete (see for example [10], [11], and [12]). We present here the design (within the context designed in the previous section) of another course on Science and Technology planned as an undergraduate course in the Department for Primary Education of The University of Crete.

The course title is 'Laboratory of Educational Robotics'. Its main objectives are:

- The understanding of the basic concepts of robots [13],
- Familiarization with robot programming,
- Apprehension of the possibilities and limitations of robots.
- Development of problem solving skills [14].

Reason for the choice of a course in robotics is (in brief):

- Robots and robot programming, although mostly unnoticed, are already being used in everyday applications (mobile phones' features, property surveillance mechanisms, electric kitchens and laundries, video and TV tuners, car engines …).
- They present an appropriate environment for exploitation by the students (and the teacher – students) towards the development of complex cognitive skills. In fact they may be considered as the evolution of the LOGO environment [15] introduced in early '70s by Papert [16].
- They provide a good example of modern technology providing also support for the development of construction skills. Teachers and students have the opportunity to familiarize themselves with new methods and materials and with the functional use of technology that will allow them to look deeper into in the (manipulation of the) natural world.
- Educational Robotics constitutes a contemporary educational environment where the user (student) is in the position to compose and guide a robot with the help of a simple optical programming language. In this sense, educational robotics is closely related to problem solving. It may also promote cooperative learning through the assignment of common projects to groups of students.

The LEGO™ Mindstorms for schools [17] was chosen as the laboratory environment for this course because:

- It promotes analysis and synthesis skills.

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- It is a natural extension into modern technology of the bricks construction kits most children are familiar with.
- The programming language it uses is rather simple with a graphic interface eliminating thus the drawback of learning a programming language [18].
- It incorporates the constructionism philosophy of Papert [16], [19].
- It has a wide range of support for the teachers.

The teaching will be through project assignments in groups of two to three persons (see point 3 in section **2. Training for the S & T teacher**.

The syllabus of the course is presented in **Table I – A Summary of the Syllabus**. It is divided in two parts with different teaching strategies. During the 1st part students are guided to know the material and its functionality use the equipment and software autonomously. They are also guided to assemble and programme simple constructions. During the 2nd part students are asked to assemble and construct by themselves (in groups of two to three persons) a robot of their choice. During this part the guidance is minimal and initiated by specific (technical) questions by the students.

Specific aims during the 1st part include:

- Using and understanding technology,
- Foreseeing technical difficulties,
- Recognizing necessary fundamental concepts,
- Defining technology practices in educational system,
- Using knowledge and understanding of IT (from other courses) to design information systems, and to evaluate and suggest improvements to existing systems,
- Investigate problems by modelling, measuring, controlling and constructing procedures
- Consider the limitations of the tools and information sources, and of the results they provide, and comparing their effectiveness and efficiency with other methods of working
- Discuss some of the social, economic, ethical and moral issues raised
- Using a system that responds to data from sensors and understanding feedback

Specific aims during the 2nd part include:

- Using equipment and software to measure and record physical variables
- Exploring a given model with a number of variables and creating models of their own to detect patterns and relationships
- Modifying the rules and data of a model, and predicting the effects of such changes
- Evaluating a complete model by comparing its behaviour with data gathered from a range of sources.

1. Students have to keep a portfolio with completed working sheets and notes on their work. Two evaluation activities are also included in the activity packet.

4. Commentary

Robotics is usually considered as a subject for engineers. Educational robotics has been used, rather successfully, with school students [20], [21]. As far as we know it is the first time planned as normal course for primary teachers' education. A test teaching made 3 semesters ago was very encouraging and lead us to the design of this course. However, some limitations were also located, including:

- For a teaching to large groups of teacher – students multiple sets are required increasing the cost of materials for purchase and maintenance.
- The multitude of specific small parts accessories increases the house keeping load.
- The support material (documentation, web pages …) is in English posing a further obstacle to non English speaking students.
- The course is designed to maximize the development of complex cognitive skills within a constructionism approach. This implies that the student has to devote time to retrospect and think especially during the 2nd part where the student should also take initiatives. These requirements imply high degree of self discipline not observed to all the students.
- Continuous formative assessment of the course is necessary.

Table I – A Summary of the Syllabus

1st PART		
1st week	Introduction, Groups	*9 introductory activities for students related to Robotics concepts. The introduction to programming and algorithmic logic is done with the following steps*
2nd week	*Know the material and software*	
3rd week	*Know the material and software*	• ***pre-programmed robot,*** *the objective is the familiarization with the idea that a series of commands leads to specific actions and vice versa, the appreciation that the action sequence can be materialized by a sequence of commands.* • ***Programming robot,*** *approach with the "logical suites" as a sequence of simple running (executing) steps.* • ***Smart robot,*** *they familiarized with the principles of programming and the control conditions*
4th week	First guided project (car)	*Each one of the guided projects are divided in four levels* *Level 1: Introduction to Robotics* *Level 2: Starting Programming* *Level 3: Further Programming* *Level 4: Structuring compound programs*
5th week	Second guided project (My Home)	
6th week	Third guided project (Bug)	
7th week	Forth guided project (Gadget)	
2nd PART		
8th- 9th week	Independent Project 1	*Two long length cooperative learning activities*
10th - 11th week	Independent Project 2	
12th week	Post-test	*Final check*
13th week		*Projects Presentation*

5. Acknowledgements

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6. Notes and References

[1] See for example the actions and programs in http://ec.europa.eu/education/index_en.html

[2] www.unesco.org.

[3] In Democracy the citizens, acting on their own capacities and not as followers of a "gifted leader" (as sheep under the herdsman), are supposed to participate actively to the decisions taken. As these decisions are increasingly dependent upon Science and Technology developments, the active citizen's participation implies that he (she) not only should be Science and Technology literate but also that he (she) must have cognitive skills permitting decisions on incomplete knowledge, i.e. also in areas he (she) is not an expert. Formation of models develops such skills and is (or should be) an integral part of Science teaching. Within this context the effective Science and Technology education may be considered as a "democratic right", a right to democracy. Otherwise, science will be mixed with religion as in the Dark middle ages or in some places (for example contemporary USA – see http://www.ncseweb.org/ (visited on June 22, 2006) where Science education, especially the theory of evolution became a legal matter competing with religious doctrine).

[4] P. G. Michaelides, '*Training of the IT Primary School Teacher*', 5th Pan-Hellenic Conference with International Participation on the 'Didactics of Mathematics and

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Informatics in Education, University of Thessaloniki, 12-14 October 2001 (in Greek).

[5] See for example in ‘Advances in Research on Teaching’, Vol. 2 • 1991 ‘Teacher’s Knowledge of Subject Matter as it relates to their Teaching Practice’, edited by Jere Brophy, JAI Press Inc.

[6]  In a previous study, John, a middle school student described the good teachers as the one who: *knows and can teach the subject, answers the questions even the next time, do not say rubbish, learn with the students and not pretending knowing everything, in summary children should learn.*

[7] Krystallia Halkia, ‘Difficulties in Transforming the Knowledge of Science into School Knowledge’, pp. 76-82, of Vol. II of the proceedings of the University of Cyprus, ‘1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens’, Paralimni-Cyprus 29/4-2/5 2001.

[8] For the case of Mathematics see: Deborah Loewenberg Ball, ‘*Research on Teaching mathematics: Making Subject-Matter Knowledge part of the equation*’, in ‘Advances in Research on Teaching’, Vol. 2 • 1991 ‘Teacher’s Knowledge of Subject Matter as it relates to their Teaching Practice’, edited by Jere Brophy, JAI Press Inc. (pp 3-).

[9] Polymorphic teaching in Science and Technology includes a common psychomotive activity (e.g. constructions, measurements, experimentation ...) which consequently is morphed into different education levels depending on the (previous) cognitive attainment and/or the mentality of the students. It resembles multilevel teaching (i.e. teaching pursuing more than one sectors and levels of learning). The need for polymorphic practice teaching arises usually in the training of teachers to the subjects they are going to teach in school where there is a requirement of teaching in an advanced level for the teachers themselves and teaching in a level more accessible for the pupils. See more in P. G. Michaelides, “Polymorphic Practice in Science", pp 399-405 of the proceedings of the 1st Pan-Hellenic Conference on the Didactics of Science and the introduction of New Technologies in Education, University of Thessaloniki, Thessaloniki May 29-31, 1998 (in Greek).

[10] P. G. Michaelides, ‘*Introduction to Informatics; A course for students of Departments for Education*’, proceeding of International on the Didactics of Mathematics and Informatics in Education, University of Ioannina and Greek Mathematical Society, Ioannina 20-24 October 1993 (in Greek). It describes an introductory course on the use of Informatics to Education.

[11] Athanasia Margetousaki, P. G. Michaelides, ‘*Affordable and Efficient Science Teacher In-Service Training*’, paper to be presented at the HSci 2006 - 3rd International Conference on Hands-on Science, 4th - 9th September, 2006, Braga, Portugal, proceedings published by University of Minho.

[12] Tsigris M. The didactics of Science through polymorphic self-made experimental apparatus of quantitative determinations. An alternative proposal for the teaching of Natural Sciences, 2nd International Conference, Hands-on Science: Science in a Changing Education, July 13-16 2005, The University of Crete.

[13] Robot means any (mechanical) device capable of performing (pre-programmed) physical tasks (e.g. moving, controlling other devices, reacting to changes in their environment, etc.) and may be considered as the evolution of automata. Robots may be controlled by a human (for example the different kind of probes used in the exploration of earth or space and in surgery) or be controlled by appropriately programmed computers separate from (or being part of) the robot construction. Although the popular notion of robots relates to *humanoids* (former term used *androids*), robots may have any form appropriate for the task they were constructed for. The word *robot* (originating from *robotovat* meaning to work, to serve) appeared for the first time in the play RUR (Rossum’s Universal Robots) by the Czech Karel Čapek in 1920 to describe humanlike creatures obeying a master. They are now very popular in (science) fiction.

[14] Dimitriou A., Chatzikraniotis E., “the educational robotics as a tool of skill

development for problem solving: Practice with LEGODACTA environment" (in Greek), 2nd Conference for teachers on "Development of Information technologies and Communication in education practice", Syros, May 2003

[15] The LOGO programming language and environments are associated with constructivist educational philosophy and are designed to support constructive learning (http://el.media.mit.edu/logo-foundation/index.html).

[16] Seymour Papert, MIT Professor Emeritus, is a mathematician and one of the early pioneers of Artificial Intelligence. Born and educated in South Africa, where he participated actively in the anti-apartheid movement, Papert pursued mathematical research at Cambridge University. He worked with Jean Piaget at the University of Geneva from 1958-1963. Papert is the inventor of the Logo Computer Language, the first and most important effort to give children control over new technology. He is the author of Mindstorms: Children, Computers and Powerful Ideas (1980) after which the LEGO ™ Mindstorms (to which Papert is on the advisory board) were labelled (see http://www.papert.org/, http://papert.www.media.mit.edu/people/papert/, http://www.connectedfamily.com/main.html).

[17] http:/www.lego.com/education

[18] Tsovolas S., Komis V., "Teaching basic programming concepts in optical programming ROBOLAB environment" (in Greek), 3rd Conference: Teaching Informatics, University of Peloponnese, Corinth -Greece, October 2005

[19] The goal of constructionism is "giving children good things to do so that they can learn by doing much better than they could before (Papert, S. (1980). Mindstorms: Children, Computers, and Powerful Ideas. NY, New York: Basic Books.)." Is a natural extension of constructivism and emphasizes the hands-on aspect. Papert discovers ways in which technology enables children to actively use knowledge they have acquired.

[20] Costa M., Fernandes J.F., "Growing up with robots", Hsci2004 – CoLoS. Summer School, Ljubljana, Julie 2004.

[21] See also the relevant activities in the Hands on Science network at http://www.hsci.info/.

Using Robotics in Classroom: LEGO Mindstorms™ and Physics

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Abstract. Using Robotics in Education may provide various benefits, particularly in Science education. Among the robotics educational kits, the LEGO Mindstorms kit fits the purpose particularly well.

This paper proposes an integration of LEGO Mindstorms in portuguese secondary school, focusing the upcoming Área de Projecto. The essential guideline for this integration is the approach of significant, technology-based problems.

In addition, will be presented the results from the implementation of a robotics program designated to young students and future teachers at Escola Superior de Educação de Viana do Castelo.

Keywords. Área de Projecto, Physics, Project-Based Learning , Robotics, Science Education.

1. The Área de Projecto in the portuguese curriculum

The last change on the portuguese secondary school curriculum introduced a new subject designated for the 12th grade students: Área de Projecto (to apply from 2006/2007).

There will be no specific curriculum for Área de Projecto: the main goal is to provide the students an opportunity to develop investigation skills, integrating the various subjects previously studied and developing new subjects as well.

The problem chosen by the students should be significant for them, thus the teacher's role should be essentially to guide them in that choice. Nevertheless, the teacher should realize that for the science courses students, the essential approach to the problem should be done by the science point of view, as this is also a preparation for further (science) studies.

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2. Using robotics in the classroom

We could say the implementation of robotics in portuguese main K-12 education is only at the beginning. In spite of some projects involving LEGO TC Logo™ in the past, there has been no systematic use of robotics. The LEGO Mindstorms robotics kit (developed at the MIT Media Laboratory, USA and released in 1998) and Robolab™ software allowed a wider use of robotics in education.

The release of these products, specifically developed for education, allowed its use by students ranging K-12. In Portugal only a few students had the opportunity to use them. With the recent introduction of the FIRST Lego League in Portugal, some schools could provide their students the opportunity to develop robotics projects in robotics clubs.

Although this is an extraordinarily important and valid implementation of robotics, different approaches are possible and desirable [1]. In particular, it is possible to use robotics in investigation projects, such as those expected to be done in Área de Projecto.

2.1. Benefits of robotics in education

The appropriate use of robotics, in particular, the constructivist approach, may provide a variety of educational benefits [12]:
- reinforcement and development of abilities concerning other subjects, such as Physics, Math or Chemistry;
- promotion of interdisciplinarity and integration of knowledge provided by other subjects;
- motivation for the study of other traditionally unpopular subjects [7], [11];
- motivation for school in general
- development of problem-solving techniques, persistence and creativity [9];
- development of formal thinking/abstraction [5]
- better understanding of models using and the associated constraints;
- development of cooperative work and investigation skills;
- better differentiation of teaching.

2.2. Advantages of the LEGO Mindstorms/Robolab

Among the several robotics kits, the choice lied on LEGO Mindstorms kit and Robolab, as the programming software. The main reasons for this choice are the following [12]:
- recognised credit of the products;
- non-demanding on particular electronics knowledge and techniques;
- easiness of construction and enthusiasm [11];
- ability to perform data logging;
- existence of a programming software (Robolab) also developed specifically for educational purposes;
- existence of other (free) programming software;
- open policy adopted by LEGO;
- provided support;
- price;

3. Using LEGO Mindstorms in Área de Projecto

When using robotics in education, many approaches are possible. In situations such as robotics clubs, the main purpose is usually to promote the students interest for robotics and science in general. The purpose of specifically developing and integrating physics (or other subjects) skills is not the main one. In addition, the attendance is usually optional.

As previously said, this kind of activities has great benefits, particularly up to the 9th grade, but it is possible and desirable to develop more structured and ambitious approaches. In fact, one of the best qualities of this kit/software is the capability to use it in very simple projects but extremely ambitious ones either.

The structure of Área de Projecto suits perfectly the purpose of approaching real, science/techonology-based significant problems. The time constraint usually pointed does not apply on this case. This been said, the guidelines defined for the use of robotics in Área de Projecto are the following:
- Emphasizing of the physics role in problem solving. The declaration of 2005 World Year of Physics by the UN recognises the need to promote Physics among society and students in particular. In fact, Physics does play an essential role in present society, which is technology-dependent. When helping to define the problem to be studied and the strategies, the teacher should regard this fact.
- Differentiation of the difficulty level. The teacher shall guide the students through a series of increasingly complex approaches to the problem: teacher shall help students on defining investigations goals which are, at any moment,

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within their capabilities. Thus, frustration can be avoided, as well as it is provided opportunity to develop students' capabilities as deeply as possible. One could say that a robotics project has always a certain degree of success and is never finished. An evidence of this fact is the use of LEGO Mindstorms with very young children as well as in university projects.

Within these guidelines, two projects have been developed for further implementation. When defining the problems there has been an attempt to involve issues beyond "traditional" mechanics.

3.1. Autonomous solar vehicle (sun tracking device)

The essential of this project could be summarized as the construction and programming of a device capable of orientating a solar panel to be used by a solar vehicle.

On this project, from the robotics point of view, the main difficulty will be the programming, rather than the Physics involved. Nevertheless, the approach of such a problem demands the study of the solar cells and applications. This shall not be new to the students as this is a Physics subject previously studied in the 10th grade.

The context to the problem is intentionally left open: the main goal on the proposals is to provide the core guidelines, rather than a final project. Anyway we could suggest an integrated approach to a monitoring vehicle: more than one group would be involved in the project and one of them should provide the power mechanism.

For the panel orientation, 2 axes will be needed, therefore, it will all come to the construction of such a system and programming its behaviour. One can start with a single (vertical) axis system: this allows separating a complex problem into easier parts. Once this is accomplished, the second (horizontal) axis orientation will be similar. In addition it provides the opportunity to achieve partial goals along the project.

On the construction of the axis orientation system it will arise the speed problem: if the motor is directly connected to the axis it will turn too fast and it will be impossible to orientate it properly. The solution is to use several speed reduction mechanisms. In the following picture has been used a 24/8 and a 40/8 gear, which provides a 15:1 reduction.

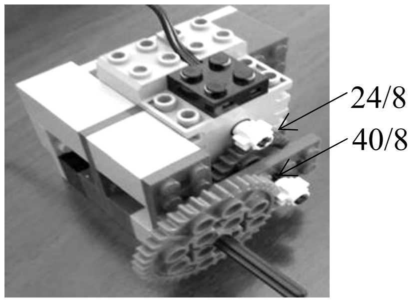

Figure 1. Vertical axis orientation system

To control the axis orientation will be used and attempt and error technique: using a light sensor to monitor the light amount, there will be made a slight change in the orientation and will be compared the light amount across the direction perpendicular to the panel, which is the light sensor direction. The control of the vertical axis with the motor A (connected on output A), can be programmed as follows:

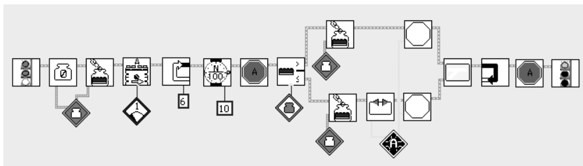

Figure 2. Vertical axis orientation program

In this algorithm has been used an interval of 0,1 seconds to perform each movement. The output power has been set to 1.

Using a similar technique for the horizontal axis, the following structure can be obtained:

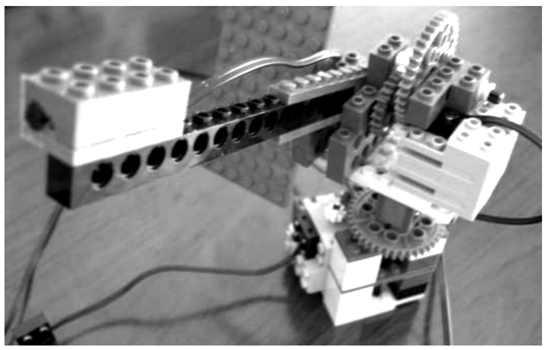

Figure 3. Two-axis orientation system

In order to control the two-axis system, a similar algorithm can be used: the orientation on the motor B (horizontal axis) will indefinitely alternate with the orientation on motor A:

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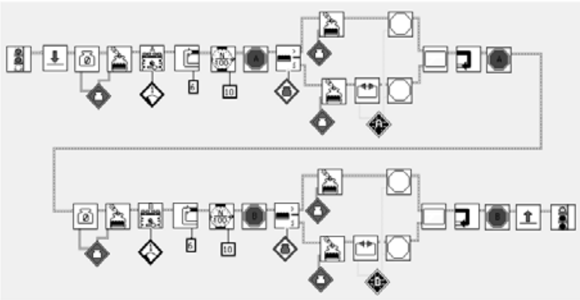

Figure 4. Two-axis orientation program

With a construction similar to this and with this program, the robot will provide the requested orientation to the panel. In spite of that, the behaviour of the system can be significantly improved. For instance, the orientation process can be conditioned to a light decrease and the time interval can be successively reduced, which provides a smoother orientation. For further reference, see [12].

3.2. Study of the LEGO motor properties

This proposal focus on the study of the DC motors. Once again, there is not provided a specific context, although can be suggested the problem of moving an elevator: what is the best way to move an elevator, using a certain motor?

On this case, the programming is very easy and the main work will be the systematic survey of information about the motor properties. From the variety of questions related to this problem, we will be focusing here two in particular:

- what is the best way to move the elevator if we intend to minimize the time (maximum power)?
- what is the best way to move the elevator if we intend to maximize the motor efficiency?

In order to answer these questions, students will have to design a way to measure the energy obtained by the object (elevator) and the energy spent by the motor in various conditions. A previous study will show that for this kind of motor, the important factor is the torque/speed [12].

A particularly easy way to measure the energy obtained by the object is to move it upwards at a constant velocity. By changing the mass of the object, we change the motor torque.

The motor efficiency can be obtained by measuring the electrical power, using a voltmeter and an ammeter in simultaneous (measures have to be made during the stationary period). In alternative, DCP sensors can be used to measure and log these values. In our work, two light sensors were used to detect the star and the end of the stationary movement:

Figure 5. The experimental setup

Using this setup, and using a simple robolab program to give the time between the “gates”, calculations have been made and the following graphics were obtained:

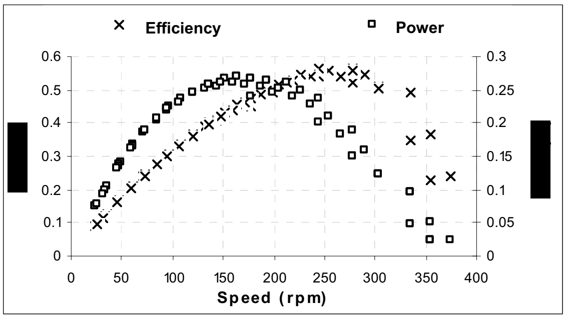

Figure 6. Efficiency and power *vs speed*

These results show that motor efficiency and power depend on the motor speed/torque in a different way. The power peak is obtained at a different speed/torque that would lead to a maximum efficiency. Thus, on an elevator design, the gear system should be different depending on what the purpose is: maximum power, maximum motor efficiency a balance situation.

The results could be obtained by theoretical considerations [12]. This allows students to compare the results obtained experimentally. Once again, we can say “there is no upper limit” on the project: although we realize the difficulty some students should have on trying to do this analysis, the teacher must have in mind that each student shall go as deep as possible.

On this project, the focus is the systematic study of the LEGO motor (provided with LEGO

Mindstorms kit). On doing that, students shall develop experiment design and data analysis skills as well as they investigate mechanics-electricity subjects. All this can be done with a specific goal but the study can also be taken as a base-study for other projects: the group that investigates this issue does not have to apply their conclusions, the work can be done in collaboration with other students whose work depends on these results. Thus, collaborative work skills will be developed within each group as well as among different groups. In fact, no investigation centre works alone!

3.3. Conclusions

On the two projects here summarized has been proved the possibility to use robotics, particularly the Mindstorms kit, to achieve the essential goals of Área de Projecto. Has been shown the possibility to develop significant problem-based projects with a strong emphasis on Physics. Has also been shown the suitability of the Mindstorms kit.

The constraints of the research work didn't allow verifying the concrete results from such integration. In fact, Área de Projecto will enter the 12th grade curriculum from 2006/2007. Additionally, there is no previous systematic work on the use of robotics in education in Portugal. Considering these limitations, the evaluation of the impact of robotics in education, particularly in Área de Projecto, has to be postponed for future investigations.

4. Other robotics projects – "Robótica para todos"

During the past year, a robotics program has been proposed by Escola Superior de Educação de Viana do Castelo and funded by FCT (Fundação para a Ciência e Tecnologia).

The main goals of this program were: demystification of robotics; promotion of Science and Technology among young children (5th to 9th grade) through robotics; promotion of Science and Technology (particularly Physics) among future 1st to 6th grade teachers through robotics; the development of experiment design skills; encouraging the use of new approaches in elementary education by the future teachers, in particular, the study of Physics subjects on a constructionist approach.

The program implementation had two ways: one focusing on the future teachers and the other focusing on the young children.

4.1. Robotics with future teachers

The students were involved in two introductory Physics courses (Fisica I and Fisica II) and a Science course (Estudo do Meio Físico e Natural). On the Physics courses, the students defined a specific problem and studied it with the Mindstorms kit. In Fisica I, two groups developed their work around the motor behaviour issue: based upon the data provided by the teacher and the Physics concepts they produced as final product two elevator systems: a vertical one and an inclined plan. The inclined elevator has been inspired on the Santa Luzia elevator (a typical elevator previously existing in Viana do Castelo). Another interesting project, suggested by a group of students, was the control of a Cartesian diver by the RCX.

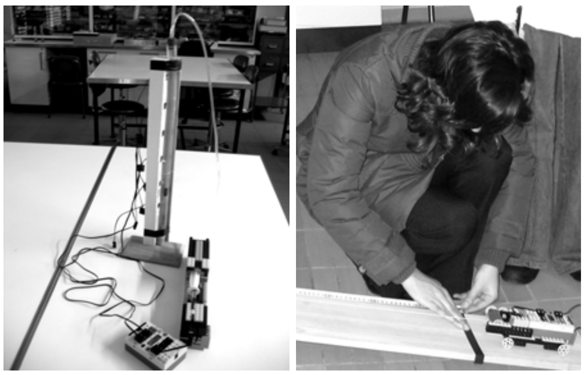

Figure 7. Cartesian diver and "Santa Luzia" elevator

In these cases, the students were asked to think about possible situations to be studied. The final plan resulted from the negotiation with the teacher. In some cases the students didn't came up with any concrete proposal but in other cases (such as the Cartesian diver) the proposal was quite surprising! In the case of the Cartesian diver, the reason pointed by the group was the "need to learn more about the subject".

In Fisica II, the students used the Mindstorms kit to study a Thermodynamics subject: they constructed a house model to study the energy spent on acclimatization. The RCX used a temperature sensor to monitor the temperature and control the heating mechanism. The collected data was later used to study the effect of factors such as the upper temperature on energy consumption.

In the Estudo do Meio Fisico e Natural course, the students also developed specific projects involving Physics. Due to the course and the desired profile to these teachers, the Physics concepts involved were not so deep. A few groups developed their works around the energy subject, particularly, the renewable sources of energy, some other groups were involved in the study of weather factors (construction of an anemometer, construction of a humidity sensor and monitoring of this factor, study of the temperature variation and the influence of the water proximity). Another interesting project was the construction of a spectrophotometer, based upon the study of light and colour.

The evaluation of the project's impact (based on the direct observation, the final works obtained, the reports presented by the students and the final survey) is very positive. The students (future teachers) were able to improve their image on Science and Technology, could enlarge their skills on constructing concrete materials and developed/applied theoretical concepts as well. It was quite surprising how easy the anemometer group did the calibration of their measure instrument.

The main issues involved on the introduction of robotics was the difficulty of construction shown by some students (which reinforce the advantage of using this kind of projects, as these skills are essential on future teachers) and the difficulty for the teacher to tutor so many different groups: have been up to 12 in simultaneous.

4.2. Robotics in a summer course

The robotics program involved two one-week summer courses. On the robotics courses, the students had a short introduction on robotics and developed their own robotics project. Some of the students who attended the first course came back on the second edition because they "enjoyed it very much" on the first edition.

The projects developed on these courses were much more specific: the main goal was not to specifically involve Physics (although Physics concepts and robotics are inseparable). On this situation, the main purpose was to allow the students to contact with such an interesting and important area as robotics.

Usually, the students tend to dislike the introductory part in comparison to the construction: they are anxious to get their robot working! There is a significant change on the attitude of the students when they see their robot doing something: those who were already very enthusiastic become even more! This applied not only in the summer courses: in every situation similar behaviour occurred. This is one more reason to promote projects where there are partial goals, easy to achieve: there shall not be the pretension of building "the final version of the robot" from the beginning.

From a written survey done at the end of the course, all the 29 participants said they liked. From the 29 participants, 2 (6,9%) said the course had been a bit bellow their expectations, 13 (44,8%) said it had met their expectations, for 9 participants (31,0%) it came above the expectations and 4 (13,8%) said it came much above the expectations. Beyond the limited statistic validity of this data, there is the student's observed behaviour: the best indicator of the student's satisfaction and involvement lies in for instance, in the fact that students "forgot about lunch" because they wanted to improve their robots in order to win the competition (this came very clear on the "sumobot" competition).

5. Final conclusions

It has been shown that not only is possible to use robotics in education but it is very useful, in particular, robotics can be used in situations such as Área de Projecto, where is intended to develop structured investigation projects.

Robotics has revealed an excellent way to study Science and Technology-based problems and provides the possibility to systematically involve and develop Physics concepts. This, along with the promotion of Physics (and Science in general) is quite essential in the present time, due to the need to motivate students into pursuing Science and Technology careers.

The integration of robotics in a formal context education has been discussed in the case of Área de Projecto. This determines some particular aspects, such as the inexistence of a formal curriculum, which allows the teacher to manage the available time without the usual curriculum constraints. This is one of the reasons we believe robotics to be very suitable for this purpose.

Beyond this, we believe to be possible to integrate robotics in "regular" classes. The work done by Barbra Bratzel [2] and Marie Abbatinozzi [1] reveals great possibilities on this matter. It would be desirable to continue this work, in particular, applied to the Portuguese education system.

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New Approach: Industrial Automation Technologies in Turkey

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Abstract. Production in the industry contains more and more control and industrial automation. The importance of industrial automation in control, distribution and forming becomes more important through applications of circuit breakers, relays, control and visualization systems and automation hardware. Industrial automation is today a new approach at vocational schools, universities and in the industry with valuable research works. The presentation of the importance of these topics as a branch to the students in electric-electronics-machine departments of the high schools, universities will result with a success in the industry and will help to increasing the production.
The dynamics of the world in which we live directs the requisites of education. In this spirit an innovative model of vocational education designed and implemented by the Ministry of National Education will be discussed and then the present status of industrial automation technologies education in Turkish vocational schools will be investigated in detail. The pilot project between Republic of Turkish Ministry of National Education and Japan International Cooperation Agency (JICA) will be introduced.

Keywords. Turkish national education, Industrial automation, Educational technology, Pilot project, JICA.

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Didactical History of a Science Fair

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Abstract. After 12 issues and different changes, Ribadeo's 'Science and Technology Fair' offer a history enough wide that could be profited. Facing their use in educational matters, are reviewing and analyzed didactical aspects in these 12 year.
In this work are submitted the guidelines of the 'Porta da Auga Science and Technology Fair' and mainlines of 'science fairs concept' as support to comment several didactical points, and is presented also a desirable guideline for future issues.

Keywords. Science fairs, Didactical approach, Scientific encouragement, Young science, Creativity, Participation, Collaboration.

1. Introduction and main concepts

This presentation is an attempt of advance in the understanding of the development of a Science Fair maintained through twelve years, to allow in the future:
- to have a temporary line of possible development of science
- to maintain a line of study with didactic base in this type of manifestations
- the learning of promoters of science fairs

In general, it can say that the science fairs are events in which scholastic works of varied thematic are exposed, in a scientific scope. Its accomplishment is based on the students: they are made mainly by students to be visited, of main form but non unique, by students, although they take part like organizing professors or educative institutions or of institutions scientific diffusion, and can be visited by all type of public.

Its conception depends much on the place of development, but especially based on the convoking institution and the objectives.

It would be possible made classifications of fairs in different ways, following one or other criteria. Thus, for example, a classification would be based on the type of convoking institution:

1.educational centre at compulsory educational level or pre-university (as the IES Porta da Auga) or a university department (case of the University Matías Delgado in El Salvador)

2.institution or zonal or regional association (like the Association of Friends of the House of Sciences, in La Corunna, that annually summons the “Day of Science in the Street”)

3.institution or national association (INICE, institute of scientific and ecological initiatives, in Spain)

4.institution or international association (Cirasti like promotional and managing organization, HSci project like grouping of organizations that leans for their accomplishment),

In function of the type of convoking organization, it varies the public to that he goes directed and in general its conception. Something similar happens if we considered a division in thematic events and generalist events (in this case, including always the possibility of sections dedicated to the physics or to any other science separately) or if the emphasis is put in the investigation and communication of works or in the diffusion of knowledge, etc.

Another approach, historical, can locate the origin of these manifestations at the beginning of s.XX, in North America, from the spirit of professors so that their students exposed works to their own companions. Between world wars, some schools began to favour the excellent works with their open public exhibition.

After the II world war, an authentic movement arose, and in 1950 the first fair at U.S.A. level took place in Philadelphia, which contributes to increase the speed of diffusion of the idea and the accomplishment of the first international fairs, that had a competitive slant.

Historically, the levels of the students who participate are varied, depending on the organization of the fairs. In same way, although the local events are smaller and of smaller organization, maybe they are most valid educatively because are more near the public and of the own students in general.

The tendency to great fairs or events of reputation, maintained by diverse interests (advertising, more facility of sponsoring, etc) can incline the call for new events to this profile, before that in places like Galicia the small fairs, at school level, have an authentic diffusion.

Throughout the history of the science fairs

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also they went marking to divisions between originality and copy, as much in the organization as in projects presented/displayed, that include at the present time an ample range from the reproduction of apparatuses or experiences to the investigation or the construction of totally novel apparatuses (in [1] can explore the consequences to take refuge in one or another part of that diversity). It is possible to say that when looking for in Internet to have ideas to presentation in science fairs, it appears the Physics in percentage next to 25%, to Chemistry or Biology, although with a natural variation between ones and other data bases.

Ending, is possible to emphasize the clear distinction between the own organization of the fair and her projects (that often tends to confuse) beginning in the objectives and finalizing in the evaluation of each one of the two facets, happening of natural form through the people in charge of the execution of each one of the steps that occur. In this sense, we can speak of the division and the relation between continent / contained like representation of the own fair on the one hand and the projects that contain by another one.

2. A small history

At the beginning of the 90's, fell in my hands a serie of articles in which a particular vision of the science fairs appeared, a concept that I had before thru the cinema, so, plus story that reality. Particularly, the mentioned article [1] gave a minimum instruction set that extended the field of vision to me the sufficient to animating to me and promoting in our school an event of those characteristics. Thus, in 1995 it began in the IES Porta da Auga the celebration of Fairs of Science, as it were said in the presentation of the first edition, with spirit of survival and improving.

From that moment we have had 12 editions ago, enough expertise to make a small compilation, from a historical perspective, but structured more by subjects, questions, and Didactics and organization.

On the part of the professors, every year the fair is approached with fear and hope: renewed fear to that it will be not managed to make the edition in course of the form about which thinks that it would have. This is because we are working with people in formation, and always is left the fear to that the formation is not sufficient.

Also hope: we are customary to fight to obtain the best.

On the part of the students, each new course, with eyes that find new features and that sometimes they take time in being accustomed to them. Also with that they happened through the fair and they remember it with affection.

The name? In this case, the name of "Fair of science" was reconciled with "and of the technology", with the perspective of not make a copy of which became in other places, but to obtain a specific adaptation to our educative center, obtaining in addition the adhesion to the project to professors of the field of the technology, an important group in a center of professional training, that was the structure that it had then. Later, "and vocational training show" was also added, to include contents of another nature and to maintain the cohesion of the educative center. The increasing success later years, this same year, to divide the event, again being with the original name, "Fair of Science and the Technology".

It will be with the present name? It seems a triviality to ask something thus. Nevertheless, the name is also a picture of the mentality and the heap whereupon confronts the event. In that sense, a change is possible, but it must be totally just, and tend to put more in clear the objectives and to favour the educative practice. Thus, a direction different from the activity gives rise to different names, and our students have participated in similar events but with directions different as they show the names to it of "Euroscience", for the events within an European project from diffusion of the idea, "Science Fairs Throughout Europe" (SFTE), or "Day of science in the street", for a project that tries to become at Galicia level with the collaboration of diverse educative centers and different organizations, but orienting its exhibitions towards science.

And the ideas? The ideas that take shelter year after year to deal with not repeating experiences have a varied origin: books, internet, other professors, etc, are alternated, and every year they appear new ideas and new places where to find them.

All the fairs were equal? No edition was similar to another one in reason of the experiences that appeared, but also in the organization, because always we tried to advance, although to small steps. The variation from an edition to another one is a weakness, but also a challenge. A weakness because the professors we are not professional of these events, but of teaching, and each new edition supposes new dangers and errors. That same mentality also supposes a challenge that makes possible improvements year to year.

It varies the people who participate? Every year vary the students, in successive promotions. The professors vary with less frequency, but between which they collaborated is people who do not know themselves because she did not agree in center educative. By all means, the same happens with the students, but in much greater degree. And the normal thing is that students and professors who participated in previous years are first people in visiting the fair.

It was always made in the same site? If we talk about the school, yes. Nevertheless, in twelve years the distribution of the scholastic space varied, including new spaces and searching for suitable places more adapted at the development of the event. Thus, the first year became in which today they are offices (before library), the assembly hall (today library) and the corridor among them. Last editions were made in the new sports pavilion, having much more space that previously.

Always participated same levels of students? First year that was possible to make the fair in school because we have the level of 1st year of technological baccalaureate (students 16 - 17 years old with an important scientific component in their timetable). Later went adding other groups until participating all the students. Even so, the level that began the experience continues being fundamental, because is one of best level of knowledge in science, lower than 2BT, but this level is oriented in its preparation for the test from access to the university.

That expansion had the fair? In the first years we looked for spread the fair, his concept, the action around her, and since then every year there is some news in the press, the radio and the television; some year, including the television at state level. Also, the fair had means of diffusion in other countries as a result of the educative European project Comenius I "SFTE". Nevertheless, one flees from the danger that to the educative yield represents an extreme growth. It is necessary to remember again that no one of the promoters is professional of the fairs and however all the contributors we are related to education.

And the poster? Good part of the years was done by my same one, but also other professors have participated, like Maite Castro and MŞ Jesus, professors both of Drawing. In this aspect, we encourage the participation of people of the school from the first moment, professors and students. Thus, only in two occasions (editions X and XI) its design was made by people out the school. And also companying the design, almost every year puts a motto, treating to relate fair, science and education. Thus, in the first edition, "fly with the reality" on an outlined air balloon that yawing an eye, animated to make possible any thing by means of the imagination and science. Mottos that in any case continue being valid nowadays: "Science? Natural!", "the sound of science", "Observe. Think. Make", "science, in the home" are some of the used mottos, words that try to see the science like something natural and inner to the nature, to listen to science, to act in a scientific form, to include/understand that science has use in all place, etc.

How many experiences happened through the fair? Around 900 in these 12 editions, only counting the disciplines that participated every year. But the number is a smaller question.

And the financing? It varied from a year to another, counting some without budge, only spending the photocopy for posters and pamphlets. There were also years in which companies and foundations have sponsored in a generous manner the event. Every year is different and depends on situation.

Who is the fair propiety? As answer could be said: of the IES. Nevertheless, that answer takes with himself a non considering people, in the same form that if we answered the question of that they are the students? with the answer "of the IES". Because the fair is of all those that participate in her, professors or students, would be called Felipe or Ana, Susi or Joaquin, Teresa or Adrián,… to name some of the participants in this last edition, professors and students. Therefore, in greater or smaller degree, of all the participants.

2.1. 2006 Science Fair history

The science fair begins with the end of the previous edition. Thus was reflected in the video gathered in the first edition, and thus it continues being. Nevertheless, the movement begins with the academic course: it is then when the challenges consider so that the students begin to work, the documents are gathered to go, begin the animation on the part of the professors, etc.

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This beginning is slow and almost invisible from outside, for the people who are not implied directly.

If we took history from a fair in particular, we are attempted to make visible what it is seen more, and thus will be made in this section, but always with warning of which what it sees it is only the end of iceberg, and hauy that to think about all the work that is made underground.

March, 31, 2006. The assembly of the fair begins. As always that we put ourselves to work, the site to occupy is empty, and only our imagination fills it, at the moment, of a blurred form that will clear step to step. We used heavy panels who are transferred slowly the warehouse, between sweat and laughter, it drags and it transports by wheels. It is clear that sometimes it is not easy to apply the wheel' technology to the movements, although the panels undergo more. Slips, scares, step to step, the ground is being covered first and soon separated one in pieces that they try to be a distribution of the space. That is to say, the sports center becomes a hall exhibition in little steps.

April, 3. Enter to the hall exhibitions gives already a different impression. Still material lack to transfer, other to vary of position, etc, but is a phase different from the one, a phase to divide spaces: now is more architecture of spaces, and after, decoration. Well, that in the morning, because advancing the day they appear the cable lines, the paper covering tables,… and more still advanced, the first exhibitions.

April, 4. The day of the inauguration is arrived. Everybody knows that there is a limit: the six of afternoon. To that hour it is the inauguration. But, in fact, this one is the first day of the fair. The diverse presentations, exhibitions, apparatus, posters, studies… are quickly filling the diverse places, in which still some change of distribution of last hour is appraised. No longer it is a hall exhibitions, is an expositions and congresses palace, because people congregate themselves indeed not only for the assembly, but also for first visits, still before the inauguration. Those are many of the exhibitors that are going to see the others, that in this case are so "collaboration" than "competence". The memory forgets express the hours until the moment of the inauguration. The sensations, always subjective, of gap of time, can be studied in a next edition of the fair, because they are interesting.

And the hour arrives. The assembly hall fills while the table is occupied only by three people. They lack authorities, with the exception of an ex--student who today holds the position of mayor lieutenant and who makes the ceremony more home-made, of the educational center, for the education and not to the gallery, and, in time represents a communication channel with the outside. So, it does not lack the press that will accompany to the fair from the leaves of newspapers to diverse programs in several televisions, happening also through the radio. If the inauguration act is natural, the first visit is the boom from exit to a small revolution in which the fear by the result disappeared, because everything is on. And soon… the thorns of coexistence, that know better after seeing than everything works, to the time that all, students, professors, directors of schools visitors, friends, companions, are a mass that eats, with a smile in the mouth.

April, 5. Today already it is a calmed day more. One knows the visits that there are, and also that there is to guide them and to explain, although not yet is the sufficient expertise to do it. Throughout the day it is taken experience, as much to guide groups as to have resources to explain, and also, a little is known the fair a little more. Well, not all the fair, but what in her is shown. And already they are left clear the preferences of each one. The attractive works begin to be more visited. The attraction can be by reasons different from the related to education. The television that begins its visits to the fair, also makes its election of which that thinks it is going to hit more. And it makes at the moment famous actors inner the school, and, part to spread experiences of bones that seem made in plastic, seeds which grow of different form, arcs which remember Roman aqueducts, electricity explained by liquids, electromagnets, studies of behaviour, bells that touch when television apparatus turn off, elevators, peculiar figures in paper, mathematics of the physics and physics of the mathematics, and many things more, until near one hundred.

April, 6. The most total day, in which the students have experience guiding groups and in explanations they take control of resources and security, the new groups of other centers that come from visit create sensation of continuity more than of newness, and also it begins to feel some disinterestedness because "I have seen everything"... But, if is verified, it is clear that is not sight with desirable depth, 'verified and certified'… always happens, better students or professors including. The "stars of the fair" comment their experience, and also it is possible to be commented that the screen of the television can be an electrical danger, that the aqueduct of Segovia was easy to do, that he is stranger that are so many forms to swell a globe or to the amount of things that can be done with a paper. It seems lie, but the most total day of the fair he is also the calm one, and easiest to describe.

April, 7. The day arrived. Last visits do not notice it, but… the mind is already thinking about the ending, in the aim and death of the fair. Everything is already controlled, students and teachers know that it was a success, and it begins to think about the continuation. No one thinks still about next year fair, but in experiences that will participate in the "day of science in the street", that will go,… until the moment arrives for gathering. Then, in just a short time, everything returns to change. Sometimes too fast, because what one takes shelter it suffers and it did not have to suffer. And it already is, later the panels (at another moment) will take shelter and the fair finalized.

It did not finalize: lack, for example, the memory of the projects, that is often made thinking about the next one that it will be made. It lacks the collection of opinions on which it is possible to be improved. Lack… the next edition. But also they are left things: the memory of those visitors whom they loved to go without guide, the visit of smallest visitors Thursdays after the hour of class, to see the fair in television, to remember how the assembly companion disappeared without helping, or that bone that seemed of plastic but that he was able to deceive a dog because was really.

3. Didactical view

When a science fair is including in the activities of a school, the daily life of the scholastic center varies. An event as the science fair has a profile with an evident didactic incidence, as well as in the structuring of education or the time available. We have learned that the person of reference in the scholastic organization tends to diminish the variations of the daily routine and therefore, to be against (of indirect form) to the accomplishment of the fair, reason why in our situation favours a tradition of twelve years, separated to the own positive evaluation of the fair. Also, it favours the possibility of developing new organizational experiences, increasing the heap of control of the fair on the part of the professors.

If we considered the time, according to the fair is conceived, it can be seen increased by way of the culture of a liking or well as extra work, or diminishing if the organization of the fair chose to use academic hours for the accomplishment of works. Evidently, the two possibilities infer very different models of work and theoretical. In relation to it, can be considered different strategies obey each professor; in our case, we have decided independence of options in each case, having contemplated some cases totally directed (in general, with students of less age) and others totally independent (of people of more age, revising work periodically or by request), and by all intermediate range. Thus, each professor inserts the fair in his didactic development of a customized form and a judgment cannot be made uniform, with the advantages and disadvantages that it derives. There have been changes in the form in which the professors exert the control or in the objectives that set out, but have not been uniform. Thus, in some the tendency is towards to a greater freedom of investigation whereas in others it is simply the exploration of new fields proposed for the development of the activity.

There is a clear relation between science and the daily life in practically any form of fair that becomes, the same that favours a vision of science like something applicable and therefore its useful and beneficial consideration, increasing in both cases the scientific interest of the students by the curricular contents and methods. This has been verified by us, but not measured in a graduated form. Also between us is a tendency clear to take advantage of materials that were developed entirely or partly by students in previous editions, as to develop the classes of one more visual and demonstrative or constructive form.

According to which model is chosen, thus allows the approach to the scientific method, better understanding or application and internalization of science. Thus, its relation with the educative theories can be studied of theoretical form to see the most advisable models in each case, or to cross that way through the experience, interpreted thru the personal trajectories or the educative theories. This is something that we have verified in particular cases, but which we have not been able to

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develop at the moment a guide system.

Often the competition between the participants in a science fair is assumed, made through its projects, declaring so a particular didactics that it is added to the active learning, and similarly, to the learning of the experimentation. We have established prizes in several editions of fairs, but we have not noticed a substantial improvement in the educative yield, and however if there has been an increase (small) of quarrels. We have had prizes of different types, and some have given better result than others, but at the present time we did not summon them in the belief that disadvantages and advantages are similar, although we did not discard to return to restore them.

The accomplishment of science fairs affects the method of projects, but the desirable autonomy of the students and its projects in relation to the professor, and the main structure of science fairs, do of all science fairs 'metaprojects'. It is necessary to consider the projects that are exposed as part of a more general project, the fair, and that must of being dealed with different form. And each professor also has a form different to do it.

The fairs also represent a didactic tool (and according to the sense of the own fair, affecting more the formation in investigation that in the formation in scientific theory) but a system of scientific spreading in two slopes: specialized and general (since the levels of the projects correspond to the “scientific magic” of smallest students to the obtained law or the demonstration of the greater ones). In both fields we have seen its qualitative utility, and in the present time we direct the presentations to different types of public, from small children to people with certain scientific knowledge, to be able to take advantage of the scientific diffusion that represents the fair, and to contribute to increase the level scientific of the society of a plus effective form.

The scientific method is the base for a project of fair, but it is necessary to consider that although can be considered minimum, exist expenses that can transform all the set. Its reduction is a practical question that it is not reviewed here, and a problem from year to year for the accomplishment of the fair that everyone has to solve of different form.

4. Students: its opinion

The opinion of the pupils is varying in each person throughout a process that concludes after the fair and begins with the preparations: the animation to participate, the election of work, the development of the previous activity, the preparation of the presentation, the exhibition, the later reflection, not only are steps in structuring an event of this type; they are also psychic phases that correspond in the students with different visions of the process and its own implication.

Finally, becomes the enthusiasm in showing the project and the confidence in the basic model (in its different versions) to make this work. Also the transition between the initial difficulty and the understanding, the dominion or the final enthusiasm in the handling of certain methods of work, including aspects of scientific methodology and others of diverse nature, like guiding groups of visitors through the fair, for example, animates to repeat the experience and to take advantage of the same one during more time. Certainly, like in any social situation, always there is a range of answers between which some of negative type can exist. Nevertheless, there has been a change throughout the time on this annual evolution: due to the valuation (in points to qualification and social vision) of the fair, the students tend to try to obtain the greater personal benefit (noneducative), which forces to a greater understanding and negotiation between the diverse participants.

The surveys passed to the students for evaluation of the process are neither uniform nor a form of evaluation used most of times, being able to say that in general the students are not consulted formally, and are evaluated in a sense that foments the competitiveness most that its didactic yield in relation to the projects and the fair or induction of a deepest learning. This is certain at general level and in individual in our fair, in which we have made attempts several times with not so good results.

In relation to the form of work, such students are able to discern only part of the usability of the works presented/displayed, since they are based of main form on the good looking. That is almost what we have stated.

5. What feeling professors?

Like promoters of the fairs, the vision that the professors have could be pronounced slanted. Nevertheless, they cannot have a unanimous agreement within the group when existing different visions from fair, insertion in the daily didactic development (in agreement with the Castilian saying that states “each little teacher has his own little book”), etc. This opinion goes, in our school and within the professors who have participated in several editions, from the total approval to the experimental repetition trying to look for a method that really convinces the professor.

Although with the previous warning, in general who proves the method is been thankful with the system, although the option to continue using it or no, depends on the circumstances of each particular educative center. This pronounces in that, in spite of the extra work that supposes an event thus, it is increasing the number of entities that promotes them. In the previous sense, it will have to consider the importance of the existence of a promotional, managing and evaluator team of a fair, and not of an individual professor who makes all the functions. Thus, the judgment on the result and its application will have to also extend to the team, in which the merit or the impulse will reside altogether to continue making other editions of the fair. Often, as in our case, this step has been bit to bit and it does not uniform, but it is necessary not only for an edition, but mainly even to maintain the necessary continuity so that the fair renders in the wished form.

In the various consulted sources it is made notice a considerable amount of experiences to reproduce, and also the existence of little manual of accomplishment. However, a deficiency of study of the process and the corresponding didactic theory notices altogether, advancing of form semi scientist by procedure of test and error, and without the equipment to do an evaluation adapted of the error.

Corresponding with the previous say, there is not either an evaluation form that as resulting from shows to the advances of each student the accomplishment of the fairs in relation to the supposition of his non accomplishment.

6. ... And society? (and parents!)

The society can watch at the fairs of different form according to the position in relation to they. Thus, it is evident that a sponsor will have interest more in the image than in the own educative result, although both things are related. Derived of this, we cannot be considered minimally uniforms ides in this section.

Another different vision offers the parents, who represent a special form of public and which they see the fair mediatized by the eyes of his children.

So, we were whereupon the parents usually have a positive vision, but often folkloric and more of type of social learning that science learning.

Even so, its participation is more and more essential, and its integration settles like one of the possible objectives, although he is not the primary one: it is the form in that they access to the scholastic life, or they retake the care of his children, or establish another type of coexistence based on the aid to complete the projects, to put three examples.

7. Perspectives and prospective

Supported at diverse levels to this type of didactic actions or the diffusion of the same ones is being increased, with which it can be foresee the future for the increase of his number.

Fairs are in apparent progress around the world, although also it is evolving his conception and tendencies since I have said in another section, and each professor and each center must look for his way to obtain the greater benefit or the mere possibility of accomplishment.

Nevertheless, a deep study of these actions and a methodology of evaluation are not yet prepared, and are needed to include the fairs of science in the common didactic use, with a suitable advantage and a practice, necessary to allow its maximum educative yield.

Related to the previous said, also is necessary an evaluation not only of the works presented / displayed to the fairs, but also of the process and the yields of the process. And as previous step is necessary to make a design, accurately in the objectives and a methodological adjustment to the didactics, pending action in most of the cases. It is possible to say that we have tried a system of quality internal to our fair, but at the moment we have failed in his application, for which a method makes lack that is not easy when the vision of the professors and the level of knowledge of the students can vary much. Even

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so, part of us we want to repeat the attempt to improve the development of the fair.

In each edition, the projects see like something individual, with few really collaborative projects unless they are imposed of some way by the professor, with which the opportunity to learn to make the work in equipment is lost, a lost opportunity to improve this necessary form of work at the advisable present time and like method of alternative learning.

A great number of professors assume that the science fairs are products with a certain format, like for example, the fair format that has a certain sponsorship, as he is the one of Intel. This type of sponsorship and "closed" format is the one that is centering good part of the growth of the number of fairs in some zones of the world, appearing therefore the imposed objectives of extra-academic form, have or not an agreement with didactic objectives.

I consider advisable to make a call to the people whom they have thought to promote fairs, so that their adjustment to the educative reality is best the possible one, over impositions of another type. The previous said, being conscious of the difficulties that would to involve in some case.

8. Conclussion. Little summary

Science fairs are a very valid method of education in science, but are following without methodologically develop, or making a practical study of their reality. These reasons will need a methodology of action and measurement of adapted form, understanding that it is necessary a development of studies of individual fairs and a method of cooperative work.

9. Acknowledgements

I always must mention to Alan Ward like the person who caused that final step until putting to go in this subject, but the certain thing is that without my companions of teaching and my family, little it could have done: consequently, per moments, our house also seems a fair.

10. References

I've divided a short list of references in two classes: directly related to IES Porta da Auga S.F., and other, these last class, mainly websites and in latin languages. This list signifies not great works but, for me, significative works in some of the aspects related with article. Both web references in internal section will signify, in dates of congress, a lot of summarized information over SF in the IES.

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Hands-on Science in Olabide Ikastola

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Abstract. Since January 2006 Olabide Ikastola(Basque school) located in Vitoria-Gasteiz(Araba) in the Basque Country has started a new program for all the grades in Primary. The program has got a double objective:

Firstly, Olabide Primary science program wants to make science relevant to students' daily lives. The program is organised in sequential units so that students will progress each year in their conceptual understanding and skills development.

One of the strong features of the program is cooperative learning, where students work with each other in small groups to solve problems.

Another feature is student-centred learning. Lessons start from students' current understanding and provide opportunities for them to test and explore this understanding. The program framework enables students to build reliable knowledge about basic scientific principles.

Activities are stimulating and 'hands-on'. Most of them require only simple equipment such as egg boxes, plastic containers, straws, paper and balloons.

Secondly, all the lessons which are with a "Hands-on Science" approach are in English.

This is a big challenge for our school where the majority of the students have got the Spanish language as mother tongue, Basque as their second language and English as third.

Finally, we are sure this program will help them to develop the necessaries capacities to arouse their curiosity, their interest, and their pleasure for discovering, understanding and explaining different natural phenomenon.

Keywords. Science fairs, Hands-on experiments.

Our First Adventure in Science

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Abstract. This project aims at raising questions and challenges in a funny and didactical way, find explanations, and, above all find pleasure in understanding science.

Touch, feel, explore, and enter the adventure of discovery, either alone or with friends and relatives, is a must. We also want to offer these children intense, gratifying, and enriching moments, that may even be responsible to change their lives in the future. Our project can help consolidate their autonomy and confidence in their capacities to understand and learn. Apart from the more obvious entertaining side and the curiosity raised to learn different things, the experiments can help develop capabilities or intuitions, upon which future knowledge can be based.

Those responsible for the project will deepen children's knowledge, helping them build scientific concepts based on their preexistent knowledge. That is, children will find out what science is by using previous knowledge and by making experiments. This project will start right away with the first experiments and will reach its climax by the end of the school year when a presentation will by given in the class of the leader of the team. In these occasions experiments, drawings, entertaining games, written descriptions, and photos will be used to help systematize what was learnt and to help register the events that took place. These will be exhibited in «Hands-on Science» Conference 2006. Those responsible for the project may add more activities to it upon the interests of the children.

Keywords. Science fairs, Hands-on experiments.

Electric Power Generating Bicycle

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Abstract. It is manifest the growing interest in both personal health and environmental issues. The device described on this paper contemplates both aspects: generating environment-friendly electric power while keeping fit. A car alternator excited through a 12V battery is coupled to a mountain bicycle, and this arrangement enables the lighting of six halogen lamps, if a cyclist pedals fast enough. Such a machine gives rise to the thought of a self-powered gymnasium. Considerable physical effort is required in order to make the lamps glow, which is pedagogical since it shows clearly that spending energy is much easier than generating it.

Keywords. Electrical Power Generation, Alternators, Alternating Current, Direct Current.

1. Introduction

The device described in this paper integrates a car alternator and a mountain bicycle (Fig. 1), allowing the generation of environment-friendly electric power while keeping fit by pedalling. This contemplates both personal health and environmental issues.

A car alternator excited through a battery is coupled to a mountain bicycle. This arrangement enables the lighting of six halogen lamps, if a cyclist pedals fast enough. The device is very suitable for science fair events, where it can be used to explain the production of electric energy and other Electromagnetism fundamentals.

2. Principle of operation of the alternator

Rotating a coil within a magnetic field (Fig. 2) induces a voltage at the coil terminals [1, 2, 3], which allows powering a load connected to these terminals. If the coil rotates at constant speed within a uniform magnetic field, an AC voltage with zero mean value is induced at its terminals. The periodic change of the voltage polarity is due to the change of the position of the coil relatively to the magnetic poles. The amplitude of the voltage depends on the magnetic field strength and the rotation speed. This is the principle of operation of an alternator.

Figure 1. Electric Power Generating Bicycle

Instead of rotating a coil within a magnetic field, as suggested in Fig. 2, it is possible to generate an AC voltage rotating a magnetic field around a fixed coil [4].

The magnetic field of an alternator may be produced by a permanent magnet or by an electromagnet.

An electric current flowing in a conductor generates a magnetic field in its surroundings [1, 2, 3]. This effect is used by electromagnets to generate magnetic fields.

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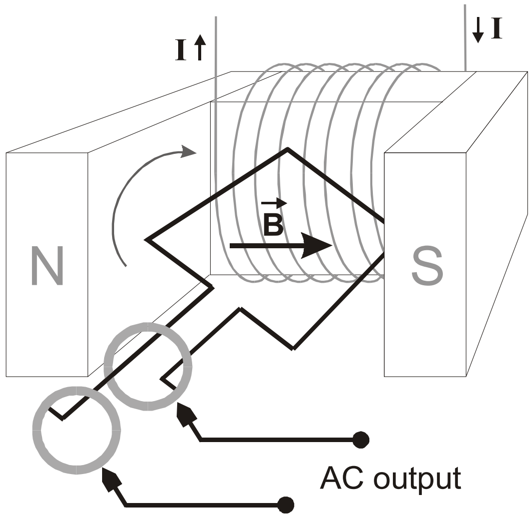

Figure 2. Principle of operation of a single-phase alternator

Typically, an electromagnet has a coil with iron core and the strength of the generated magnetic field depends on:

- the number of turns of the coil;
- the amplitude of the current that flows in the coil;
- the type of iron core used.

The current flowing in an alternator electromagnet, which is called the *excitation current,* may come from an external energy source – a battery, for instance – or from the electric circuit of the alternator itself.

The principles described so far explain the operation of a single-phase alternator. The alternator used in this project is three-phase: it has three identical coils symmetrically mounted on the rotor, (with an electrical 120º angle between each two coils). As long as the rotor keeps turning, three alternating currents of the same frequency and amplitude are generated. These currents are displaced by an angle of 120º.

Usually, a three-phase alternator would require six wires to conduct the currents induced in the three coils. It is possible to reduce the number of wires to three by connecting the coils between each other. They may be connected in electrical delta or in electrical star. A delta connection only requires three wires out of the coils. A star connection requires three or four wires.

In car alternators, the coils where the voltages are induced are usually mounted in the stationary part of the equipment (the stator). The coils that produce the magnetic field are placed in the mobile part (the rotor) of the equipment [5].

2.1. Rectification of the alternating currents

The alternating currents generated by a car alternator cannot charge the car battery and are not appropriate to supply the electric and electronic parts of the vehicle, either. The solution used to overcome these limitations is to rectify the currents. This rectification is made with a semiconductor rectifying diode bridge.

The output of the rectifying bridge is a pulsating direct current. The ripple in the current can be reduced by the battery, as well as by a capacitor connected at the same time to the bridge output.

2.2. Self-excitation of the alternator

Initially, a current from the battery is required in order to create a magnetic field in the armature of the rotor. When the voltage in the stator is high enough, it becomes possible the self-excitation of the alternator. This means that the rotor is supplied by the stator. Eventually, a voltage that is higher than the initial one will be induced in the stator, allowing the charge of the battery and the powering of all electric and electronic parts of the car. This voltage is controlled by the voltage regulator.

2.3. Voltage regulator

The function of the voltage regulator is to keep the output voltage of the alternator constant, regardless of the rotation speed of the rotor and the electrical load of the alternator [5].

An automatic regulation of the voltage is not simple because the motor of the vehicle, which powers the alternator rotor, constantly changes its rotation speed. Besides, many of the electric and electronic devices of the vehicle only stay connected for short periods of time or are operated manually. Therefore, the load that the alternator has to feed is not constant.

When the motor achieves high rotation speeds or when there are only a few loads to be fed, it has to be ensured that the output voltage of the alternator is limited to a predefined value. The voltage regulator accomplishes this task by interrupting the excitation current, which makes the magnetic field of the rotor decrease. When the voltage falls under a predefined value, the excitation current is re-established.

3. Development of the project

An iron structure was developed to support a mountain bicycle, a car alternator and six halogen light bulbs. It keeps the rear wheel of the bicycle suspended, so that the user can pedal without moving forward.

On the rear wheel, a medium-sized cogwheel fixed on the rear wheel is linked to the alternator by a chain (Fig. 3). The cogwheel of the alternator has a smaller diameter. This difference in cogwheels diameters is essential to achieve high rotation speeds of the alternator rotor.

The alternator used in this project had a damaged voltage regulator. So, a 12V battery was permanently connected to the rotor. This way, the rotor generates a constant magnetic field. When the rotor starts to turn, it induces a three-phase alternating current system in the coils of the stator. These currents are then rectified and the resulting direct current is used to power the halogen light bulbs.

The generated magnetic field opposes to the movement, offering a resistance that depends on the number of lamps used. The higher the current consumed by the lamps, the higher the effort by the user. To make the halogen lamps glow, the user has to make a considerable physical effort.

4. Conclusions

Generating environment-friendly electric power while keeping fit is possible with the device presented in this paper.

Figure 3. Car alternator linked to the rear wheel of the bicycle

A three-phase car alternator excited through a 12V battery and coupled to a mountain bicycle enables the lighting of six halogen lamps, if a cyclist pedals fast enough.

Such a machine gives rise to the thought of a self-powered gymnasium and is also very suitable for science fair events. It can be used to explain the production of electric energy and other Electromagnetism fundamentals. Considerable physical effort is required in order to make the lamps glow. This is pedagogical since it shows clearly that spending energy is much easier than generating it.

5. Acknowledgements

The authors are grateful to João Sepúlveda for the explanations and the revising of this paper.

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Alternating Current and Direct Current Generator

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Abstract. Spinning a wire loop within a uniform magnetic field in a convenient fashion induces a voltage between the loop terminals. This effect can be used to build an electric power generator, such as the one described in this paper. A coil attached to a shaft spins within the magnetic field of a "U" shaped magnet. Three conveniently designed conductive disks allow

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the electrical load of the generator to be fed either with alternating current or direct current.

Keywords. Alternating Current, Direct Current, Generator, Magnetic Field, Induced Voltage.

1. Introduction

Although diverse forms of energy (mechanical, thermal, chemical etc.) can be converted into electrical energy, the expression *electric generator* is reserved, in the industry, only for the machines that convert mechanical energy into electrical energy. The generators that produce direct current (DC) are called *dynamos* and the ones that produce alternating current (AC) are called *alternators*.

The device described in this paper is a generator capable of supplying an electrical load with the desired type of current: alternating current or direct current.

2. AC generator principle of operation.

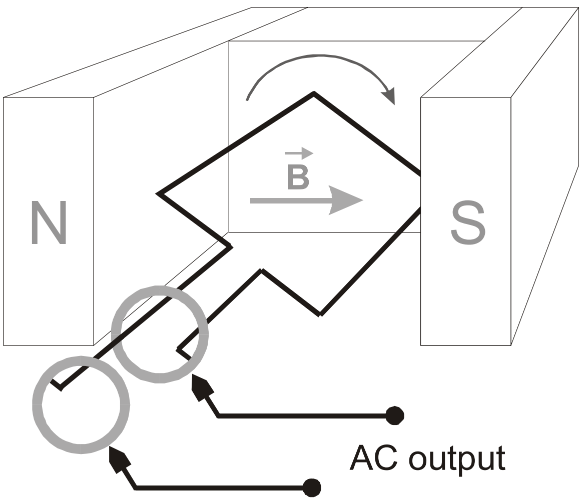

Figure 1. AC generator

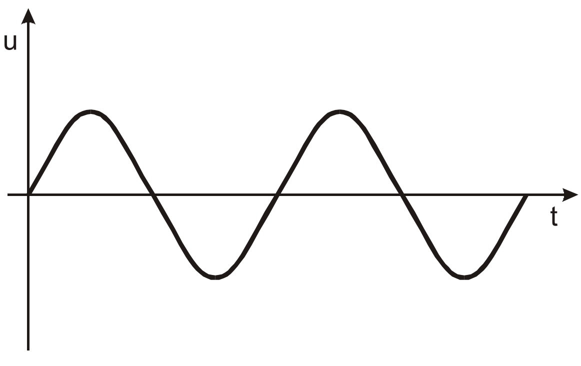

Figure 2. AC generator output

Figure 1 illustrates the principle of operation of an AC generator. A wire loop rotates within the magnetic field generated by a magnet, which induces an AC voltage between the loop terminals. The periodic change of the voltage polarity is due to the change of the position of the coil relatively to the magnetic poles. The amplitude of the voltage depends on the magnetic field strength and is also directly proportional to the rotating speed [1, 2, 3, 4]. If the magnetic field is uniform and the rotation speed is constant, the voltage induced between the loop terminals is sinusoidal with zero mean value (Fig. 2). Its frequency is equal to the number of revolutions per second executed by the loop.

Each terminal of the loop is connected to a metallic ring. The contacts with rings are made by means of fixed brushes. If the brushes are connected to an electrical load, an alternating current will be established in the circuit.

3. DC generator principle of operation

The described AC generator may be transformed into a DC generator, substituting the contact rings by a mechanical commutator. As illustrated on Fig.3, a simple commutator may be done with a metal ring divided into two isolated halves (segments), which are mounted in the axis. This type of commutator is denominated *collector*.

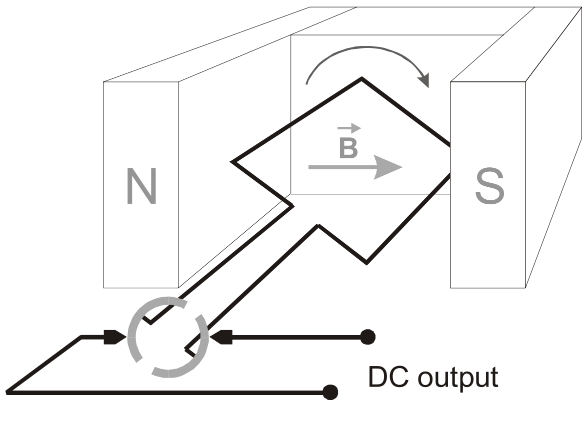

Figure 3. DC generator

Each terminal of the loop is connected to a segment of the collector. When the loop rotates, an AC voltage is induced in the coil, exactly as in the AC generator. But, before reaching the load, the induced voltage is transformed into a DC voltage by the collector (Fig. 4), which works as a mechanical rectifier. The contact segments of the collector move to a different brush each half turn of the loop, keeping a unidirectional current flowing through the electrical load of the circuit [1].

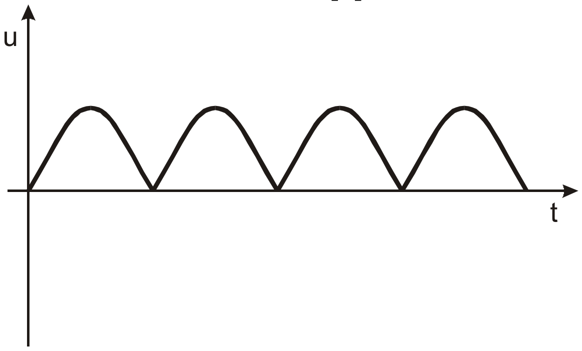

Figure 4. DC generator output

The rotation speed has to be well determined so that the final result is the expected one. As stated before, the rotation speed influences the induced voltage amplitude and frequency.

4. Built generator description

Instead of a simple loop, an iron core coil with 1241 turns of 0,16mm^2 varnished copper wire was used. The iron core and its windings are shown in Fig. 5.

Figure 5. Coil with iron core

The magnetic field used to induce a voltage between the coil terminals was provided by a "U" shaped strong permanent magnet, shown in Fig. 6.

The most challenging part to build was a contact rings and collector unit (Fig. 7). It was made of three printed circuit board disks, coaxially mounted on the rotating axis.

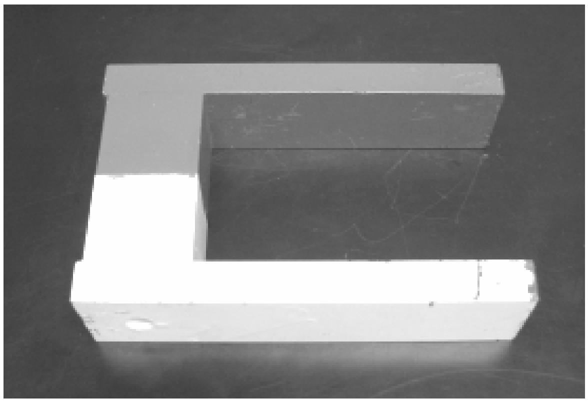

Figure 6. Permanent magnet used to induce a voltage in the coil

The two smaller disks were kept with their entire conductive layer and were intended to supply the generated AC voltage. The conductive layer of the larger disk was cut into two halves, in order to implement the collector, which mechanically rectifies the generated AC voltage.

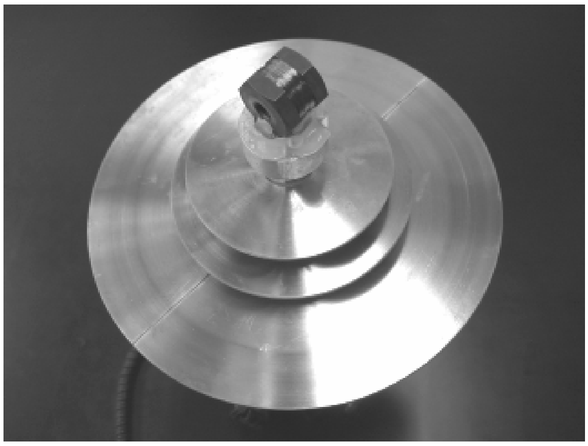

Figure 7. Three coaxial printed circuit board disks with coil on top

Fig. 8 and Fig. 9 illustrate how the rings and collector unit was built in a more comprehensive way.

In Fig. 8, a cross-section of this unit is shown, revealing how electrical connections were made: one terminal of the coil was connected to one of the smaller disks and to one of the halves of the larger disk (collector); the other terminal was connected to the other smaller disk and to the other half of the larger one.

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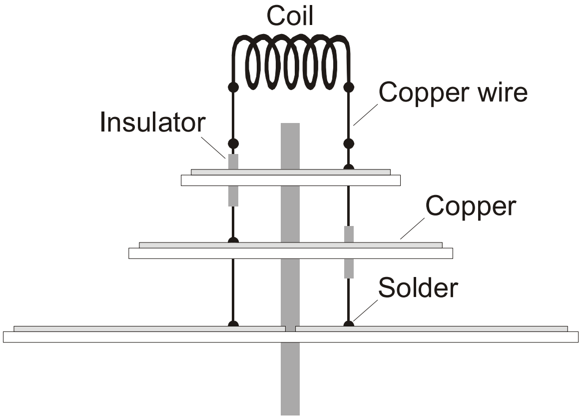

Figure 8. Connecting the coil to the three coaxial printed circuit board disks

Fig. 9 shows a panoramic view of the assembly and the generator outputs responsible for supplying alternating or direct current to an electrical load. In order to make the generator operate properly, the DC output brushes positions must be displaced by 180º from each other. The AC output brushes may be placed anywhere on the respective disks.

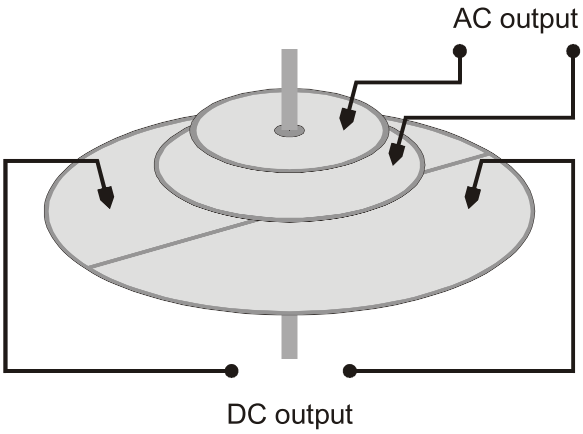

Figure 9. Outputs of the generator

5. Practical results

The energy efficiency of this generator was not possible to determine. Although electrical power could be easily measured, some sort of mechanical power meter was needed and it was not unavailable. There are always mechanical and electrical power losses in the process of transforming mechanical energy into electric energy. Mechanical losses may be reduced by lubricating friction points.

The generator was put to rotate at 3000RPM; the measured induced voltage was 1,2V peak-to-peak, with a 50Hz frequency.

6. Conclusions

Spinning a wire loop within a uniform magnetic field in a convenient fashion induces a voltage between the loop terminals. Rotation speed influences the induced voltage amplitude and frequency. If an electrical load is connected to the loop terminals, a current will be established in the circuit.

The current generated by a basic electrical generator is alternating current. If the generator is intended to supply direct current, it must have a device working as a mechanical rectifier: the collector.

A device capable of generating both AC voltage and DC voltage has been presented. A coil attached to a shaft spins within the magnetic field of a "U" shaped magnet. Three conveniently designed conductive disks allow the electrical load of the generator to be fed either with alternating current or direct current.

This device is very useful to illustrate the principles of electrical energy generation. It also shows the main similarities and differences between AC and DC generators: the working principle is the same for both machines, but the AC generator has contact rings and the DC generator has a collector.

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Olimpíadas_de_Química_Júnior @Quimica.Uminho.pt

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Abstract. The Chemistry department of University of Minho has organized the Olimpíadas de Química Júnior for the last two years, under the auspices of the Portuguese Chemistry Society. One of the main goals of this event is to encourage the establishment of closer relations between Basic Schools and Universities. It has also other purposes, namely to show to young students the importance of chemistry in everybody's daily life and to motivate them for a scientific-technologic area such as chemistry.

In this year circa 180 students aged 14-15 from different schools, arranged in teams of three, participated in the Olympics. They spent a full Saturday at the University where they participated in different activities.

The contest itself was composed by two assessments. One took place in laboratories and comprised 29 questions based on observation and manipulation of materials and apparatus. The second evaluation occurred at an auditorium and comprised quizzes based on the observation of puzzles, films and simulations of transformations presented through multimedia technologies totalizing 21 issues.

Photo 1. During the assessment at one of the laboratories

The subject matters covered included:

- Interpretation of labels,
- Elements and compounds,
- Molecular models,
- Materials' density,
- Phase transitions,
- Analysing mixtures: identification and separation of components,
- Properties of solutions: Concentration, pH and conductivity,
- Writing chemical equations,
- Lavoisier's Law,
- Rate of reactions.

Photo 2. The experimental set up for the quiz regarding the density of materials

Photo 3. During the assessment at the auditorium

In this work we present the main information and results of the Olimpíadas de Química Júnior in the two editions that took place in Braga. In both editions the students' performance in the examination was very good; marks were between 50 and 90%. At the end of the contest students stated: " …it was really challenging!" "Pretty difficult." and "Very stressing."

In the last edition a survey concerning the students' plans for the subject of graduation was made. This inquiry demonstrated that the majority of students have already made their mind up.

Keywords. Science fair, Chemistry contest.

An Overview on Chemistry at the Olimpíadas de Química Júnior

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Abstract. The Olimpíadas de Química Júnior is an organization of the Chemistry Departments of Portuguese Universities and the Portuguese Chemistry Society. The main goal of this event is to establish closer relations between Basic Schools and Universities in the different regions of the country.

Besides the contest, other activities are proposed for the day that students spend at the University. The activities are planned to demonstrate the importance of chemistry in everybody's daily life and to motivate students for scientific-technologic areas related to chemistry. In this year, it was presented a lecture, entitled "QSI - Química Sob Investigação". In this presentation, Chemistry was presented as the science of the welfare: Starting up with the available raw materials (Matter), chemists can operate the adequate reactions (Transformations) in the development of important goods (New Materials and Medicines), search for clean energy sources (Energy) and evaluate (Chemical Analysis) for safe monitoring (Environment and Food).

Matter

The origin of matter and its characteristics are explored. Matter appears anywhere and in different states.

Transformations

Chemistry is present on our daily lives and not only at laboratories. Photosynthesis is an example of a natural chemical reaction.

New Materials and Medicines

Creation of new materials with specific characteristics, such as, colour, transparency, resistance to temperature, etc, is an important task of chemists. The development of these materials is vital in areas like medicine and electronic, that are constantly using new materials for the welfare of the population.

Energy

Fuels are running out and therefore it is extremely important the development of clean energy for the survival of the planet. Nowadays in portable equipment the use of rechargeable batteries is common.

Environment

Chemistry has a main role in maintaining the equilibrium of an ecosystem. When the equilibrium is damaged chemists evaluate the situation and take the necessary moves to restore the equilibrium.

Chemical Analysis

Monitoring environment, forensic investigation and food control are essential issues currently. The diversity of available techniques allows the analysis of small and complex samples in a reduce period of time.

Keywords. Chemistry diffusion, Lecture.

An Alliance between the Theatre and the Science of Primary School Teaching

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Abstract. With the developed work it was intended to utilize the theatre with science in such a way of rising into power, the emergency of inter and multidisciplinary practices in primary schools. Why the concern?

We live in a time where it is urgent that a school assumes itself as a privileged space of action and projects that will contribute to combat the specialization and dominant compartments. In this combat, the primary schools can and must

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assume a determining role, for it's in this level of teaching that exist ideal conditions of working so that these projects can emerge. Facing the nature of this level of teaching, a single teacher, team work, interdisciplinary areas, community links and facilitator factors (or inhibit) of those inter-links and complementation.

On a first phase of the study, we did a follow up and an analysis of a multidisciplinary and interdisciplinary project which alliance the science with the theatre, that parted from the construction of the play based on the text "O Homem que via passer as estrelas" by Luís Mourão, integrated in a seminary work of a Training Primary School Teachers' plan of the University of Aveiro.

On a second phase of study we intended to know the risk of casting that project to a professionalized space that would function as an interface, experimentation and provocative of the dialogue crossing between the different areas of knowledge. That space was the "FÁBRICA – Centro Ciência Viva de Aveiro" that functioned as a mediator between the University of Aveiro and the primary schools, where it was possible to experiment technical constructions of interdisciplinary projects, centred on Education in Sciences, in which their actors/authors would be teachers. This project was an object of transformation and open to the collaboration of other partners. The arrival of a stage-director of the Trindade Theatre implemented a dynamic artistic production with other reach. That project transformed into "RPIP – Reunião de Professores que interpretam planetas" where the group of teachers experienced the work's construction in the dimensions of dynamic and artistic compositions.

It was intended that the "FÁBRICA" assumed itself as a space capable to challenge and contaminate schools' daily routine and motivate the teachers to the implementation of interdisciplinary in schools. At the same time, we intended that this space of "FÁBRICA" assumed itself as a space of reference in the dominion of theatre and of the science, that would end up being like a strategic place, such as in the dominion of theatral production in Portugal as to the construction of projects.

Keywords. Theatre, Science, Interdisciplinary.

The Week of Science and Arts at "Batalla de Clavijo" Secondary School

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Abstract. The secondary Education in Spain has traditionally established dissociation between the scientific studies and those which have to do with humanities as if they had nothing in common. However among several of the teachers at "Batalla de Clavijo" Secondary School emerged the idea of trying to offer a complete perspective of the human knowledge, in which Maths and Sculpture, Literature and Biology, or Painting and Physics, were harmoniously intermingled. The work, which commemorated the European Week of Science, was carried out by students and teachers and finally turned into a whole week entitled Art and Science which was full of events that we are describing later on.

Keywords. Science Week, Secondary Education, Art, Science, Teaching.

1. Introduction

The school provides the first contact with science. Our society gives the school the task of introducing us to the first scientific facts of increasing complexity. However, we consider that the traditional method of teaching science was missing something very important to understand science not only as another mere knowledge but also to understand how it is obtained, the history of science, its philosophy, its sociology, and, specially, the importance of the scientific world in the development of our society and in the building of different cultures and social features.

This is the second year in which our teachers have got involved in this new type of teaching to give the students a "pleasant" view of Science.

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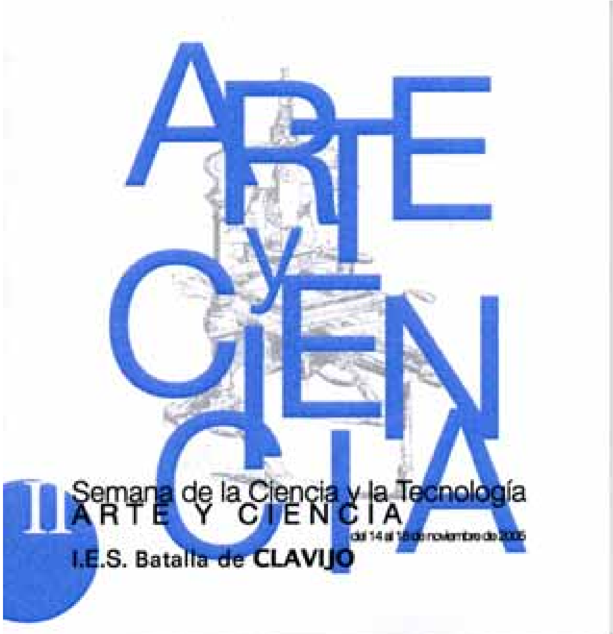

Figure 1. Cover of the poster 2005

Those teachers collaborated in the organization of the activities, for example, the posters' design. Fig. 1, a gigantic wall painting, the supervision of the workshops, lectures and exhibits aimed for the different groups of students. We also had the honour to enjoy the visit of important people representing universities, institutions, research centres, and even someone from out of this world: A special Leonardo Da Vinci, who was the delight of all the students wherever he appeared with his wonderful sense of humour, and, what was even more important, filling the air with the Renaissance working atmosphere. Fig.2

Figure 2. Leonardo animated with his presence to students and professors in the week of science

All this hectic activity, which is still fondly lingering in our minds, took place from the 14th to the 18th of November 2005 and there were more than 500 students involved, together with 40 teachers who controlled the activities.

2. Description of the activities

The Antarctic. A scientific adventure.

The Week started with a lecture given by the delightful teacher Josefina Castelví. She told us about her experience as an investigator and director of the first Spanish research centre on the iced continent.

Her lecture was illustrated with some images of extraordinary beauty. Her warmth and enthusiasm fascinated the audience. Fig. 3

Dalí and Mathematics.

This was an exhibition carried out by the Department of Maths. The aim of it was to remark the mathematical and physical aspects in the works of Dalí. It was a very interesting work which showed the close relationship between Arts and Science.

Figure 3. Professors of secondary School with Castelví doctor, first director of Spanish the Antarctica station

Pythagoras' school and the Musical Scale. This activity was promoted by the music department and was aimed for the students of Secondary Education. By using a single stringed instrument the students were taught about the mathematical base, deduced by Pythagoras, of the musical Scale. The students were again given the opportunity to realise how Music and Maths are closely related.

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Microphotography workshop.

Some groups of students of ESO were allowed to "dive" into the microuniverse and discover shapes and colours harmoniously combined producing images of spectacular beauty.

The students' task was to choose and take the most impressive pictures. Fig. 4.

This activity was organised by the Natural Science Department.

Figure 4. Microphotography made in one of the workshop of Biology

Aesthetics and Science.

The departments of Technology and Physics got involved in this occasion in the developing of two workshops, which built an ornamental iron wall sundial. It is hanging now over one of the School's wall.

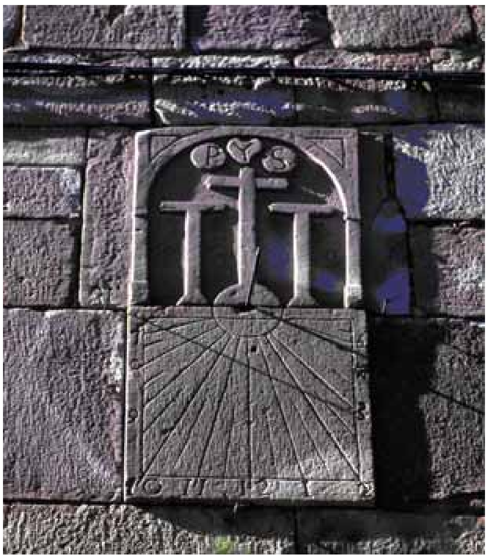

Figure 5. A Sun clock of century XVII was used like model in the workshop of Aesthetics and Science

Other students made small sundials and discovered the existence of many other of different styles and some of which are spread among different buildings along the region, Fig. 5.

Birds and Music.

The music department prepared some audiovisual material about some birds' singing and how these sound melodies were the inspiration for some famous compositors.

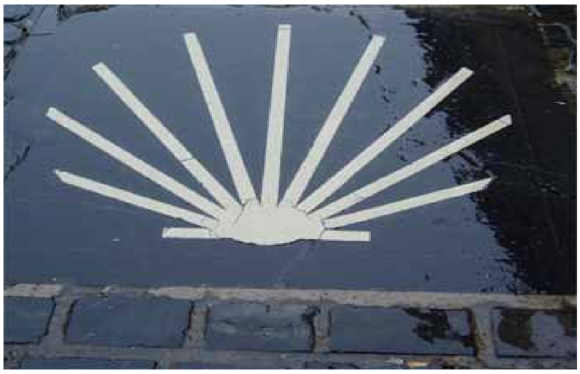

Figure 6. One of the symbols analyzed in the stroll by the town

Mathematical walks along the town.

The teacher Juan de Blas led the students along the town to show them the geometrical elements of the buildings, their evolution and movements. This interesting activity was another opportunity for the students to realise how geometry, architecture and ornamental elements are interconnected, Fig. 6.

Music, Science and Poetry.

The Spanish department organised an activity of great beauty in which the students recited poems, accompanied by music and images. The interesting point of this activity was that the poems were about science and some students were brave enough to write and read their own compositions, Fig. 7.

The Geometry of paper folding (origami).

The teacher Milagros Hernández conducted this workshop in which some students built different geometrical shapes by folding paper. The figures were of extraordinary beauty. The students analysed the mathematical base of this type of works.

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Kandynsky and the circle.

The A-level students directed by the teachers of history and Geography made a research and analysis of Kandynsky's works and of his own reflections about shapes and colours. The students themselves became the authors of several works of art following Kandynsky's method.

Mathemagic.

The teacher Pedro Alegría gave us a show of magic and mathematics. The students had to prove his guessing power which was later explained thanks to their mathematical knowledge.

Understanding Beauty.

It was the Maths Department the one to organise this workshop. In this case the higher level students had the opportunity to analyse the geometrical elements around us. The interconnection between several Disciplines (maths and arts) was made evident among the students.

Figure 7. Poem reading of scientific subject by a participant

The anniversary of Relativity.

The teacher Francisco Lera gave a lecture to the higher level students about the remarkable role of Physics in the developing of science and technology, and also in other fields of Knowledge, Culture and Arts.

Science and Archaeology.

The archaeologist Juan Manuel Tudanca directed this activity for the students of Bachillerato, showing them this interdisciplinary work in which experts on different fields: Art, Prehistory, Palaeography, Zoology, etc. work together to try to reconstruct the life in the past, Fig. 8.

Numbers 2, 3 and 4 go for a walk.

This suggesting title was meant for an activity designed by the department of Music. The objective of this activity was to create a melody made out of a mixture of rhythms based on numbers and interpreted by a human voice accompanied by percussion instruments.

Figure 8. The archaeological investigations are example of connection between several sciences

The relativity workshop.

The Spanish Foundation for Science and Technology (FECYT) organised several activities to teach the lower level students the theory of Relativity.

All these activities, highly entertaining, showed the students in a clear and simple way, the main principles of this theory.

The essential part is not visible to the eye.

This was the title of the lecture given by the teacher Carlos Usón, whose aim was to make the students understand that apart from the practical side of Mathematics, there are also other aspects closely related to feelings and sensibility. In same cases, the artistic works based on mathematical principles, are a source of spirituality, as happens with Mudejar style.

All these activities before mentioned, and some others ,like the production of a 4x4m wall painting, Fig. 9, gave the students and teachers the opportunity to work hand in hand and to realise that the barrier created between art and science is artificial and unjustified.

Figure 9. Installation of the painting mural of Kandynsky on a wall of the building

8. Acknowledgements

We would like to thank all the teachers for the dedication and enthusiasm they have showed all these days, as well as the Regional Administration of Education for their support.

To Lola Sanchez Flores we appreciate its excellent collaboration in the translation of this summary.

And, finally, to all the professors of outside our School who have collaborated with us of disinterested way. Without their work, many of the activities could not have been made.

9. Further information

Further information can be obtained by emailing *carf0002@ alerce.pntic.mec.es.*

Interdisciplinary Science: An Interpretative Exhibition

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Abstract. Interpretation (on-site informal learning programs at parks, zoos, nature centres, historic sites, museums, and aquaria) was defined by Freeman Tilden in 1957 as an educational activity which aims to reveal meanings and relationships through the use of original objects, by first-hand experience and by illustrative media, rather than simply to communicate factual information [1,2].

Figure 1

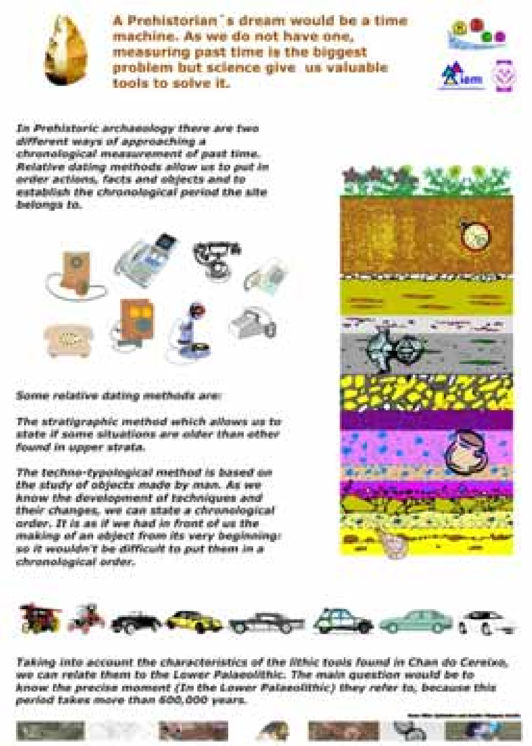

Figure 2

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In this context we have designed an interactive exhibition in order to present the interdisciplinary aspects of the Archaeology. This tailored exhibition consists on an interactive exposition associated with Archaeology and their auxiliary sciences and focused on the investigation of a neighbouring Lower Palaeolithic settlement: Chan do Cereixo-Donas-Gondomar-Spain [3], where high school students experience a first-hand vision of the associated interdisciplinary scientific work. We intend also that students discover the wonders of these special historical places and their value to the community. This positive spirit is given by proper messages provided by fifteen interpretative panels, like-life models, didactic guides, scientific instruments, hands-on activities and audiovisual material. This exhibition has been set up in several high schools of Galicia [4-6] and it is going to be set up during HSci Conference 2006.

Keywords. Archaeology, Exhibition, Hands-on Science, Interpretation.

1. Acknowledgements

We would like to thank the members of the Instituto de Estudos Miñoranos, as well as the scientific material provided by the ETSE de Minas of the Universidade de Vigo. We would like to thank the network "Hands-on Science" (110157-CP-1-2003-1-PT-COMENIUS) of the Socrates/Comenius programme of the European Union and the *Fundación Pedro Barrié de la Maza* for its financing.

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Sciences in your Hands: An Exhibition

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Abstract. As people learn Science from a diversity of sources, we designed, as a supplementary learning tool, an interdisciplinary interactive science and technology exhibition [1,2]. This exhibition consists on an interactive exposition with 60 simple and easy hands-on experiments related with Physics, Geology, Chemistry, Biology and Technology, where students in an informal way are able to touch, play and experiment with these easily reproducible hands-on activities.

Figure 1

Figure 2

Each hands-on activity is explained by a didactic poster where information on how to interact with the activity is provided and scientific concepts related with school curriculum were given. Our intention is to show them that, with some scientific knowledge, they could explain a lot of daily situations. Moreover, we intend to increase their interest for the scientific world in an enjoyable and interactive way.

For each experiment, there is a student as monitor, explaining the experience to their mates, as well as some of the projects made by themselves. During two years most of the students of the high schools of Val Miñor (Pontevedra) attended to the exposition. Their parents and relatives were also invited together with the students and the sixth level students from the associated schools [3,4]. This interactive exhibition is going to be set up during HSci Conference 2006.

Keywords. Hands-on Science, Informal Learning, Interactive Centre, Exhibition.

1. Acknowledgements

We would like to thank the student monitors who helped and the colleagues from Escolas Proval Secondary School. We would also like to thank the local authorities Nigrán, Gondomar and Baiona for their financing, as well as the network "Hands-on Science" (110157-CP-1-2003-1-PT-COMENIUS) from the Socrates/Comenius programme of the UE.

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"ALL SCIENCE CLUB"- (OUR CLUB) HANDS ON SCIENCE

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Abstract. Our school has joined the project in its third year, creating a club named "All Science Club" especially for this purpose. During the club sessions, the students have investigated natural phenomena (using the scientific methods from fields such as physics, chemistry, biology and astronomy) have gathered information from internet, have created materials using the Power Point programme, have translated Romanian materials into English and English materials into Romanian.

They have also prepared short artistic moments and posters. Our students have also taken part in the activities related to Hands on Science Project, both at city and national level. Most of the time, our projects have been connected to our school's specialization – construction and public works: "The Acoustics and Sound Insulation of Buildings", "A simple System of Warning against Fires", "Photovoltaic Panels and their Integration in Building Design",

The Physical and Chemical Study of Construction Materials. All the final products have been gathered on CD's, photos and posters, which we are going to present during the September session of the project.

Keywords. Created materials, Natural phenomena, Photos and posters, Short artistic moments.

A cycle-ergonometer

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Abstract. The importance of technology on every day life and its continuous evolution demands the conception and production of new pedagogical materials and equipment that may allow a permanent and efficient update of our student's knowledge key aptitudes and abilities in science and technologies.

In this communication is presented a hands-on experimental activity centered in … cycling, an appealing and, hopefully, highly disseminated hobby of our youngsters. If to a regular bicycle we adapt an alternator or dynamo we will be able to monitor the speed of cycling and eventually the amount of energy and effort spent by the cyclist. Different and varied subjects from physics, chemistry, biology, medicine and ergonomics can be studied in an interdisciplinary way at different in depth levels suitable to virtually all school grades.

Keywords. Interdisciplinarity, Physics, Biology, Chemistry Electromagnetism, Mechanics, Ergonomics, Sports.

1. Introduction

The ability to integrate, to reason and to operate in situations involving diverse and varied types of knowledge from typically "not related" fields – physics, biology, maths, chemistry, ergonomics…- in our education system it might surely be of utmost importance in a sound effective science education [1].

The hands-on activity herein proposed intends to tackle this need of interdisciplinarity through activities directly related and significant to our everyday life [2,3]. We propose the study setting up and use of a digital cycle-ergometer.

A cycle-ergonometer can be defined as bicycle that, in general, is kept stationary and to which are adapted instruments that allow measuring the physical effort developed during the pedalling process [4].

2. Physics, ergonomics and life…

The measurement of the physical effort developed by an individual in the course of a certain physical activity, may give relevant information allowing doctors and health technicians (mainly of sports and rehabilitation medicine) and also ergonomists to assess the patient or athlete condition or physical state. Overall physical condition can be characterized but also different medical situations can be detected even in early stages of evolution, i.e. hearth diseases [5,6].

Ergonomics can be succinctly defined as the scientific discipline concerned with the study of the interaction between man and the physical or technical environment where he lives in, studying different human activities - at work, in sports, leisure, etc. - and the influence of certain environmental conditions on individuals [6,7].

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There are various ways to accomplish this measurement. One of them is the employment of the ergonometric bicycle or ergonomic cycle frequently used for instance in sports to assess the athletes' physical conditions [5-8].

3. A homemade cycle-ergonometer

In the cycle-ergonometer we assembled (Figure 1.) the energy spent by the user while cycling is registered through electromechanical energy conversion using an alternator or a dynamo.

Figure 1. The homemade cycle-ergonometer

Figure 2. Details of the coupling of the electromagnetic energy conversion units to the *stand-still* bicycle

The DC generator shaft will be connected to the back wheel of a fixed bicycle in such a way that when the user pedals the generator' rotor rotation (in the case of the alternator an excitation current allow us to control the amount of mechanical resistance to cycling) will generate an induced electrical current (Figure 2.). The output electrical signal, proportional to the pedalling rotation speed (Figure 3.), is digitalized processed registered and presented in real time to the user himself at the monitor of a microcomputer attached to the bicycle' wheel [9,10].

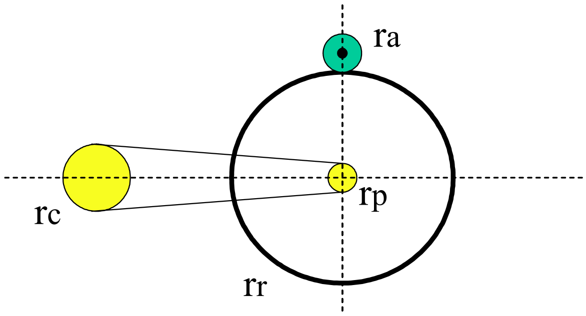

Figure 3. Simple mathematical relations of elementary mechanics should be sorted out

The energy spent by the user while pedalling can be calculated from the dissipated electric power in a load resistor at the DC generator. However, it has been verified that only about 25% of the user's spent energy (the acquired energy from the "transformation" of ingested foods) is effectively used to make the bicycle pedals movement (from the remain most will be freed as heat - the average body temperature during intense sport activities can surpass the 39/40 ºC). As well a certain amount of energy is lost in the mechanical parts and in the direct-current generating machine [11,12].

4. Study and using the cycle-ergonometer

Cycling can be a rather demanding activity in physical terms [12]. Before using the cycle-ergonometer it is very important to guarantee that the users do not suffer from significant health problems. Besides being necessary to verify if the users know of any health problems they might have - cardiac diseases, respiratory problems, renal or hepatic insufficiency, hypertension, ... - it will be necessary to carry out a short test. The user should pedal at moderate speed and mechanical resistance during a couple minutes. The cardiac rhythm should be read (during 30s) before the exercise and 30 seconds, 1min30s and 2min30s after its conclusion. Users can be considered "apt" if they present a deceleration rate of the cardiac rhythm higher than 10 pulsations per minute.

Several questions may be raised along the study and use of this cycle-ergonometer. Let us just draw your attention on the way the paddling process unrolls. A careful observation of the registered graphs, like the one presented in figure 4., may indicate that the cycling effort is developed alternately through the two legs, on the two pedals, and that when, for example, the right pedal goes down "pushed" by the respective leg, the left one goes up "dragging" the left leg. When the right pedal reaches the lower level, the left pedal will start "to be pushed" by the left leg (entering the right leg in "rest"), but not in a homogeneous way: until the horizontal position (roughly) the force developed by the leg will be higher and from this point on it will probably be more difficult to push the pedal down to the lower level (when the left leg almost does not have to make effort), "recommencing" then the action of the muscles of the other leg. On Figure 5 we intend to illustrate this process.

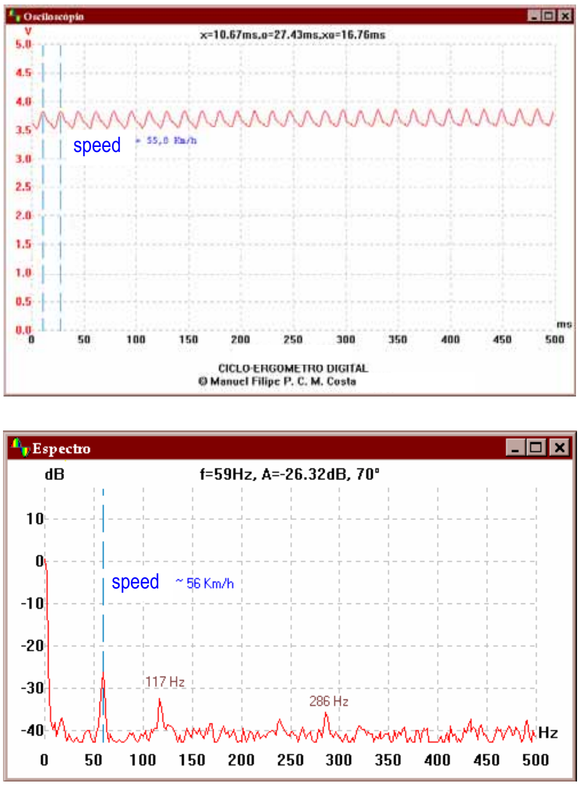

Figure 4. The voltage generated with an alternator at a certain excitation current during a pedalling process

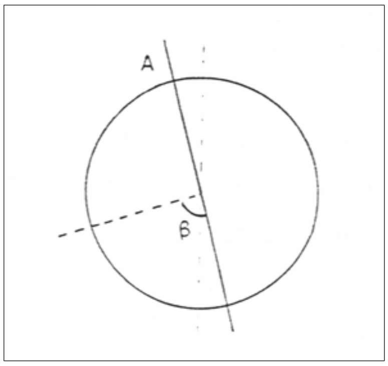

Figure 5. The pedalling process presents a particular sequence that is rendered evident on the graphs representing the evolution of the *effort* spent during the process (Figure 4)

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Learning Communities in Education for Sustainability: A Pathway for Success in Adult Education

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Abstract. Recurrent education can undertake the challenge of including adults through curriculum practices promoting the construction of a learning community. Environmental Education can be its starting point. Collaborative work and project work contribute to the development of a learning community and peer interactions, facilitating knowledge appropriation and the mobilisation/development of competencies. We developed projects of environmental education and education for sustainability both within and outside school. These projects contributed to the academic and social inclusion of a group of adults attending compulsory education. Students continue developing actions of environmental education for the social community and their competencies in environmental citizenship.

Keywords: Environmental Education, Adult Education, Learning Community, collaborative work, project work.

1. Introduction

In Portugal, many active adults have low academic qualifications [12]. This is an uncommon situation in Europe and Portugal has been pointed out in international studies as presenting a low literacy population. There is a need to minimise this problem, namely through school practices. Since the 90s schools have offered the *Sistema de Ensino por Unidades Capitalizáveis* (SEUC), a system based on students' autonomy. But their lack of autonomy and a school that is almost the same as the regular one brings them to failure. The elaboration of an alternative curriculum, conceived by a group of teachers for specific underachieving groups, was able to promote students' school achievement and their social inclusion. At the same time it also allowed them to define more ambitious life projects, some of them connected to a longer school path.

2. Theoretical background

The inclusive schooling claims that all students should have the right and the conditions for succeeding [2] [5]. School can undertake this challenge through a curriculum that promotes the construction of a learning community [10] [14]. Learning communities evolve from practice communities [26] and consist of dynamic structures which we integrate as social beings that we are [4]. Belonging to a learning community, at school, has the potential to suit the institution to the adult public, because their school experience will have greater resemblance to the other social experiences of adults. Wenger identifies "three dimensions in the relationship by which practice is the community's source of coherence (...) 1) **mutual engagement**, 2) **joint enterprise** and 3) **shared repertoire**" ([26], pp. 72-73). The concept of practice community has been used by educators for the creation of learning environments [21] [22]. We find it useful to analyze the process of curricular differentiation we sought to implement [19], viewed as the creation of educational itineraries adapted to students.

Wenger [26] refers to participants' **mutual engagement** as their involvement in the execution of actions with negotiated meanings. Membership is the result of mutual engagement and is the core feature of the community's presence. A learning community exists when deep relations of mutual engagement are established regarding actions under way. Mutual engagement is facilitated by the creation of logistical conditions for the community to put into practice the actions in which it is involved. Another element that contributes to mutual engagement is the diversity of the community's members [22] [26]. When working collaboratively, the members of the community develop "shared manners of doing things" ([26], p. 75), that allow each one to develop his or her own identity, through the process of mutual engagement. Thus, collaborative work is an intrinsic condition of community practice, contributing to its development, for it favors the establishment of social interactions, among peers and in terms of the group, that facilitate knowledge appropriation and the mobilization of competencies such as the decision-making processes [5] [6] [10].

In Wenger's model, the second feature of practice as the source of the community's coherence is the negotiation of a **joint enterprise**. For joint enterprise to contribute to the community's maintenance it must: 1) result from a collective process of negotiation that reflects the complexity of the mutual involvement; 2) belong to the community, regardless of external influences, as it is the result of its negotiated response to the situation, and 3) generate relations of reciprocal accountability among participants, that become part and parcel of the practice. Project work, one of the forms of collaborative work, allows the learning community to bring joint enterprise to life [10]. It consists of a pedagogical practice whose starting point are concrete problems [1] [15] that are relevant to the group; the development of the project and its assessment can (and should) be the result of a process of negotiation among the participants. When project work is carried out in group, it facilitates discussion, negotiation, knowledge appropriation and the social experiences of each participant [16]. This way, it mobilizes and develops essential competencies, thus contributing for the personal, academic and professional development of the participants, who responsibly engage in the joint enterprise surrounding a collective motive [22].

In Wenger's model [26], the third feature of practice as the source of the community's coherence is the existence of a **shared repertoire**, that includes " routines, words, tools, ways of doing things, stories, gestures, symbols (…) actions, or concepts that the community has produced or adopted in the course of its existence, and which became part of its practice" (p. 83).

We consider learning to be a situated activity, implemented as members of the practice community who become legitimate participants after being peripheral ones, raising their level of membership in the community [14].

The school and the teachers involved in adult education play a fundamental role in the development of potentially facilitating conditions for the emergence of learning communities. These conditions include changing the rules that implicitly or, more rarely, explicitly, regulate the didactic relationship, that is, the didactic contract [23], in the sense of moving from the usual didactic contract, mainly based in vertical interactions (teacher/students), to a novel didactic contract, in which horizontal interactions (among peers) are stressed [16]. In order to facilitate these changes in the didactic contract the school organization must also change. The cohesion between the didactic contract and the didactic meta-contract [24], viewed as the institution's set of rules of functioning, is an essential step towards innovation.

Sustainable development is needed in a world whose development is being increasingly shaped by science, technology and market [20]. The curriculum can contribute to achieve this goal [4] [6] [10] by promoting the existence of a learning community. Environmental Education and Education for Sustainable Development (ESD) are types of life-long education and have the potential to develop students' abilities and competencies, in order to develop values, attitudes, behaviours and life-styles consistent with a sustainable development [9] [10].

3. Method

This work is part of the *Interaction and Knowledge* project whose main goal is to study and promote collaborative work both among students, teachers/researchers, and teachers and their students. It has two levels: *quasi experimental* studies and an action-research level. This study analyses the elaboration and implementation of an alternative curriculum (to the SUC), in the action-research level. As class director and researcher we sought to create the conditions for a learning community to emerge and develop, including the 7 students from this class, their teachers and other members of the social community.

For data collection we used participant observation (daily activities, reports and audio/video recording), questionnaires, materials produced by the students and interviews. Later we studied the emergence and the effects of the participation in this learning community as a case study, following up on the participants, using a qualitative and interpretative methodology inspired in ethnographic methods [3].

3.1. Procedure

The process of curricular differentiation was led by the technical-pedagogical assessor of the

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Executive Board for evening school who invited a group of teachers to form the pedagogical team. This team was in charge of planning, undertaking and assessing the alternative curriculum course. Students were contacted and chosen among those who presented higher difficulty in adapting to the SEUC. The curriculum planning process and constitution of the class took place during the third term of the 1999/2000 school year and the course was developed during the next three school years, from 2000/2001 to 2002/2003. The class and the curricular project were presented and approved by the Ministry of Education.

4. Results

The learning community arose from the curricular field of Environmental Education, one of the recommended components of the curriculum [7]. In the first term we followed the usual didactic contract, though we devoted some time to collaborative work [9]. We became aware of the students' special interest in the topic of urban solid waste (USW). So we offered them the possibility of inviting specialists from the Seixal Mayorship (SM) to hold a thematic meeting on USW and pipe and waste waters, at school. They welcomed this idea. Thus, the preparation of their participation in the meeting was a turning point in the pedagogical practices. The students elaborated the questions they wanted to ask the specialists so as to participate actively in the meeting. As we have already said, we had implemented an action-research project and we participated in the meeting as participant observer. Having discovered students' interest and the relevant, autonomous way in which they asked their questions, we decided to suggest they would undertake project work on the theme that most touched them during the meeting. The teacher/researcher presented this new working method to the class and discussed it with them so that the whole planning of the projects was assumed as a joint task.

The development of project work illuminated the presence of features that made this practice a source of coherence of the emerging learning community [26]. The participants showed a **mutual engagement** concerning a **joint enterprise**.

During the three school years that we worked with this class we observed the emergence and development of a learning community, including students, their teachers and some members of the social community who assumed different levels of engagement.

The project works were based on the students' presentation of environmental problemas or on suggestions made by the SM specialists who collaborated with us [9] [10]. In the latter case, the students appropriated these suggestions, negotiated them and made them a part of the learning community, using the resources provided by the collaborators outside the school, by the school and by the *Interaction and Knowledge* project, without failing to put a personal touch in the actions they developed. Thus, each project work was a **joint enterprise** of the whole class.

We watched students develop their autonomy (regarding the EE teacher) and their increasing engagement in discussing objectives, strategies and the assessment of the project works. The students' and teachers' engagement in project work facilitated the emergence of rich practices that are compatible with the development of learning communities [22] which, as these authors state [8], "are irreconcilable with uniformisation and are much more than instruction and accumulation of knowledge" (p. 23), allowing each student to use and value his/her cultural patrimony.

Changing the didactic contract, along with the increase in horizontal interactions (peer interactions), led to the mobilisation and development of competencies which, in turn, allowed participants to discuss and negotiate actions, valuing and integrating different ways of approaching and solving problems in the community of practice.

Students developed a positive self-esteem, both general and academic, throughout the project works. When the students showed their work to the school community (peers, teachers and other members of the school community) and to elements of the social community, they interacted and gave explanations about environmental themes, acting as awareness/ environmental education and ESD agents. Later, the product of this work was presented in several kindergarten and primary schools of the region. Subsequently, the feeling of belonging to the learning community was incresed. This is illuminated by the fact that several students (those most available in terms of timetable) continued to participate in awareness/ environmental education actions for the

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educational community even after finishing their course. This is also illuminated in the follow-up interview, a year after finishing the course: all students stated they wanted to go on participating in this kind of action.

Through the development of the community of practice, a **shared repertoire** was gradually built up [26], based on an accumulation of common experiences. The development of the community's identity stood to win from its maintenance in time [22], corresponding to three school years. The identity of the learning community was felt, for instance, in the second year of the course, when the class suggested to the researcher that the third school year should include a curricular space devoted to undertaking projects the students valued, supervised by the Environmental Education teacher. This proposal was taken to the class board, which considered that this space should be managed by the above mentioned teacher/researcher and by the teacher who, besides teaching this class, was also technical-pedagogical assessor for evening school. As a consequence, one of the students' hours in their third-year timetable was converted to Project Work, constituting a change in the original project [11]. This initiative is an empirical evidence of the students' active role in the curriculum construction.

In Project Work, the students decided to make a Coursebook as a memory for each participant and also as witness of their time in the school. The quality of this work and the fact that its assessment would not count for the conclusion of the course clearly show how strong this learning community was and what belonging to this community meant to its members.

The identity of the learning community is also illuminated by students' desire to continue their studies, in secondary education, in the same school, with the same colleagues and teachers and with an alternative curriculum to SUC.

To understand how the emergence and development of a learning community in the school was possible, we must look at the didactic meta-contract [24]. The analysis of the case of the Coombes school, described by [13] as "a paradigmatic case of a learning community" (p. 123) illuminates some of the noteworthy aspects in the school where this investigation took place: the Manuel Cargaleiro Secondary School (ESMC). Jeffrey and Woods [13] explain the success of the Coombes School due to the presence of a charismatic principal (1971-2002), the contributions of other elements of the social community, the collaborative and democratic way of working in the school and the community spirit that thrived there.

There are some similarities between the report about the Commbes School [13] and life at ESMC, particularly as regards adult education at evening school. For instance, the technical-pedagogical assessor for evening school knew how to gather teachers and other members of the school community in projects that enabled the construction of a lively, dynamic school, delegating and sharing responsibilities, thus allowing each one to assume a part of the action in accordance with his/her engagement.

As in the Coombes School, at ESMC the leadership of the teacher in charge in the evening was supported by a team of equally enthusiastic teachers who shared her vision of the role of school in adult education. The group sometimes disagreed, but this was seen as a means to stimulate debate and creativity. The leader of evening school knew how to intervene according to the school needs, creating conditions for collaborative work and debate, with democratic decision-making. These conditions facilitated the emergence of a learning community and the subsequent involvement of the school community in the evening regime.

In the alternative curriculum class, there was a weekly meeting to facilitate teachers' collaborative work. In these meetings teachers discussed project works, adjusted their contribution and subjects, changed timetables so that the activities related to project work were not harmed by a rigid distribution of school schedule of time, which can be a bad hindrance for its success [8]. Changes in the school routine, for instance, receiving collaborators from outside the school, involving the other classes in the projects under way and the students' participation in extra-school events, are only possible in the context of a didactic meta-contract based on trust and respect for teachers' work and that promotes their autonomy. This kind of meta-contract is clearly present, for example, in the following text, written by an evening school teacher in the dedication book offered to the evening-school technical-pedagogical assessor (third term of the 2001/2002 school year).

«Thanks Rosa. Because you set an example of availability and friendship, even when your face shows how tired you are. Because you never turn your back.

Because you have the capacity to simplify what seems difficult. Because you value quality.

Because you trust in others (students and teachers) as people and you know how to show it.

For how demanding you are. For your cumplicity. For your confidence. For always being by our side.

Thankyou».

At ESMC, as in the Coombes School, the participation of the social community in the school was promoted and valued (former students, SM specialists and citizens willing to share with us their knowledge in certain fields) and students participated (and participate) in activities of awareness/environmental education and ESD in kindergarten and primary schools of the region.

The project we developed had a set of features that facilitated the emergence of the learning community, namely its longevity (three school years); most of the teachers already had prior experience in teaching alternative curricula, and chose to participate in the project from the start, staying on for two or three years.

Another element accounting for the success of this alternative curriculum was that the teacher/researcher activity, especially in EE and TP, was framed by a process of reflection and discussion provided by the researchers' membership to the project *Interaction and Knowledge*. Thus, based on our practice, we gradually built a theoretical background to change and improve our practice, as it is common in action-research projects [17]. This project of curricular differentiation and development, associated to an action-research project, had positive outcomes, not only in these students' inclusion and academic achievement, but in involving the school community and in the personal and professional development of the teacher/researcher.

5. Final Remarks

With a few students giving up at the start, of the group of fifteen who initially attended the project [11], six reached the end and concluded the third cycle of basic education successfully. It is not an ideal situation, but it is also true that in Portugal only 5% or less of the students attending the SEUC 3rd cycle conclude it in three years [18].

To live up to the challenge of adult education, the school must be able of getting away from the kind of school that creates underachievement, proposing curricula that are adapted to different target-publics, built by teachers and even by the students themselves. This enables more democratic relations, in accordance with the social statute of adults. Learning communities are one way the school can be changed and be successful [4]. There is no magic formula to build a learning community in the school, for the social relations and practices that exist in the school can lead to its emergence or to its absence [4]. Contributions to its emergence and development include the implemented pedagogical practices, namely collaborative work in the form of project work, the didactic contract, the didactic meta-contract, and the establishment of partnerships with the social community.

By presenting this case study, we hope to contribute to the promotion of reflection upon action, leading to the emergence of more learning communities in schools. Belonging to a learning community is an effective way of promoting the inclusion of adults with a history of underachievement and from cultures away from the mainstream one.

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Environmental Research Activities in an Heavy Industrialized Region

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Abstract. On behalf of the European Youth Ecoparliament project, a group of 17 students of

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3º ESO have planned and developed research and experimental activities related to the environment in the central part of the region of Asturies. In this area a significant concentration of heavy industries (siderurgy, thermal power plants, chemical plants, etc.) is present, as a consequence of the coal and iron mines operating from the XIX century. Experimental measurements of acid rain, thermal pollution, water pollutants and noise levels have been carried out, as well as visits to industries and inquiries to professionals, authorities and local people.

Keywords. Environment, Industry, Pollution, European Project, Secondary Education.

1. Introduction

As is defined by the International Planet'ERE Collective [11], environmental education is, from the viewpoint of sustainable development, education that puts values first. Its aim is to make people aware that the Earth is our common property and it is our responsibility to take care of it, that all human beings exist interdependently with the Earth and everything that lives on it. This education should develop autonomy and responsibility. Sustainable development education generates a highly constructive outlook and is geared towards action. It encourages individuals and groups to get involved in the social and political life of their country and the Planet. Sustainable development education is an education that encourages participation and solidarity throughout space and time.

In the framework of the II Youth Eco-parliament project, a group of students from a secondary school located in Candás, in the north coast of Spain, have planned and carried out a broad set of activities during the school year 2005-06 guided by the teachers of sciences and technology.

The work presented in this paper has been developed in the municipality of Carreño, geographically located in the central area of Asturies. Asturias is an autonomic community of the north coast of Spain; this region is highly industrialized since the end of the XIX century, resulting from the exploitation of a great number of coal and iron mines.

After some decades of a successful heavy industry, mainly iron and steel production and transformation as well as zinc production and aluminum transformation, during the 80's a severe industrial rationalization has take place and another industries raised in this region. Nowadays, in a relatively small area of 100 km^2 a large number of pollutant industries can be found: blast furnaces to obtain iron, converters to make iron, a thermoelectric power plant, a cement factory, a zinc metallurgical plant and a chemical complex, apart from other small industries.

Consequently the quality of life is high in this region from the economical point of view, nevertheless the consequences on the health of people and on natural ecosystems should be taken into consideration and it constitutes a subject to think over and a question under social and political discussion.

The municipality of Carreño has a population of 14000 habitants approximately, distributed in the capital Candás and a rural area of around 80 km^2. Apart from the special relevance of industries, agriculture (milk and vegetables production) and fishing are other important economical areas of activity, as well as tourism, mainly in summer.

2. Aim

The final goal of this project for these students was to participate in the collaborative writing of the Open Letters for the Environment, together with other eighteen schools from different countries of Europe, Turkey and Canada. This document is directed to the European producers (industries, farmers …) in order to encourage them to promote positive attitudes and to apply good practices concerning environment preservation.

Furthermore, an added value was achieved from the pedagogical point of view, derived from the participation in the different stages of this project, since it is described in this paper.

One of the main aims of this work is to encourage students to obtain information from different sources concerning local environmental problems and to broad their thinking and concerns to a global level, together with a critical interchange of information with colleagues working on similar issues.

In our case, and due to the special characteristics of our municipality and the surrounding areas described above, we decided to present our project based on the study of the

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different types of pollution: air, water, soil as well as noise pollution. We analyzed the main sources and the consequences on the environment and the health of people living in this region.

The accessibility of some of the agents involved in the matter like people working in local companies with responsibilities on environment management, as well as environmental technicians, politicians, etc was also a powerful reason to carry our the different activities. In some cases the contact with these experts were made directly by the students due to some familiar or vicinity relationships.

3. Activities

This project was launched in November 2005 when the IES de Candás was selected to represent the region of Asturias together with another approximately hundred European schools. The asturian students were organized together with other two schools from the neighboring regions of Galice and Leon in order to work simultaneously to obtain some conclusions and proposals for a common document.

One of the first questions to decide was how to constitute the group of students to be involved in this project. We decided to work with an entire class that were under the supervision of all the teachers involved and only one class in order to facilitate the organization and schedule of the different activities to carry out.

Figure 1. Geographical situation of the studied region

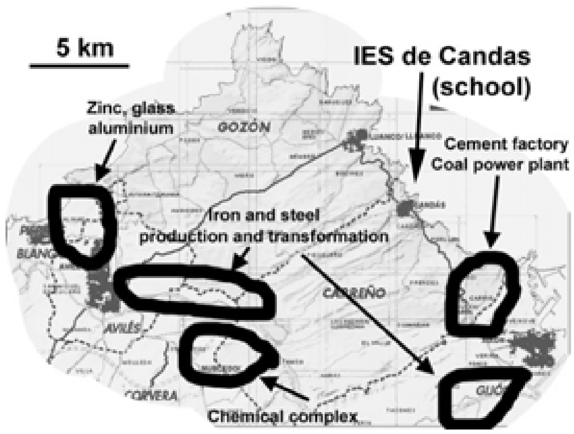

Figure 2. Location of the main industrial areas in the region

Our project was entitled "Improving the quality of our environment" and consists basically in the following activities:

- An initial search for information in different sources (webs, books, environmental reports of local industrial companies …) about pollution and its causes and consequences in our region.
- Collective design and carry out of opinion polls about the knowledge and feeling of citizens concerning some questions related with different kinds of pollution and its relation with industrial activities.
- Inquiries to experts who could give more precise and technical information and a more objective point of view.
- Measurements of different parameters directly on nature in order to determine experimentally the levels of pollutants in our municipality.
- Discussions about the information obtained from bibliographical sources as well as from experimental measurements and inquiries to experts.
- Elaboration of a presentation to show in the thematic meeting held in Aranda de Duero together with the other schools from Galice and Leon, with representatives of the main Spanish industries.
- Collaborative writing of the Open Letter to the Environment, in coordination with the other European schools involved in this project.

4. Information search

The first step in any activity of this characteristics and dimension should be based on

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obtaining information on bibliographical resources about the subject. In our case, we had a broad range of information sources suitable for this purpose. The libraries of the school and the village were visited to obtain general information about ecology, pollution, industries, manufacturing methods …

Another resource that if more attractive for young people is Internet and the different webs about pollution and environment damage.

The environmental reports of big companies such as Arcelor and Dupont were very useful to obtain more detailed and technical information on nature and amount of pollutants and the different methods that are in use or are planed to install in the future.

The different sources provide information with particular characteristics. In books and encyclopedia general information about ecology, environment damages, pollution and manufacturing processes were found. From the webs we obtained a wider range of information from different viewpoints: technical and accurate reports, political and sociological opinions …, depending mainly on the author (governmental institutions, researchers, non-governmental organizations including ecologists, etc.). The environmental reports of local companies should be understood from a critical perspective since present only partial environmental parameters and in some cases exhibit a poetical or advertising character.

5. Results of public opinion polls

Public opinion polls constitute a powerful tool to explore what and how citizens think about any social or economical problem. The industrial, traffic and domestic pollution is, certainly, a socio-economical problem, even is also a technical question, because a great number of socio-economical agents are involved in.

In most of the cases, the result of the opinion polls depends on how the questions are proposed and also on where and when people are asked.

Taking this premise in mind, the design of the questions was done collaboratively between students and teacher with the intention of wide as much as possible the field of themes.

Nearly a hundred people were requested trying to reach the big amount possible of different personal situations (students, workers, senior citizens, housewifes …).

The most significant results are show in the Figure 1. As shown these graphs, there is an important public concern about the different environmental damage aspects. People see the industries as the main contributors to the pollution; there is also an extended public opinion thinking that pollution influences strongly the appearance of some diseases and it is also responsible for climate change. On the other hand, citizens call the governments for more active attitudes and dealings and for developing laws in order to preserve the environment. Curiously, some troubles were found in the knowledge of what can individuals do for the environment protection, since, for example, most of the people considers that the electric heating systems are less dangerous than gas of fuel heating systems.

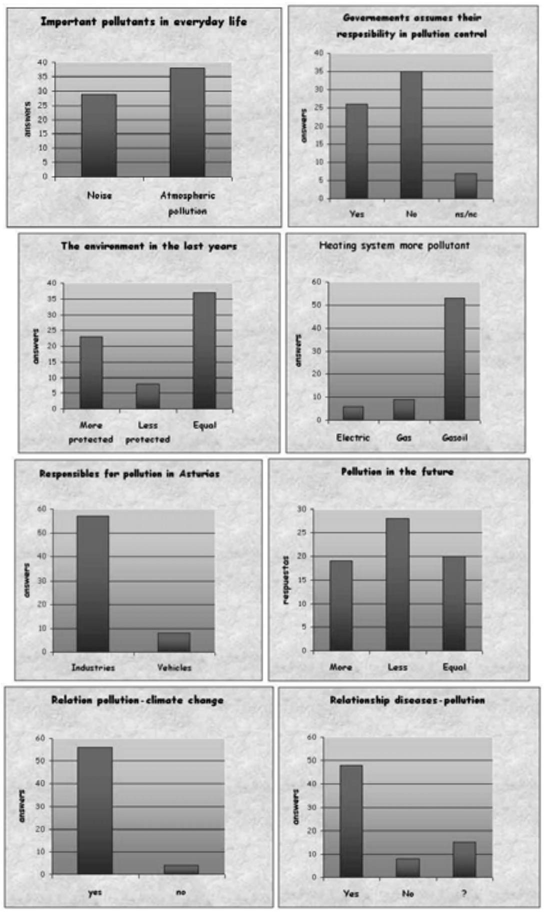

Figure 3. Most significant results of the public opinion polls

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6. Experimental procedures and results

The most powerful learning occurs when students develop projects in response to their investigation of real world problems. In the course of getting involved in these activities, students can learn much about different aspects of science and their surroundings through their observations and the resulting data. As they take measurements, they understand better what they mean and doing research they can answer their own questions about science and environment. This approach requires certainly an added effort and hard work, but the excitement that comes with the discoveries and new insights makes it worthwhile.

Besides the information collected from different sources, as was mentioned before, some experimental work has been done.

The main difficulties encountered in these procedures were the needs for technical instrumentation that is not easily available in secondary schools and the low accuracy of the measurements. However, from the pedagogical perspective, the results are not so important as the method and procedures, since the activities done in the framework of this project were a good starting point to scientific research and for obtaining conclusions by combining data obtained from different sources.

7. Acid rain

Rain water is naturally acidic, because carbon dioxide in the atmosphere combines with water molecules to form carbonic acid. The precipitation of acids occurs when sulfur dioxide and nitrogen oxides in the atmosphere react with oxygen in the air to form sulfuric acid (H_2SO_4) and nitric acid (HNO), which falls to the surface as rain, snow, or dust. To be considered acid precipitation, the precipitation has to have a pH of 5.0 or lower.

Sulfur dioxide (SO_2) from human sources comes primarily from smelters and coal burning power plants. Nitrogen oxides come primarily from automobile exhaust and other combustion processes, and some is created by lightning and soil microbes. To reduce air pollution in areas near power plants, utilities built tall smoke stacks to vent emissions high up into the air, away from local communities.

In the region studied not only the Aboño power plant is responsible for this phenomenon, but also other industries and also the intense traffic of the near cities of Gijón and Avilés. The use of coal and petroleum as energy sources generates a considerable amount of nitrogen and sulphur oxides emitted directly to the atmosphere. In winter the contribution of the domestic and commercial heating systems is also important.

Figure 4. Thermoelectric and cement plants uses fossil energies and emits nitrogen and sulphur oxides to the atmosphere

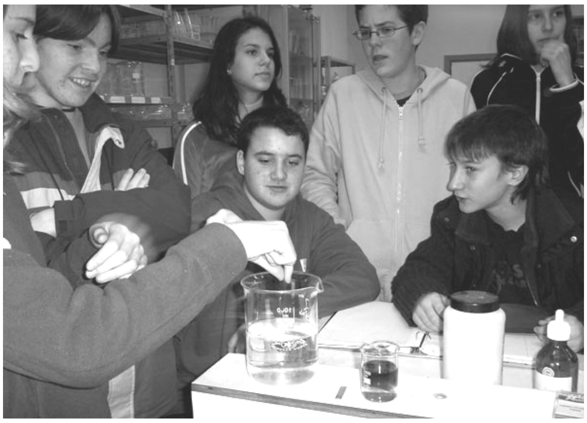

Figure 5. Measurements in the lab of the pH of rain water samples

During the first week of February some samples of rain water were collected by students and other people who collaborated in different points strategically distributed. After some sunny days and high atmospheric pressure, the level of atmospheric pollution was visibly high, due to the emissions of the buildings and houses heating systems and other causes that are independent on the weather. This fact has taken into account when the results of the measurements were interpreted.

All the samples were kept in clean and closed bottles to avoid the influence of external

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contamination and the evaporation of carbon dioxide dissolved in water.

Ph paper was use for this purpose because it easy to use and a previous calibration is not necessary; the main disadvantage is that the resolution is not as good as the pHmeter.

The results obtained shown values ranging from 5.1 to 5.4, which suggests a relatively high acidity compared with the value of 5.5 reported from geographical areas far away from pollution emissions [3] [4]. Nevertheless these values cannot be considered as an indication of acid rain, since typical values for pH of acid rain are less than 5, and values from 5 to 6 can be simply caused by the dissolution of atmospheric carbon dioxide.

8. Thermal pollution

Thermal pollution is a physical phenomenon produced by the emission of water to rivers, seas and lakes with a temperature higher than the natural typical values.

In our case, the most significant focus of thermal pollution is the river Aboño and the beach of Xivares, located adjacent to the mouth. About a kilometer from the mouth, a flow of 24 m^3/min of water at high temperature is transferred to the river from the refrigeration system of a thermoelectric power plant.

Figure 6. Measurements of the temperature of water in Xivares beach

Water temperature is sometimes called a master variable because almost all properties of water, as well as chemical reactions taking place in it, are affected by it. Dissolved oxygen is strongly correlated with temperature since the oxygen solubility increases for colder temperatures. Thus, the temperature influences the amount and diversity of aquatic life since, at higher values, the amount of plankton increases and therefore the different small and large fish species.

This thermal pollution is well known by some tourists who are fascinated by this atypical relatively hot beach water in the Cantabric coast. This phenomenon also benefits some fishers who can obtain large pieces in the area.

Temperature is an easy measurement to carry out; the only problem is how to place accurately the thermometer into the sea or river without any personal danger or risk. In order to make this experiment on the Xivares beach, a practical method was arranged consisting of a classical thermometer held by a fishing rod.

Figure 7. A thermometer held on a fishing rod was used to determine the thermal pollution

A series of measurements were made on different points of the beach, from the mouth of Aboño River to the most distant point. Temperature in other beaches was also measured to take as a reference to compare the results.

The data obtained reveal that in the part of the beach more close to the mouth of the river, a temperature of 25 º C is reached, but this value drops drastically towards the10-11 ºC measured in most of the points considered and in the other beaches. The temperature in the river was also measured near the mouth and values around 30 º C were obtained.

The influence of the tides it is important in the interpretation of the data obtained, nevertheless it is very difficult to establish how this can affect the water currents in the beach and even more complex to quantify the influence. In the moment of the measurements the tide was low and probably this is the cause of the drastic variation of temperatures from the mouth of the river, since the hot currents flows in a perpendicular direction to the coast and hot and cold water don't mix well.

All these observations were discussed during the activity and also after in the classroom, giving an additional point of interest to the experimental work for the students.

9. Water pollution

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly.

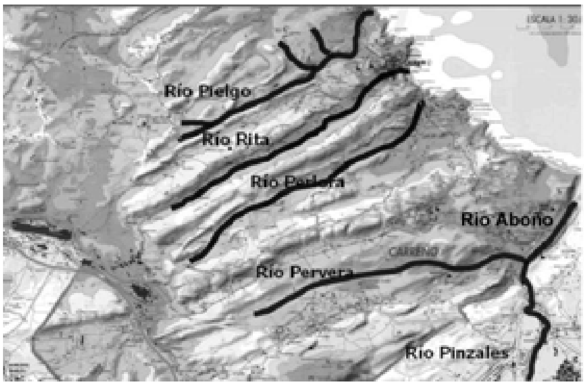

Figure 8. Location of the rivers analyzed

There are many pollutants entering the rivers, from soluble and suspended pollutants derived from treated and untreated domestic and industrial wastewaters to solid waste indiscriminately dumped in the rivers or left on the river banks which are floated off during rain storms when the river levels rise. As a result, we found several problems of both water quality and aesthetics. In our case both rivers and sea are affected by different types of pollutants: plastics, oils, chemicals, solid particles, biological and chemical fertilizers, heavy metals, etc.

The most important water stream in the studied region is the mentioned Aboño River, which flows along a highly industrialized area transporting a wide range of liquid and solid products and wastes originated in different industrial plants, apart from the above mentioned thermal pollution.

Figure 9. Some samples of waste were observed in different beaches and rivers

Other small rivers were also examined: in the Pielgo and Rita rivers some pieces of plastic and metals were found as well as consequences of pollution due to manure and biological fertilizers that are commonly used in winter by local farmers in important quantities.

Figure 10. Outdoor activities to inspect the pollution or rivers

In order to obtain some experimental data about water pollution, the transparency has been determined using a Secchi disk. This method is based on the decrease of transparency of a liquid with the presence of molecules and particles that can absorb or scatter light.

In still, deep water, students have lowered a Secchi disk until it could not be seen and then pulled up the disk until it just reappeared. Both distances from the surface were considered.

The most severe values of low transparency were found on Aboño River, since the disk disappears at distances ranging from 25 cm to 50 cm depending on the measuring point. In other rivers values up to more than 1 meter were

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found, the problem was to find a suitable point to deep the disk due the small size of these streams.

Concerning to beaches, different species were found such as a wide range of packaging items (bottles, metal cans, plastic bags …), objects used by small and large boats and ships (ropes, mesh, woods …).

Other two important pollutants were found related with two important events occurred near this area: the biggest oil spill in recent years occurred when the tanker Prestige broke up near the Galician coast, around 300 km far from these beaches, two years before this observations and the sinking of the Castillo de Salas, with around 80.000 tons of coal near the entrance of the Musel Harbor in 1974. Curiously no traces from oil were observed but some amounts of coal can be frequently observed on some beaches, mainly on the Palmera beach.

The reason for this effect should be the natural depurative effect of the sea that eliminates the oil from the rocks; nevertheless the coal deposited on the bottom of the sea is removed by the ocean streams and sediments toward the nearest beaches.

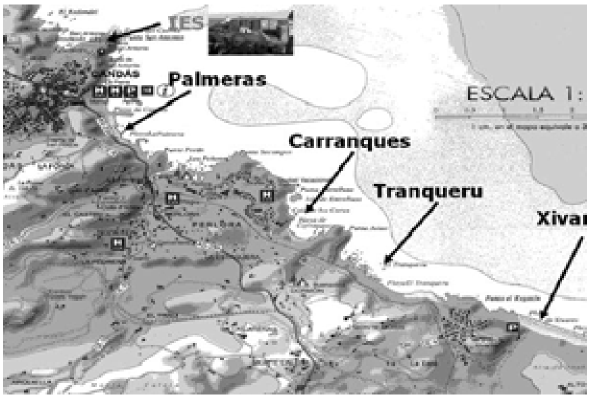

Figure 11. Location of beaches

10. Air pollution

The quality of the air we breathe is one of the most key issues to consider in the evaluation of the quality of the environment, since people can directly and easily perceive it. Despite the visual and smell feeling of people regarding air pollution, there are also other important factors that should be determined by specific mechanisms and devices.

Figure 12. Air pollution is clearly visible in the industrial area of Tabaza, in the municipality of Carreño

The main air pollutants are carbon dioxide, responsible for the greenhouse effect and the global warming, also nitrogen and sulphur oxides which reacts with the atmospheric water vapor and provokes acid rain, and other toxic gases (carbon monoxide, volatile organic compounds, ozone …).

Moreover, suspended particles coming from natural and artificial processes contribute to the contamination of the atmosphere and are even more apparent than gases and cause an aesthetic degradation of the environment.

The experimental parameters evaluated by the students were taken from the data reported by the automatic environmental station network of the Principado de Asturias and other similar stations of the private industrial companies which monitories in real time the concentration in the air of nitrogen and sulphur oxides, carbon monoxide and ozone, as well as the amount of particulate matter suspended.

The results shown that, in average, the pollution parameters are in agreement with the legal terms. Nevertheless, in some particular short periods and locations the measured values exceed the officially permitted standards.

In human population air pollution is responsible for respiratory problems, allergies, strengthens lugs, and a risk for cancer.

11. Noise pollution

Noise is the most frequently overlooked form of pollution because while water and air are regarded vital to life, noise is merely an annoyance to most people. This oversight is a mistake because noise affects man provoking

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some physical, psychological and social consequences.

While it can at the outset interfere with communication and be annoying, it will damage hearing if the intensity is too high and at a less obvious level it can cause tiredness and reduce efficiency. It has been clearly proven that long durations in extremely noisy environment can lead to permanent reduction of hearing sensitivity. This damage is irreversible and is the reason why noise dosage is clearly stipulated for the work environment and it is also limited to a maximum value by the laws for the residential areas.

In the studied region there are several sources of noise pollution and, in some cases, the protests of affected citizens are shown to the local authorities and made public in through journalists in local newspapers.

These causes are, mainly, the following:

- The motorway that is made of grooved mineral cement instead of smooth asphalt. This feature was designed to increase the traffic safety but provokes a high noise level that is perceived by the drivers and affects mainly the people living in the surrounding area.
- The mills, pumps, air discharges and turbines of the cement factory, the thermoelectric plant, the iron and steel plants and the Sontara plant in the chemical complex, as well as the movement of heavy vehicles related with the different industrial activities.
- The train transporting the cast iron from the blast furnaces to the converters. These trains are usually very old and noisy machines, which operate regularly at intervals of 40 minutes (day and night) on a 12 kilometers railway crossing the rural area of our municipality.

Experimental data were not directly measured by the students due to the unavailability of instrumentation. Noise measurements are carried out by the environmental service of the local government of Carreño and several community areas were monitored. The data reported by these studies were provided by the technicians and reveals some values that are, in some cases, outside from the legal maximum values, mainly in the nighttime.

12. Visits to industries and other sites of environmental interest

Among the mentioned activities, some visits were organized to some sites of special environmental interest.

Figure 13. The control board of the coal fired power plant

Some industries were visited in order to know directly in-situ the different manufacturing processes. In the industrial plants, students were received and they had the opportunity to ask the environmental technicians about some questions related with the main environmental damages originated and the procedures that are used or are planed for the future in this direction.

In the plant of Renault in Valladolid students could observe the robotized assembling of cars and car engines. In the factories of Pascual Group in Aranda de Duero they followed the process of milk sterilization and packaging as well as transformation into other products such a cheese, yogurt, drinkable products, etc. At the Eolic experimental park of sotavento in Lugo they could see how an aerogenerator works and they made some experiments related with the renewable energies. In the thermoelectric power plant of Aboño the electricity generation process from coal, fuel and gas was shown.

In all these sites a special approach was given to the visitors concerning environmental related aspects such as reduction of energy consumption, packaging reduction and systems to reduce the air and water pollution.

Figure 14. Visiting how milk is transformed and packed in the plant of Leche Pascual

The installation of cyclones, electrostatic precipitators, scrubbers, catalytic converters and particle traps were proposed as the most important mechanisms that industries are installing to reduce the emissions of pollutants to the atmosphere. On the other hand different systems are used to reduce the water consumption and treatment of utilized water before be discharged to rivers or seas.

Moreover some interviews and meetings with experts and technicians were used to balance the results of the experiments and bibliographical data.

Figure 15. In the eolic experimental park Sotavento the students can know and experiment with the renewable energies

In this way it should be mentioned the meeting with the major of Carreño in the town hall and an interview with a doctor, who has been working in Candás for many years and could report on the influence of some pollutants (mainly air and noise) on the health of the citizens.

Figure 16. Students meeting with the major in the town hall

13. Outcomes and evaluation

As was mentioned, the final result of this project was the elaboration of an Open Letter for the Environment addressed to the representatives of European producers. The final version of this document can be found on the web www.eyep.info.

Beside this material product, the main outcomes from which students were benefited can be summarized in the following points:

- These activities encourage students to share ideas, monitor their own environment, collect different kinds of data and reflect on what has learnt.
- Outdoor activities engage students to do scientific and cultural research in their own surroundings, to explore different ways of sustainable living and implement the use of learning diaries.
- The direct experiences carried out seem to be an extremely important factor in educating students to be environmentally aware adults.
- The information empowerment leads to an active participation and awareness of their responsibility towards the community and environmental policies.
- Students have learned the basics of the environmental management and sustainable development in the holistic manner.
- The knowledge and experience gained during such a project is incomparable with common curricular school activities.

Moreover, from the educational, pedagogical and social point of view the skills specially developed were:

- Determine the validity of evidence from a variety of sources.
- Analyze critical issues on economic growth and environmental protection.
- Develop presentational writing skills.
- Work cooperatively in teams.
- Independent research with news journals, statistical reports, and on-line resources
- Interview skills
- Planning and organizational skills

14. Acknowledgements

The activities above described should not be possible without the effort and enthusiasm displayed by the students of 3º A of the IES de Candás during the school year 2005-06. The contribution of Ceferino García, teacher of sciences and Elena Fernández, teacher of physics and chemistry was also essential to succeed in this project. The availability and openness of the major of Candás and the environmental technician was also valuable, as well as the doctor Mario García.

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Initial Findings of the *"UNIQUE and UNIVERSAL"* Project

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Abstract. This project is a comparative case study. The aim is to introduce endangered species (plants and animals) and threatened ecosystems that are unique, yet have universal and global values to the students. Further, the study aims to enable students to establish the cause- and-effect relationship in nature and interpret this relationship through the use of scientific processes. Twenty-one students from Turkey, twenty-two students from Romania and seven students from the USA participated in the project. The data was gathered from the students not only at the very beginning of the project but also at the end of the project. During the pilot study, a field visit was carried out to one of the threatened regions in the neighborhood.

Keywords. Awareness, Endangered species, Scientific processes, Sustainability, Threatened ecosystem.

1. Introduction

Today's environmental problems emerge as a result of human beings' intensive activities in the natural environment. These activities have damaged the environmental balance and ecological systems. Urbanization, construction, and extensive use of environmental resources can be recognized as the most influential reasons for environmental problems. In addition, other reasons for environmental problems have been noted such as the global population explosion, a growing demand for food, tropical deforestation, and the extinction of biological resources (genes, species, populations and ecosystems) [1]

All over the world, protection studies have been carried out for a long time. But it should not be ignored that prevention is always better than cure. For that reason, problems should be controlled before they occur. As indicated in the literature [1], the best way to overcome not only local but also global environmental problems is to educate and to make people become aware of their negative influences on the natural environment, and also develop environmental consciousness among them. In schools, there are several environmental activities (planting, watering, summer camps…etc) organized within and out-of-schools addressing environmental education. The ultimate aim of all these activities is to promote environmental awareness and consciousness among individuals, and motivate them to take action to overcome problems and sustain the environment.

A number of research studies [2, 3, 4, 5, and 6] have indicated that in order to motivate individuals to behave responsively in preventing environmental problems and sustaining the natural environment for the future, their action skills should be developed. There are some factors influencing the action skills of individuals. For example, action taken for the environment is affected by the factor of environmental knowledge. As claimed by [7], development of environmental responsibility can best be achieved outdoors, namely in a natural setting which allows active participation in outdoor activities; this in turn increases interest and concern in the environment. One of the outdoor education programs is a field trip to the natural regions. During the field trip, the participants can easily grasp an understanding of cause-and-effect relationship in ecological systems. In addition, participating in a field trip enables students to combine many variables. These factors can be awareness of natural environment, knowledge of environmental concepts and issues, action on environmental issues, and positive attitudes towards the environment [3].

1.1. Significance of the study

Carrying out the UNIQUE & UNIVERSAL Project with the fifth grade students is important, because it is believed that the project will provide environmental understanding for the students. The students are also expected to gain an understanding about the cause-and-effect relationship on the ecological balance. In addition, the project will enable the participants to “own” global environmental values, endangered species and threatened regions, and to gain a global view of the environment.

It is also expected that the findings of the study will contribute insights to curriculum developers and publishers.

1.2. Purpose of the study

The study aims to present the initial findings of the project titled as *Unique and Universal* (U&U), carried out with the co-operation of three schools from Turkey, Romania and the United States of America.

The general aim of the U&U Project is to investigate the students' understanding on natural processes through the use of scientific methods. In addition, the project mentioned here aims at developing students’ knowledge of and attitudes toward threatened regions (natural regions) and endangered species that are unique and universal.

2. Methodology

This study is a comparative case study. Three schools, one from Turkey, another from Romania and the third from the USA participated in the study. The in-depth information was gathered by use of qualitative methods (especially focus group interview and observations). The data gathered from the participants were analyzed by means of not only qualitative methods but also quantitative methods.

2.1. Sample

Fifty students were included in the study; twenty-one students from Turkey, twenty-two students from Romania and seven students from the USA. While selecting the student sample, their willingness to participate in the study was

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considered. That is, volunteer-based sampling selection was used. The characteristic of the sample is given in table 1.

Table 1. Gender of the students in each country in the project

Country/Gender	Female	Male	Total
Turkey	10	11	21
USA	7	-	7
Romania	11	11	22
Total	28	22	50

2.2. Instruments

Six different data collection instruments were developed by the researchers to gather data from the participants. The characteristics of the instruments are mentioned below, one by one.

(a) Knowledge Test:

This test aims at investigating the students' knowledge about endangered species (in particular: Centaurea tchihatcheffii, the Grey Stork, and the Monarch Butterfly) and threatened regions (specifically; Mogan Lake in Turkey, RPCS Backwoods in the USA and The Tur Valley, Satu Mare County in Romania). Further, it also aims to determine the source of students' knowledge on the topics investigated. The items in the instruments are all open-ended. It is adapted for each group of students from different countries.

(b) Attitude questionnaire:

This questionnaire aims to investigate the attitudes of students toward endangered species and threatened regions. There are 13 closed-ended items on a 4 point Likert-type scale (1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree). In addition, the students are also asked to respond to reasons behind their tendencies / responses.

(c) Picture form:

Each group of students focused on a different endangered species; the Turkish students focused on Centaurea tchihatcheffii, the Romanian students on the Grey Stork, and the American students on the Monarch Butterfly. The picture form aims to determine to what extent the students know the characteristics of the endangered species they are studying. In the picture form, the participants are required to draw the picture of specific endangered species, and also to identify the characteristics of the species on which they focused.

(d) Field trip tests:

These tests include two different instruments. The first one aims to determine students' knowledge about the scientific experiments carried out during the field trip. The second aims to determine the students' knowledge of the endangered species upon which they focused.

(e) Focus group interview schedule:

The interview schedule including thirteen open-ended items was designed to investigate the students' perceptions on endangered species, threatened regions and the contributions of the project to themselves.

2.3. Data collection process

This Project is a unique study which, by targeting primary school students, aims to protect endangered species and also to be the part of universal measurements by using scientific processes. This project commenced at the METU Development Foundation Primary School as a pilot study. The students studied the area around Mogan Lake which is close to their school. They also studied the characteristics of Yanardöner Plant (Centaurea tchihatcheffii), which are endangered and grow around Mogan Lake. Further, the other schools involved, Roland Park Country School from the USA and School Number 5, Satu Mare from Romania, cooperated during the study.

In order to collect data from the participants, the instruments were administered at the beginning, middle and end of the study. The data collection process mainly includes three steps; *at the beginning, in the middle, and at the end*. The steps followed are as below;

(a) At the beginning:

Fist of all, at the beginning of the project, in order to determine the initial knowledge and attitudes of the students, a knowledge test, an attitude questionnaire and a picture form were administered to the students in each country.

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Later on, the regular meetings were organized with students and then these meetings were held regularly with the participation of the students during the project. These meetings were organized by the teachers and the students.

(b) In the middle:

During the process, field trips were organized to the selected threatened regions. Mogan Lake in Turkey, RPCS Backwoods in the USA and The Tur Valley Satu Mare County in Romania were the regions selected for the project. In addition to the threatened regions near to the participants' schools, each group also selected one of endangered species in their country. The Turkish students selected the Yanardöner Plant (*Centaurea tchihatcheffii*) which is one of the endemic plants to Turkey, the American students selected the *Monarch Butterfly,* and the Romanian students selected the *Grey Stork.*

Before and after the field trip, field trip tests that target the students' pre-and post- knowledge about endangered species and threatened regions were administered to the Turkish students. However, these tests were not administered to the others in Romania and the USA. Their ideas on the field trips were stored by and shared with coordinator teachers.

(c) At the end:

At the end of the study, the Turkish students were put into five groups; two groups of five students, two groups of four students and one group of three students. Focus group interviews were carried out with these groups separately. Furthermore, the attitude questionnaire and picture form, which were administered initially, were given to the students again. However, because of the communication problems, the same processes were not followed in other countries. Similarly, the responses of those students were stored by and shared with coordinator teachers.

2.4. Data Analysis

Once all the data was gathered from the participants, the data analysis procedure could begin. In order to analyze the data, not only quantitative but also qualitative data analysis procedures were used. Since the attitude questionnaire includes closed ended items, the responses given to those items were analyzed by use of descriptive statistics, particularly mean, standard deviation, percentage, and frequency. On the other hand, the responses given to the open ended questions were analyzed by the use of content analyses, which is one of the qualitative analysis procedures [8].

Before analyzing the attitude items, the reverse items were first manipulated. For the total score, eleven items targeting the students' attitudes toward endangered species and threatened regions were considered. The remaining two items were more related to determining their opinions on protection measures taken. The total score of attitude questionnaire ranges from eleven to forty-four. The higher the students' score, the more positive their attitude toward endangered species and threatened regions.

The initials of the students' names and surnames are stated in the quotations and pictures. For example, AS1 refers to one of the American students who was coded as number 1.

2.5. Limitations of the study

This study is limited by the number of the students and schools involved in the project. Also, the ommunication among the schools was not as extensive as had been intended, because the coordinator teachers preferred to devote more of the time they had available to the field trips.

3. Results

The results of the study will be discussed under three titles that are mentioned above in the process part.

(a) At the beginning:

At the very beginning of the project, the students' initial knowledge of and attitudes towards endangered species and threatened regions were investigated by considering their responses to the instruments administered. Further, they also drew the picture of the species upon which they focused.

The responses of the students from Turkey

The knowledge test results indicated that the students had little knowledge about endangered

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species at the very beginning of the study. As they reported, the sources of their knowledge on these issues were the internet (especially the Google and Yahoo search engines), their teachers and schools, science books, encyclopedias, documentaries, their parents, newspapers, the U & U project itself and the environmental club associated with the project.

Nearly of them had no ideas initially about the Grey Stork and the Monarch Butterfly. They expected to learn about these species during the study by communicating with their partners in Romania and the USA.

As responsible citizens, they believe in the importance of taking an active role in protecting the environment. Their suggestions for taking care to protect endangered species and threatened regions are;

making new environmental laws,
administering fines,
building special areas for endangered species,
raising people's environmental consciousness.

The students drew the pictures of Yanardöner Plants and also wrote about its characteristics. The following picture was drawn by one of the students.

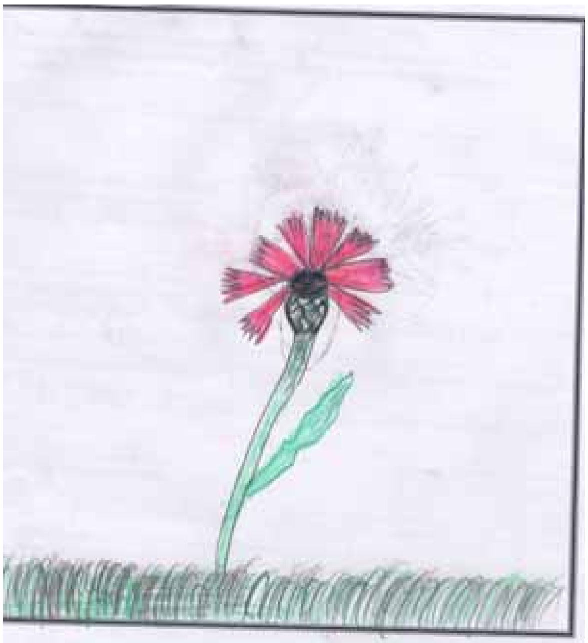

Figure 1. The Yanardöner Plant drawn by one of the Turkish students (TS.1)

They indicated the characteristics of the plant as following;

"It grows around Mogan Lake in Ankara (A.K.)"
"It flowers in spring (B.T.)"
"It flowers in May (D.B.K.)"
"It only grows in Turkey (Y.D.)"
"Its color might be red and pink (A.Y.)"
"It was first found in Afyon. It is endangered (C.A.)"

The total mean score of the Turkish students from the attitude questionnaire is $\overline{X} = 39.37$ (Sd = 3.84) indicating their positive attitudes. They indicated that the endangered species must be protected because these species have as much right to survive as human beings do. To them, pesticides used in agriculture should be used under the control of agricultural engineer because some plants and animals might die due to wrong usage. Nearly all of them are opposed to killing wild animals. They believe that these animals have an important place in ecological cycle (especially in the natural food web).

Since they think about the depletion of natural resources in future, all of them reported that natural resources should be used carefully and cautiously. They did not approve of the use of natural regions when this was dependant only on people's needs (new buildings, park areas and offices).

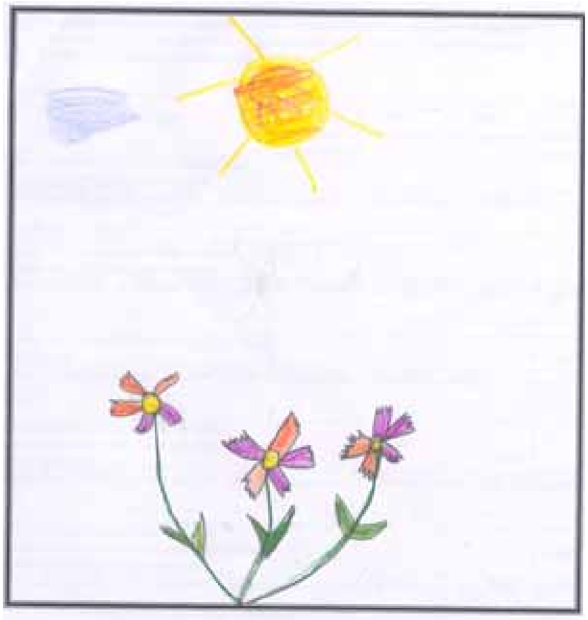

Figure 2. The Yanardöner Plant drawn by one of the Turkish students (TS.2)

The responses of the students from Romania

The responses of Romanian students to the knowledge test revealed that they have little knowledge about endangered species and threatened regions. The sources of their knowledge on endangered species and threatened regions are encyclopedias and books, textbooks, TV, their teachers, their parents, and people who protect the environment.

Further, they discussed on the main reasons for the problems affecting endangered species and threatened regions.

The students thought that they contributed to environmental protection studies done in Romania. To them, protection studies for endangered species are adequate in the World.

As responsible individuals in Romania, they made some suggestions for the government, their parents, friends, relatives, teachers, schools, and media.

They drew the pictures of the Grey Stork and wrote about the characteristics of this bird. The following pictures were drawn by RS.1 and RS.2.

Figure 3. The Grey Stork drawn by one of the Romanian students (RS.1)

The characteristics of the Bird about which the students mentioned are given below;

"It is 90 cm tall. Its wings are 170 cm wide (A.D.1)"
"It weighs between 2,5-5 kg (I.)"
"It has long legs and feathers (R.Z.)"
"It is endangered animal. It is found in Central Europe. The Grey Stork eats fish, mice and insects (A.D. 2)"
"The Grey Stork lives near to rivers (C.B.)"
"It flies with its neck in the shape of 'S' (D.I.)"
"It builds its nest 8-10 m up in trees (E.K.)"

The total mean score of the Romanian students from the attitude questionnaire is $\overline{X}$ = 40.13 (Sd = 1.55), representing their positive attitudes toward endangered species and threatened regions.

Like the Turkish students, the Romanian students also believe in the importance of helping endangered species and threatened regions in order to achieve a natural balance. Nearly all of the students reported that since endangered species have the right to live in their natural environment, they must be allowed to survive. Furthermore, in relation to threatened regions, the students expressed the concept that human beings should not extensively use natural areas to build a new building, park areas and offices based solely upon their needs, since their use of these natural regions might destroy the natural environment in which many animals and plants survive.

Figure 4. The Grey Stork drawn by one of the Romanian students (RS.2)

At the end, the students reported that they became happy when they thought of solutions for preserving endangered species and threatened natural regions, because they all liked the nature, and believed that they could help animals and plants.

The responses of the students from the USA

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Like their partners, the American students also have ideas about the protection of endangered species and threatened regions. They believed that endangered species must be protected, because they have rights to get by and are important parts of ecological cycles. One of the students reported that "*(endangered species) could disappear for the planet if we do not try to save them*". Another child indicated that "*if endangered plants and animals are not protected, they may become extinct and future generations would not be able to enjoy them*".

The total attitude score of students ($\overline{X}$ = 39.83, Sd = 1.72) indicates their positive attitudes towards endangered species and threatened regions. That is, the American students in the study seemed to have positive attitudes toward the targeted topics.

Figure 5. The Monarch Butterfly drawn by one of the American students in the project (AS.1)

Figure 6. The Monarch Butterfly drawn by one of the American students in the project (AS.2)

They opposed human making changes to natural regions in order to build new homes, parking lots or offices based only on their needs, because they think that people are destroying too many natural regions to build new complexes.

These students focused on the Monarch Butterfly. Two examples of the pictures of the endangered species drawn by two American students are given below.

(b) In the middle:

During the project, a series of meetings was held with the project teams in their schools. The characteristics of the endangered species and threatened regions were introduced to the students in each team. The students shared their knowledge with the other teams in the project in other countries. For example, Turkish students in the Project drew pictures of the Yanardöner Plant and wrote the characteristics of this plant on paper. Next, they sent these papers via e-mail to the Romanian and American students in the Project. The same procedures were followed by the other students. In doing so, they shared their experience with their partners. For this Project, each group of students prepared a corner in their school. They introduced the Grey Stork, the Yanardöner Plant and the Monarch Butterfly to their schools in this way. In the display corners, the students attached the documents on endangered species and threatened environments, together with the pictures of these three species sent by other countries.

In addition, each project teacher together with the students composed a "Unique and Universal Song" for the Project. The song included three verses. One verse of the song was written in Turkish, one in Romanian and one in English. It was a kind of promise to protect, conserve and sustain the ecosystems studied in the project by the students together.

(c) At the end:

At the end of the pilot study for the Project, focus group interviews were conducted with the groups of students. Also, the students were given the attitude questionnaires and picture forms again.

The findings of the focus group interviews indicate that the students were happy to participate in the study, because they believe that during the study they learned comprehensively about the target topics. Their new knowledge stimulates them to act responsibly toward the natural region. They want the project coordinator to continue the project next year with another endangered species (e.g. Toy Birds) and a new threatened region (e.g. Eymir Lake). They would like to participate in the Project next year voluntarily.

They used the experimental apparatus and chemical substances during the field trip so as to analyze the parameters of the water quality of Mogan Lake. They assert that doing experiments with the help of these materials enables them to understand the parameters of the water quality and level of these parameters.

As far as the attitude questionnaires are concerned, students' attitudes towards nature have improved. However, there is no statistically significant mean difference between the pre- and post- results of the students' attitude scores toward the target topics.

The pictures of the Yanardöner Plant drawn by the students at the end of the Project indicate that they acquired detailed information about the plant, because they reflected their new knowledge in their drawings.

4. Conclusion and Implications

The pilot implementation of the "Unique and Universal" project was carried out with fifty students from Turkey, Romania, and the USA (see table 1). In order to assess their knowledge, attitudes and opinions about endangered species and threatened regions, several data collection instruments were developed by the researchers and administered to the participants.

As revealed in the results, all students taking part in the Project have positive attitudes toward the target topics. Nearly all of them would like to take an active role in protecting the endangered species and threatened regions in their neighborhood. Their responses can be interpreted as showing that the more knowledge they acquire on the target topics, the more they have a tendency toward taking action to protect endangered species and threatened regions.

During the project, from time to time, communication problems occurred. In order to solve this problem, it is clear that an international website aiming to share global values and educational outputs among the students, not only in developed but also in developing countries, will serve as a science education tool. This website will also initiate the development and improvement of understanding of global ecological literacy, as well as stewardship. All the scientific methods, hands-on activities, the data collected and the experiences of the students and teachers will be shared with the communities involved on this web site.

5. Acknowledgements

Special thanks to Prof. Dr. Ali Yıldırım for his continuous encouragement and motivation. Thanks to the METU Foundation School for its encouragement to carry out the project. Thanks to La Motte Company for their technical support with portable testing equipment. To these dedicated teachers, we extend heartfelt thanks for their great contributions in our project: Martha Barss, Science Teacher at Roland Park Country School, Baltimore, MD, the USA Ancuta Nechita, English Teacher in School Number 5 Satu Mare, Romania. Thanks to Jill Aslan for her contributions to the study. And finally special thanks to 5th grade students at the METU Foundation School and those in other schools, who have been volunteers in this project.

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Microcontroller-Driven Hydrogen Car

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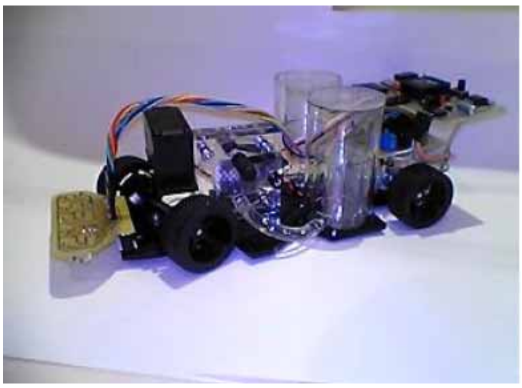
Abstract. This paper presents a hydrogen-powered car with 8 minutes autonomy driven by a system based on an 8051 microcontroller. The hydrogen is produced by electrolysis, which requires an external power supply. The gas is retained on an isolated compartment in the car. Then, it goes to the fuel cell, which produces the energy for the car motor. The car follows a white line on a black track using five infrared sensors that detect white and black colors. A servomotor controls its direction. Guidelines to the servomotor are given by the microcontroller according to the information it receives from the sensors.



Keywords. Fuel Cell, Infrared Sensors, 8051 Microcontroller, Hydrogen, Electrolysis.

Landscape in Science Education

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Abstract. Introducing Science to primary schools in Poland enables to transfer the knowledge on nature in an integrated way. Students learn a wide range of issues, including those referring to the landscapes of their home region as well as of the other parts of Poland, followed by the landscapes of Europe and the entire world. Classification of natural landscapes is based on relief and geological structure, and it is interwoven with climatic and vegetation zones, while that of cultural landscapes – in interrelation with the economic activity of people.

Landscape variety enables teachers to use a range of teaching methods activating a student, including the ones which influence student's emotions. In doing so, observation and description of both natural and anthropogenic elements of landscapes proves to be very useful. The prime goal is to make students aware of the necessity of landscape protection in order to preserve the world natural and cultural heritage.

Keywords: Landscape, Landscape boundaries, Natural landscapes, Cultural landscapes.

1. Introduction

One of the main reasons for introducing Science into Polish primary schools in 1999 was a search for an integrated model of teaching about the nature. As a result, Science incorporated the knowledge of the old subjects of Biology, Geography, Chemistry and Physics. The blocky structure of this subject enables teachers to fulfill the task properly. If it comes to teaching basic scientific knowledge, however, it is very difficult for many previous Biology, Geography, Chemistry or Physics teachers to give up their old teaching methods. They tend consciously or unconsciously to prepare lessons in an established and verified way. These methods, though, do not suit well the lessons of

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Science. As a result, special attention must be paid to the interdisciplinary character of the taught material.

One of the topics tackled by Science refers to landscapes. In accordance with the subject curriculum, which is based on the National Curriculum, Science teaches about the landscapes found in the student's home region as well as those found in other parts of Poland, in Europe and in the world. A very important aspect of teaching about landscapes (and other geographical topics: [3], [4]) is conducting observations and writing descriptions (for instance of natural and anthropogenic elements of landscapes or managements styles found in the studied landscapes) followed by analysing how people's lives depend on both natural and anthropogenic elements. (Fig. 1).

Classification of natural landscapes is based on relief and geological structure, and it is interwoven with climatic and vegetation zones of the world. Classification of cultural landscapes, however, is correlated with the economic activity of people. Teaching about each landscape is done by presenting its dominant features supported by an example of the area where a given landscape is found.

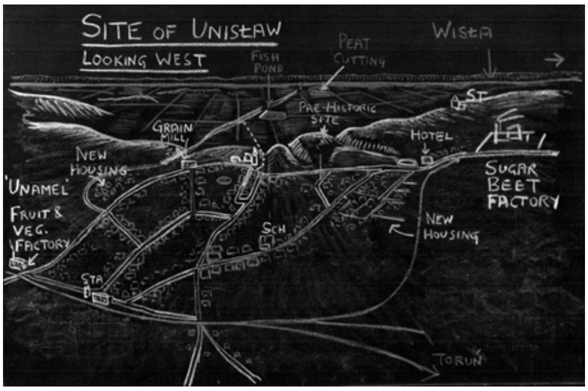

Figure 1. A sketch of the Vistula River Valley to the north of Toruń drawn by a student of Primary School in Unisław
Source: archive material of Prof. P. Bailey, 1990

After a whole set of such lessons, and thanks to generalization process, a student is able to classify the studied landscapes. What is more, a student gains the skills indispensable for collecting and integrating the knowledge useful for describing numerous natural phenomena, or for understanding how landscape features are presented on maps.

2. The range of teaching material about landscapes

The teaching material about landscapes includes three blocks. The first one deals with the term 'landscape' and, basing on the home region, the landscape elements. The second one refers to the landscapes of Poland, while the third one – to the landscapes of the world.

The first thematic block mentioned above includes the following issues:

- elements of a landscape; natural and anthropogenic landscapes;
- elements of a natural landscape (relief, altitude, main forms of relief: lowlands, uplands and mountains; relief of the student's home region);
- soils (soil profile, soil forming process, people's influence on soil fertility);
- surface waters and groundwaters;
- vegetation and animals (ways of recognizing flora and fauna species, plants and animals in the home area, forms of nature protection);
- anthropogenic landscapes (cultural elements of a landscape: fields, factories, roads, railways, buildings, water reservoirs, waste-tips etc; spatial management of the school vicinity; cultural heritage; similarities and differences in landscapes and lifestyles of the region's population).

The second thematic block deals with the selected landscapes of Poland (Fig. 2):

- mountain landscapes (high mountains – the Tatras – 1; medium mountains – the Sudeten Mts. – 2; low mountains – the Świętokrzyskie Mts. – 3);
- upland landscapes (limestone (karst) landscape – the Krakowsko-Częstochowska Upland – 4; loess landscape – the Lubelska Upland – 5; industrial landscape – the Silesian Upland – 6);
- lowland landscapes (including plain landscape – the Silesian Lowland – 7; river valley landscape – the Mazovian Lowland – 8; lakeland landscape – the Masurian Lakeland – 9; coastland landscape – the Słowińskie Coastland – 10; depression landscape – the Vistula Delta – 11).

The third block enables a student to acquire basic information on zonal landscapes (such as ice desert, tundra, Siberian taiga, steppe, Mediterranean landscape, desert landscapes of Sahara, landscapes of savanna and tropical

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rainforests), and azonal landscapes (such as the high-mountain landscape of the Himalayas).

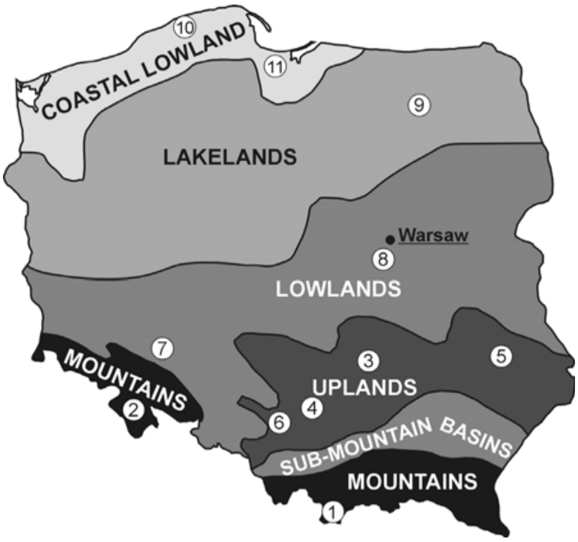

Figure 2. Landscape diversity of Poland
(key in the text)

While teaching about the landscapes a lot of attention is paid to developing map reading skills and presenting the influence of climate and, especially, vegetation, on natural elements of a landscape. Much attention is also paid to studying how natural conditions influence people's lives and activities. Moreover, this block refers to the examples of how human activity changes the natural environment.

3. Discussion – teaching Science versus traditional teaching about landscapes

A systematic study of Poland's landscapes begins with a lesson on the landscape of high mountains. Traditionally, this landscape is exemplified by the Tatra Mountains. Elementary character of this issue suggests devoting at least two lessons to studying it: the first one to the features of high-mountain relief, while the second one – to vegetation diversity and climate. The concept of the first lesson is presented in Fig. 3 and 4, which enable students to recognize natural elements of the high-mountain landscape (such as ridges, rock towers, deep and narrow valleys, gullies, passes, talus cones and postglacial cirque lakes).

Figure 3. High-mountain landscape of the Polish Tatra Mountains
Source: Mityk J, Geografia VI, Warsaw: WSiP; 1976: p. 96

As the high-mountain elements are not studied before, they have to be treated separately and based on the direct observation followed by a description and analysis. Next, it is necessary to explain to students the processes which have led to forming the selected landscape. Grouping the results of the observation enables students to generalize, which then influences the mind-creation of terms and concepts of the objects being observed.

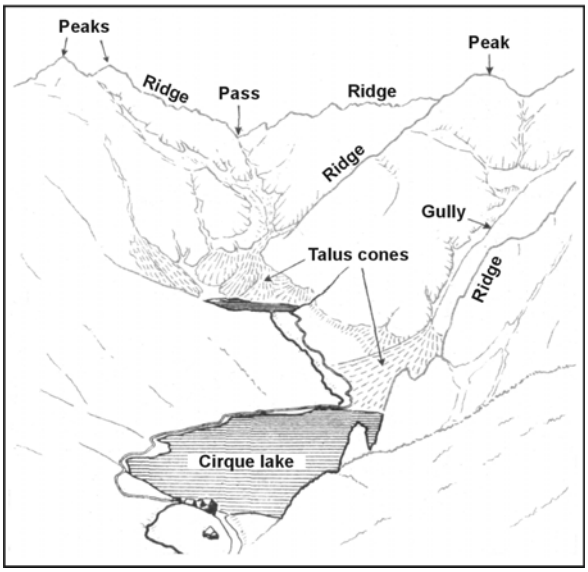

Figure 4. Elements of the high-mountain relief
Source: Mityk J, Geografia VI, Warsaw: WSiP; 1976: p. 96

Proper conduction of the second lesson, however, necessitates either drawings, photographs or a short film to be used to present

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plant layers in the mountains (Fig. 5). It is also necessary to discuss climatic conditions and the way they influence the weather changeability, hydrological processes, nivation phenomena etc. Generally, this lesson aims at showing the rules; in this case the fact that precipitation is much higher than in other parts of Poland, and that air temperature lowers with the growing altitude (0.5ºC per 100 m).

Studying the above aspects is followed by the characteristics of the natural resources of the area as well as the reasons for their protection within the Tatra National Park. It is one of the 23 such areas in Poland, and in 1993 was turned into the UNESCO biosphere reserve.

Although there is no intention here to discredit the above didactic solutions, the authors want to put forward numerous questions. Their importance is supported by the way the high-mountain landscape of the Tatras is used at present and what the perspectives are for its future development.

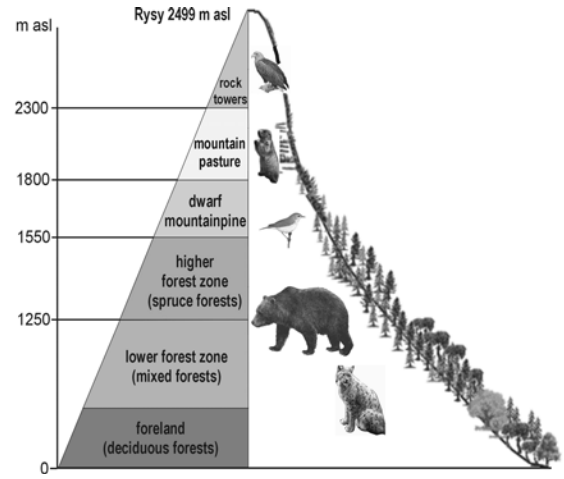

Figure 5. Plant layers in the Tatra Mountains

Why does it happen so often during their lessons that teachers mention neither human presence nor its consequences for the high-mountain landscape? Is it a mere coincidence? Or is it the result of a conscious decision to teach those aspects during one lesson more? As the results of the analysis of the didactic process in numerous schools in Toruń show, most teachers introduce high-mountain landscape during three or even four lessons. These extra lessons aim at presenting management issues in the Tatras, such as the traditional activities of the population (sheep-grazing, craft), and the modern ones (including the most important tourist industry). Other aspects these lessons deal with include the rules of how to move around the national park and, especially, along the 245 km of footpaths.

Figure 6. Space management is still problematic in the Tatra Mountains

It is important to stress, though, that Zakopane – the largest town of the Tatra Mountains – is viewed by young Poles as the ‘winter capital’ of Poland. For many of them a trip to the mountains is often an unfulfilled dream. Before such a trip they should be equipped with the information on rich culture of this region (traditional clothes, local dialect and music), as well as traditional wooden architecture. Its style corresponds fully with the local climatic conditions by using steep roofs with large eaves to protect the walls. Such a construction makes torrential rainwater flow down instantly and snow cover move down easily due to gravitation.

Figure 7. Tourist management in the Tatra Mountains

As the above examples show, students, supervised by their teachers, aim at gaining a wide range of knowledge on a high-mountain landscape. While doing so, they study the issues in the following order: abiotic elements, biotic elements, man in the landscape. It is certain that students reach not only the above goal but also a number of useful skills, such as tourist map-reading.

Complementary way of teaching Science means that students have to develop the skill of careful observation. Only then will they be able to analyze cause-and-effect relations and interrelations between man and environment, which is necessary for integrating the Science knowledge. However, this means there is a profound need for deep changes in the way teaching process, including teaching about landscapes, is treated. The changes are expected to take place as early as at the stage of lesson-planning and the lesson plan evaluation. There is significant room for the above changes [9]. Important criteria useful for introducing the suggested changes include the following:

- striving for locating properly the discussed geographical areas and objects in geographical space;
- paying attention to interrelations between natural and cultural elements of a landscape;
- teaching facts, definitions, interdependencies and rules necessary for presenting events, phenomena and processes;
- introducing students to reading, interpreting and processing information from maps, texts, tables, graphs, photographs, models and diagrams;
- developing students' skills in constructing simple models of man's positions in the geographical environment;
- preparing students for using their knowledge for problem-solving.

4. Discussion – is it necessary to talk about boundaries in landscapes

While teaching about landscapes during Science lessons teachers rarely pay attention to the course of their boundaries. Generally, it is accepted that a landscape boundary is blurred as it is usually a zone where the features of the neighbouring landscapes overlap [6], [7]. The more features are considered while differentiating the landscape units and the higher their range, the boundary zone is less blurred [2]. The existence of boundary zones might cause three problems during lessons:

- deciding to which landscape the boundary zone belongs;
- presenting the boundary zone on maps;
- continuity of boundary zones.

The second of the above issues turns out to be quite important if we accept that landscape boundaries are linear. According to E. Neef [6] landscape boundaries are not absolute, while according to D. L. Armand [1], delimitation of such boundaries is a very subjective process. Even though, these boundaries are proved to exist. What is more, they can be easily pointed at when the neighbouring landscapes are, for example, of primitive and cultural character. As far as the course of the agricultural landscape boundary is concerned, it is delimited by the range of farmland. A geomorphologist, though, would define it as the limit of agrotechnical denudation which results in creating numerous landforms (Fig. 8). According to L. Kozacki [5], other anthropogenic boundaries, and especially those which result from direct influence of man on the Earth's surface, show linear character at first. After some time they get wider and wider, and finally turn into boundary zones.

It was also G. Bezkowska [2] who proved the existence of linear landscape boundaries. According to her research, the boundaries in basins in various landscape zones in most cases show linear character. In savanna and desert zones the boundaries show natural character of the winding course. Their clarity is the result of the long-lasting and undisturbed processes forming the landscape units.

Figure 8. In the background agricultural and primitive landscape (Tabarka region – Tunisia). High balks and waste-mantle at the slope-foot are the result of agrotechnical denudation

As durability of landscape boundaries is a very complex issue, this paper may only mention it. What should be stressed, however, is the

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movement of linear boundaries and the change in the width of boundary zones. Both the rate and the range of the movements of linear boundaries depend directly on the course of natural processes as well as the size and character of anthropopression.

Figure 9. Pile of phosphorites – state at the moment of the formation termination (Metlaoui region- Tunisia)

In this phase, the direction of the movement of the linear boundary sections is outward, i.e. the area where the landscape is found widens. The distances between the landscape limits reflect the forming stages of the cultural landscape. The movement of the linear boundary (or of its sections) takes place until the boundary stabilizes. It means the phase of landscape forming by man has finished. Extreme events, however, may distort the process of boundary-forming, or even change their course (Fig. 10).

Figure 10. Boundary zone of agricultural landscape distorted due to torrential rain (Tabarka region – Tunisia)

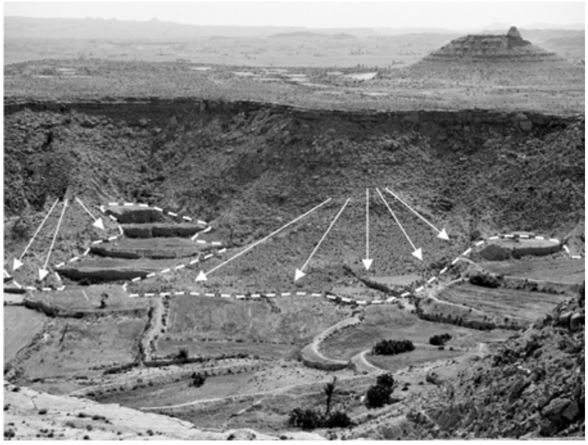

Figure 11. Transformation of boundary zones due to denudation can result in turning superficial anthropogenic relief into fossil forms (agricultural terraces in the Tataouine Mts. – Tunisia)

The analysis of the landscape boundaries in the areas where anthropopression weakens shows that this weakening results in blurred linear boundaries and boundary zones. Such changes are, for instance, found in the areas where natural basins experience natural morphological processes on their slopes. Movement of the matter along the slopes may end up in distortion of the development of these forms and their landscape boundaries.

Figure 12. Grave-mound from the 1st c. on the cemetery of Goths in Grzybnica near Koszalin (photo K. Hahuła – 1992)

Transformation of boundary zones (or of linear boundaries) may either precede disappearance of these forms, which means their total destruction, or transformation of superficial anthropogenic relief into fossil forms (Fig. 11) [8].

Besides natural processes, the reason of transformation of the linear boundaries and

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boundary zones is replication of anthropopression [8].

Restarted human activity often brings the changes different from the previous ones. As a result, the newly formed landscape may contain 'untypical' elements (Fig 12).

5. Summary

Science teaching necessitates using various methods and didactic tools. Diversity of Polish landscapes, not to mention the diversity of the entire Earth, encourages teachers to use active methods of teaching, including the ones which are related to student's emotions. Introduction of these methods arouses students' involvement in the teaching process, and favours the development of their pro-ecological stance and emotional relation to the landscape of the home region. It makes students aware that protecting landscape or its selected invaluable elements is necessary nowadays. Lack of protection deprives the world of its natural heritage.

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Issues of Environmental Risk Management in the Greek Schools

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Abstract. Environmental issues, especially these involving environmental hazards show an ever-increasing concern in our modern and technology dependant societies. Some of these hazards may be attributed mainly to natural causes (for example earthquakes, flood …) while others are due to human activity (for example water pollution, leaks from chemical factories …). Due to the high population concentrations observed these days and the intense environmental exploitation, an otherwise environmental disaster may lead to catastrophic effects. Consequently, there is a need for environmental risk management including measures of prevention, of anticipation, of deterrence etc. In all these aspects, the active cooperation of the public may be proved very useful if the people involved are literate to the subject, an issue where school education may be proved appropriate. In this work, we present how environmental risk management and related issues are considered within the formal school curricula in Greece.

Keywords. Risk management, Environmental risk.

1. Introduction

Environmental education became a priority issue in the Greek schools since the early '80's [1]. By now the environmental education component of the Greek schools' curricula is more extent than in many other countries [2]. Environmental education in the Greek schools takes 3 distinct forms:

- As formal education included in the school curricula. There is a specific subject, 'Study of the Environment', for the first 4 classes (ages 6 to 10 in the primary school) where topics from the natural and the human (social) environment are discussed. Specific topics are also included in all other subjects of the primary and the secondary education school curricula. In addition, in all the school subjects there is as an explicit objective the development of environmental conscious behaviour [3].
- As optional activities involving the study of specific environmental issues, usually from the school (natural or social) environment. These activities are on a voluntary basis and outside the compulsory school program. They have the form of long term (e.g. projects) or short term (e.g. environmental 'sightseeing') organized studies with the central or the local government support. Long term activities (usually from 5th grade – age 10) are effected through the formation of environmental groups where team of students under the supervision of one or more teachers undertake to study in depth a specific topic [4].
- As informal activities that reflect the culture of every specific school and its school environment [5].

An ever-increasing concern in our modern and technology dependant societies involves environmental hazards. Some of these hazards may be attributed mainly to natural causes (for example earthquakes, flood …) while others are due to human activity (for example water pollution, leaks from chemical factories …). Due to the high population concentrations observed these days and the intense environmental exploitation, an otherwise environmental disaster may lead to catastrophic effects. Consequently, there is a need [6] for environmental risk management including measures of prevention, of anticipation, of deterrence etc. In all these aspects, the active cooperation of the public may be proved very useful if the people involved are literate to the subject, an issue where school education may be proved appropriate. In this work, we present how environmental risk management and related issues are considered within the schools in Greece.

'Risk' is potential (future) events that have an impact (positive or, as conceived usually, negative) on an asset or a (human) value. Risk management includes processes of assessing (measuring or estimating) the risk and actions of developing measures to avoid or reduce its negative consequences. In this work, the following environmental risk management aspects were searched for in the curricula of Greek schools:

a. Processes of assessing an environmental risk,
b. Measures of avoiding an environmental risk,
c. Anticipation measures to confront a risk once happened,
d. Reduction measures to reduce negative impacts of an environmental risk,
e. Conditions under which the (negative) impacts of an environmental risk may be considered acceptable (retention).

2. Methodology

For this work the following resources were used:

- The official school course curricula and textbooks were studied to locate issues related to environmental risk management either in the course outline or in its objectives. These resources covered the formal environmental education.
- To cover the optional environmental education form, a search of the literature on the issues discussed within the optional environmental education activities was made. This search was limited because of the scarcity of relevant published works and time constraints. To a great extent we used our own results from relevant studies. Guidelines and circulars from the central and local education authorities were also used.
- Our experience with school environmental education issues is the only resource for the informal environmental education activities.

As stated earlier, all courses in primary and secondary education schools in Greece have a significant environmental component. According to the relevant course objectives, environmental education should be taught in a holistic interdisciplinary way. However, this is not reflected in the textbooks. In general, the topics related to environmental education are discussed isolated. The required systematic interdisciplinary approach, relating aspects of the social and of the natural environment, is missing.

In the humanities' courses the approach is mainly towards the human environment with the (explicit or implicit) objective focused mainly to the appreciation of the local culture. In the Science courses (Physics and Chemistry in particular) there is a more systematic approach with the emphasis being towards the knowledge of the natural environment. Only in the 'Study of the Environment' course of the first 4 grades (ages 6-10) of primary school an interdisciplinary approach may be traced.

For the formal environmental education the content of the courses 'Study of the Environment', 'Chemistry' and 'Physics' were analysed to locate aspects of environmental risk and of risk management (see in 0 above). In the secondary education schools (Gymnasium, Lyceum and Technical Vocational schools) the course on 'Geography' (natural and human) could also be used but, surprisingly, its syllabus does not include any topics or related to environmental risk and risk management. The same is true for the course 'Biology' where only an incidental mentioning to genetic engineering is mentioned. In order to have an indication of the extent these aspects cover the course we used the (rather naïve) approach of the pages in the textbook [7].

The topics related to environmental risk and risk management that were located are presented in the next sections.

3. Results.

Primary school. The course analysed was 'Study of the environment taught in the first 4 grades (ages 6-10years) of the primary school. The objectives of the course are focused mainly to understand and appreciate the (natural and the human) environment and the interrelations between its constituents. There is no specific provision for environmental risk and risk management topics which, with the exception of earthquakes (see later) occur only incidentally. However, in many of the topics discussed, the suggested teaching provides to the teacher the opportunity to discuss aspects of risk and of risk management. These topics cover about 15% of the textbook pages in total, starting from almost 10% for the 1st grade (age 6) and increasing to about 20% in the 4th grade. The situation is similar with the course 'Science' for the 5th and 6th grade [8]. Of this 15% the majority (80% in the 1st grade to 50% in the last) are associated with water, water management and related risks (e.g. pollution, flooding). Other topics include Food chain [9], Fires, Energy, Landscape forming, Thunder- and Wind- Storms (all with two instances) and Ecosystems (with 7 instances). In all the cases mentioned, the specific risk aspect favoured falls within the risk assessment. Only a few exceptions on reduction (treatment of household wastes, alternate energy sources) and anticipation (e.g. river bed or coast line shaping to anticipate flooding).

Gymnasium. In the low secondary education (middle school – grades 7th to 9th, ages 12-15) the relevant courses examined are Chemistry and Physics. They are taught in the 2nd (8th grade) and 3rd (9th grade) years. The topics for which the suggested teaching may provide the teacher the opportunity to discuss aspects of risk appear in 27 instances and cover (only) 3% of the total textbooks of Chemistry and Physics. The split is: Chemistry 9% and 5% for the 2nd and 3rd year respectively, Physics 1% and 1% for the 2nd and 3rd year respectively. The presentation suggested however is plainer towards risk aspects, mainly on assessment [10]. Of these 27 instances 19 (70%) relate again to water but there is a wider diversity on the viewpoint adopted extending into pollution (including detergents, fertilizers, quality of drinkable water and eutrophication), management, dams, hydroelectrics, acid rain, waste, drought … . A wider diversity is also observed into the rest of the topics that include volcanoes, European and Greek legislation, the Rio [11] and Kyoto [12] conventions, the sustainable development, the greenhouse effect …, all with one 'en passant' instance (see also note [10]).

Lyceum. In the upper secondary education (high school – grades 10th to 12th, ages 16-18) the relevant courses examined are (general) Chemistry and Physics taught in all the 3 years of Lyceum and 'specialty' Chemistry and Physics taught in the 2nd and 3rd years [13]. The topics whose the suggested teaching may provide the teacher the opportunity to discuss aspects of risk appear in 26 instances, mostly within the general courses, and cover (only) 2% of the total textbooks of Chemistry and Physics (4% in the 1st year shared as 8% for chemistry and 2.5% for Physics). The topics, always within the contexts described for the primary school and the gymnasium, show a wider variety and include

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the green house effect, acid rain, nuclear wastes, radioactivity, nuclear explosions, industrial wastes, emission of chlorofluoro compounds and ozone hole, explosives, earth waves and antiseismic measures, sea waves and tsunami, volcanoes…

TVE. Only 3 instances were found covering about 7% of the textbooks. The three instances were waves with a rather extensive (8 pages) presentation on seismic waves and protective measures, acid rain and air pollution. The result is rather expected due to the technical vocational orientation of the schools [14].

Optional activities. Optional environmental activities operate in primary and secondary (general) education schools with the largest number of activities in the middle school. They have no definite syllabus. Instead, every activity is planned beforehand by the environmental group. The environmental groups consist of the teacher or teachers who supervise the group and a number of students who decide on the topic to study. Although, most of the topics are from the immediate vicinity of the school quite a few are of a more general nature. This is especially true for the long term project activities [15]. To check if these activities include environmental risk or risk management issues we searched the (limited) literature on the subject. The information here is from specific studies on the reports from these project activities [4], [16], [17]. There are no centrally kept records for the optional environmental education activities. However, for the long term project activities, in order to gain financial support from the state or local education authorities, the environmental group must make an application with their project's description. We used these files to examine the type (as it appeared in the title of the application) of the activity undertaken and classify its contents. Incidental evidence from other studies indicates no significant variations on the kind of topics studied between long and short term activities [18]. Out of the 193 projects analyzed in [4], the 89 (46%) refer to the natural environment and 104 (54%) refer to the human environment. Of these 104, 13 (~7%) included also elements from the natural environment. About 15% of the students participate on these activities per year. Consequently, during the whole of the compulsory education period (9 years, 6 in primary school and 3 in Gymnasium) the majority of the students have participate in at least one such activity (about 15% of the students participate to more than 1 activity). The majority of the projects provide opportunities to discuss aspects of environmental risk and management. However, as the focus is on the environmental education aspects of risk are discussed incidentally (see note [10]).

Informal activities. There are no records on these activities. From ongoing studies (see [5]) it seems that these activities, although not systematic, are numerous. The subjects refer to pollution, treatment on wastes, landfills, road traffic safety. The focus is to form a clean and safe school environment. Again only incidentally issues of environmental risk and management are discussed.

Earthquakes. Due to the high seismic potential of Greece [20], special measures have been taken. These include special actions in all levels of school education, especially in the compulsory education. Apart from the specific cases mentioned previously for the formal environmental education there are supplementary actions, such as:

- Anticipation measures including guidelines on what to have ready before an earthquake, how to behave during an earthquake, what to do afterwards,
- Drills (at least once per year) to apply the guidelines,
- Specific courses on the necessity to observe the antiseismic measures regulations,

4. Comments

Despite its significance, environmental risk and environmental risk management in the Greek schools is only incidentally discussed within the broader context of environmental education. As a result important environmental risks either they are discussed superficially (e.g. landslides) or not at all (e.g. extreme weather conditions, nuclear power plant accidents).

This is a common situation in other countries also. It could be attributed to the still existing from the past attitude that risk issues are not of such an extent that could justify special actions within the school program. Similar attitudes were present a couple of decades ago on environmental education. Such an attitude could be justified in the past where environmental intervention was rather limited and, in order to be noticeable, required long time. With the advance of technology this is not any more the case – the importance now associated to (the protection of the) environment is very indicative.

Environmental education should be enhanced to include in a systematic way issues of environmental risk and of environmental risk management. Towards this end there is a need for appropriate (education) material and means.

The OIKOS project [21], financed by the European Commission under the Leonardo program includes in its objectives the production of such material and means that could be used within the formal or the optional education in schools.

5. Acknowledgements

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6. References and Notes

[1] See a summary in P. G. Michaelides, '*Environmental Education in the Greek Schools*' in G. Flouris, M. Kassotakis (editors) Honorary Volume of Professor B. Masialas, Rethimno, 2005.

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[5] See a brief expose in Theodore Antoniou, '*Environmental Issues on the Newspapers of HERAKLION – CRETE*', 2nd International Conference on Hands on Science Hsci2005 – Science in a Changing Education, July 13-16, 2005 – Greece, The University of Crete campus at Rethimno (http://www.clab.edc.uoc.gr/2nd/).

[6] A simple web search on June 30, 2006 with the keyword '*Environmental Risk Management*' produced about 2 million hits, the majority being web sites of organizations and commercial companies, most of which having this keyword as there name. This high return is indicator of the concern.

[7] For all courses in the official school curriculum of the Greek school a textbook is provided free of charge to all the students. This textbook is accompanied by a guideline book for the teacher. Our experience from previous studies show that the vast majority of the teachers follow very closely the material as it is presented in the textbook although the guide lines stress that this is to be used only indicative. There is also a (rather direct) relation between the time planned for the different topics and their coverage in the textbook. Consequently, we believe that we may rely on our 'naïve' index.

[8] 'Science' is a unified course for the 5th and 6th grades (ages 11-12) of the primary school with element from Physics, Chemistry, Biology ….

[9] Only as Food chain. Food webs (or networks) are totally ignored with the consequence to raise many misconceptions (for example 'elimination of a prey leads to the elimination of all its predators'.

[10] It must be stressed however, that the presentation's viewpoint is on the acquirement of knowledge without specific planning on risk. So, even on the assessment aspect, the relation to risk is only by providing the different parameters (e.g. relations between the various factors present in a phenomenon) without any attempt to estimate (assess) the risk involved or even the relative importance of these different factors.

[11] See more at the United Nations web site on 'The Convention on Biological Diversity' http://www.biodiv.org/default.shtml (visited on June 30, 2006).

[12] See at http://www.unece.org/trade/kyoto/ky-01-e0.htm, a web maintained by UNECE - the United Nations Economic Commission for Europe (visited on June 30, 2006).

[13] In 2nd and 3rd years the Lyceum is in 3 study paths; Humanities, Science and Mathematics, Technology. 'Specialty' Chemistry and Physics are advanced courses for the last two study paths (counting somewhat more than the 2/3 of the students. Due to the highly competitive entrance to higher education examinations, students' attention is directed almost exclusively towards the courses relevant to their examinations.

[14] However, depending on the specialty study path followed, specific courses on job environment and safety exist. These were not analysed as they were considered specialist's education.

[15] Long term (project) activities have a duration of a semester (at least) or a whole school year. The environmental group selects a topic to study in depth. At the end of the school year a school fair with the results from all the environmental groups of the school (or of the schools in the region) is organized. Short term optional environmental activities have duration of less than a semester. They may be only of one day (environmental visits –sightseeing) as environmental awareness activities.

[16] Theodore Antoniou, P. G. Michaelides, 'Optional environmental education in the Greek schools' paper to be presented at the HSci 2006 - 3rd International Conference on Hands on Science 4th - 9th September, 2006, University of Minho, Braga, Portugal.

[17] Georgios Kimionis, P. G. Michaelides, 'Environmental Education in Greek Schools: The Viewpoint of the Local Coordinators', proceedings of the 2nd International Conference on Hands on Science: Science in a Changing Education, July 13-16, 2005 – Greece, The University of Crete campus at Rethimno pp 196-200 (http://www.clab.edc.uoc.gr/2nd/).

[18] Michaelides P., Kimionis G., Charalambidou F., "The Participation of Pupils in Environmental Awareness Activities", in "3rd Pan-Hellenic Congress in Didactics of Natural Sciences and Application of New Technologies in the Education" Rethymno 9-11/5/2002", pp 108 (in Greek).

[20] An earthquake of the order 4 in the Richter scale occurs almost once per week. Antiseismic measures for the construction of (new) buildings in Greece are quite strict and in some areas the measures are for constructions to withstand (at least) earthquakes of a magnitude of 7.5 in the Richter scale. As a result, the cost of buildings is quite high.

[21] Leonardo da Vinci project OIKOS, Contract number 2004 - I/04/B/F/PP-154025. Web site http://151.8.193.227/oikos/ or www.e-oikos.net.

Optional Environmental Education in the Greek Schools

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Abstract. Environmental education constitutes a major component of the Greek schools' activities. It is delivered as formal education, as optional education programs and as informal activities. The formal education includes specific courses or, more often, modules and related activities within the syllabus of all the school subjects. The optional education programs take place outside the normal school hours, usually in the form of 'environmental education groups' studying in depth a specific environmental issue. The informal activities are within the context of the school culture in its daily operation. In this work, we present a review of the optional environmental education programs during the previous years as they were implemented by the schools of Heraklion, a prefecture in the area of Crete, which may be considered as representative of the whole Greece.

Keywords. Environmental education.

1. Introduction

The Environmental Education started as a separate education subject in the decade of 1970 as the result of a raising awareness on environmental problems and the inadequacy of Science and Technology alone to solve these problems without a conscious change in society

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modes of life. The education of environmentally responsible citizens, with knowledge, dexterities attitudes and behaviours, who participate actively in environmental issues, has been considered since then as one of the most important factors that will contribute in the confrontation of environmental crisis and the implementation of sustainability. The introduction of optional environmental education in the education systems of most countries indicates the public awareness on environmental problems. The Non-formal environmental education in Greece was introduced on a pilot basis the school year 1983-84. It was established as official supported optional school activity in 1990 and since then it is an important element of the school activities.

Environmental education now constitutes a major component of the Greek schools' activities to an extent greater than in most other European countries [2]. It is delivered as formal education, as optional education programs and as informal activities [1]. The formal education includes specific courses or, more often, modules and related activities within the syllabus of all the school subjects. The optional education programs take place on a voluntary basis outside the normal school hours, usually in the form of 'environmental education groups' studying in depth a specific environmental issue. These studies are of long or short term duration. Long term (project) activities have a duration of a semester (at least) or a whole school year. The environmental group selects a topic to study in depth. At the end of the school year a school fair with the results from all the environmental groups of the school (or of the schools in the region) is usually organized. It is the form of environmental activities encountered mostly in secondary education. These programs quite often complement the formal education courses. Short term optional environmental activities have duration of less than a semester. They may be only of one day (environmental visits – sightseeing) as environmental awareness activities. Their character is to develop environmental awareness and they are encountered mostly in primary education. The informal activities are within the context of the school culture in its daily operation.

In this work, we present a review of the optional environmental education long term (project) activities during the previous years as they were implemented by the schools of Heraklion, a prefecture in the area of Crete, which may be considered as representative of the whole Greece. This study complements other studies on optional and informal environmental education [3], [4], [5].

2. Methodology

The current study is based on an analysis of the optional environmental projects that were implemented in the schools of the Prefecture of Heraklion during the school years 2001-02 until 2004-05. They include Pre-Elementary (infant school ages 4-6), Elementary school (ages 6-12), Gymnasiums (ages 13-15), Lyceums (ages 15-18) and Technical Vocational schools (ages 15-18). Optional environmental activities (especially long term ones) may have financial support from central (or, less frequently, from local) education authorities. To this end the schools should apply including the title, the duration, the plan of activities, the requested budget …. The application forms were used extensively in this study and, where necessary, were complemented by supplementary information from the schools (only in a few instances to clarify some ambiguous points).

Table 1. Schools in Heraklion prefecture

Area	Pre -elementary	Elementary	Secondary
Urban	79	59	29
Semi -urban	16	12	4
Rural	152	34	49
Total	247	105	82
Percentage (%)	57.57	24.47	19.11

The Prefecture of Heraklion includes the highly urbanized greater area of Heraklion city (urban area), large villages mainly in the valleys and the sea coast (semi-urban area) and rural areas mainly in the mountains. About half the population of Crete (0.6 million habitants) live in the Heraklion prefecture. In the greater area of Heraklion city live about 150.000 habitants. The number of schools and their distribution is presented in Table 1 while in Table 2 the distribution of secondary education teachers in the area of the Heraklion prefecture is presented. Of the total number of teachers about 60% are within the schools of the Heraklion urban area. The numbers are consistent with the corresponding numbers for the whole of Greece.

Table 2. School Teachers in Heraklion prefecture

	Total	%	Females	%
Language	602	26	498	83
Mathematics	349	15	98	28
Science	292	13	108	37
Other	1.048	46	624	60
Total	2.291	100	1.328	58

3. Results

During the three school years 2001-05, the secondary education schools realized 262 environmental projects. The primary (pre-elementary and elementary) education schools realized 191 environmental projects.

Tables 3, 4, 5 and 6 present distribution of environmental activities of the secondary education schools in the Prefecture of Heraklion.

Year	Gymnasiums	Lyceums	Technical
2001-2002	37	22	2
2002-2003	57	24	7
2003-2004	39	11	5
2004-2005	27	19	12
Total	160	76	26
Percentage (%)	61	29	10

Table 3. Projects in general secondary education

Table 4. Projects in Gymnasiums

Year	Urban	Semi -urban	Rural
2001-2002	19	3	15
2002-2003	21	6	30
2003-2004	15	3	21
2004-2005	2	1	26
Total	57	13	92

Table 5. TVE schools

Year	Urban	Non-urban
2001-2002	2	0
2002-2003	5	3
2003-2004	5	0
2004-2005	10	1
Total	22	4

Table 6. Lycei

Year	Urban	Semi -urban	Rural
2001-2002	3	4	12
2002-2003	7	2	10
2003-2004	4	2	5
2004-2005	7	5	13
Total	21	13	40

It is apparent that Gymnasiums are more active than the Lycei in environmental activities. Also schools in non-urban areas are more active than schools in the urban area. This is consistent with the results obtained in [3]. Possible reasons include:

- Students in Lycei are absorbed with their preparation for the entrance examinations to higher education and do not volunteer to any other activity,
- Students in urban areas have also other opportunities for their time (private lessons, foreign languages, sports, etc),
- Teachers in non-urban area are younger and, presumably, more energetic.

The number of environment projects per year seems constant for the period under study. A closer examination reveals that while some schools implement environmental activities occasionally quite a few schools do it on a regular basis. Possibly, in these schools a critical mass of supervising teachers has been formed and a relative culture has been developed.

Worth noticing is also the activities of the TVE schools (9 in total 2 of them night schools). Tables 7 to 9 present the number of optional environmental projects for the primary education schools. There are 192 environmental projects in total 67% of which were implemented by pre-elementary schools. Taking into account the number of schools in each category it seems that the per school optional environmental activities is comparable between elementary and pre-elementary schools despite the significant age differences a rather pleasant result for the pre-elementary schools. It may also be observed that pre-elementary schools in the urban area are much more active than in the non-urban areas. This is in contrast with the situation in elementary schools and in secondary education schools. Comparing the per school activities between the different types of schools (see also Tables 10 and 11 in reference with Table 1) the Gymnasium schools seem more active. It should

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however be noted that the primary school activities observed in this study are more numerous than a corresponding study in the prefecture of Rethimno [3]. The explanation of these results requires further study taking into account the following:

- Prime objective of the pre-elementary school is the socialization of the children including familiarization with the local (social) environment,
- In the urban areas a short term (a couple of hours) visit to a local institute park or service is easier for the pre-elementary schools in the urban areas,
- Recently, a great number of pre-elementary and elementary school teachers were appointed. These teachers are young (and presumably more energetic) University graduates who have sound environmental education training.
- The circulars and guidelines in primary education suggest that all student study should preferably be done within the school hours only (avoid homework if not specifically justified).

TABLE 7. Primary education schools

Year	Pre -elementary	Elementary
2001-2002	28	24
2002-2003	35	16
2003-2004	34	10
2004-2005	31	14
Total	128	64

TABLE 8. Pre elementary schools

Year	Urban	Semi -urban	Rural
2001-2002	13	2	13
2002-2003	23	1	11
2003-2004	24	0	10
2004-2005	19	2	10
Total	79	5	44

TABLE 9. Elementary schools

Year	Urban	Semi -urban	Rural
2001-2002	10	2	12
2002-2003	6	2	8
2003-2004	3	2	5
2004-2005	9	0	5
Total	28	6	30

TABLE 10. Primary and secondary schools

Year	Primary	Secondary
2001-2002	61	52
2002-2003	88	50
2003-2004	55	44
2004-2005	58	45
Total	262	191

.

TABLE 11. Primary and secondary schools

Area	Primary	Secondary
Urban	107	100
Semi -urban	11	26
Rural	73	136
Total	191	262

The number of programs per year appears to be generally constant in the elementary and secondary education as well

In secondary education all specialties' teachers participate as supervisors of the environmental education groups as is shown in Table 12.

TABLE 12. Teacher specialties

	2001 -02	2002 -03	2003 -04	2004 -05
Language	55	71	35	38
Mathematics	6	17	6	7
Science	31	36	30	21
Other	53	101	50	65
Total	145	225	121	131

Taking into account Table 2 the percentages of the different specialties as environmental group supervisors are 33% for Language teachers, 10% for the Mathematics teachers, 40% for the Science teachers and 26% for the other specialties with an average of 27% of secondary school teachers participating to the (voluntary) optional environmental education activities.

We used the categories introduced in [4] to classify the 453 optional environmental education projects of the different types of schools. The results are presented in Table 13. The first 3 classes refer mainly to the natural environment while the remaining 3 refer mainly to human environment.

There is a slight prevalence of the project related to the natural environment in Gymnasium. This is increase in the other types of schools. For the primary education schools this is rather expected because of the age of the students [6]. However the missing class of *t* even from TVE should be noticed.

Table 13 Type of projects

	Gym	Lyc	TVE	Pre-el	Elem
Activities for the environment (Recycling, - cultures, cleanings, configuration of spaces)	20	16	7	6	12
Environmental subjects general or world interest, Environmental questions	41	8	6	28	51
Study and acquaintance with the local environment	29	18	5	9	27
Social subjects, modern economic activity, Sensitization of public	20	9	3	1	2
Cultural environment, Traditional occupations and professions	45	25	5	19	36
Structured and artificial environment	5				
TOTAL	160	76	26	63	128

4. Acknowledgements

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5. References and Notes

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[6] In a Piagetian context children in primary education are before or approaching the stage of formal logic so the observation of the natural environment is more appropriate than concepts from the social organization.

Funiculars. Science on Tracks

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Abstract. Funiculars have been used for centuries with success moving peoples and materials up hill even if very steep. It combines the technology of an elevator (a cable pulling a car up) and the technology of a railroad (a car on a track). A train with its steel wheels doesn't have enough traction against steel rails to move up steep inclines. Funiculars overcome this traction problem in a simple and "clever" way: the cars are… pulled. Typically two cars independent but connected by a cable, run on parallel tracks and when a car moves up the other moves down. A particular kind of funicular uses gravity to run. Is the so called water or counterbalance water funicular. The cars have a water reservoir that is filled full of water when in the upper level and empty in the bottom of the steep track. In Braga at Bom Jesus hills we can find the oldest water funicular in operation. It was built by an Eiffel' student Raul Mesnier du Ponsard and begin

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operating in March 1882. It travels a distance of 274 meters with a slop of 42% in 2.5 to 4 minutes depending on the load. Each car has a capacity of nearly 6000 l and is filled according to the number of passengers to be carried up and down the hill.

Keywords. Physics, Mechanics, Optic Fibers, Telecommunications, Scientific Method.

1. Introduction

Hands-on studying of Science, observations, laboratory experiments and field experiments are necessary to experience and understand the natural phenomena [1]. The more they become part of our every day work in class the more our students will get interested in Science.

Fig. 1. "Bom Jesus" funicular in Braga

An experiment tests a hypothesis, so it is directly related to a scientific theory. Through the experiments the students learn the concept of controlled variables; if two or more parameters vary in an experiment then you cannot have clear results from the experimental data. It is difficult, in this case, to correlate specific changes to the relevant magnitudes. One should be careful in designing an experiment and selecting the devices, to avoid such complications. Thus, a school experiment is designed to be as simple as possible in order to make easier for the students to understand the relationships among (usually) two physical quantities.

The applications in real life are much more complicated. Sometimes they are the combination of different techniques. It is important, though, to give to our students the opportunity to understand the technology around us; interesting would be also to study an application and its evolution through the years. Since the modern applications are many, we can study just a few of them in school projects; a group of students selects an application, work with it throughout the school year and present the outcome at the end of it.

2. Real world situations. *Real life and history.*

Fig. 2. The "Elevador do Bom Jesus": the cars

What would be the criteria to select a modern application as the subject of a school project? The importance of an application could be judged by:

- Its direct relation to the scientific theories included in the school curriculum.
- How useful it is to the modern society.
- How interesting is the story about its development.

An important element would be, if it is used in other parts of the world; a school project is always an opportunity of team work among student groups of different schools and even of different countries. Internet is a suitable platform to materialize such cooperation [2].

One of the applications related to the history [3] and the development of several areas all over the world, is the funicular railways.

3. Basic ideas behind funiculars

Funicular railways exist in many cities along the world, in places with steep slopes.

The principle is quite simple; similar mechanisms were used back at the 15th century as a way of getting people and things up steep hillsides [4].

How does it work? A vehicle is pulled up the mountain by a cable. Its wheels guide it up the mountain; they don't provide any of the

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pulling power. Simultaneously, another vehicle connected to the first one by a pulley, is going down the slope. The descending vehicle's weight helps pull the ascending vehicle up the mountain or hill. The ascending vehicle keeps the speed of the descending one from going out of control. There is still a motor powering the pulley; it helps to overcome the difficulties because of the difference in weight between the two vehicles (e.g. the weight of the passengers) and to overcome the friction in the system.

Fig. 3. The "Elevador do Bom Jesus": the tracks

Many times funicular railways used to lift tourists up to tops with beautiful view; thus, often they are located in places with local and tourist interest. A few examples of funicular railways from all over the world:

- Eight inclines railways have operated in proximity to the Niagara River at various times over the past 230 years [5].
- The Lynton & Lynmouth Cliff Railway in England [6].
- The funicular railway in Bergen in Norway [7]
- The Allegheny Portage Railroad in the United States of America, part of the Pennsylvania Main Line Canal, built in 1834 with ten planes as the first railroad across the Allegheny Mountains of Pennsylvania [8]
- The funicular on Mount Vesuvius, which inspired the song Funiculì Funiculà written in 1880. That funicular was wrecked repeatedly by volcanic eruptions and finally abandoned after the eruption of 1944 [8].
- The funicular railway of Braga in Portugal. Born Jesus do Monte is a hilltop pilgrimage site reached via a funicular ride.

Fig. 4. Filling up the water deposit to begin the downwards trip (of this car... the other on will go up pulled by this one...)

4. A few notes for an in-school project on funiculars

A school project about funicular techniques can deal with questions like:

- What is the mechanism of the funicular railways?
- What kinds of forces are involved?
- What are the alternative techniques of lifting up vehicles? Refer to its advantages and disadvantages.
- What is the history behind the funicular techniques? How many companies of how many countries are involved?
- How the funicular railway is related to the development of the area?
- Design a simple experiment with ropes, a pulley and weights to reproduce the phenomenon at the school laboratory.
- A web site where students can upload information related to the funicular constructions of their city can become the beginning of a bigger project of school cooperation.

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"Solar Energy - Awareness & Action": Describing the developments of the 1st year of a Comenius school partnership project.

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Abstract. The "Solar Energy – Awareness & Action"[SEAA] is a Comenius 1 project with 5 partner schools from Portugal, Spain, Italy, Malta & Greece [(Escola Antré Soares (PT), Colexio de Educación Infantil e Primaria Froebel (ES), Scuola Secondaria di 1° Grado C.B. Cavour (IT), Stella Maris College Junior School (MT) & 9th Primary School of Rethymno (EL)]. All project participants have become associated members of the "Hands-on Science" Network and the activities of this project also enroll in the activities of the network. The main aim of the project is to sensitise the pupils on issues and aspects of solar energy, within a framework of sustainable development and environmental and ecological awareness, both at conceptual and at practical-experiential level. Furthermore, the pupils are encouraged to act as conscious citizens, construct their own devices which work with solar energy and present them to local communities within open Science Fair procedures and activities, in an attempt to inform and sensitise the general public. A thematic approach to solar energy has been planned to include or even interweave formal, non-formal and informal teaching and learning approaches. These include investigations, hands-on activities and project work within formal and non-formal educational contexts, but also within a free-choice learning environment involving outside classroom activities (e.g. on site visits and science fairs). Shared project activities have been planned and undertaken by groups of children in each school, encouraging pupils to learn from the experience of working on a contributed set of ideas and projects from all participating countries.

Keywords. Solar energy, School partnership projects, Socrates-Comenius 1 project, School based projects and activities, Hands-on science activities, Thematic-holistic approaches.

1. Setting the framework of SEAA project activities

Photo 1: SEAA group in front of *Escola Antré Soares*, 2006

Two meetings have been conducted during the first year of the SEAA Project. Members of the participating schools first met at the *9th Primary School of Rethymno*, Crete in November 2005 and then they met again at the *Escola Antré Soares*, Braga in May 2006.

In both meetings project issues have been discussed, whereas ideas and activities have been proposed and developed within a framework of prospective classroom approaches and/or applications. Discussion regarding the selection of particular activities and/or applications to be implemented as project tasks appears to be an open on-going process, based on a plethora of available activities and resources retrieved and distributed by the coordinator in an electronic form. Of course, these may be complemented with others to be found on the course. Some of these resources are being progressively uploaded as links on the project site (cf. URL:< http://9dim-rethymn.reth.sch.gr/contents_en/project_resources.htm >). Nevertheless, as part of our policy orientation, we have discussed and decided the variety of activities to focus on the 1st and later during the 2nd and 3rd year of the project. We have agreed to work on all possible categories of solar energy applications and constructions, but on particular distinct designs for each project year. In this sense, different groups of pupils and different classes will deal with a similar, but differentiated, set of solar energy applications and constructions every year throughout the project years.

Furthermore, by the end of the 3 year-period of the project we will have accumulated a broader set of solar energy applications and constructions tried out and tested within classroom practice, which can be delivered as a final outcome of the whole project. In this sense, we believe that a broader range and number of future citizens will become aware and activated on solar energy issues. This appears more likely to establish a tendency in local citizens' communities for a considerate decision making process and future actions regarding alternative energy policies and a sustainable development, within a framework of environmental sensitivity and care.

Collaborating teachers have exchanged ideas on experiments and investigations regarding aspects of solar energy to be treated with pupils. Information on applications and/or constructions about *passive* (e.g. solar houses and solar architecture, greenhouses, solar cookers, solar dehydrators etc.) and *active solar systems* (e.g. solar water heaters, solar heating/cooling for homes, solar power stations with reflectors etc.) as well as *photovoltaic systems* (e.g. solar cells and arrays, solar cars and solar toys with PV cells and motors etc.) has been shared and discussed. A particular set of six activities on solar energy applications has been developed and put forward as a basis for the first year approach to solar energy applications. In more detail, two activities, one simple and one more advanced, for each of the three categories of solar energy applications (*passive, active* and *photovoltaic*) have been designed as follows (cf. URL: < http://9dim-rethymn.reth.sch.gr/contents_en/downloads.htm >):

1. **A simple pizza box solar cooker** with investigations on "hot boxes" and "heat traps".
2. **A more advanced solar box cooker** with one reflector and without a top lid.
3. **Simple solar collectors to heat up water** made out of plastic bags affixed on black and white cartons, providing the foreground for relevant experimentation activities.
4. **A solar water heater** with a collector with an "**S**" tube arrangement and a plastic bottle tank, setting the scene for an investigation on the *thermosiphon effect*.
5. **Experiments with a photovoltaic cell** and the performance of a motor after shading the cell or covering it with transparent, semi-transparent and non transparent materials.
6. **A solar toy car with a PV cell and a motor** in an attempt to sensitise pupils about the potential of photovoltaic systems in a rather familiar and playful way.

Thus, project work has been done in each participating school based on the above indicative activities for the current year, although partners have also developed their own projects within a broader thematic framework including other subjects apart from science such as language, mathematics, environmental education, theatre and drama, music, crafts and technology, geography, ICT, etc. An indicative list of such activities is as follows:

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- text production by pupils related to the Sun and solar energy in the form of leaflets, narrations and poems
- collecting and rewriting stories and tales about the Sun in various cultures and civilizations throughout history
- the story of the sunflower and its products, presenting tales about the sunflower in various cultures and creating a collective piece of art with sunflower craftwork
- technological interventions and/or improvements on solar energy applications like solar cookers, solar water heaters and solar toys, based on problems needed to be resolved in terms of better construction and performance of the devices
- construction of horizontal sundials with simple materials, their orientation and calibration through principles of mathematics and geography
- dancing and singing songs related to the Sun in various languages
- role playing and theatre performances with a "Sun" or "solar energy" topic.

There has also been an attempt to actively develop a communication amongst participating pupils from different schools through an exchange of letters and postcards organised in pairs, groups and/or classes. This has proven to be a difficult task mainly due to language difficulties and adequate combination of interests and age groups, but it has been considered essential in building up a warm atmosphere of friendship amongst participants to function as a solid basis for future joint experimentation and project development.

An electronic mailing list has been developed, involving all participating colleagues from the partner schools, providing *in vitro* communication with first hand and updated information about the developments of the project for everyone. Moreover, a web site of the project has been launched under the site of the coordinating school, the 9th Primary School of Rethymno, accessible at the URL: < http://9dim-rethymn.reth.sch.gr/contents_en/Comenius.htm >, which provides information about the project to partners and the general public.

2. Indicative project activities conducted during the 1st year

Teachers and pupils have been involved in a variety of project activities throughout the 1st year, 2005-2006. A more precise view of the number of pupils and teachers participating in the project is presented in the table below.

Although, it more likely appears that a greater number of pupils and teachers have participated explicitly or implicitly in project activities, than those initially declared. Some indicative project activities have been selected and grouped in terms of subject areas involved, within a thematic approach and are presented below.

SEAA School Partners	Pupils		Teachers	
	F	M	F	M
Escola Antré Soares (PT)	58	54	6	1
Colexio de Educación Infantil e Primaria Froebel (ES)	25	28	5	1
Scuola Secondaria di 1° Grado C.B. Cavour (IT)	148	62	10	5
Stella Maris College Junior School (MT)	0	90	5	5
9th Primary School of Rethymno (EL)	75	70	5	5
semi-total	**306**	**304**	**31**	**17**
Total	**610**		**48**	

Table 1: Numbers of pupils & teachers participating in project work per school and in total numbers

2.1. Language, literature, history and culture related project activities

The revival of myths, tales and stories, which deal with the Sun in one way or another, has been conducted through classroom activities and text production. For example, the myth of *Phaeton* ("the shining one"), the son of the Sun-god Helios, who when finally learned who his father was, went east to meet him. He induced his father to allow him to drive the chariot of the Sun across the heavens for one day. The horses, feeling their reins held by a weaker hand, ran wildly out of their course and came close to the earth, threatening to burn it. Zeus noticed the danger and with a thunderbolt he destroyed Phaeton. He fell down into the legendary river *Eridanus* where he was found by the river nymphs who mourned him and buried him. The tears of these nymphs turned into amber. For the Ethiopians, however, it was

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already too late. They were scorched by the heat and their skins had turned black.

Another interesting tale is that of *Dedalus* and *Icarus*, where Dedalus was a famous Athenian architect/engineer that Minos had invited to Crete to build him a Labyrinth. When Dedalus finished, Minos jailed him in the Labyrinth. Dedalus however, build two sets of wings using wax and feathers, one for himself and one for his son Icarus, and they flew off Crete. During the flight to Athens Icarus, happy and excited from flying, decided to challenge the Sun. He flew too high and the Sun melted the wax that kept his wings together. Icarus fell in the Aegean and died. The island *Icaria* is named after him.

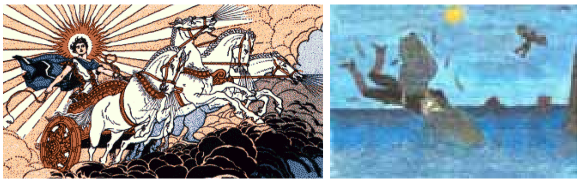
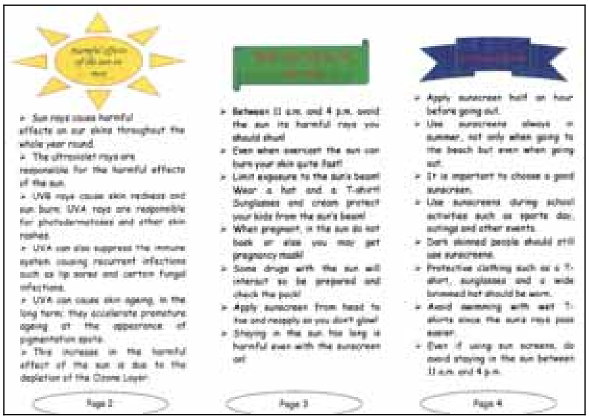


Figure 1: Pictorial representations of the tales of *Phaeton* & *Dedalus and Icarus*

Both of these tales, alongside with other local myths and stories related with the Sun have been discussed and rewritten with children in class. In some cases, they have even "come into being" through dramatization.

Furthermore, the legendary story of *Archimedes'* (287-211 BC) *"burning mirrors"* against Marcellus ships, perhaps the first known application of solar energy, has been thoroughly examined by the pupils of *Scuola Secondaria di 1° Grado C.B. Cavour,* since Catania is just a short distance away from Syracuse, in Sicily, where the legend is said to have taken place. As *John Tzetes* (circa 12th century AD) contends *"when Marcellus withdrew them [his ships] a bow-shot, the old man [Archimedes] constructed a kind of hexagonal mirror, and at an interval proportionate to the size of the mirror he set similar small mirrors with four edges, moved by links and by a form of hinge, and made it the centre of the sun's beams - its noon-tide beam, whether in summer or in mid-winter. Afterwards, when the beams were reflected in the mirror, a fearful kindling of fire was raised in the ships, and at the distance of a bow-shot he turned them into ashes. In this way did the old man prevail over Marcellus with his weapons"*, [*Greek Mthematical Works* (1941), Ivor Thomas (tr.), Loeb Classical Library, Cambridge: Harvard University Press, Vol. II, p. 19].

Figure 2: A wall painting representing Archimedes' "burning mirrors", painted by *Giulio Parigi* (1571-1635)



Figures 3 & 4: A leaflet explaining how … "too much Sun will spoil your fun" *(Stella Maris College, MT)*

Text production in the forms of creative writing (personal letter writing) and persuasive writing e.g. newspaper articles and leaflets have been developed in schools and especially by language teachers like the colleague *Claudia Caruana Anastasi* from the *Stella*

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Maris College in Malta. One example of a leaflet dealing with the harmful aspects of solar radiation to peoples' health is presented below (see Fig. 3 & 4).

Another interesting language activity from the same colleague has been the revelation and etymology of "Sun related words", under an educative scenario that went on like this: *"just to prove once again how influential the Sun has been to mankind we looked up some things that had the word "Sun" in their names"* (such as: sunshine, sunrise, sunset, Sunday etc.).

Story writing and poetry have been two more text production techniques used by colleagues in *Scuola Secondaria di 1° Grado C.B. Cavour* in Italy (*Ketty Bufardeci, Antonella Piccin, Andrea Pantellaro* and collaborating teachers). What follows is a poem about the Sun, written by *Irene Napoli* from 1° G class of this school, together with a nice drawing.

Il sole nasce al mattino
Illumina i fiori del giardino,
Colora tutte le cose
Risveglia tutte le rose,
La sera va a nanna e si addormenta
Tutti gli uccelli giocano con le foglie di menta.

Figure 5: The original text of the poem embedded in the pupil's drawing *(Scuola Secondaria di 1° Grado C.B. Cavour, IT)*

2.2. Science and environmental education related project activities

All partner schools have set up experiments and investigations on *solar thermal energy and active solar systems*, such as: a) solar water heating in various aluminium containers and/or plastic bags, b) observe the melting of ice cubes on carton papers of various colours, c) construct a small model of a solar water heater out of a plastic soda bottle to be used as a tank and a small black box collector with a rubber tube etc. In order to understand how solar heaters work, the *"thermosiphon effect"* has been discussed and analysed. Later, pupils did some project work on solar water heaters by constructing a serpentine solar water heater and/or a spiral solar water heater to be presented in a final science fair.

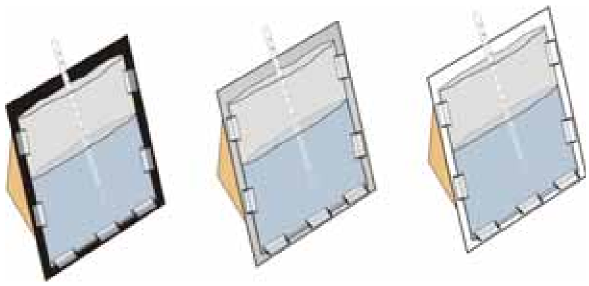

Figure 6: An experiment with a "simple solar collector" made out of a plastic bag filled with water, affixed on cartons of various colours, e.g. black, white, aluminium covered etc. *(9th Primary School of Rethymno, Crete, EL)*

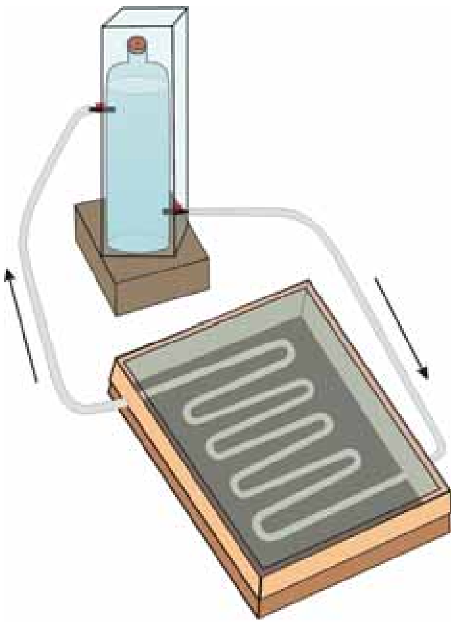

Figure 7: A drawing of a simple solar water heater out of a plastic bottle and a collector with a serpentine tube arrangement *(9th Primary School of Rethymno, Crete, EL)*

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All participating schools have also set up experiments and investigations on *solar thermal energy* and *passive solar systems*, such as: a) make greenhouse models out of boxes with plastic glazing, b) experiments with "hot boxes", c) a simple pizza box solar cooker etc. In order to understand how solar cookers work, the *"greenhouse effect"* has been discussed and analysed. After that the pupils undertook project work and constructed *box solar cookers* with or without a top lid and a simple *solar dehydrator* out of a box in order to experiment with the drying of herbs, fruits and vegetables, which could also be presented at science fair activities. The pupils and teachers have been encouraged to record measurements and exchange data and information with their pen pals at all times.

Photos 2 and 3: The preparation and construction of a serpentine solar water heater *(Scuola Secondaria di 1° Grado C.B. Cavour, IT)*

This has not been achieved, in terms of the exchange, but several experimental recordings have been made by pupils at partner schools involving data representations in tables and charts. In this sense, mathematics have also been involved in the experimental processes, providing some quantitative or semi-quantitative approaches to a more general qualitative observation and interpretation of phenomena under study, within the framework of hands-on science activities.

Photo 4: Pupils experimenting with hot boxes and the construction of solar box cookers *(Scuola Secondaria di 1° Grado C.B. Cavour, IT)*

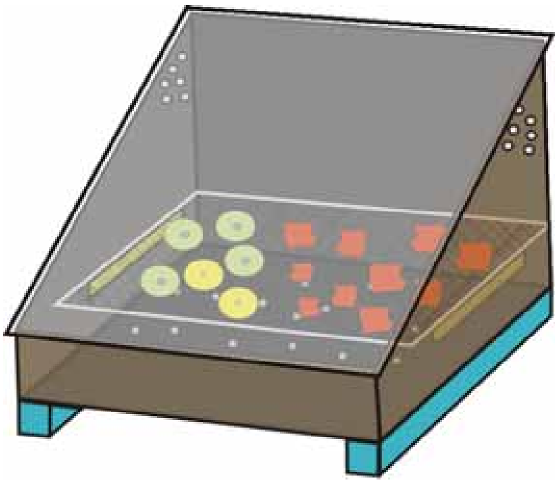

Figure 8: A drawing of a "solar dehydrator" (Sun dryer) out of a cardboard box, for drying out fruits and vegetables *(9th Primary School of Rethymno, Crete, EL)*

The Italian colleagues and pupils of the *Scuola Secondaria di 1° Grado C.B. Cavour,* worked on the construction of a *"greenhouse-tunnel"*, where they grew seeds and plants. Through guide cards they analysed the different families of angiosperms, in order to

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select the most suitable to be grown in a greenhouse like monocotyledons and plants belonging to the family of *gramineae*. After the theoretical stage a group of students assembled the parts of the greenhouse made up by metal poles that we had fixed together.

Photo 5: Two models of solar dehydrators and a box solar cooker presented at a primary science projects contest organized by Elinogermaniki Agogi in Athens *(9th Primary School of Rethymno, Crete, EL,* a distinction received*)*

The work was divided to different groups: The first had to cover the structure with plastic film. After that they began to plant narcissus and tulip bulbs, having prepared the ground adding a little of mould in order to make it softer. Other groups spread the seeds of broad beans and peas at a side of the greenhouse. They used some farm tools such as rakes, small and big hoes for digging holes, not very deep and 10 cm far one another. They often visited the garden and the greenhouse to take care and water the plants with a pump or with a pail. This greenhouse project is to be continued next year.

Moreover, the Spanish colleagues and pupils of the *Colexio de Educación Infantil e Primaria Froebel* have worked on the growing of plants and conducted experiments in their garden (*Teresa Couto, Manuel Carpintero Vázquez, Ana Lorenzo Bello* and collaborating teachers). They have looked at plants as self feeding organisms and they have discussed the process of photosynthesis and the role of solar energy in the growth of plants etc. After all, it was *Friedrich Froebel* (1782-1852) who contended that *"the garden is a place to learn the consequences of one's actions in a very direct way."*

The colleague *John Lahnidakis* from the *9th Primary School of Rethymno, Crete* has worked on sundials with pupils from the 6th grade of the school. They discussed how sundials work revisiting the Sun-Earth systems of motion (orbit and spin) and they created basic horizontal sundials out of simple materials like plywood and cardboard, which they oriented and calibrated out in the school yard.

Photos 6 and 7: Pupils building the "greenhouse-tunnel" and planting the plants inside *(Scuola Secondaria di 1° Grado C.B. Cavour, IT)*

All school partners have also dealt with a third set *solar energy experiments* using *photovoltaic cells* such as: a) measure the rounds per minute of a circular piece of carton with a dot drawn on it, which is attached to the shaft of a motor operating with electrical energy coming from a solar cell, studying its performance under different conditions b) experiment with the performance of motors after orienting the solar cells at different angles towards the Sun, c) use transparent and non transparent materials on top of the solar cells

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and study their behaviour with motors etc. Pupils have undertaken project work in constructing solar toys with photovoltaic cells and motors (e.g. toy cars and/or boats).

Photos 8 and 9: Young pupils growing plants in raised wooden containers and in pots *(Colexio de Educación Infantil e Primaria Froebel, ES)*

All schools worked on the solar energy projects and prepared the set up of science fairs, which have also been incorporated in the final events of the school year. Pupils and teachers have exchanged ideas and information amongst the partner countries and the coordinating school has provided advice and hints for the development of solar energy projects and constructions, eventually presented in science fair activities.

Photos 10 and 11: Pupils of the 6th grade constructing and testing their sundials *(9th Primary School of Rethymno, Crete, EL)*

Photo 12: A "big toy car" with a PV cell and a battery, which can carry a child *(Escola André Soares, Braga, PT* with *Maria da Graça Martins Pereira de Moura, Esperança Fernandes, Avelino Garrido* and collaborating teachers*)*

Photo 13: Explaining to science fair visitors how a solar water heater works *(Stella Maris College, MT)*

Photos 14 and 15: Two science fair exhibits, a solar boat (left) & a solar carousel (right) *(Stella Maris College, MT* with *Ivan Misfud Bons* & collaborating teachers*)*

2.3. Crafts, music and theatre related project activities

Some groups of pupils have worked to present other project related activities such as: theatrical plays, songs, craft work and happenings as well as paintings.

The colleague *Dafni Tsombanidou* from the *9th Primary School of Rethymno* has worked with children of the 3rd grade on a theatrical play *"The Sun-dropped lady"*, which has given several performances receiving a warm welcome and the compliments of the spectators. In its story, the Sun helps a good woman, who cannot have children, by giving her a child, the Sun-dropped lady. But, the Sun makes an agreement with the woman that she is to bring the child back to him when she becomes 12 years old. The mother takes care of the Sun-dropped lady, but when she reached the age of 12, the mother no longer wanted to keep the agreement. Then the Sun finds a way to take her to his palace, where the child has a nice and rich life, but feeling nostalgic, she wants to go back to her mother. She finally convinces the Sun to let her go back to her mother and they lived happily thereafter.

Photo 16: Pupils of the 3rd grade with their teacher on stage after the final performance of "Sun-dropped lady" *(9th Primary School of Rethymno, Crete, EL)*

Photo 17: Primary school children performing a Sun related story *(Colexio de Educación Infantil e Primaria Froebel, ES)*

Drama and role playing has been used in many cases amongst teachers and pupils in order to introduce and highlight aspects of solar energy and its applications. Even shadow theatre, for instance the Greek *Karagiozis*, has been used to play with light and its effects.

Pupils have sung and danced several songs like the "I'm walking on sunshine" and the "Here comes the Sun" by the Beatles. But, they have also created their own songs like the one from *Stella Maris College* in Malta, the *"Thank* *you Brother Sun"* song (Music: *Alfred Camilleri* & Lyrics: *Frank O'Neill*).

Come on let's use our energy.
To work as one in harmony.
We can do wonders, and have fun.
Just look above and watch the sky.
Fill with a glow that blinds the eye.
Move clouds away, here comes the sun.

Shining bright - what a sight.
Wonderful, powerful, beautiful
Dazzling light, radiant white
Energy, all for free –Powerhouse.

Bring in the sunshine (x2)
Bring in the light (x2)
One giant battery (x2)
Super energy.

Thank you, brother sun
(God Bless you)
You're my number one
(God bless you)
Shine on in the sky forever more (x2)

Figure 9: The *"Thank you brother Sun"* song *(Stella Maris College, MT)*

Pupils have worked with simple, common materials and have constructed several pieces of craftwork and paintings. They have been constructed either individually and/or collectively, sometimes accompanied with depicted texts like stories or even speech balloons and comics.

Photos 18 and 19: Collective craftwork by young children (18) and by primary pupils combined with story telling (19) *(Colexio de Educación Infantil e Primaria Froebel, ES)*

Several pupils have also prepared power point presentations to share their work with other fellow pupils and teachers. Those presentations deal with a variety of topics related to solar energy, alternative forms of energy, energy crisis, sustainable development etc. They are to be uploaded on the project web site soon (cf. URL: < http://9dim-rethymn.reth.sch.gr/contents_en/downloads.htm >).

3. Concluding remarks

A variety of solar energy activities, solar applications and constructions, which took place during the first year of the SEAA Comenius 1 project, have been presented and documented. It appears that there has been a thematic and rather holistic approach, not only restricting itself to a conceptual and practical level (cf. CAT, 1999; GSP, 2000), but also posing emphasis on social and cultural perspectives related to the issues tackled, at least for the majority of the activities (cf. Madanjeet & UNESCO, 1998).

During the two project meetings, we discussed the possibility for the establishment of an "e-twinning network" (cf. URL:< http://www.etwinning.net/ww/en/pub/etwinning/index2005.htm >) amongst school partners, in order to use the services and the *"TwinSpace"* for communication and exchange of project information. This seems to be an interesting idea under elaboration for the following project year.

Finally, we would like to thank all pupils and teachers of the collaborating schools, who have done such a wonderful work on the first year of the project, which credits a valuable asset for the future.

Photo 20: Pupils with logo T-shirts and an SEAA poster *(Scuola Secondaria di 1° Grado C.B. Cavour, IT)*

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Renewable Energies. Solutions for Our Future

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Abstract. The United Nations declared the decade 2005-2014 the decade of "Education for a sustainable development" stressing the importance and impact education may and should have on the future development of our world. The sensible and rational use of energy and the generalization of the use of renewable energies are fundamental to an effectively sustainable development. A good knowledge of the basic issues of energy production conversion and use including its ecological impact should be achieved by your students beginning its study as earlier as possible in their school progression.

Keywords. Energy, Ecology, Sustainable development.

From a Planetary Emergency to the Construction of a Sustainable Future

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Abstract. We present this exhibition in order to disseminate and support the Decade of Education for a Sustainable Future (see web http://www.oei.es/decada/), established by United Nations for the period 2005-2014 as another urgent call to educators of all levels and areas.

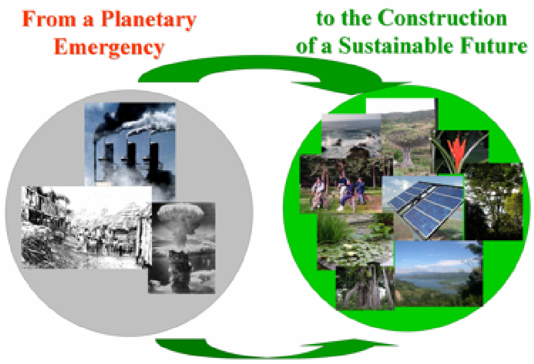

Figure 1

We are currently in a situation of planetary emergency (World Commission on Environment and Development, 1987; Bybee, 1991), marked by an array of very serious problems that are closely related and demand global treatment and citizen awareness and understanding of the state of the world in order to participate in well-founded decision-making.

The exhibition aims to promote a holistic study of the problems humanity has to face nowadays: pollution and depletion of natural resources, climatic change and environmental degradation, unsustainable demographic growth, extreme inequalities among different human groups, destructive conflicts and loss of biological and cultural diversity... (Worldwatch Institute, 1984-2006).

Moreover, the exhibition looks to enhance our view of individual and collective behaviors that are responsible for this situation of planetary emergency and, above all, about what each of us may do, together with others, to face this situation while we still have time (Mayor Zaragoza, 2000; Gil Pérez et al., 2003).

Figure 2

Keywords. Planetary emergency, Sustainability, Education for a sustainable future.

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"Geology in Action". An Education for Sustainability Project

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Abstract. Sustainability is a challenge that can only be achivied if education is involved. An Education for Sustainability project developed in a geological theme is presented in this work.

Keywords. Action oriented Project, Cabreira Mountain, Education for Sustainability, Geological Heritage.

1. Introduction

The concept of sustainability involves accepting and appreciating today the roll that each one of us has, in the definition of our future. It´s essencial to create space and tools for this personal reflexion [1]. This ideia locks up a great challenge because sustainability means different things to different people and to society sectors. Education for Sustainability (EfS) offers the "skills and thought processes" necessary to react to this challenge and, so school has a primordial role, in the sense that it can create the necessary conditions to encourage the active participation and the responsable decision taking, of the future citizens in the construction of a sustainable future [1]. How to handle uncertainty and controversial issues must be key elements in any kind of education wich aims to contribute to the capacity building of people towards sustainable development [2]. In this sense, EfS projects should have action competence (that is ability to get involved, to investigate, to reflect critically, to make decisions and to act accordingly, socialy and individualy) as an education ideal and should involve the target-groups as active agents [2]. In fact, action competence is both political and democratic education and so an important competence needed for a civic society. The sequence EfS →action competence→reflective, active citizens→sustainable development resumes the role EfS should have [2].

A EfS project developed within this action oriented methology, that is action developed in real context, is presented in this paper.

2. Project "Geology in Action"

Biology & Geology is a subject of science courses, in portuguese secondary curricula, that includes a unit called "Geology, geologists and their methods". To study this theme the teachers involved decided to use Cabreira Mountain as *study object*. From this moment

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on, all the actions and activities developed result from commom decisions between teachers and pupils (so, through this article, the word *us* means exactly teachers and students). In fact, actions plans were made in classroom to guide the project.

2.1. Activities

2.1.1 Research works on Cabreira Mountain geology

In the scope of the drawn action plan, students identified the need to research about Cabreira Montain geology, as a starting point. So, research works were done by groups of students and, later on, presented in classroom.

2.1.2 Field trip "Cabreira Mountain, a geomonument to visit?"

A field trip was the obvious next activity needed to comment/see *in situ* the geological aspects identified in the research work. So the stops (places to visit) were selected among teachers and pupils once more. A field trip notebook was made by teachers to support not only student's field work but also to help them in the report they had to make later.

2.1.3 Congress "Young Geoscientists, actors in the sustainability of a changing planet"

The congress was organized by Coimbra University and was focused on basic and secondary students and intended, between others things, to stimulate student's behaviours towards Earth Sustainability.

Figure 1. Students in "Young Geoscientists, actors in the sustainability of a changing planet" congress

The investigation developed by students made them realize that, on one hand, there is an important geological heritage in Cabreira Mountain, near by its tallest point, and, on the other hand, that this heritage is at risk and needs protection. Therefore, through this project, sustainability aspects began to be considered and the fact that the main cause of the geological damage has been made by the implementation of a aeolian park contributes to accentuate the discussion around the different aspects needed to take into account for sustainability.

The participation on this congress seeamed us to be a good way to promote and value the geological heritage of Cabreira Mountain. Nine students participated (Fig. 1) with two articles and presented in Coimbra two posters.

2.1.4 Interactive Exposition "Science in motion"

This is an anual exposition in our school and involves, not only Geology and Biology, but also Chemistry, Physics and Mathematics. This iniciative is opened to all school community but the primary schools are the main visitors (around 800 students). All the experiments are actively explained by secondary science students to the little ones (Fig.2). In Geology, students explain the visitors, aspects of Cabreira Mountain geodiversity, through slide exposition (with the photographs they had taken during the field trips), rock and geology maps observation.

Figure 2. Interactive Exposition "Science in motion"

2.1.5 Field Trip "Cabreira Mountain Geology – How to promote?"

The need to promote and preserve Cabreira Mountain Geological Heritage, naturally rose during this project and a new question emerged, "What can we do?". Several possibilities were identified and after a discussion the activities selected were ordered by there feasibility in the present. In any of the cases, a new field trip (Fig. 3) was essential to collect new information, mainly visual (photography and vídeo).

Figure 3. Students working in a field trip on Cabreira Mountain

2.1.6 Field Trip Guide Book

The ideia of making a field trip guide book appeared in the first action plan made. Each group was responsible for a stop, and after a class discussion, the work began. A decision was taken, that this guide book should focus only on the area where an important geological heritage was identified. The final draft was made and called "Glacial and Periglacial marks in Cabreira Mountain: an heritage to preserve".

2.1.7 Postcard collection "Visions of Cabreira"

This activity involved a partnership with Vieira do Minho City Hall that agreed to publish this postcard collection and commercialize it in the Tourism Office. After the field trip, began, in classroom, the process of selecting photos and, after the format of the postcard was decided, it was also necessary to name each one of the twenty postcards made (Fig. 4). A little guide book was also made where geological aspects of each postcard were described.

Figure 4. One of the postcards of "Visions of Cabreira" postcards collection

2.2. Whats's next?

Some activities are already planned to develop next year: an geological exchange between national and international schools to exchange photos, rock samples and field trips, a short movie promoting and valuing Cabreira Mountain Geological Heritage and finally a web page to promote and divulge work done in our school.

An important activity is being prepared for the end of September, when students will work as monitors in geology field trips to Cabreira Mountain for the general public. This activity is included in a program named "Geology in Summer" promoted by a National Agency for Tecnological and Cientific Culture, called Ciência Viva (Live Science).

The next step is to protect the Geological Heritage of Cabreira Mountain. Can we do something? If so, that will be our next task.

3. Final considerations

This project meets the principle "Think globally, act locally". It shows that is possible to work towards on sustainability in an action oriented way and within secondary curricula and subject´s programs. Such action competence is difficult to develop and consequently it's development can be difficult to measure but the student's envolvement on this project shows that we might be in the right way.

This project received an award for its participation on the competition «Science at School Prize» promoted by a national entity, the Ilídio Pinho Foundation.

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Science Education for Sustainable Development: A Concrete Experience in the Secondary School of Vieira do Minho

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Abstract. Teaching science is something truly stimulating. It can not be said that a perfect method exists, but teaching practices show us that the existence of concrete situations allow students to learn new concepts with greater ease. Most students learn easily through the teaching of actual experiences. This project is intended on teaching students to learn science while simultaneously awakening them up to the principals of sustainable development. In the context of the program of the various disciplines that make up the basic curriculum the use of a global and general theme will allow for the integration of the various areas of knowledge and contribute for a better learning.

Keywords. Sustainable development, Science Education, School, Hands-on experiments.

1. Introduction

When referring to Sustainable Development the first idea that normally occurs is that society's progress should be accompanied by the preservation of Nature. The concept is vaster and presumes that progress is capable of generating wealth and contributing to the improvement of the quality of life in the society as a whole. "Development" cannot only be equivalent to "economic growth", it should definitely also include other perspectives such as social well-being, environmental quality, cultural identity, as well as other. Included in this development is the fight against poverty and social inequalities, without putting at risk the quality of the atmosphere or causing the exhaustion of natural resources, and in a way assuring a good atmosphere for future the generations. Only with well educated citizens with a good level of scientific literacy will we be able to reach this objective.

Students begin to value and learn more about their region (Vieira do Minho) through the various disciplines that make up the national school curriculum, as well as through activities. They learn to understand the need to consolidate the development of the region with its preservation. Teaching students to learn Science and simultaneously awakening them to the principles of Sustainable Development is the great challenge.

Aware of the importance of the Sustainable Development UN approved resolution 57/254 in 2002 that consecrates the decade of 2005-2014 as the "Decade of the Education for Sustainable Development", with UNESCO as the main agency responsible for its promotion.

Vieira of Minho's high school's 7^{th} – 9^{th} grades are giving great importance to educating their students in the principles of Sustainable Development. The Science Department is developing this project and programming several activities in order to cultivate the philosophy of Sustainable Development in students. This work began in the middle of the last school year and various activities have already taken place. Simultaneously with this project the School adhered to Hands-on Science network, a group of institutions that promote new ways of teaching Science.

The seven hundred students that go to this School are divided into six grades, from 7th to 12th. The faculty is made up of eighty five teachers, most of which have permanent contracts with the School. Many successful projects have been developed in the past years, in order to well equip the laboratories with the essential equipment needed to teach science. An annual science fair takes place that has had repeated success, with the participation of many students, some of which come from the School, but most come primary schools of the

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district, these are given special treatment due to a reduce amount of resources for experiments.

One of the main concerns of the School's administration is the fight on failures and abandoning school all together. In this sense, measures have been taken that seek the promotion and valuing of all the knowledge acquired by the students and the introduction of diverse methods of evaluation, mainly in primary schools.

The Town of Vieira of Minho is located in a mountain region, at the foot of the Mount Cabreira and a few kilometers away from Peneda of Gerês Natural Park. The whole area has vast natural and heritage resources, where the use alternative energy, hydraulic and eolic, is one of their main wealth. The people live on agriculture, from small businesses, services, tourism and from some industry in the region. In general, there is little access to the culture and there is a high level of illiteracy. As collateral objectives this project is also intended on promoting the levels of the student literacy and consequently of the society where they live, increasing this way the rural population's access to culture [2]. The United Nations entitled the decade 2003-2012, The Decade of Literacy.

2. The Project's Presentation to the students

Figure 1. Demonstration of how photovoltaic solar panels work

November 24th 2005 (National Day for Scientific Culture) was chosen for the presentation of the project ″ Learning science towards a sustainable development″. This day will also be celebrated annually at the school as the day for Sustainable Development.

During the third and fourth week of November of 2005 a couple of initiatives took place at the School that involved the whole community and that were related to this theme. The activities at the School are part of the Science and of the Technology Week promoted by the National Agency for Scientific and Technological Culture, Live Science.

On November 24th a demonstration of how photovoltaic solar panels work was held at the school, with the objective of showing that it is possible to produce energy from solar light. The groups from the 7th – 9th grades (debated the subject of the sustainable development in one of their Civics class.

3. Participation in the Socrates/Comenius Project

This project is intended to be implemented in other schools in Portugal and in other European countries, located in mountain regions, and that want to share with us their experience and knowledge. We plan to have an exchange program that allows for visits from groups of teachers and students that will be organized by the receiving school, in charge of preparing a complete itinerary for the visit. In order for this exchange to take place, in January of this year, the school formalized its candidacy to the Comenius 1 project and, in conjuntion with other five European schools, Poland, Lithuania, Germany, Greece and Turkey, will develop a project partnership among schools entitled "Living in Europe", where Sustainable development, culture and sports will be discussed.

The school is available for partnerships with national schools and contacts will be established in the future so that, at a national level, various schools may associate themselves to this project and making up a network of schools promoting sustainable development.

4. Project Activities

The activities foreseen cover various domains and in order to support the costs involved in the acquisition of resource material for the experimental activities, in December of

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2006 the school submitted its candidacy for the National Program Ciencia Viva VI.

Most students learn easily through the teaching of actual experiences [1]. In the Physics area work will involve the study of the several renewable sources of energy and the viability of their implementation in the region. These studies are intended to show that it is necessary to reduce dependence on fossil fuels and promote the use of “clean" energies. Aspects related to energy conservation and insulation of houses will also be discussed and tested. The township of Vieira do Minho welcome central electrical energy plants that obtain energy from renewable sources and how important it is for students to learn the value of these sources of energy and recognize their great importance of the country’s independence on energy. The students will build solar collectors and they will test their effectiveness [3].

The chemical analysis of the river waters or lakes and the identification of possible polluters are already being done by the students in partnership with Vieira of Minho’s Health Center, who supplied the water analyses for the consumption. The information was handled by the 11th graders, through research work and investigation, and they concluded that there is no great water pollution in the Ave and Cávado rivers in this area. Whenever necessary we request support from the University of Minho, from laboratories or of other institutions [3].

The students will study the pollution sources that mostly affect the environment. The practice of the compostation will be promoted as a method of producing excellent fertilizers. The 12th year students have already made a pile of compost. They will investigate the process of garbage collecting, treatment and recycling in the region. In the school the practice of selective garbage separation is already being implemented to be implemented and Braval (company that treats of the residues urban solids of this area) it has already been asked to install more ecopoints in the school [3].

The local studies of the animal and vegetable species that are at risk of extinction are already being discussed in Natural science and Biology classes. Field trips to rural areas are being held to identify species and respective habitats characteristic of the biodiversity of Mount Cabreira. A permanent exhibition panel will be built with pictures and the respective identification of species and habitat of Mount Cabreira. After this information is collected, students will be requested to do a bibliographical research study where they will have to identify which, of among the studied species, are at risk of extinction or on the road to extinction, as well as some possible causes for this situation. Through the requalification of the school’s green spaces, making pamphlets and itineraries for field research, the students were more involved and in touch with these problems [3].

Figure 2. Students working in a field trip on Cabreira Mountain

In the Geology field, students are doing geological studies of the region and identifying areas that may be of interest and that are at risk of being destroyed. They are then elaborating itineraries for field visits to Mount Cabreira. Some student groups also participated in the Congress “Young Geoscientists, actors with a role in the sustainability of a planet in change", that took place in Coimbra on March 30th- 31st. [3].

5. Science in motion

This year, just as it has been in previous years, an interactive display of science entitled "Science in Motion” took place from March 28th-30th. This display was put together by the enthusiastic students of the school, where the monitors that accompanied the visits to the Science laboratories, were the actual students. The school’s cultural week took place this year at the same time as this initiative.

6. Final considerations

With this project we also intend on using a general and global theme, to integrate several areas. It is important to have exchange visits among the participants, involving teachers and students, to develop a feeling of European citizenship and increase the level of the students' scientific literacy and consequently of the society that they belong to. The entire school is involved in this project, because these ideas of consolidating the economic and social development of a region with the preservation of the environment have to be adopted by all. At the end of this project we can conclude that many of the subjects that affect our future should be taught in school. Only a solid scientific knowledge will change attitudes. The region will benefit from a stronger environmental and heritage protection. The participation of various schools, from several European countries, will give a European dimension to the project.

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The Physical Discovery of the Environment

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Abstract. *It is indispensable to stimulate students to* discover, early, the Physics beauty and their practical applications through creative craft work. The physical discovery of the environment, central theme of this work, tries to associate the science to phenomena of the day by day, as well as, to allure the young for the scientific investigation, stimulating creativity and group work. Regarding this, it was intended to build simple prototypes, using low cost materials. These simple experience are destined to help students to learn and reflect that Physics is part of our everyday life.

With this teaching mode, project-based learning, the teacher is not the holder of knowledge, but a resource and stimulator. The intention is to promote cooperation among students. Specific situations are studied with the objective of prepare and motivate students to critically examine other environmental problems.

The evaluation of the impact of this type of teaching was made through the analysis of non - parametric statistical, based on the construction of categories of answers of pre and post-tests, and students opinions .This evaluation, allowed to conclude that of this curriculum resulted more effective learning and greater development of competences of students.

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Keywords. Sustainable development, Science Education.

Experiences for the II European Youth Ecoparliament Project

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Abstract. The Youth Ecoparliament is an educational innovation project integrating around 100 groups of students aged 14-16.The aim is to appeal to influential people in society through the medium of “open letters for the environment” written collaboratively and based

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on observations made during the course of working on local environmental projects.

Several experimental and research activities were designed and developed during the school year and different meetings have taken place involving students and teachers from participating schools. As a conclusion, a list of proposals included in open letters have been addressed to influential representatives of industries, researchers, public authorities, journalists and NGOs.

Keywords. Environment, European Project, Open Letter, Secondary Education.

1. Introduction

From the origin of the development of the first human societies, the harmony between man and nature has become a basic need to keep in mind and take into account in all artificial activities.

Nevertheless, the aspiration of comfort and a quick and sometimes an uncontrolled growth and development of our economical system in different fields such as agriculture, mining, materials production and transformation, power generation, etc, has give as a result a broad damage of our natural environment.

After some time (years, decades, even a century…) our society realized that this way was not completely right in the direction to achieve a good quality of life.

Then, the concept of sustainable development has emerged as a principle to follow in all the economical and social activities for the future.

School is a suitable scene to develop activities and encourage attitudes in this direction. In this way, a multinational group of secondary school pupils, aged 14-16, from different schools in Europe, Turkey and Canada, conscious that the future is in their hands, they have been developing, during the last months, some school and outdoor activities to promote positive attitudes on the protection of the environment

The Youth Eco-Parliament programme is an international educative project that involves about 100 schools from the above mentioned countries. The aim of this big plan is to raise awareness of sustainable development.

In this paper we describe the organization and activities related to this project focusing more deeply in the Spanish teams and activities developed.

2. Planning and developing the project

Aims

The main objectives of the Youth Eco-Parliament are to encourage students to observe, analyze and find out solutions for local environmental problems, as well as to broad their thinking and feeling to a global level within the framework of planning and conferring with classmates and others in the international writing group.

Sustainable development education generates a highly constructive outlook and encourages individuals to get involved in the social and political life of their geographical region and the planet.

Moreover, the participation in this project gives the opportunity to the students to make contacts and share experiences, feelings and knowledge with other colleagues from different countries and cultures. This collaboration opens their minds to others ways of thinking and contributes to emphasize the concept of European citizenship.

Figure 1. General meeting of the 1st youth eco-parliament in Berlin 2004

Another important objective is to promote educational and outdoor activities that are especially attractive for teenagers and increases their interest towards the different matters such as natural sciences, technology and English.

The communications and information transfers between the different students, school, coordinators and national and international moderators result in a key role of the information and communication technologies in this project.

Background

Supported by the organization Pro Europe (Packaging recovering organization Europe) in partnership with Ecole et Nature (a network of organizations and individuals who work in the field of environmental education), the Youth Ecoparliament is an international educational platform.

In 2004 this project was launched, involving some 3000 European students that have elaborate a *European White Paper for the Environment* divided into five thematic units: energy, water, food, waste and air.

Figure 2. First edition of this project

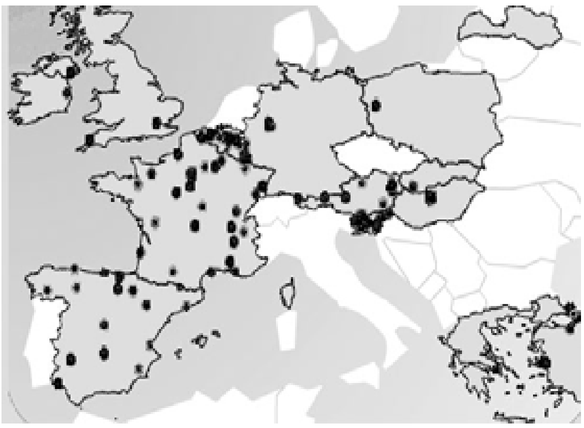

Figure 3: Location of the participating schools from Europe

This document, containing resolutions and proposals for action; was given to the President of the European Parliament Josep Borrell, the President of the Environmental Commission Karl Heinz and to the European Commissioner Stavros Dimas.

The second edition, in 2006 takes the form of Open Letter for the Environment, as a document based on assessments and observation and practices on local environmental issues and addressed to influent groups in our society.

Calendar

This project was launched in November, after the selection of the participating schools. Even there were some differences in the evolution of the different activities depending on the national moderators of each country, in the following table is shown the calendar of the different steps, from the formation of the groups until the international meeting.

Table 1: Calendar

1 December 2005	Website goes online
December 2005	Choosing the addressees
Mid-January 2006	Forming the writing groups
Jan-March 2006	Planning the contend of the letters
March 2006	Thematic meetings (Spain only)
May 2006	National meeting (only Spain)
April-June 2006	Drafting the open letters
October 2006	International meeting in Paris

The organization of work in Spain

Spanish students have demonstrated to be one of the most active groups in this scheme, as was shown regarding the web in the different developing stages.

Taking into account the administrative distribution of Spain in 17 autonomic communities, the first step was the selection of one school to represent each autonomic community. Then, and considering that the final addressees of the open letters were five socio-economical groups, the schools were integrated into five thematic groups (seven groups in all countries), regarding the geographic locations, in order to elaborate their open letter with common objectives: The addressees of the open letters were:

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- Producers, industries.
- Non-governmental organizations.
- Journalists.
- Researchers and scientists.
- Public authorities.
- Educators
- International institutions.

Figure 4. Small group discussions in the thematic meeting in Aranda de Duero

In order to coordinate and take charge of the different activities, tree main meetings have taken place between teachers and students from the 17 schools from Spain:

- One general meeting in Madrid involving the coordinators of each school, in November 2005.
- Five thematic meetings in different places of all the teachers and students involved in the project, during March 2006.
- One general meeting in Madrid with the coordinators and two student delegates representing the group of each center in may 2006.

In the first meeting, in November of 2005, the characteristics of the projects was presented to the representatives of each school and were established the main guidelines and procedures for the following stages.

Then, in the following months, from December to march, different activities have been carried out by the different groups of students and based of the study of some issues related with some local environmental questions. Each school has planned and developed the work independently and depending on their own resources and possibilities.

Figure 5: Visit to the Aboño electric power plant (Asturias, Spain), which produces electricity from national and imported coal

The different tasks carried out by the participants can be classified in different groups:

- An initial search of information using books, newspapers, webs, environmental reports of industries and public institutions.
- Visits to different sites of environmental interest, such as industries, laboratories, waste treatment plants, etc.
- Meetings and interviews with expert people such as technicians, politicians, journalists, researchers, active members of NGOs, etc.
- Design and realization of inquiries to people about their knowledge on different environmental issues, such as causes and consequences of pollution, waste treatment, package recovering, sustainable development, etc.
- Exhibitions and presentations of the works directed to the school community as well as participations in radio and television productions.

According with the possibilities and the more relevant environmental aspects in the area of each school, each group decided to focus their work in a particular approach. Thus, in the south and Mediterranean regions of Spain, as well as in Greece and Turkey the needs for drinkable water were specially considered. On the other hand, in industrial regions of Belgium and Germany there is more sensitivity regarding pollution emissions to the air and water from industries.

Figure 6: Students presenting the local project of Candás (Asturias) in the thematic meeting of Aranda de Duero

Some examples of topics covered by the participating schools are the following:

- Improving the quality of the environment
- Promote recycling materials.
- Obtain drinking water.
- Reduce pollution emissions.
- Preserve water resources.
- Ecological agriculture.
- Use renewable energies.
- Urbanization problems.
- Invasive foreign plants.

After that, during the month of March the five thematic meeting were held in different locations depending on the geographical distribution of the schools involved in each theme: Valencia, Zaragoza, Aranda de Duero (two meetings) and Seville.

In this meetings students, teachers and coordinators had the opportunity to know each other and make some presentations concerning the work done in the respective schools and the main conclusions obtained. From this meeting a concise list of resolutions, proposals and calls for action came into view summarizing all the outlooks made by the students and directed to the representatives of each category of influential people (producers, journalists, non-governmental organizations, researchers and public authorities).

These meetings have provided the opportunity to make some activities involving groups of students from different places, such as small and large group discussions about different environmental topics.

In each of these five thematic meetings the students and teachers were received by an important person representing the influential group to whom the open letters were addressed to. In most of the cases, this person and the represented institutions have invited the groups to make some visits to sites of special environmental significance, such as industries (focusing the visit on waste management, reduction of energy consumption and reduction of the packaging mass and volume). We can mention the visit to Leche Pascual in Aranda del Duero, to Canal Sur and Doñana National Park in Seville, the University of Valencia and the Foces del Duratón in Segovia.

Figure 7. General overview of the national meeting in Madrid on may 2006

In the third meeting, in Madrid, on May 8th, a teacher and two student delegates from each of the autonomic communities of Spain had meet and presented the main outlines of their work. Furthermore, they have been trained for the final gathering in October in Paris with the other students from the involved countries.

Resources and activities on line.

All the schools were included in a web site, in which each school had the opportunity to create their own presentation. Depending on the goal, each class have choose the tool they thought was the most useful for the message and content they wanted to communicate; then they have prepared the web assembling the material in the form of photos, images, films, texts… to facilitate the description of the work done and the results obtained in the different steps. The web was public, but the possibility to edit the different branches was restrained to

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the corresponding school by means of a login and a password.

Besides the different academic and outdoor activities, the chat and the forum, included in this web, were a powerful tool that have contributed to make communications more fluent and to facilitate the interchange of ideas and feelings and even informal relationships between students and teachers from different countries and regions.

Figure 8. The students representing the schools from Asturias, Galicia and Leon present their conclusions in Madrid

Nevertheless, some technical problems, such as the slowness of the process of edition and the different class timetables constitutes a negative aspect that makes this web not so suitable as was supposed to be at the beginning.

The use of the information and communication technologies helps the students to deal with contacts and links with colleagues from different schools geographically separated, and to know the activities and the results obtained by all the partners.

The participation in this project has also contributed to enhance the use of the new technologies at school and to make the students aware of the relevance of the computers and Internet in the different fields of our world.

Since the project involves international collaboration, the language used within the writing groups is English. In order to allow a good level of exchange an effective communication between students it was essential the collaboration of the teachers of English. Even considering the subject matters are more suitable to be supervised by teachers of natural sciences or technology, in some cases, the teacher of English has participate as a coordinator of the project in some schools.

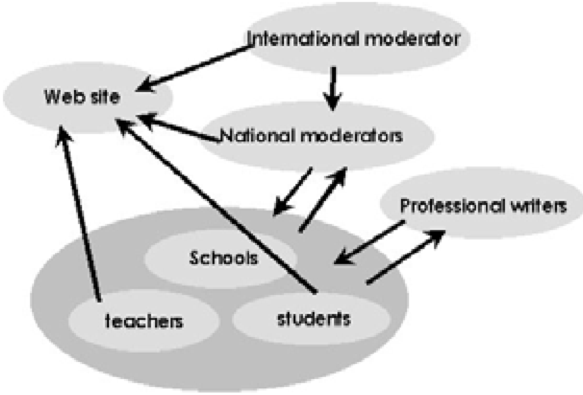

Figure 9. Scheme of the different agents involved in this project

Figure 10. Main page of the web of the project

By participating in the forums, students can exchange ideas and respond to questions posed by experts. They could start to make connections between their day to day actions and their local situation in respect to the environment and sustainable development. They could share their experiences with other European students.

The forum offers also some pedagogical advantages: allows students to enter into dialogue with others about environmental issues, promotes the use of Information Technology in an educational framework, contributes to build skills in constructing effective arguments and encourages social behavior as well as develops reading, writing and verbal skills.

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3. Collaborative writing

At the end of March and once all thematic meetings had finished, the process of collaborative writing has started.

The first step was a call for volunteers made by the international moderator to take part in the drafts and in the final version of the open letters. These documents were composed arranging the contributions made by the volunteer participants with the help of two professional writers. It should be mentioned that only sixteen schools were able to participate in this stage and five of them were from Spain.

During four weeks the volunteers have been working on the open letters: writing a fist draft, sending it to the writers and correcting the feedback received from them. Tree different parts compose the structure of the letter:

1. Position of the addressee and introduction of the project and the schools.
2. Showing the results of the assessments and the conclusions obtained after the different activities. Proposals
3. Calls for responsibility and calls for action.

The open letter is the final result of this project and will be handed to the representatives they are addressed to by a delegation of around 100 eco-parliamentarians in Paris in October 2006, during the Third Pro Europe Congress for professionals working in the field of recycling and the environment.

The goal of this document is to encourage the influential people to promote positive attitudes and to make good practices in their respective domains to preserve the environmental values.

4. Outcomes

After the data recompilation from different sources, as was above mentioned, and taking into account the results of the experiments, inquiries and other training activities, in the different meetings in each school and in the thematic meetings, a list of proposals has been elaborated summarizing the contributions of all the schools working in the open letter with the same addressee.

Although it is impossible to present in this paper a complete description of the seven open letters, a summary of some issues elaborated by the group of producers is shown in the following paragraphs:

- Follow the Kyoto Protocol
- Use more renewable energy
- Make energy audits to reduce their energy consumption
- Promote carpooling and public transit for their employees
- Developing public awareness and information campaigns for the public about sorting and environment care
- Invest on new technology to reduce pollution
- Reduce packaging to minimum size to envelop the product
- Take part to the collect and selective sorting of their products during international events
- Create logos on products to explain where the product should be recycled
- Let people visiting the recycling companies and producers in view to better understand how much product are produced and recycles
- Use only plastic easily recyclable to make plastic bottles
- Analyse garbage and identify where garbage can be re-utilized by other industries
- Conduct an annual or semi-annual environmental audit of the company and formulate an environmental action plan to follow
- Create an environmental office to ensure implementation of a plan

Similar proposals and calls for action have been elaborated by the other groups.

5. Evaluation

In this kind of activities evaluation cannot be understood as a synonym for scientific measurement. The feelings of those involved in the project can be taken into account as well. Evaluation should be carried out throughout the development of the project.

This project has been devised and achieved in line with the values and objectives of environmental education.

For the young people, participation is an opportunity to experience, in their group, a form of democracy, exercise their citizenship, and become open to the cultural differences that help individuals to understand the importance of diversity and to build their own lives in consideration of others.

Methodology is also an essential aspect of sustainable development education. The methods used in this project were field work, to bring people into direct confrontation with reality; group work, to build solidarity; creativity, to devise new ways of working together; cross-disciplinary work, for a comprehensive approach; and debate, to prepare people for real-life democracy.

By working in this project, students benefited from two important types of learning:

- Understanding the methodology of managing and running projects
- Learning not only concepts and facts, but also skills and social behaviors, through the process of learning by doing.

The improvement of the use of communications technologies and the development of English language skills are also two important aspects achieved along this project.

Moreover, the participation in this activity has been a powerful stimulus and incentive for students and also for teachers in their diary job.

6. Acknowledgements

The author of this paper wants to acknowledge the effort and enthusiasm of the students of class of 3º A of the IES de Candás during the school year 2005-06 and also to Amelia Lopez (Ideactiva), Nieves Rey (Ecoembes) and Veronique Lapostolle (École et Nature) for the brilliant task of management and support during all the stages of this project.

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Promoting Ecological Education among Students

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Abstract. Regarding the new values and stand points that the new curriculum has for students, and the awareness that each program wants to form, we want to put in action some applications through which the students could use their knowledge of science and mental capabilities in order to take decisions to solve general problems. The main objectives that we wanted to achieve with the students are:

1. developing team work spirit (valuating your own work and the work of others)
2. taking note of the repercussions of human activities for the environment and the effort to defend, maintain and improve it as a critical element in our lives
3. using the knowledge in physics, chemistry, biology and informatics in order to apply solutions to problems regarding the environment.
4. Promoting the idea that the recycling process in its different phases has a small negative impact to the environment.

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5. Recycling and reusing different types of materials, used in elaborated products, characterized by singularity and creativity.

In our days we are starting to be more and more preoccupied in solving environmental problems. Starting with the participation in the program of recycling paper waste, initiated by the city the Prefecture of the city of Bucharest in collaboration with the School Inspectorate of the city of Bucharest, and continuing with the "Eco-park" and "Schools spring" programs organized by the city Hall of sector 2, the Public Domain Administration and the School Inspectorate of sector 2, the collaboration with S.C. ECOROM S.A. Through these activities we are trying to change the behavior of students, teachers and parents towards the problems raised by waste deposits. Our activities take place on two fronts:

- Finding new and ingenious solutions in order to protect the environment and save energy resources.
- Promoting ecologic activities among students.

The teams that participate in the project of finding the most ingenious utilization of recyclable materials and promoting the idea of recycling are:

- "9G-nii ecologiste' (9 ecological G-niuses)(students from classes IX A,D,E,F,G)
- "11 As and Fs" (students from classes XI A and F)
- "prochimistii" (students from classes X E and XII D)
- Coordinated by teachers: principal Nedelea Elena, Gheorghiu Rodica (chemistry) si Dumitrescu Mihaela, Mantea Doina (physics).

We are now presenting these two projects:

1. A project regarding paper recycling.
2. Ways of promoting ecological education among students.

"An elf story". Environmental Education on Elementary School

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Abstract. It's our belief that children should be made aware of the environmental problems, primarily on a local perspective: the sooner we start, the better and faster will be the results. The development of the ecological conscience on children is absent from several elementary school textbooks, edited to be a specific support to teachers. So, we developed a new approach to evaluate the environmental education on elementary school. We defined three indicators: environment skills, environment concerns and global knowledge. Ecology and Biology issues supported the first and second indicators and quantitative evaluation was proposed based on defined parameters. Global knowledge articulates the environmental education with essential skills determined by the National Curriculum on Elementary School and the goals defined in the Annual Activities Program by the school. We propose a qualitative evaluation based on the abilities of knowledge mobilization, performance and personal engagement. Each indicator grouped same strategies, composed by twenty-six activities related to the protection of fauna and flora, learning how important is to Reduce, Reuse and Recycle, discovering and writing about interesting things in Nature, learning more about animal habitats, celebrating special nature days, and so on.

A pioneer project was implemented on a private school group pf seven years old children, through nine months, during school time and always attending all areas of knowledge. On diagnosis, only 49 percent of the children demonstrated environment concerns; however, seventy-eight percent of the children developed environment skills and 83 percent revealed environment concerns at the end of the project. We can clearly say that children have a natural curiosity and interest about these matters. Environment knowledge was evaluated as very good. Children seemed

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motivated, interested and active during the development of the project and revealed to be prepared to be more responsible and active citizens.

Keywords. Environmental education, Elementary school.

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SUPERCOMET2: Superconductivity to Motivate Students to Learn Electromagnetism

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Abstract. Superconductivity is used in the SUPERCOMET European project as a topic to motivate the interest about magnetism, current, electromagnetic induction. SUPERCOMET has been designed as a computer application combining graphics, animations, text and navigation to make selected parts of the physics curriculum in upper secondary school more interesting and accessible. A teachers guide is also available that is intended to outline the pedagogical rationale for using SUPERCOMET and suggest effective ways of using it in the classroom, as part of everyday teaching, in stand-alone mode and in combination with practical demonstrations, and other Information and Communications Technologies. In this communication we will show shortly the contents of the application, some conclusions of our participation within a “Student Fair” and the results of the teacher’s seminar.

Keywords. Superconductivity, Learning with computers, Physics.

The Xplora Portal – A Gateway to Science Education

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Abstract. This paper presents the content and the services offered by the Xplora portal (www.xplora.org), the new European gateway for science education, launched in 2005, within the European Science Education Initiative". The portal, aimed at teachers and pupils, intends to propose an innovative use of ICT in science education balancing information services with communication, networking and exploration activities.

The crisis in following scientific careers and the lack of scientists in the European context is quite recognized. In this context, the use of ICT could ensure some improvements, offering to pupils and teachers tools for more active learning science while giving them networking and cooperation potential to communicate with peers and scientists.

The services offered on the Xplora portal can be categorized in:

-information content: news, information about events and seminars, lessons and laboratory activities, presentation about open source software;

-communication services: “online discussions with experts” on several science topics;

-exploration services: registered users, may participate to the “community” activities of the portal.

Teachers and students can also take part to web experiments, database and collaborative projects. Within the Xplora initiative an Xplora Knoppix DVD, containing software applications focused on science education, as well as a number of educational materials from the Xplora repository, has been developed and distributed to teachers for free.

The experience of the Xplora portal indicates that an interactive approach in using ICT in science education may facilitate pupils and teachers involvement in the learning process.

Keywords. ICT, Science education, Web portal, Schools and ICT, Learning model.

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The "*UNIQUE AND UNIVERSAL*" Project Exploring and Sharing our Ecosystems through Scientific Processes

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Abstract: The Unique and Universal Project targets students aged ten to fourteen and helps them understand the relationships in nature by studying the impact of human activities on the environment, through the use of scientific processes. Students in three schools, one in Turkey, one in Romania and one in the USA, are collaborating to learn about endangered species in their own countries and how the local habitat can be enhanced to improve the survival rates of the selected species. The project began as a pilot study, with twenty-one 5th grade students in a Turkish private foundation school during the 2005-2006 academic year. These students studied the Yanardöner, an endangered native plant (Centaurea tchihatcheffii). They also studied water quality in Mogan Lake, the local habitat of this plant. The students in Romania studied the Grey Stork and the American students studied the Monarch Butterfly.

Keywords. Ecological literacy, Endangered species, Hands-on experiments, Scientific processes, Threatened ecosystems, Water quality assessment.

1. Introduction

In Turkey, the process of developing a National Environmental Action Plan (NEAP) was initiated in 1995, and completed in 1999. Recently, a 'Science and Technology Course Curriculum' has been developed by the Ministry of National Education with the cooperation of the Board of Education.

As far as the newly developed curriculum is concerned, it is important for the students to learn how to use their scientific knowledge outside the school. In the new program, the students' affective and psychomotor aspects are emphasized, as well as their cognitive aspects.

The dimension of the environment is highly emphasized in the new curriculum, when compared to the previous science education curriculum. Environmental issues are introduced with "learning by doing" methods instead of theory-based instruction. Not only hands-on but also minds-on activities can be improved by the new approach. In teaching and learning environmental issues, student-centered instruction methods such as discovery learning, inquiry learning, role playing and games are designed. Problem-based and experimental-based approaches are used instead of didactic approaches.

In this study, in order for the students to understand and interpret the interrelationships within ecosystems, field work (with particular emphasis on a water monitoring program) has been adopted.

Pohl notes [1] that Dr William Stapp from the University of Michigan launched an environmental program in 1987 that went on to become the basis of water quality monitoring in educational institutions.

1.1. Review of the Literature

As far as the research carried out by [2] is concerned, there is no correlation between students' knowledge about the environment and their behaviour towards nature. The findings of another study of 5th grade children indicated that there is a negative correlation between these two factors [3]. This shows us that even though students have some knowledge about the environment, they are lacking in knowledge about how to apply this in real life.

As a result of this project, students will be able to use scientific processes to understand the cause-and-effect relationship of their scientific knowledge. They will be able to apply their knowledge in real life situations to alter negative aspects of human behaviour into the positive action.

Students will be able to gain an "ecological identity" by finding the answers to four basic questions [4];

- What do I know about the place I live?
- What is the source of living and non-living organisms?

- What is the relationship between the Earth and me?
- What is my role as an individual, what can I do?

1.2. Study Site

Mogan Lake is the wetland ecosystem that has been chosen as the target area to be studied by the author and the project team. It is a large, shallow lake located about 20 km south of Ankara in Turkey. There are several small villages around the lake. It is an important recreational area for the people living in Ankara. The Lake is highly eutrophic.

The Lake has been polluted by nutrients and other pollutants together with the domestic and industrial wastewater discharged from a nearby town, villages and industries.

Figure 1. Mogan Lake photographed by a Turkish student in the team

1.3. Study Plant

Centaurea tchihatcheffii is an endemic plant in danger of extinction (according to the criteria used by the IUCN- The International Union for the Conservation of Nature and Natural Resources). It is also included in the list of the plants under preservation in line with the Bern Agreement [5]. The students in the author's school first planted the seeds of this flower in 2004 and have been in the process of adopting and conserving it voluntarily since then.

1.4. Significance of the study

In this pilot work, a water quality assessment model making use of hands-on science activities for students, together with the characteristics of an endangered species living in the surroundings have been studied.

Figure 2. The Yanardöner Plant (Centaurea tchihatcheffii) photographed by a Turkish student during the field work

1.4.1. Why Field Trips?

Field trips are significant, because by providing an active and effective learning environment, they can promote various aspects of student development. For example they;

- facilitate the learning and retention of abstract concepts [6]
- motivate students through increased interest and curiosity [6]
- teach scientific methods by example [6]
- increase science scores when collecting data monthly [6]
- increase student-student and student-teacher social interaction [6]
- provide useful experiences for students with behavioural problems. [6]
- facilitate a sense of community among students through shared experiences [6]
- together with museum exhibits, provide 'hands-on and minds-on' activities which encourage students to experiment and ask questions [6]

1.4.2. Why Water Monitoring?

Water is significant. Water is life. Without water, no living organism on Earth can survive. As revealed in the study carried out by Pohl [1], the water quality monitoring study encourages the students to get involved in real life situations through the monitoring of a local stream or river.

Pohl also adds that monitoring water quality promotes students to create their own solutions and develop thinking skills.

1.5. Purpose of the Study

The *ultimate purposes* of the Unique and Universal Project are to:

- unite students from around the World through their understanding of the responsibility humans have to sustain the environment, not only for themselves but for all living things, upon which they depend for continued existence. Our students are the future leaders of the World, and they need to grow up with a sense of the importance of sustaining the environment
- help the students understand the relationships in nature by studying the impact of human activities in the environment through making use of scientific processes
- encourage the students to understand that threatened ecosystems and endangered species have both unique and universal values [7]

Specific objectives are to:

- increase the understanding of and gain practice in scientific procedures and practices, through investigation and research into endangered species
- increase knowledge, tolerance and appreciation of other cultures by communication between classrooms via the internet and other sources
- learn about the natural world and how human behaviour has impacted on the Earth
- increase knowledge and respect for science
- increase students' appreciation for scientific research and knowledge.

Desired outcomes can be summarized as:

- developing awareness, tolerance and appreciation of the differences and similarities between different cultures across the Globe from each other
- increasing the knowledge of scientific practices
- increasing the practice of scientific procedures
- increasing critical thinking skills, for example by having students involved in many of the decisions in this project, creating their own presentations, small and large group involvement, local and global awareness
- promoting creative abilities by having students design their own presentations
- increasing self-confidence through positive cultural and scholastic experiences
- improving other language abilities for Turkish children, and introducing Turkish to their partners
- increasing communication skills in a variety of ways
- increasing inter-personal skills by using both small and large teams
- interviewing a variety of people who are involved in this topic
- increasing awareness and knowledge of local and global environmental concerns
- generating discussion of problems and possible solutions of environmental concerns.

2. Methodology

2.1 Sample

At present, the majority of people collecting data are volunteers. They have an interest in their immediate environment which suggests that they would be interested in carrying out a monitoring program.

Figure 3. The Romanian children preparing a bulletin board for the project

In the pilot implementation of the Unique and Universal Project:

- Twenty-one 5th graders at the METU Development Foundation School and their parents participated voluntarily in the project.

The study group is a combination of ten year old boys and girls.

- Twenty- two students in the same age group from School Number 5 in Satu Mare, Romania also took part in the project.
- Seven volunteer students aged 11-14 (grades 6 to 8) from Roland Park Country School for girls in the USA were the third partner in the project.

Figure 4. The American students recording their observations

2.2. Data Collection

At the beginning and at the end of the project, assessment instruments including a knowledge test, an attitude questionnaire and a picture form of the endangered species were given to the students. Also, during the field work, immediately prior to and after completing observations and testing the parameters, the students were given two knowledge tests (one for testing water quality parameters at Mogan Lake and one for observing Yanardöner Plants).

2.3 Description of the Study

The time frame of the pilot implementation of the project was defined as October through June. The annual activity schedule was constructed with the author and her volunteer students on the Unique and Universal Project Team.

The students in the project team had organizational meetings every Monday after school, during which they researched the related topics using several sources with the guidance of the author, who was also their science teacher. They also discussed the issues with the research assistant from the Biology Department of Middle East Technical University (METU) who came to our school to deliver presentations about Yanardöner Plants. They visited the laboratories of the Biology Department of METU to observe the samples of daphnia.

The data collection instruments were prepared by the other author, from the METU Faculty of Education and these instruments were given to the students before and after the pilot implementation of the project. In addition, he carried out focus group interviews with the students. The students shared the knowledge about chosen endangered species to be studied in their target area with their overseas peers via e-mails, created a Unique and Universal Song (with each school in the project contributing a verse in their mother tongue), planted the seeds of Yanardöner Plants within a protected special area in their school garden and took care of them regularly.

Figure 5. The Turkish students being introduced to water creatures during the field work

2.4. Conducting hands-on experiments as part of field work

A significant part of the project was the field studies at Mogan Lake [7]. The first visit was planned by a small group of three volunteer students, who then acted as leaders of the team during the subsequent visits, along with the author. In the field work, qualitative and quantitative data were collected by the students. The qualitative data concerned the general quality of water aspects such as colour, odour and appearance which were tested subjectively by using the five senses.

Immediately prior to the test, a questionnaire with sample questions such as 'C*an you tell the general quality of water without conducting* *scientific tests or using scientific equipment?*' was given to the students and they were expected to write their answers on it before and after the practice [9]. As a whole, three types of parameters were observed and tested in order to get qualitative and quantitative data during the fieldwork. These were:

Physical parameters of water quality such as temperature, depth, and turbidity.

Chemical parameters of water quality such as DO (dissolved oxygen), pH, nitrates, phosphates, iron and copper.

Biological parameters of water quality, such as phytoplankton, zooplankton, insects and amphibians.

Mainly, colorimetric tests were conducted to analyze water samples. Each pair of students tested their own water samples and conducted two tests (for example pH and DO) whereas the other pair conducted two different tests (nitrate and phosphate) [9]. Students shared their test results within their group so that each student had a completed data sheet.

Figure 6. Two Turkish students recording their observations during the field work

The observed and measured parameters during the field work by the Unique and Universal Project Team were as follows:

(1)Colour, depth, and temperature (2) Turbidity, (3) pH, (4) Dissolved Oxygen (DO), (5) Nitrate, (6) Ammonia, (7) Phosphate, (8) Iron, (9) Copper, (10) Bacteria.

During all the testing activities and observations, La Motte test kits and sampling equipment were used. The portable field laboratories containing all the equipment and chemicals were provided by La Motte Chemical Company, our laboratory equipment sponsor.

Figure 7. A Turkish student conducting a pH test, using La Motte kit

The interrelationship between water and living species was observed and then interpreted by the students. Pre- and post- knowledge tests were administered.

During the field visit, the parents of the students joined in the process of taking water samples from the Lake, in order to measure the physical and chemical parameters of the water quality.

On the same day, the students and their parents also had a chance to observe and study the characteristics of the Yanardöner Plant (*Centaurea tchihatcheffii*), which is endemic and endangered within this area.

A week later, during the follow-up science activity at the Project's regular meeting, the students had short discussions on their findings as they compared and contrasted the differences and the similarities in water quality among the three habitats which were Test Site A (within Mogan Lake), Test Site B (within Mogan Lake) and Test Site C (the neighbouring test site in which Yanardöner Plants grow).

The observed physical characteristics of the chosen endangered plant were also discussed and recorded by the team during this follow up activity.

Throughout the pilot study, the research about the endangered species and the target regions were exchanged amongst the students from Turkey, Romania and the USA.

Figure 8. The Turkish students conducting turbidity test

At the end of the term, the same data collection instruments such as knowledge tests, attitude questionnaires and the picture form of the endangered species (which were given at the very beginning of this study), were re-administered to the students and as the final step, the students were presented with an environmental stewardship certificate by their coordinator teacher.

Figure 9. Three Turkish students examining water colour

3. Findings

The author has observed that when introduced to a field based water monitoring program, students were able to collect, compare, classify and evaluate the data effectively. In addition, the students reported that they enjoyed the learning process far more than when they studied in the laboratory or in the classroom.

From direct observations and testing instruments applied in the author's school, all of the students showed their interest in joining the meetings regularly and in taking part in the field work.

School **: ----- *Teacher* : -------- *Name* : -----**

ACTIVITY NO : 2
Student Data Sheet
Test Site A

***Study Site*: Mogan Lake**
***Time*: 11.30 a.m. *Air Temperature*: 19 °C**

WATER QUALITY TEST CONDUCTED	*TEST RESULTS*
COLOR	Green
DEPTH	1 m
WATER TEMPERATURE	16 °C
CLARITY / TURBIDITY	50 cm from the surface 15 JTU
pH	8.75
DISSOLVED OXYGEN	6 ppm
NITRATE	2 ppm
AMMONIA	0.5 ppm
PHOSPHATE	4ppm
IRON	1 ppm
COPPER	0.75 ppm
PRESENCE OF COLIFORM BACTERIA	Positive

Table 1. Example of water quality monitoring data and test results

Most of the students in the Unique and Universal Project Team were confident in applying their knowledge for testing physical and chemical parameters of water quality and able to express the cause-and-effect relationship between the test results and their impact on the ecosystem. All of them are keen to continue their studies next year, without being prompted. Letters of appreciation were received from the parents. Some quotations from these letters are given below:

Quotation – 1:'At the beginning of the school term, when my son told me that he would be volunteering in a project, I hesitated at first, because I have never seen my son showing any sign of interest on a particular subject. Then a couple of months later I was very surprised on seeing his enthusiasm, motivation and energy while studying in the project team. Soon after, everyone in the family started to get interested in Mogan Lake and Yanardöner Plants! It turned out that we all ended up being volunteer research assistants for the survival of a plant which I had never known before.'

Quotation – 2: 'It is so significant that this project targets young students. The younger the children are, the faster it is for them to gain environmental consciousness.'

Quotation – 3: 'It was a beautiful day in terms of organizations and experiments done. Once again I strongly believed that conducting hands-on experiments as part of field work was the best teaching strategy. It was very effective study not only for our children but for us as well...'

Quotation – 4: 'This study has been highly successful in showing us what a scientific project is like. I have learnt a lot as well.'

4. Conclusions

As far as the outcomes of the activities are concerned, science education through hands-on experiments may be perceived as a new, effective and accelerated method for transforming the study of ecology both into classroom environment and into homes.

In every academic year, at least six field trips are to be organized in light of this pilot study; two in the first term, two in between terms and another two in the last term. Based on the outcomes of each year's study, a different quality monitoring program for water, soil and air is to be studied in order then to be adopted into the science curriculum in the author's school. Students will attend field trips together with their families. The interviews and research questions prepared by the authors will help determine the change in knowledge and attitude of the students together with their parents. The trips will be videotaped. The qualitative findings will be analyzed through qualitative methods and the quantitative findings will be analyzed through quantitative research methods.

Figure 10. The Monarch Butterfly studied by the American students

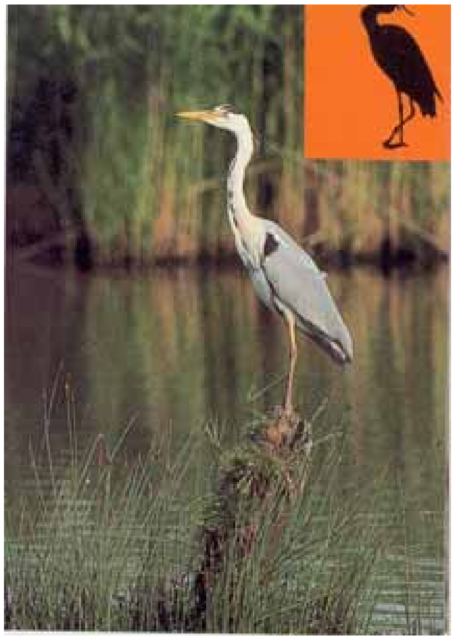

Figure 11. The Grey Stork studied by the Romanian students

Students will publish the results on the website so as to share their knowledge with as many children as possible both nationally and internationally. They will also carry out the mission of sharing their vision with students all over Turkey. During the second year they will survey an agricultural area close to their school. They will also study Toy Birds, soil analysis, soil pollution and the materials causing the pollution. They will apply similar hands-on scientific techniques in the third year for air quality monitoring program. The workshop that will be carried out in the conference will include the assessment of water quality parameters and interpretation of the results by making use of hands-on experiments for colorimetric analyses and the data charts.

It is the author's hope that this information will be used to educate public, and promote collaborations between NGO's and educational institutions, so as to form a sustainable future not only for the human kind but for all creatures in the universe.

5. Acknowledgements

I owe a special debt of gratitude to Professor Dr. Jim Westgate. Without his support, I would never have been able to share knowledge and ideas with my American colleagues. Special thanks to Prof. Dr. Ali Yıldırım for his continuous encouragement and motivation. Thanks to the METU Foundation School for its encouragement to carry out the project. Thanks to La Motte Company for their technical support with water monitoring test kits and sampling equipment. To these dedicated teachers, we extend heartfelt thanks for their great contributions in our project: Martha Barss, Science Teacher at Roland Park Country School, Baltimore, MD, the USA, Ancuta Nechita, English Teacher in School Number 5 Satu Mare, Romania. Thanks to Jill Aslan for her contributions to the study. And finally special thanks to my 5th grade students and those in other schools, who have been volunteers in this project.

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Integrating a Complex View of the Customer into the Quality Assurance Systems of Institutions of Higher Education

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Abstract. Every European country – with one exception – is committed to developing the European Higher Education Area. The declared aim of the Bologna Process which has been furthering the international cooperation of universities from 1999 is now to establish a uniform market of knowledge in Europe that can play an important role in enhancing the competitiveness of Europe.

Hungary has chosen to participate in reaching these objectives. This commitment is also reflected in its new higher education law coming

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into force this March, which is in concordance with the Bologna Process and strives for modernization. This document forces institutions to conduct significant reforms of process and structure through defining a framework for their functioning. Additionally, it includes the necessity of changing the current approach towards management. Besides the matters of strategic thinking, adaptation to the market and economic and social responsibility, the question of quality is also emphasized.

Many Hungarian universities have been running quality assurance systems for years, but now the new regulations consider it as one of the foundations of their operation. In Hungary's university sector this task of reviewing old quality assurance systems and implementing new ones requires significant efforts.

In our PhD research studying organization-level innovation processes in the Hungarian higher education we also addressed the issue of the quality of education. By using the method of document-analysis we were seeking the answer to what quality management systems the universities of Hungary are establishing, and how they are adapting the concept of quality assurance to education. We put an emphasis on the problem of defining and interpreting the key quality assurance category of the „customer". Our study revealed a complex view of the customer, posing a serious challenge to quality assurance. In our paper we make suggestions for dealing with this matter to the management of institutions of higher education.

Keywords. Bologna Process, Innovation, Quality of education, Customer.

Science Education in Poland. Challenge for New Millennium

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Abstract. In 1999 a major reform was carried out in Poland's educational system. Unlike earlier reforms, this one was comprehensive and all-embracing as the changes affect organization, curriculum, grading and all tiers of education.

Amongst other changes in Polish Elementary Schools was introduced new subject – 'Science'. This subject exchanged 4 separate ones of previous system - Geography, Biology, Physics and Chemistry - and is a mixture of them.
Teachers of above mentioned subjects had to face challenge of teaching topics of another subjects, task, to which they was not trained.

However, after 7 years from reform the problem of teachers biased in her/his teaching in original subject still exists. At the beginning of new millennium Teachers and Teacher Training Institutions as well as Ministry of Education should cooperate to resolve this problem for benefit of pupils.

Keywords. Curriculum Reform, Educational system, Science.

1. Introduction

First of September 1999 was the beginning of huge educational system reform in Poland. Unlike earlier reforms, this one was comprehensive and all-embracing as the changes affect organization, curriculum and all tiers of education. The curriculum reform aimed to overcome major weaknesses of the former educational system which encompassed:

- lack of correlation between contents of particular school subjects;
- overloading in school curricula;
- failure to adjust the contents to the abilities and needs of pupils;
- teaching encyclopedic facts with insufficient focus on comprehension of phenomena and processes;
- failure to develop skills;
- lack of correspondence between knowledge taught at school and pupils' life experience.

Hence, one of solutions to mentioned problems was integration of related subjects on level of elementary school. Amongst other changes in Polish Elementary Schools was introduced new subject – Science. This subject exchanged 4 separate ones of previous system - Geography, Biology, Physics and Chemistry - and is a mixture of them. Content of Science consist of 45% of Biology, 45% of Geography and 5% of Chemistry and Physics each.

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Teachers of above mentioned subjects had to face challenge of teaching topics of another subjects, task, to which they was not trained. Government solution to this problem was introducing post-diploma courses for such teachers to prepare them to teach integrated Science.

However, after 7 years from reform the problem of teachers biased in her/his teaching in original subject still exists. At the beginning of new millennium Teachers and Teacher Training Institutions as well as Ministry of Education should cooperate to resolve this problem for benefit of pupils.

2. The System of Education in Poland

New School System is not a goal in itself of Reform, but it is way to accomplish its aims:

- raising level of education by widening participation in middle and higher education;
- equalizing of educational chances, especially children from villages and small towns;
- stimulating high quality of education

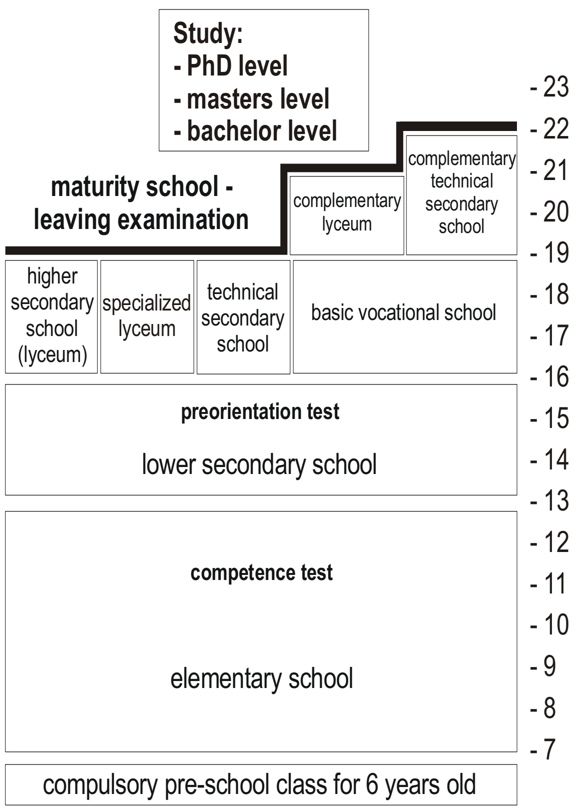

Figure 1. The System of Education in Poland

Comprehensive description of the System of Education in the Republic of Poland could be found in [2] and [3]

3. National Core Curriculum in Science

Ministry of National Education for every school subject prepared a National Core Curriculum. It's a document, which gives a brief description of educational aims, learning topics and student's achievements.

National Core Curriculum of Science:

Educational aims

1. Interest in beauty, wealth and variety of the world;
2. Understanding of interrelations in natural environment;
3. Gaining skills to observe and describe natural phenomena;
4. Understanding of interrelations between human and environment;
5. Appreciation of behaviour, which lead to safety of people and environment;
6. Establishing of responsibility for natural environment.

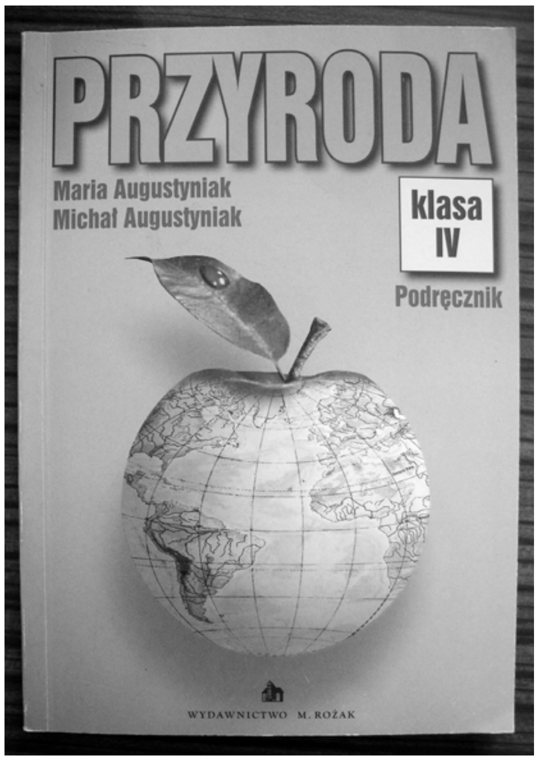

Figure 2. One of Science Textbook, published by M. Rozak

Learning topics
1. The structure and life functions of organisms;
2. Complexity of the world of living creatures;
3. Examples of diversity of plants, fungi and animals and their habitats;
4. Description of the students' surrounding area (morphology, rocks, waters, soils, vegetation);
5. Quality of the people's life in the neighbourhood area;
6. Orientation in the field (field sketch, map);
7. The landscape of the student's neighbourhood area – observations and descriptions:
- elements of the natural landscape,
- types of the spatial managements,
- people and their culture,
- people and nature interdependence;

8. Lowland, highland and mountainous landscapes:
- environment and its management (chosen Polish landscapes as an example),
- natural and anthropogenic landscapes,
- examples of positive and negative spatial management,
- regions of Poland.

9. Description of chosen world's landscapes:
- continents,
- oceans;

10. The weather and climate, meteorological observations.
11. Properties of various chemical compounds:
- metals and non-metals,
- mixtures,
- water and water solutions; dissolution and crystallization,
- the properties of matter in solid, liquid and gaseous state,
- chemical processes known from daily life (e.g. combustion, corrosion, coagulation of proteins);

12. Kinetic-molecular model of matter structure;
13. Basic physical phenomena:
- mechanical,
- electrical and magnetic,
- optical and acoustical;

14. Human life functions, stages of human growth (with special attention to pubescence), hygienic rules;
15. Importance of chosen plant, fungi and animal species for people.
16. Bacteria and viruses – threats and benefits for humans;
17. Harmful substances and its influence on organisms and natural environment;
18. Human influence on natural environment;
19. Influence of environment on human's health:
- harmful substances and their influence on the human organism,
- functions of water, air and soil, their pollution and protection;

20. The Earth as a part of Solar system. Astronomical observations;
21. Geographical discoveries.

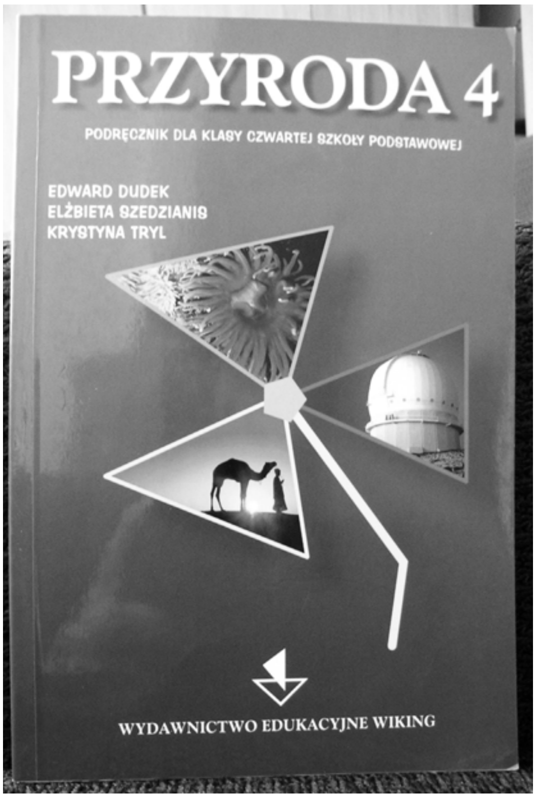

Figure 3. Science Textbook, published by Wiking

Achievements
1. Holistic perception of environment;
2. Observation and description of environment elements;
3. Collection and integration of knowledge, necessary to description of natural phenomena;
4. Recognition of physiological states of human organism. Health care (hygienic life and recreation);
5. Perception of the natural values of the nearest region, the knowledge connected with cultural and natural monuments. Recognizing of common species of plants and animals;
6. Perception of the dependencies between the natural environment and human activities.
7. Explanation of physical and astronomical phenomena;

8. Observation and identification of various substances and chemical processes in the surrounding area;
9. Proper usage of widely available chemical products;
10. Perception of human influence on natural environment;
11. Orientation in the field;
12. Interpretation of maps, graphs and tables,
13. Solving of basic problems connected with neighbourhood area;
14. Perception of cultural values of the nearest Region. [1]

On the basis of Core Curriculum there are prepared learning programs. Currently there are 27 learning programs authorized by Ministry of National Education. [4] Apart of them every teacher can create her/his own program and use it in school.

In accordance with authorized Programs there are elaborated Textbooks. Currently there are in Poland 15 Publishers, which are publishing Science Textbooks (Fig. 2 & 3) [5]. Textbooks are supplemented by Exercise books and Methodical Guides for Teachers.

5. Polish Association of Science Teachers (PSNPP)

Polish Association of Science Teachers (PSNPP) was founded in 1993 due to the initiative of teachers of physics, chemistry, biology & geography. Number of PSNPP Members has risen from initial 66 in 1993 to 736 in 2006 (Fig. 4).

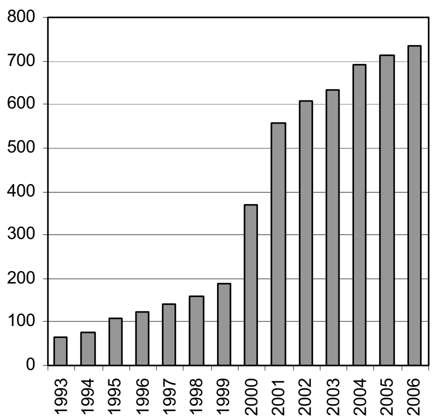

Figure 4. Number of Polish Association of Science Teachers Members

Aims of Association are as follows:

- promoting activities in the development of science education at all educational levels;
- encouragement of the vocational activity and professional development of Science teachers;
- promoting recognition of the value of science knowledge and skills in the society;
- integration of Science teachers in creation and exchange of science teaching resources;
- organization of conferences and workshops;
- co-operation with other world-wide Science Teacher Associations and participation in the international projects for teachers and their students.

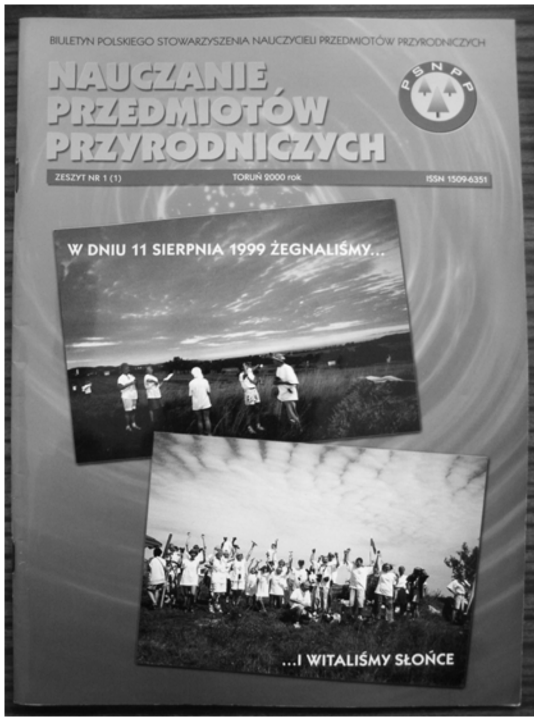

Figure 5. Very first Issue of PSNPP Bulletin Science *Education* (No 1/2000)

One of the forms of activity of PSNPP is publications. Amongst them is Bulletin *Science Education*, as well as many Didactic books (e.g. [6]. It's leading Polish Journal promoting excellence in 'Science' teaching.

Another important form of Activity of PSNPP are Annual Symposia, which brings together on average 300-400 participants and set a platform to exchange interesting didactical ideas. In 2006 Annual Symposium will take place in Warsaw in September. PSNPP is also the member of

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International Council of Associations for Science Education (ICASE).

Figure 6. Most recent Issue of PSNPP Bulletin 'Science *Education* [No 1(17)/2006]

6. Conclusions

Teachers of Science to face challenge of teaching topics from four subjects: Geography, Biology, Physics and Chemistry. Because there is no such university subject as Science, this subject has to be taught by persons, who have teacher training in only one of above mentioned subjects. They were not trained to do it, so they have to enrich their teachers' skills.

Government solution to this problem was introducing post-diploma courses for such teachers to prepare them to teach integrated Science. Apart of that, such teachers to widen their horizons can become the PSNPP members and take part in seminars and conferences focused on Science teaching. Also papers to be found in Bulletin *Science Education* can help them, as well as many Didactical books.

However, after 7 years from reform the problem of teachers biased in her/his teaching in original subject still exists. At the beginning of new millennium Teachers and Teacher Training Institutions as well as Ministry of Education should cooperate to resolve this problem for benefit of pupils.

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Education in Physics in Romania. Critical review

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Abstract. Generally the young generations are no more confident in their teachers, professors, they want to be independent, they are the products of an information system and some of them having a natural gift could register a quick promotion at the level of recognition of their value. It is well known that the scholars participating in different national and then international contexts obtain very good results those who are motivated either to be accepted in a famous college or university very often abroad. I'd like to mention that last year 2005 at the International Physics Olympiad the Romania team scored the 4-th place after China Taiwan and Russia, It is worth to notice that all the teams provide from countries with a high motivation for the young people to be accepted for study abroad. All Romanian laureates have been

invited by the US universities to continue their professional accomplishment. There are many other students who left Romania for MS or PhD study abroad and after graduation accepted to work abroad

It is a great responsibility on the shoulders of a professor and sometimes the results are longtime waited but there are.

The research institute absorbs yearly the graduates in physics and engineering since the policy of the govern is favourable in this respect (half of the salary was paid by the govern and only half by the institute).

Unfortunately Romania did not adopted the Timberger model (the planning of the education in respect to the economical development) probably because of the huge transformations of the economy after the collapse of the communist time and the long time planned economy in the ex totalitarian system. In the last years the quality of the graduates decreased very much as compared with some 8-10 years ago. One reason could be the high number of private universities with different profile not all according the need of the economy. The physics graduated are not easy absorbed by other working fields- generally the graduates in physics are absorbed by IT. The schooling is not attractive since of unmotivated earnings and the often reforms, the lack of authority of the teachers.

The physics graduates in the last years are less well prepared, either because those who followed Medical Physics are not absorbed in the hospitals and can't find other working places; thus they have a lower level of knowledge in mathematics and physics and have to recuperate. The candidates for physics from the high school are less since of some other more attractive and better paid professions (economy, juridical science, sociology, management, business).

Keywords. Education, Physics.

Cultural Diversity at School

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Abstract. The cultural model that has predominated in the last centuries has the homogenousidentity, based in the equality value, as the strongest support. A consciousness of the differences between cultures, mainly from the XIX century, did not introduce relevant changes to the cultural standards. Post-modernity faced the occidental society with new questions, being many of them inspired by the globalisation phenomenon.

School education has been the instrument of the majority to drive and perpetuate its culture and identity. With a culture based in values and practices of a majority, the minority sees its expression being reduced, contributing for the school failure and posterior abandon.

Having the diversity and success in mind, schools organization, teacher's education and curriculum are questioned in this paper, suggesting a different perspective based in the "new thoughts/new actions" binomial.

Keywords. Culture, Education, School failure, Diversity.

Validation of the Composite Costumer Image in Quality Management of Higher Educational Institutions

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Abstract. As one of the part-spheres of our PhD research work, investigating innovation processes on organization level in Hungarian higher education, quality questions of the higher education were dealt with. By the aid of document analysis- and interview method we endeavoured to become acquainted with the systems of quality assurance and quality management to be introduced by the universities in Hungary and to know, that how will they adapt the fundamental conceptions of quality assurance to the domain of education.

We dealt outstandingly with the questions of interpretation of the "consumer" as the key-category of quality assurance. Our examinations revealed a composite consumer image, implying a serious challenge from point of view of quality assurance. In our present publication recommendations on the treatment of this problem are formulated for the management of the higher educational institutions.

Keywords: Consumer, Higher education, Innovation, Quality.

1. Introduction

In the first years of the decade, the European higher educational systems faced a challenge unprecedented in the history till now.

It began to draw on the analysts of the global economic competition already at the beginning of the nineties, that the backwardness, manifesting itself in economic performance is traceable to significant extent to the structural problem of the higher education, to its routinish operation, being in want of innovation (Papadopulos [1991]). All these were confirmed by the European Commission as late as the beginning of the year 2005 only. According to the report, European higher institutions "don't have the power to put their whole capacity into service of economic growth, social cohesion and creation of better and a great number of working places" (European Commission [2005]).

It was a possible consequence of the publication of the late recognition, worded as criticism, that it gave a new impetus to the reform process, being protracted for several years.

The realization of the Bolognese process, supporting economic dynamisation led everywhere in the ETF countries to lesser or greater transformation of the national systems of higher education. It can sincerely be stated, that these reforms were of drastic extent for Hungarian higher education, affecting all spheres of its operation. It pertains to the truth, however, that domestic higher educational institutions, led by managerial way of thinking, sensitive to environmental changes, have carried out changes already long before the appearance in the year 2006 of the higher educational law, determining the direction line and concrete agenda for the reforms. For the universities, becoming "mammoths" because of the institutional integration, the pattern of transformation was given first of all by the organizational-managerial practice of the large-scale companies.

By way of the appearance of the modern managerial principles, strategic way of thinking asserted itself in the university operation and also the striving after efficiency and quality too, already before coming into force of the administrative regulation, entirely because of market effects.

In association with the development of the quality assurance systems of the universities, all these are emphasized, because according to our experiences, the demand on quality service rendering is present in most of the institutions. The main care is ment by harmonization of very different ideas, clarification of expectable results from the quality assurance systems and creation of long-term commitment. In our publication, we should like to cast light – through the treatment of costumer demands, to be considered as headstone in the matter of quality – on the importance of the gap between quality assurance an quality management, which may out into a gulf for want of real commitment.

2. Who is the consumer in higher education?

It is most obvious answer to the above question, that consumer is the student, who will take educational service (Corbitt [1998], Little et all. [1997]). This simplification may make easier the adaptation of business models to the university environment but it distorts the reality to a significant extent. Strikingly marked contrary opinion is represented by Bay and Daniel [2001], according to whom on the one hand, students have no relevant knowledge of that, what they should know, on the other had, generally they are not those, who pay for the service, rather at least partly their parents, the state or other sponsors, therefore they can not be interpreted, as consumers, representing real requirements. Authors throw out as an additional problem, that students are influencing the quality, perceived by other students. All these factors – according to their opinion – make almost impossible to gain consumer based to the services.

There is no doubt, that quality development, responding exclusively to the student's demands, would result in an interesting educational practice but we think, that inobservance of the perceptions of the students would have harmful effect alike. We regard as a problem to be solved harmonization of short-term interests of the students (e.g. quickly obtainable diploma, low number of lectures and low level of requirements etc.) with long-term interest of the servicing university (e.g. survival, high reputation etc.). Nevertheless, we accept that as regards quality, the statement of Bay and Daniel [2001] relating to asymmetrical informedness, comes really in full display, appearing not only in student-university but also in student – employer (university) – employer relations. A new aspect is added to the consumer based way of thinking by the motive of financing, that is, who pays for the services and who will the higher educational institution convince of making use of its service. Higher educational serves for total national interest, the state – in Hungary to an especially significant extent – is active participant in the university sphere as finance- and rule making institution. According to this approach, however, in addition to the state, private persons financing the student (parents, family) and also institutions, granting studentship may be regarded as consumers.

It is very popular approach – also traceable to the asymmetrical informedness – that the consumer is neither the student, nor the financing agent, but the labour market, for which, educated students as product are produced by higher education. The dominance of this view is well demonstrated by the fact, that one of the most important content elements of the domestic higher educational reform is even the incitation of the active relation between educational institutions and the world of labour.

According to our opinion, in the course of the development of quality education service, all of those, mentioned above, may be regarded as consumer, thus, it is necessary to deal with the composite consumer image. The terminology of Liu [1998] helps to make order among the view-points on primary and secondary consumers. The interest of the student – being regarded as primary consumer – relating to the mode of taking advantage of the service (time-table, demand on supporting services, etc.) should not be unobserved by the service rendering institution. The short-term way of thinking, however, may be a barrier to quality education, therefore experiences of the service rendering institution and requirements of the so-called secondary consumers (grantors, representatives of the industry, financing institutions) must also be taken into account in the course of quality determination. A higher educational institution may further the interests of the financier if it will take into consideration the demands on behalf of the labour market, will keep on high level the standard of the education, i.e. for a long-term, it will render for its primary consumers, namely for the students high-quality service. From this, also the product- and service conception, applied mostly in quality assurance, may be deducted, i.e. the product, offered by the higher education is the competence and knowledge, acquired by the students and represented by the diploma, and the service is the process, through which all these can be reached by them.

3. The concept of quality in higher education

The concept of quality seems to be quite simple, nevertheless it is difficult to put it into words. We are so with it, as Saint Augustine with the time: When nobody asks me, what does time mean, then I know it, but when I have to inform the questioner on it, then I don't know.

Several definitions exist for explanation of quality. Without demand on completeness, we would like to accentuate a few of the most interesting ones:

- Quality is the measure of that, to what an extent does one group of own characteristics meet the requirements (MSZ EN ISO 9000:2001)
- Everything is through the quality, what it is. If it will loss its quality, it will cease to be what it is (Hegel).
- Quality is such as the art: it touches us immediately; we recognize it without delay when we meet it (Csath [2005]).
- Quality is a "mobile target" of certain kind (Feigenbaum).
- Quality means for all inquirers something else; therefore determination of consumer demands in exact way is extraordinarily important (Deming).
- According to the most simplified determination, however quality means the "meeting of requirements".

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The above quality definitions give rise to further questions:

- If quality is a "mobile target" and means for everybody something else, how can it be standardized?
- If quality depends on subjective judgement, how can consumer demands accurately be identified?
- Does "absolute quality" exist at all?

We don't intend to answer the above questions within the frame of our present theme, although we held important to raise these questions, since they mean the pledge of success for the systems of quality assurance and quality management.

4. Quality assurance in higher education

If the management of an organization will assume the obligation to introduce and make operate a system of quality management this will be a half-success. Then, however the question will emerge, that what kind of system should be built up. In answering the questions, several problems must be gone round. Among them, it is one of the questions to be studied, that what quality definition will be accepted by the institution. If the definition of ISO will be accepted, then the ISO model should be adopted and it must be based on the criteria contained in the standard. In this case, it is reasonable to let certify the system by an independent certifying organization.

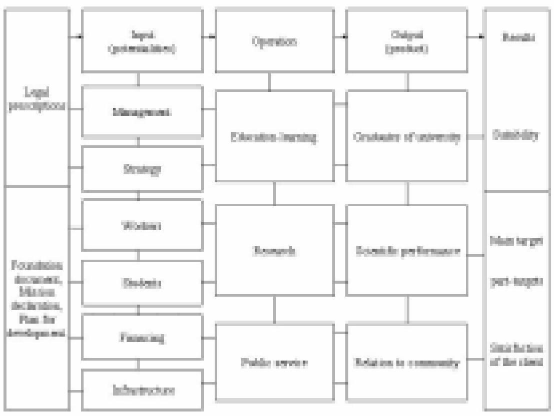

Figure 1. A potential quality model in higher education

By all means, it is important to emphasize, that the certificate, acquired by way of certification does not guarantee outstanding or excellent quality for the consumers, merely a constant quality is assured.

In case of some kind of own quality concept, it is to start from a model of TQM-way of thinking, and self-evaluation must be taken for supporting basis.

The European Excellence Model, elaborated for the non-profit sector by the EFQM Centre of Brussels in 1994, seems to be a suitable basis for the development of a higher educational quality model.

5. Actors in the quality

Quality policy is determined by the Ministry of Education (henceforth ME) in the light of social expectations.

Further important pillars of the quality matter are as follows:

- Quality authentication, pertaining to the scope of authority of the Hungarian Accreditation Committee (henceforth: MAB).
- Quality assuring systems. Institutions must take care of their building up and efficient operation.
- Quality control, which is the task of the ME under the provision of the law.
- Quality evaluation, realizers of which are those interested in education, namely partly the users, e.g. professional alliances, organizations for representation of student's interests, actors in economic life, students, choosing the institution, partly on behalf of the public administration – on the basis of authenticating activity of the MAB – the ME (Kiss [2002]).

It may be probable on the basis of the No. CXXXIX. Law of Higher Education issued in 2005, prevailing in Hungary, that models of TQM-way of thinking type will spread in higher education, a basis for which can be the quality model, outlined by us.

6. Recommendations

"Panta rhei" – everything is flowing, changing – was held by Herakleitos 2500 years ago. This can't be otherwise even today. Change, complying with actual circumstances, facing newer and newer tasks, and their solution are natural concomitants not only to the life of individuals, but also to that of the organizations.

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We know, that adaptation and ability to undergo changes are fundamental criteria of viability (Szántó [2003]).

This holds true of the quality too. Continuous survey, revaluation, improvement of guaranteed "constant quality" are indispensably important.

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Teaching Science in Primary School: Serbian Experience with the Project "Ruka u testu" (Hands-on, La main à la Pâte)

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Abstract. The operation "Ruka u testu" found in Serbia a favorable ground for its development. Started in 2001, it was found a broad echo in the public opinion beyond the teacher's world. The operation was also supported by many institutions as well as a great number of university professors and researchers. Since 2003, the Serbian Ministry of Education decided to propose an option "Ruka u testu - Discovering the World" for pupils of 6-8 years old. This option allows to children a process of self-discovery of sciences through the experimental process. The first South - East European Summer School for Hands on Primary Science Education, has been organized in Serbia.

Keywords. Experiment, Hands-on, Internet, Ruka u testu, Self-discovery, Teacher's resource.

1. Introduction

The education system in Serbia needs thorough improvement at all levels due to the extensive advances in didactic methods in the past decade in the world. Successful teaching of natural sciences proved to be the most challenging task. Natural sciences are commonly considered as difficult to understand and boring, which is in evident conflict with the increase of their role in our every-day life.

According to the results of active teaching approaches (like in the world-wide spreading program "Hands on"(in USA)," La main a la pate" (in France), "NTA" Sweden, Ruka u testu (in Serbia) the best results are obtained when teaching is accompanied with experimental demonstrations and exercises, and Internet. Implementation of such approach, commonly adopted in developed countries, is at present impossible in Serbia due to the lack of necessary laboratory equipment and good WEB-site pages on Serbian language. For that reason we have developed very intensive collaboration with French Academy of Sciences and French team

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"La main à la pâte" with hope that in the near future we will achieve *specific objectives:*

- To raise the quality and effectiveness of the teaching provision and learning process in primary schools in Serbia.
- To create a solid base for the reform processes in Serbian schools and enable the implementation of the envisioned changes.
- To enable teachers to apply modern didactic methods.
- To facilitate acquaintance of pupils with natural sciences and technologies.
- To get closer to European and world standards.

And *anticipated impacts*:

- Instant rise of quality of existing teaching practice in primary school.
- Instant rise of pupils' and teachers' motivation.
- Facilitated implementation of modern teaching methods adopted in developed countries.
- Rise of pupils' individual interest, comprehension and skills in science and technology.

2. Why teaching science and why a focus on pre- and primary school? (Ages 3-12)

By teaching science we **develop** a scientific literacy for all citizens, technologically competent workforce, decrease dangers due to ignorance and overcome social barriers. In this manner we help the future of our societies because many issues in the future will need science and mainly Europe needs scientists as a society of knowledge. But, current state of science education is inadequate in most countries of the world!

Primary school is an ideal place to implement an in-depth renovation of science education because children ages from 3 to 12 years old: spontaneously question natural phenomena, have a great ability to learn, can learn language and science together, in contact with the real world are less influenced by media…

Since the 1990s, a worldwide effort, led by scientists and Science Academies, in cooperation with education authorities have organized numbers of international conferences and started with active renovation projects in this field. From these activities a common approach is emerging, respecting diversities.

All these activities incorporated a general philosophy of *Hands-on*, *La main à la pâte, Ruka u testu:*

- Science as an investigation,
- Something pupils do, not something that is done for them,
- Teacher helps pupils to build their own knowledge,
- Action, experimentation, interrogation, collective reconstruction,
- Deeper understanding with an oral or written presentation: *science notebook.*

European innovations in this field [1, 2, 6] are developing rapidly and becoming a reference for many countries all over the world.

3. Hands on (Ruka u testu) in Serbia

We have started in **2001** by translation and first edition of the book "*La main à la pâte*" [3] and conferences for teachers relating to the 10 "*La main à la pâte*" principles, the teaching process, the partnership…

In 2003: visits of Mr. Pierre Lena, Mr. Yves Quire to Belgrade and Mr. David Wilgenbus participation to the 5th General Conference of the Balkan Union of Physics - BPU5 in Serbia had great influence on Serbian teachers and scientists in Balkan region.

Second edition of *La main à la pâte* book [3] with the preface by George Charpak, Pierre Léna and Yves Quéré, translation and edition of the book "Graines de sciences 1" [4] and participation of Ms Vera Bojovic in the preparation of book *Graines de sciences 6* are the mains points of our activity in 2003.

During 2004: translation and edition of the books *Graines de sciences 2, 3* and *Teaching sciences at school* [4]; study visit to France of a Serbian delegation of 10 members (educational researchers, College professors and school teachers) with objectives to study the French device and to adapt it to the Serbian context.

One class from Belgrade's primary school "Sveti Sava" had successfully participated in the international competition "the Egg-naut" defined by European Space Agency (ESA). They landed an egg with a very original parachute Fig. 1. and received for it the award for originality.

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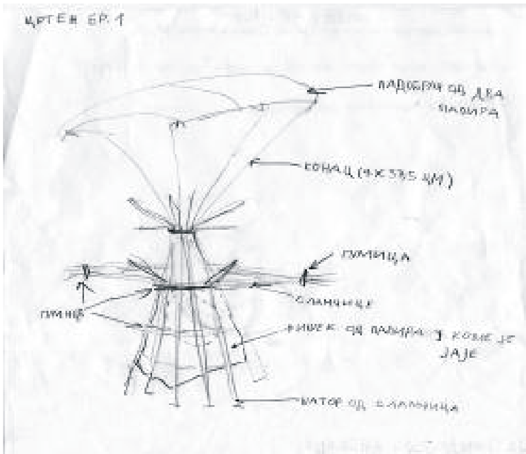

Figure 1. The schema of the parachute from children's science notebook

In 2005: translation of books *Graines de sciences 4 and 5*, *L'Europe des decouverts* [5]. Continuous training organization to answer teacher's requests. Development of scientific activities for the classroom with help of the group from the University of Belgrade and Novi Sad in charge of didactic for sciences. They are contributing to the new breath that this didactic initiative brings.

At 21 of June one class from Belgrade primary school "Uzicka Republika" (age 12) will participate in video-conference among Alexandria – Assouan – Grenobl - Belgrade in the frame of the project "*Sur les pas d'Eratosten"*, Fig. 2.

Figure 2. The group of children from primary school with gnomon

Finally we have organized South - East European Summer School for Hands on Primary Science Education, Zlatibor, Serbia, June 11-16, 2005 [6]

In 2006 we will continue with translation and edition of books *Graines de sciences 6, 7* and "*Découvrir le monde à l'école maternelle*". We hope to make a semi-mirror of the French website www.inrp.fr/lamap on Serbian language and start the collaboration with our national TV for presentation of this method in 10 - 15 emissions.

4. Future activities

We can say that we have finished **the first step** of our *Ruka u testu* action:

-Certain numbers of our teachers in all regions in Serbia participate in contemporary movement in new approach in science education in the frame of *Hands-on* method;

-Some of our primary schools, with the help of Vinca Institute, have participate in European competitions

-10 books about this method have translated. Our teachers and parents can buy now 5 books in almost any bookshops in Serbia, the 5 others should be published in 2006/7.

The **second important step** for project *Ruka u testu* will be the translation and accommodation of French *La main à la pâte* Website (this is the Website of the French Academy of Sciences and the French *La main à la pâte team.* In 2001 it was the best website in education field in Europe and to day has about 150 000 connections par week) permitted texts, make it available on the site *Ruka u testu,* make the network of *scientific consultant* and *teaching specialists,* education for teachers which will use this e-resources. With this step we will give to Serbian teachers and teachers in region which speaks Serbian language:

-very important and more completely resources, for hands-on method, on the Site *Ruka u test* and CD version of the Site;

-the possibility of the communication among them via Internet;

-the possibility of the communication, via two networks, with *scientific community* and with *teaching specialists;*

-also for teachers from Serbia we will organize in e-centre VINČA, which has: *Computer Room, Library, Experiment Room,* seminaries about IT and how to use the resource from the site *Ruka u testu* for *Hands-on method science education* in primary school.

The third important steps, in 2007, will be supply a specific resources for the classroom, including material kits and guidelines for teachers. We expect to create in 100 Primary schools all over the Serbian territory The

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Experiment Room which will give to teachers a model of research and inquiry-based process implementation in a convenient place with convenient tools. These kits special constructed for Hands-on method will be buying from the known producer in France. They cover some themes in the science and technology curricula. Each set theme contains the whole equipment for one class, documents for the different teaching sequences. Kits will be also borrow by others schools form the region. In the future we will try to developed collaboration with European producers in this field with the aim that some of these kits would be made in Serbia.

The fourth steps, in 2008, creation of the Resources Centers in Vinca Institute which will have The Media Library, The Experiment Room, The Experiment Library and The Computer Room. With this Resources Centers we will try to approach Serbia to *12 Seed Cities for Science – A community approach for sustainable growth of science education in Europe (Pollen project in the frame of FP6).* We are sure that this is real idea because Vinca Institute has now the very good Library which would be easily complete with the books for Hands-on method, the Experiment Room with 10 boxes with mentioned kits and the Computer Room. The most important is the human resource that we have in different sciences and technologies. Also, we are sure that this idea will be supported by many companies in Serbia because with this project we will help the renovation of sciences and technologies education in our schools and our children will be better prepared for the knowledge based society.

5. Conclusion

Serbian experience with Hands-on ("Ruka u testu") project shows that the training and class protocols available on French language can be very easily translate. The inexpensive school equipment can be used. A support of prestigious scientists and Academies are very important and possible. The role of Internet and teachers-oriented ICT can be very useful in dispersing the idea of this method for science education in primary schools.

If we use a high quality expertise in several EU countries than the Hands-on pilot projects may easily be implemented in South-East Europe.

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Teaching Electrical Engineering through Demonstration of Real Devices and Computer Modeling: Electromagnetic Gun and a Miniature Circuit Braker

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Abstract. The paper presents an example of a demonstration experiment used to motivate students for better understanding of basic electromagnetic phenomena. Two devices are incorporated in one device: one is an electromagnetic gun and the second an electric miniature circuit braker. We discuss operation of a device through demonstration and explanation of design issues, we perform some basic measurements such as charging and discharging of a capacitor and show some examples of real factory testing of the circuit brakers. We give the students some information on possible modelling of the phenomena using tools such as Matlab, Femlab or Spice. The intention of the authors is to share ideas and also concrete demonstration devices and learning concepts in order to improve our teaching methods.

Keywords. Circuit–braker, Electrical engineering, Electromagnetic Gun, Education, Demonstration tools, Teaching tools.

1. Introduction

Teachers are continuously seeking methods for better motivation of students. It is not difficult to find parallels between good motivation and a learning success. Besides, we all agree that learning should not be only gathering information but being capable of using this information in practice. Although computers and computer animations are still a very important means of motivation, we believe the most attractive approach would be to use both - real as well as virtual experiments. Furthermore, there are many possible ways of using real as well as virtual experiments. There is certainly not only one good solution but rather a large variety of possible ways to efficiently incorporate real as well as virtual experiments in the learning process.

We present in this paper a concept of teaching basics of electrical engineering at the faculty level (1^{st} year of studies) through a demonstration of real experiments and use of several approaches in order to achieve improved understanding of the underlying concepts.

The core of a concept is a (real) experiment: a device that incorporates two devices in one. The first is an electromagnetic gun that is in reality an electromagnetic valve and the second is a miniature circuit braker (MCB). The first device is prepared mainly for explaining the basic principles of electronics and formation of electric and magnetic field while the second is a real apparatus made by a local industry. The name for the device »electromagnetic gun« is used mostly for the purpose of raising interest. We have successfully used this device at the expositions for youth that our faculty organizes each year at a local technical museum and as a supplementary motivation based material in the classroom. One can explain through it some basic principles of electrical engineering such as charging of capacitors with electric charge, rectification, operation of an electromagnetic valve, conservation of energy, etc. We will present some of these concepts in this article.

2. Construction of a device

The device is shown in figure 1. The most visible part of the device are a bank of capacitors (five of them with capacitance approx. 70 μF each), a voltmeter (used to show the charging process), the electromagnet with a tube for “loading” the “ammunition” (ping pong ball), the transformer used as an isolation transformed and a printed circuitry with necessary residual elements used to run and monitor the experiment. On the side of the case is mounted a miniature circuit braker.

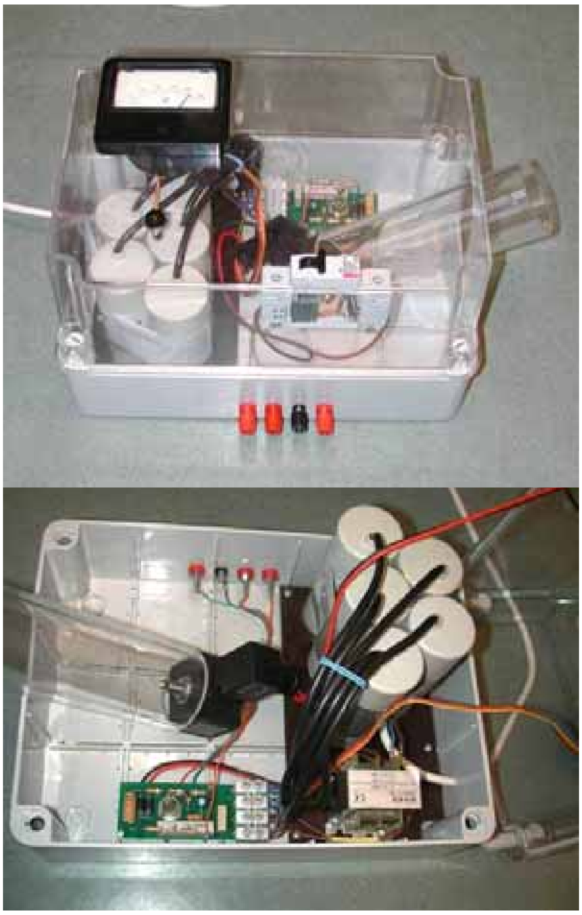

Figure 1: Electromagnetic gun and a circuit-braker. The capacitors are charged using simple half rectification. The energy is released through the electromagnetic valve (if the MCB is in the off state) or through the MCB (if it is in the on state). On the front side is a MCB with one side removed so the discharging event (small spark) can be observed. Current and voltage signals of the charging and discharging event can be monitored by connecting the device to the oscilloscope

3. Operation of a device

The device operates as an electromagnetic gun and/or as an electromagnetic miniature circuit braker. They are connected in parallel so if the MCB is in the off state, the released current is fed directly to the electromagnetic valve. In case the MCB is on, its resistance is much smaller that that of the electromagnetic valve, especially in case of a sharp current discharge (that we are practising in this configuration). We use simple rectification from AC 230V source (home appliance) with a single diode to rectify the current and charge the capacitors. The charging is slow (complete charging is achieved in about 30 seconds) in a sense that it can be tracked visually on the voltmeter mounted on the top of the case. Furthermore, special pins are added to the side of the device so the capacitor charging (rectification principle) can be tracked on the oscilloscope (Figures 3, 4 and 5).

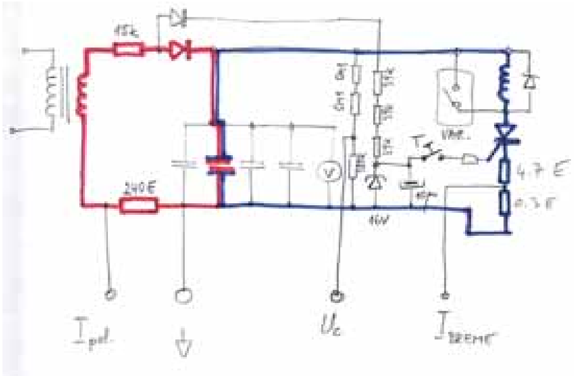

Figure 2: A sketched drawing of a device with two main circuit loops. Left (red): charging loop, right (blue): discharging loop

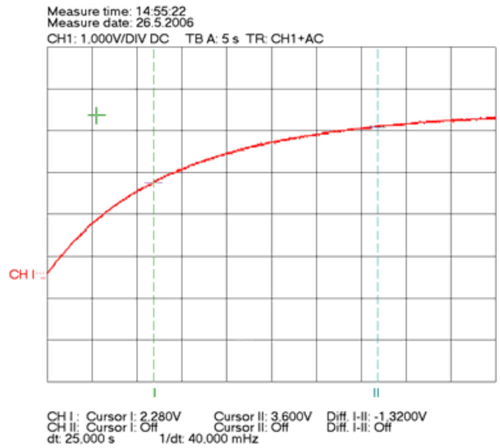

Figure 3: Capacitor charging demonstrated through quasi exponential increase of capacitor voltage

After the capacitors are charged they can be discharged through the electromagnetic valve or through the MCB. Instead of a simple mechanical switch, we use an electrical element - tyristor. The reason is relatively large discharge current (several amperes) that could lead to destruction of a mechanical switch after its frequent use. Furthermore, we have an opportunity to demonstrate the operation of a tyristor as well.

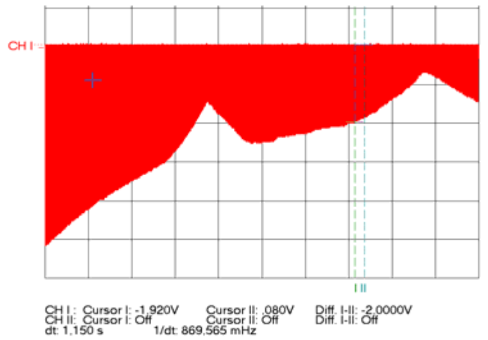

Figure 4: Charging current is decaying as expected. However, some still not well explained current bumps are observed at not completely charged capacitor voltage

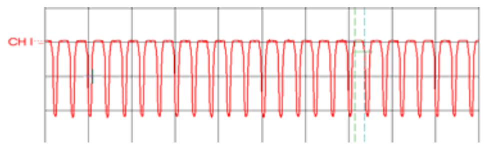

Figure 5: Zooming a detail from figure 4 would give the following current signal

If the energy from the charged capacitors is released through the electromagnetic valve, the force on a piston is sufficient to shoot a projectile into the air. Most frequently we use a ping-pong ball as a projectile. A resistor of a small value is used to demonstrate the discharge current on the oscilloscope (Figure 6).

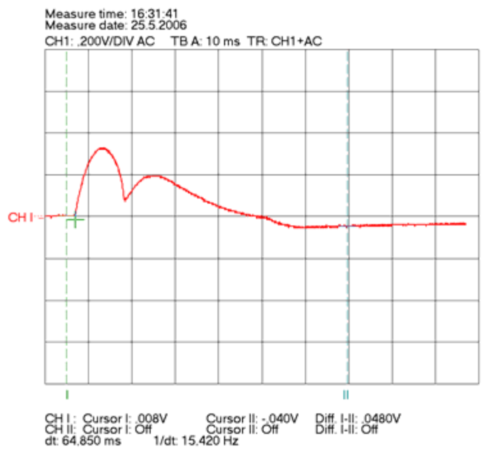

Figure 6: An interesting current discharge through an electromagnetic valve is observed. The reason is inductivity change invoked by movement of the piston inside the electromagnet

In another experiment the MCB is in the on state and the capacitors are discharged through the MCB. The current waveform is much sharper and much higher currents are achieved (Figure 7). The second part of the curve shows similarities with the current through the electromagnetic valve. In fact we observe action of a parallel connection of a miniature circuit braker and the electromagnetic valve.

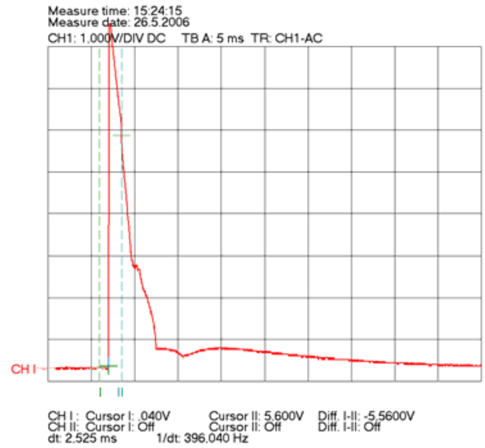

Figure 7: A discharge current observed when the MCB was released

4. Demonstration of high-current tests performed on miniature circuit brakers

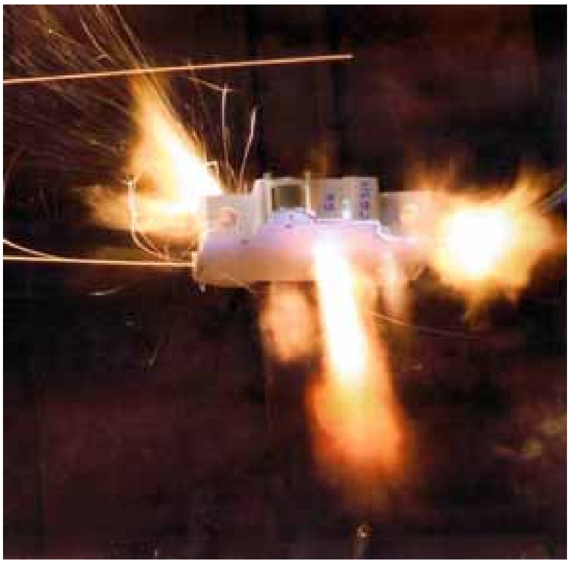

Figure 8: Sparks and noise at testing of MCBs subjected to currents of several thousand amperes

The miniature circuit brakers are required to sustain very high currents – they have to remain in the off state even if extremely large currents destroy the device. Therefore the producers have to perform tests where the miniature circuit brakers are subjected to currents of several thousand amperes. Due to requirements of instantaneous high currents (at a voltage of about 250 V) these tests are performed in special testing room located near the electric power station. These tests are very attractive since breaking of such high currents results in flashing, sparks and noise. Figure 8 shows a picture of one such event.

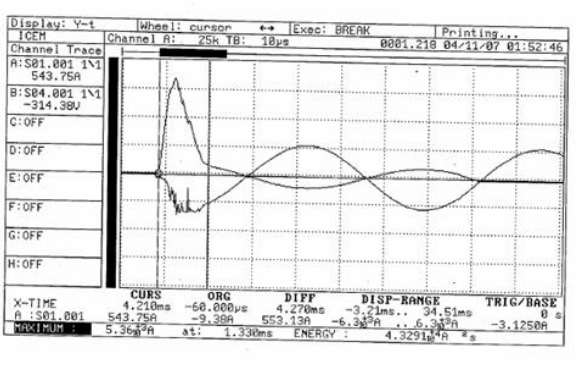

Figure 9: Current and voltage of the curcuit braker in a disconnecting (braking) phase

The students observe these photos and figures and discuss the following procedures: what are the requirements the producers have to meet, what are the maximal currents at disconnection, what are the spikes in voltage signal (due to the arc formed), why is the current not completely disconnecting the device after the spark, etc. We also discuss some important parameters such as dissipated energy at the disconnection, time to complete disconnection, etc. Discussing these parameters through the theoretical knowledge they have gained through the lectures gives them a sense of importance of the (otherwise useless) theoretical learning phase.

5. Modelling

Several possible ways of modelling are discussed. First we remind the students of the charging and discharging events discussed at the lectures and then show some alternative ways of modelling these events. One possibility is through use of the programs for circuit simulation. At the University level most often the program SPICE is used, although some students come from secondary schools with some knowledge on simulation using programs such as Electronics Workbench. For information purposes we demonstrate a version of a SPICE program called 5Spice that has a capability of using a graphical user interface.

First, the charging process is modelled and discussed. The result of simulation is presented in Figure 10. The similarities and differences between the simulated and the measured curves are discussed and attributed to the differences between the ideal and real elements.

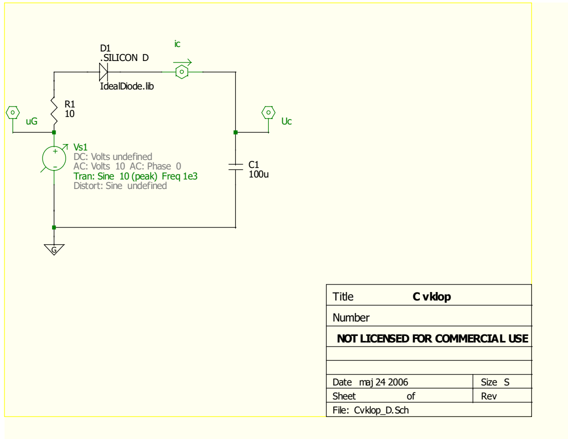

Figure 10: Schematic layout for modelling capacitor charging constructed with 5Spice (www.5spice.com)

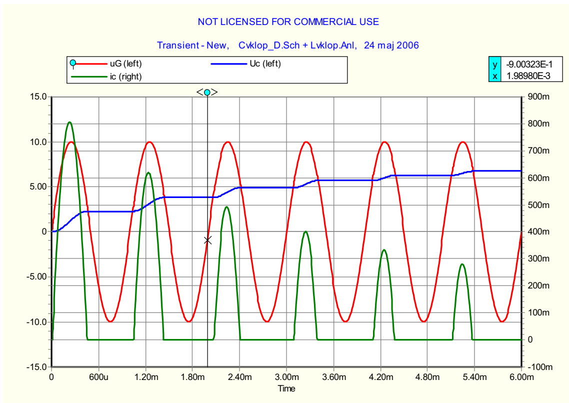

Figure 11: Source voltage, capacitor voltage and circuit current. An increase of capacitor voltage and decrease of charging current can be observed

Discharge is modelled using a series RLC circuitry. A large current increase is observed and compared to the measured one (Figure 12). The most notable difference is a double kick that is observed at measurements but not in the simulation. The reason is the time dependant (more exactly movement dependant) inductance of the electromagnetic valve that is in the simulation disregarded. The most important message is that simulation gives a good and nice (graphical) insight into the basic principles of operation of the device, however, the practice would bring some non-ideal conditions that would also need to be discussed and explained in order to understand the operation of the device in depth and to be able to improve its design and operation.

An important part of the electromagnetic gun as well as the miniature circuit braker is an electromagnetic valve. Its operation is modelled using numerical simulation program Femlab (www.consol.com) that enables study of magnetic field distribution inside the element. The magnetic field density is visualized using arrows (vector field) as well as colours (absolute value of magnetic field) as presented in Figure 13. Concepts as magnetic field lines, permeability, magnetic energy, force, inductivity etc. are discussed.

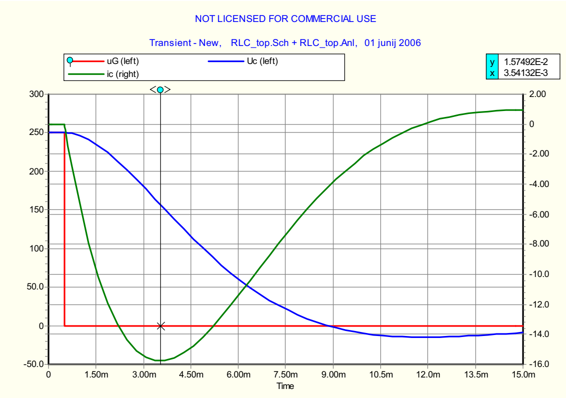

Figure 12: A discharge process is observed through Spice simulation

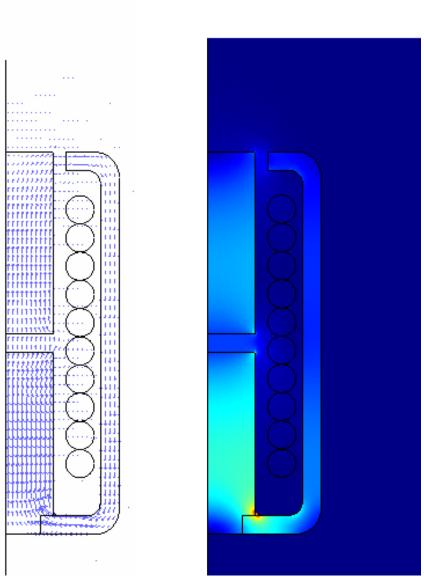

Figure 13: Numerical simulation of magnetic field inside the electromagnetic valve.

7. Discussion

We have shown a device that we have developed in order to demonstrate to the students the operation of real devices and discuss the details of design and implementation. It is used in the first year of University level of study of electrical engineering.
There are several reasons for development of such devices:

With a lack of hours for practical work (more than 100 students can attend lectures) we need to add some flavour to the explanation of the theoretical basics.

The students want to know why they will use the knowledge they are attaining. We have to show this not through experiments used to demonstrate the basic principles but through the operation of real devices.

At the moment we do not have special classes to perform computer experiments (modelling) although this is our long term goal. In the meantime, we give the students opportunity to be informed on the possibilities offered through the computer technologies and try to motivate them to use them on their own. Programs such as Matlab or Spice are used in higher classes but we would like to introduce them already in the first year of studies.

8. Conclusions

In order to motivate students for the study of electrical engineering in the first ear of university studies we are continually searching for new methods of teaching. Through several years of experiences we have learned that students are not only interested in real experiments but also want to see how they will be able to use their knowledge in real life. For this purpose we started to develop devices that are at the same time used for demonstration of basic principles of electrical engineering and are containing knowledge that is applicable in real life. In this paper we showed a device that is incorporating an electromagnetic gun and a miniature circuit braker. Through discussion of design and operation of the device the students learn such material as rectification principles, charging and discharging phenomena, energy stored in electric and magnetic field, etc. It is intention of the authors to share ideas as well as devices with other researchers and pedagogic workers that would see the same benefits of this type of

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supplementary material for learning basic electromagnetic phenomena.

Science Teacher Beliefs about Contents and its Relation with the Practice. A case study in the Context of Chilean Education.

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Abstract. The selection and organization of the content are key aspects describing what the teachers thinking is and how his practice is. Our objective was to explore these aspects in the beliefs of a Chilean biology teacher and, in addition, to describe what relations have these beliefs with the practice. To achieve this, we have used different instruments and undertaken a quantitative and qualitative analysis of the information. Although there is a relation between the beliefs and the practice, the teachers thinking does not correspond with what he is actually doing. He was more constructivist in his thinking and more traditional in his practice.

Keywords. Curricular beliefs, Actions, selection and organization of the content, Subject matter content, Professional knowledge, Professional development.

1. Introduction

We are conscious that there has been an increasing interest to study and investigate how the aspects related to the beliefs that are part of the teachers thinking influence in the processes of education and learning [1, 2, 3, 4, 5, 6]. The investigations have referred not only to general aspects of the scientific knowledge, the teaching, learning and curriculum of sciences, but also to specific topics related to the subject matter contents, like for example, the methodology and the evaluation [7]. Thus, it is necessary to treat these beliefs in the teachers' formation [8, 9, 10, 11]. Based on this fact, we pretend to describe the curricular beliefs and the curricular actions of a Chilean professor of Biology with respect to the contents. Furthermore we want to find out what relations there are between the teachers thinking and action. Although this is only a first approach to the reality of Chilean science teachers, we think that it will increase our understanding of the teaching profession and contribute to an improvement of teaching and the science teachers' training.

2. Antecedents and context

Since 1990 Chile is undergoing a process of educational reform, to improve the quality and equity levels of the educational system [12]. In this process, the teachers' roll and challenges have been widely recognized [13]. The most important of these challenges are firstly to get involved in the reform process and secondly to modify ones practices and forms of understanding learning and teaching to make them more coherent with the reform. It seems that none of these challenges have been successfully faced in Chile, which has been attributed to numerous factors. Among others, there are the lack of interest on the part of the teachers [14] and the big difference between the models proposed by teachers and those proposed by the reform [15]. The result is that the reform has come to a standstill rather than generating changes. This is the context in which we have undertaken the present study which is part of a broader investigation on the curricular beliefs and actions of science teachers in secondary schools in the Eighth Region of Chile.

3. The research of the teachers' thinking and practice

There are several factors that promoted and defined the research about teachers' thinking and practice. Nevertheless, the most important were, on the one hand, the massive proliferation of studies related to the students' conceptions and the conceptual change [16] and, on the other hand, the thought that the teachers' practice is influenced by his beliefs, thinking, judgments and decisions [17, 18]. For example, there have been studies that indicate that a majority of the teachers have empiric, positivist and absolutist beliefs and visions about what science is [8, 19, 20, 21, 22]. Other studies have indicated that a majority of the teachers have a traditional idea on what is teaching [23, 24] and learning [25].

There are also studies that have tried to determine if there exists a relation between the beliefs about science, teaching and learning [26, 27]. Finally, they are those studies that have demonstrated that only sometimes exists a relation between what a teacher thinks and what he does [28, 29].

Nevertheless, in some way all these studies treat curricular aspects that are related to the contents, the methodology and the evaluation. In fact, results of the research about planning process (methodology) show that the teacher directs his attention mainly towards the subject content [30, 31]. Therefore, we considered that a substantial contribution to this question is the investigation of the science teachers' curricular beliefs and practices in relation to the contents. Consequently we have especially in this part of the research focussed on the following question: What relations exist between the curricular beliefs and the practice of a Biology teacher concerning the contents?

4. Methodology of the research

The research to which this study belongs is of an ethnographic nature. Its methodology includes a case study with a qualitative and quantitative analysis as well as an interpretation of the data obtained.

4.1 The sample

Although the research to which this study belongs contemplated the case study with six science teachers in the subjects of biology, physics and chemistry we will present here only one of the teachers: Pedro, biology teacher, 42 years old and 20 years of experience in the classroom.

4.2. Instruments

We needed different instruments for the data collection that allowed contrasting the results. Thus we worked at different levels as indicated next.

a) **Identification level:** For our purpose we needed an instrument that allowed us to explore the teachers' beliefs or, better said, to find out with which curricular beliefs the science teachers identified themselves and with which beliefs on their curricular acting. For this reason we adapted a questionnaire used in another investigation [23, 32].
b) **Declaratory level:** The semistructured interview consisted of open and flexible questions about which we talked with the teachers [33]. These questions dealt with the same aspects as we had exposed in the questionnaire. We tried to obtain spontaneous answers and to avoid those idealising answers that often are given to make a good impression [34, 35, 36].
c) **Action level:** In order to describe and analyse the classes we applied a non-participant observation [34, 35] registering the facts in the moment they were produced. Previously, we established the aspects of interest [34], preparing an observation table, in which we entered information approximately every five minutes [37].
d) **Design level:** Written material has been considered frequently as source of information, especially in the study of the teachers' conceptions and beliefs [30, 34]. For that reason, we asked the teacher for didactic units elaborated by himself and related to the subjects that were to be worked through during the observation of the classes.

4.3. Category system

We used those categories that included the curricular aspects of the contents, methodology and evaluation [23, 32, 29, 38]. Specifically the content category that we used in the present study contemplates to the following aspects or subcategories:

a) Knowledge implied in the school context (Ce): it is related to the origin of the scientific knowledge, the identity of the subject matter content, the importance of the ideas of the students, the role of history in the science teaching and the types of contents.
b) Sources and organization (Fo): it is related to the role of the textbook, the use of several sources and the type of content organization.

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4.4. Data analysis

For the analysis of the data a quantitative and qualitative methodology was used.

a) **Quantitative**: analyses on the basis of classic statistics were conducted following the model used by Martinez et al. [23].
b) **Qualitative:** the information of the declaratory, design and action level was treated in successive phases in an analysis of a thematic content [33, 39, 40]. These phases included transcription, selection of information units, categorization of the information units and codification of the information units.
c) We considered important to indicate that, in the declaratory level a fifth phase was included. In this phase the "propositional units" which reflected faithfully what the subject wanted to says, but with more sense [35, 39], were elaborated based on the selected, categorized, enumerated and codified units of information. Finally, in the action level it has been worked with frequencies to complete the description of the teacher's action [37].

5. Results

a) Questionnaire

The quantitative analysis of the information revealed that there are inconsistencies between the curricular beliefs and the action beliefs (Table 1). According to Pedro the scientific knowledge (Cc) is a product of the human activity. That's the reason why he indicated in his beliefs of action that he uses history to see the evolutionary and relative nature of science and applies this knowledge to everyday life. He also thinks that the scientific knowledge (Cc) is a product of proven theories and therefore is a true knowledge. So, what he is really teaching and going through in the classroom (subject matter content) is updated and simplified scientific knowledge.

Regarding the students' previous ideas (IP) he doesn't think that they are erroneous, but in the beliefs action he doesn't consider them an alternative knowledge and therefore he doesn't work with them.

However, in the contents sources and organization he manifest one with certain coherence when indicating that it uses diverse sources and it establishes relations between contents, also identified whereupon the main source is the text book and that is better to follow the logical sequence given by the official programs.

Table 1: Curricular beliefs, Level Identification

	Thinking	Action
T	Cc product of proven theories and therefore, is true Ce is simple and equal to Cc Logical sequence	What I explain is a version updated and simple of the Cc Las The IP they do not work Logical sequence Text book
C	Cc product human activity The IP is not errors Diverse sources	I works with the history of science and daily life Diverse sources

b) Interview (Declaratory Level: E)

b.1. Knowledge implied in the school context (Ce)

In the propositional units related to the knowledge implied in the school context (Table 2) we see that Pedro considers the subject matter contents are equal to the scientific knowledge. This knowledge is generated through an experimentally proven scientific method and should be actually teaching (**E.P.C$_1$.Ce**, **E.P.C$_{1.1}$.Ce**., **E.P.C$_{1.2}$.Ce** and **E.P.C$_2$.Ce.**). This shows us that the teacher considers the scientific knowledge to be above the subject matter content or scholar content. Which indicates an absolutist vision, that is to say, a truth has to be taught. Although Pedro doesn't declare contents those which are related to the habits, values and behaviours, he does say that the content he delivers should be of use in everyday life (E.P.$C_{2.1}$.Ce.).

Table 2: Propositional units in knowledge implied in the school context (Ce)

1. The content that you teach in the classroom, is a scientific knowledge? 2. What type of knowledge you beliefs would to give?
E.P.C_1.Ce. The school knowledge (content), is equal to the scientific knowledge and this it is a proven knowledge.
E.P.$C_{1.1}$.Ce. What I teach is related to the scientific method and this method is the one that allows to discover or to arrive at a scientific concept.
E.P.$C_{1.2}$.Ce. It supposes that this knowledge (the one that I teach), is a proven knowledge experimentally.
E.P.C_2.Ce. It would be teaching a proven knowledge scientifically, because thus, has value for the students.
E.P.$C_{2.1}$.Ce. Also what we teach must be used for the daily life of the students.

b.2) Sources and organization (Fo)

Although we obtained a greater part of propositional units, the majority of them is related to the organization of the content (Table 3). Pedro declares to use several sources (E.P.C_3.Fo.) but rather prefers to use those indicated by the Ministry of Education, in other words the textbook (E.P.$C_{3.2}$.Fo.). Pedro thinks that there is a truth to be taught, which is obligatory and which is defined by those obligatory contents determined by the official programs. He says that he organizes the information, but with the objective of being able to work with the students. In other words, he uses the information in practice which in any case means to simplify it and choose a less in-depth level (**E.P.C_4.Fo., E.P.$C_{4.1}$.Fo., E.P.C_5.Fo., E.P.C_6.Fo., E.P.$C_{6.1}$.Fo and E.P.C_7.Fo**.). Concerning the last point he says that in high school education in-depth knowledge of the content is not really provided and that it is even better to simplify (**E.P.$C_{4.2}$.Fo**.). When he talks about organization he refers to guidelines, which provide the possibility to know on which content one is working, although without being able to establish a relation between these contents. On the other hand, he indicates that it is not necessary to always work with these guidelines. He prefers to trust in his experience of years of work. In other words, he questions that the organization of the content is important (**E.P.C_5.Fo., E.P.C_6.Fo., E.P.$C_{6.1}$.Fo**.). Once again he indicates the importance of the official programs and considers that it is there where the contents and the way of working with the students can be found (E.P.C_7.Fo.).

Table 3: Propositional units in sources and organization (Fo)

1. Where do you obtain the information for your classes? **2.** You organize it? How? **3.** Is it important to organize the information? **4.** Where do you think should one obtain the information to structure the contents to be taught to the students?
E.P.C_3.Fo. I use several sources (Internet, magazine and courses) although I always keep to the logic determined by the Ministry of Education.
E.P.C_4.Fo. I organize the information and I take it to a practical level, which means to the level of my students.
E.P.$C_{4.1}$.Fo. I organize to simplify and to decrease the in-deep level.
E.P.$C_{4.2}$.Fo. There is not difficulty on contents in high school education, although there are exceptions
E.P.C_5.Fo. I frequently use guidelines (lessons) with some courses, in which I place that content I can see or work with the students.
E.P.C_6.Fo. I only sometimes use the guidelines. I've got it all in my head, which is the result of years of experience. So I know more or less what I have to teach.
E.P.$C_{6.1}$.Fo. Only some of the classes are planned in my notebook. I do it just to remember the sequence. It is not so important to organize the information.
E.P.C_7.Fo. The teacher should at least adhere to the official programs, because there he finds the minimum contents.

c) Didactic unit (Level of design)

Table 4: Information units originating of the Didactic Unit

U.P.1.C. "Fundamental Objective: Appreciate the common elements in the organization and structure of living organisms and the cell as their functional unit".
U.P.2.C. Transversal objective 1: Evaluate how the interchange between the cell and the environment is done and the aspects of the cell.
U.P.3.C. Fundamental transversal objective 2: To appreciate the common elements in the organization and structures of the living organisms and the cell as its functional unit.
U.P.4.C. Expected Learning 1: Understand that the cell as well as complex organisms are in continuous interaction with their environment, incorporating and expelling substances through the plasmatic membrane.
U.P.5.C. Expected Learning 2: Understand that some substances pass through the plasmatic membrane impelled by diffusion or osmosis, of free form or using transport proteins. While others do it against gradient, with cost of energy.
U.P.6.C. Obligatory minimum **c**ontent 1: Interchange between the cell and the environment.
U.P.7.C. Obligatory minimum content 2: Mechanism of passive and active transport
U.P.8.C. Obligatory minimum content 3: The cell as a functional unit - Organization, structure and cellular function - Comparison between animal and vegetable cells- Organic molecules - Molecular composition of the organisms - Structure and function of organic molecules - Interchange between cell and environment - From cells to tissues, organs and organisms - Metabolism - Cellular Activities - Tissue, organs and systems.

The didactic unit (planning) of Pedro indicates that the contents are organized by objectives with the most important one being the conceptual objective (**U.P.$_1$.C**). Basically, the organization is already given according to the different types of objectives (**U.P.$_1$.C., U.P.$_2$.C.,**

U.P.$_3$.C.). Nevertheless, the types of objective are not clearly defined. For example, the unit of information U.P.$_2$.C indicates a value objective, but he refers to a conceptual objective (acquisition of concepts). On the other hand, it is clearly stated in the design that the students must dominate a minimum conceptual content (**U.P.$_6$.C., U.P.$_7$.C., U.P.$_8$.C**.). With respect to the organization, the content is a listing of concepts which are not explicitly related one to another (Table 4).

d) Observation of classes (Level of action)

d.1) Knowledge implied in the school context (Ce): types of contents

We have located a total of 71 information units with a variety of contents. Nevertheless, we found out that most of the contents are conceptual contents, referring to the cell, its organization and function (Table 5).

The quantitative analysis of the data also indicated that the teacher fundamentally works with conceptual contents, in fact he made 178 interventions of conceptual type (Table 5).

Table 5: Number of interventions and types of contents

Nº OF INTERVENTIONS	IMPLIED CONTENTS
178	Conceptual
1	Attitudinal
3	Procedural

The procedural contents are understood as procedures through which he accedes to the conceptual contents, therefore, they are not really contents but part of the methodology.

d.2) Sources and organization (Fo)

With respect to the organization of the content we found out that the teacher presents a fragmented and linear organization, which depends on the different objectives. In addition, he is highly influenced by the textbook regarding the organisation of his classes in a logical sequence.

Finally, to find out what type of content the teacher works with and where he obtains it we considered it to be necessary to make an quantitative analysis of the interventions (frequencies) identifying all the interventions of the teacher and those of the student (Table 6).

He constantly uses the textbook to guide himself. In addition, he constantly extracts information of the students asking general questions which sometimes are not responded by the students. Very rarely he uses passed experiences as a source of information or analogies to explain things. Nevertheless, most of the information that circulates in the class comes from the teacher and consist of contributions of information, explanations and definitions of concepts (Table 6).

Table 6: Aspects analyzed in the interventions of the class of Pedro

A contributes the information without requirement	*Fo5.1*	*0*
A contributes information with particular requirement	**Fo5.2**	**1**
A contributes information with general requirement.	**Fo5.3**	**38**
A makes a question without requirement	**Fo5.4**	**13**
Total interventions students(A)	**52**	
Teacher contributes information (explanations).	**Fo5.5**	**142**
Text book (it is used)	**Fo5.6**	**6**
Experiences (information from experiences)	**Fo5.7**	**2**

A: student

Although, not very often it uses explicitly the text book, constantly observes it to guide itself. In addition, constantly it extracts information of the students, through general questions, that sometimes the students do not respond. Not very often it uses passed experiences to contribute to information or analogies to explain. Nevertheless, most of information that circulates in the dynamics of the class comes from the teacher and consist of contributions of information, explanations and definitions of concepts.

In synthesis, the teacher works of a traditional way in the form to conceive the contents. Basically the contents that are introduced come from the text book or the professor, through explanations. On the other hand, although the students make different contributions, those that are introduced as questions, answers to questions or by own initiative of the students has made. But they are not considered like sources of the content. In addition, the contents are introduced in an ordered and logical form.

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6. Conclusions and implications

The selection and sequencing of the content to teach are two necessary tasks of the professor and are related to the profile of action [31]. In the case of Pedro, the curricular beliefs (thinking) have been consistent with his practice (Table 10). It arises a strong traditional tendency at the declaratory and identification level regarding the identity of the subject matter content, its organization and its sources. He presents for example an absolutist vision of the scientific knowledge and an empiric and positivist vision about the origin of that knowledge. This influences in the form the contents have to be worked out with the students. Basically the content is logically transmitted in a simplified and reduced form, considering that the students must reach a minimum level of knowledge. In fact, the disciplinary content in this case is the most important thing within the teaching and learning process. The textbook constitutes the fundamental reference, the content is rather theoretical than practical and the ideas of the students are not considered to be an alternative content.

We think that to obtain a substantial change in the curricular questions and, therefore, in the practice, first of all it is necessary to know the beliefs to be able to later make the teachers conscious about what relation they have with their practices.

We consider that this is the kind of problems (obstacles) that has to be must be solved, because the beliefs of the teacher is a variable that can influence in the correct implementation of the curriculum. There is no doubt that this will contribute to an improvement of our understanding of the knowledge and the professional development of the Chilean sciences teachers.

Table 10: Synthesis of the results, the case of Pedro

	Level Identification (Questionnaire)	Level Declaratory (Interview)	Level Design (Didactic Unit)	Level Action (Observation)
Contents	Presents inconsistent in his curricular beliefs Constructivist with respect to the origin of the knowledge and in the relations that it establishes with the daily life. Traditional with respect to the identity of the school contents, the ideas of the students and the sources	Presents traditional tendency. Constructivist with respect to relating the contents to aspects of the daily life Traditional with respect to the identity of the school content. Presents an absolutist and empiro-positivist vision: the school knowledge is equal to the scientific knowledge but simpler. The scientific knowledge is a knowledge proven through scientific method. To organize means to simplify (reduccionist vision) and to decrease the complexity degree is translated to a list of contents without relations (segregate vision). No consider the ideas of the students like other contents.	Presents a strong traditional tendency Traditional with respect to the form in which to raise the activities that were developed with the students. The contents are presented like a list of concepts that the student must learn. The planning is by objectives of conceptual type (contents). The planning is incomplete. No present relations between the concepts. Is explicit that the students must reach minimum contents.	Presents a strong traditional tendency His class is developed on the basis of explanations and questions. Considers to the students like receivers of information. The content has a logical, ordered and rigid structure. The organization is fragmented and linear. He doesn't make any systematized or individualized diagnostic of the student's ideas. He use the strategy of questions to motivate for make participate to the students. He follows a strategy of transmission of the content, with a fast rate and without pauses. He guides himself by the text book.

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Beliefs of Chilean and Spanish Teachers' About Scientific Knowledge and Scholar Knowledge: First Advance

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Abstract. One of the most important goals of the contemporary scientific education is the development among students of a broad understanding of science and its relation to their personal and social life. The cognitive model of science (MCC) proposes, among other things, that science teaching should be reasonable and reasoned. In this sense, science teaching and learning must first of all be a reconstruction of the facts of science using the language and experience of the students. Nevertheless, these objectives still seem to be attained only to a small extent in the classrooms. In fact, the teachers' beliefs about scholar knowledge and scientific knowledge practice moving into the opposite direction. This prevents the teacher to be an agent that generates scholar knowledge which is epistemologically, ontologically and axiologically differentiated from the knowledge elaborated by the scientists. The objective of this investigation is to explore the thinking of a Chilean and a Spanish science teacher concerning the scholar knowledge and scientific knowledge. Both teachers were interviewed and the obtained data was qualitatively analysed. The difference between the declarations of the Chilean and the Spanish teacher were rather small. Both of them consider the scientific knowledge to be superior to the scholar content, where the more traditional scientific method acquires great importance. In addition, the text book reaffirms these beliefs for it is used as the principal content source. In conclusion, we can say teachers' beliefs that science teaching and scientific knowledge are equally valued for them. This prevents that the teacher develop science teaching agreed with actual models. Finally, these results and the later ones will allow one better description of how it is the science teacher thinking in order to give a better understanding about its and toward a new way to school science.

Keywords. Scientific Knowledge, Scholar Knowledge, Teacher.

Learning Geographic Space by Using Documents

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Abstract. This publication investigates the relationship between teaching and research through a methodological study on Geography teaching. This methodological approach favours the concept of organization and production of geographic space and the concept construction in the classroom through the use of base materials and primary sources.

The research was conducted in a seventh grade class from junior high school (called 'Ensino Fundamental II' in Portuguese) in a state school in Jundiaí. First, the observations were done in class in order to analyze the use of pedagogical materials. At the same time, interviews with the teacher and the students were done with a two- fold purpose: to know the dynamics of the relationships between the teaching – learning process and to conduct the reading and analysis of necessary documents involved in the planning of a methodology for Geography teaching. Next, workshops were done with students so that they could build the scientific concept of 'geographic space'. The base materials used were four cartographic maps from the city of Jundiaí (from 1657,

1888, 1893 and 2001) and the primary sources were memorial books and fourteen city photographs (from the XIX and XX centuries).

Since there are different concepts of learning and curriculum design, this research was based on Ausubel's theory of meaningful learning and contributes to Geography teaching in assuming that the work with the concept of geographic space in the classroom as a fundamental one in order to understand the relationship between society and forms of production.

Keywords. Geography teaching, Teaching methodology, Meaningful learning, Geographic space, Documents.

European Science Teachers: Scientific Knowledge, Linguistic Skills and Digital Media

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Abstract. This poster tries to describe the Socrates Comenius 2.1 project PEC: European Science Teachers: Scientific Knowledge, Linguistic Skills and Digital Media.

The intention of the project is to improve Initial Teacher Training (ITT) in order to teach Science, and the main aim is to use an innovative methodology including Language and Internet as classroom tools, methodology which can be transferred to other subjects, educational contexts and European countries.

Seven European Universities from Spain, United Kingdom, Slovakia, Portugal, Finland, Sweden and Turkey are working in this project. This combination of countries is due to the different results obtained by them in 2003 Pisa Report, for example, Finland was extremely successful whereas other members of the project got results worse than expected. We think that the cooperation among all the members of the project could enhance a better acquisition of scientific knowledge. Furthermore, some European countries have suffered a decrease of university students choosing science subjects when they have to decide their professional future. To increase pupils' motivation we try to elaborate and implement Science didactic materials based on authentic Science web pages selected from Internet. The project also focuses on the linguistic skills transferred to Science lessons to help school pupils to acquire scientific knowledge. We think that exploiting these materials with trainees, and guiding them to design similar materials could facilitate their first contact with their teaching of Science at school. This could also contribute to an improvement in the teaching of Science.

The project will last three years, and it is financed by the European Commission.

Keywords. Science Didactic, Initial Teacher Training.

Strategic and Financial Issues of University-Based Knowledge Centres in Hungary

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Abstract State universities in Hungary are in for major restructuring. Government funding is declining in real terms as the state is less and less willing to foot the bill of rising operational expenses alone. This forces universities to introduce tuition fees that are determined more or less by market conditions and to exploit this source of revenue. At the same time, however, the government assumes almost total control over the higher education sector. Student numbers increased threefold in the wake of economic transition and there is fierce competition in the labour market with employers growing ever more demanding when it comes to hiring new employees. The role of universities as knowledge centres is becoming increasingly important in today's globalized economic environment. With sustainable development increasingly gaining prominence, the prerequisites of which are – among others – the establishment and

extension domestic technological capacities, universities, academic research facilities and knowledge centres are growing in importance. Qualification is connected with environmental consciousness. Environmental consciousness is one of the most important positive externality and this is the main implement of the preventive environmental policy. Hungarian universities, however, are still being managed and financed using methods and practices that have been inherited from socialist times, while the competitive environment is increasingly demanding higher standards and more sophistication. Thus universities will have to overcome many difficulties on their way to better contribute to increasing the share of intellectual capital in output. Nevertheless it is their mission to help the Hungarian economy to converge and to do the catching up by laying the foundations for a knowledge-based society and for the creation and promotion of industries and services that are increasingly relying on intellectual capital.

Keywords. Globalized economic environment, Knowledge centres, Positive externality.

1. The Dimensions of Knowledge-Centres

The importance of education in general and of higher education in particular in creating a knowledge-based society that is up to the challenges of our modern age and in sustaining a balanced and high growth rate can hardly be overestimated. The major "breeding place" for skilled labour that is indispensable for producing goods that are exhibiting a high degree of value-added is higher education, which thus plays a crucial role in developing the key features of new products and technologies, in enhancing the standards of services and thus in the research and development activities underlying any innovation.

The way Europe is going to tackle the new and ever more complex challenges was set out by the Lisbon conference of the European Council held in March 2000. The main aims of the so-called Lisbon strategy are the following: "By 2010 Europe should be the most competitive and most dynamic knowledge-based society capable of achieving sustainable development and creating ever more and better job opportunities and a higher degree of social cohesion." Both the European Union and other developed market economies devote a great deal of attention to higher education and vocational training, to offer up-to-date knowledge and to getting more participants involved. The share of people taking part in some form of education, vocational training or higher education and the knowledge and skills thus acquired are key in determining how developed a given society and economy is. The quest for novelties, unearthing the driving forces of development and discovering new disciplines is being ever more strongly integrated into the system of higher education. Having been integrated, such state-of-the-art knowledge is being "processed" and passed on to the potential workforce and eventually transferred to the manufacturing and services sector to improve technical standards and enhance the usability, safety and environmental features of the goods and services and to thus induce societal and political changes in the long run. Two thirds of research facilities in Hungary are operated by higher education institutions. Some 40 percent of researchers are employed by the higher education sector full-time. Another basic task of higher education is to prepare students enrolling in ever larger numbers for their later profession in a sound and thorough way. By training a new breed of researchers higher education contributes to the desired broadening of research and development activities thereby simultaneously improving the standards of societal processes. In developed market economies it is becoming increasingly uncommon to stop studying after holding one's first degree, as permanent technological and economic change forces people to enrol in various forms of education or training, to take part in regular further education or even to swap professions as a consequence of economic transformations. The most intense and highest standard tasks pertaining to the training and retraining of the workforce are performed by the higher education sector.

2. Features of the Hungarian System

In Hungary's transition from a planned to a market economy the industrial sector took centre stage, where the formerly dominant heavy industry came to be superseded by industries manufacturing the latest wave of technologically more sophisticated products. Multinational firms with their greenfield investments and participation in the privatization of formerly state-owned companies have created a competitive industrial environment and structure. Under the new economic setup the machine industry is still playing an important role, whereas the degree of sophistication is a much higher one and technical excellence is an absolute must. A common feature, however, of post-communist countries' economic transition remains the missed opportunity to embark upon a comprehensive restructuring of the services sector that would otherwise play an even more crucial role in such countries' economies. Government funding of the higher education sector is, alas, still in short supply or at least it is not enough to cater for the increased needs of universities and colleges in the wake of a more global, more competitive and more demanding environment. As a consequence, the output of the higher education sector – workforce that is – combined with inefficient fiscal policies has not yet contributed much in the way of creating favourable conditions for attracting high-standard direct investment exhibiting the desired properties.

In the period between 2000 and 2004 we witnessed a change of paradigms in Hungarian fiscal policy aiming at strengthening internal resources and focusing on the promotion of internal demand and internal supply. The so-called Széchenyi Development Scheme, funding investments among others in the tourism sector and various government initiatives to provide domestic hospitality and tourism businesses with funds, did not yield the expected reward. Implementing an alternative economic policy at a time of global recession and falling Hungarian exports was the right decision by the government in order to sustain a growth-rate of about 5 percent. The new scheme tried to prop up GDP-growth with measures aimed at compensating for falling exports by stimulating domestic economic activity. The other reason behind the increased funding of the services sector in general and of the tourism industry in particular was that the balance of trade and thus the balance of payments started to run even higher deficits in the wake of the 9/11 events (the institutionalised threat by terrorism and the consequential changes in world politics) than before, which needed to be balanced in some way. This policy aiming at improving the country's balance-of-payments situation brought some relief but only in the short run (Table 1).

The balance of payments, just as the budget deficit, is exhibiting negative trends year after year, so the country has to deal with a twin-deficit. The permanent character of the twin-deficit seems to be inherent to the economic setup of Hungary.

What is more, the deficit – as compared to what is planned for the respective year and to prior year figures – has grown substantially both in absolute value and as in terms of GDP over the last couple of years. The weak resource allocation capability of the central budget, escalating deficits and slowing economic growth combined lead to a crowding out on the money and capital market, thus harming among others service sector enterprises, whose funding requirements go unsatisfied, as the flourishing government bond market – sparked by rising deficits and national debt – while providing a safe investment opportunity to foreign portfolio investors, is absorbing liquid bank and capital market resources. This phenomenon that may be verified by analysing the balance sheets of commercial banks and the national bank emerged in the mid-1990s and remains an unsolved challenge putting the stability of the national economy at jeopardy. Using the analogy of communicating vessels the consolidation of the situation and achieving equilibrium between the market for corporate borrowing and the government bond market may only be the result of a longer process exhibiting elements of organic economic development.

In the course of analysing the prospects of the Hungarian human resource and public services sector (including higher education) foreign direct and portfolio investment merits further investigation. After the end of mass privatization in 1996-1997 greenfield investment and investment in the manufacturing industry that served as the foundation for economic transition started to decline. Having privatised the energy and utilities sector state-owned assets available for sale were reduced considerably.

The role of universities as knowledge centres in an unfavourable macro-economic environment is a crucial one. In an environment of scarce funding by the government and declining foreign direct investment the Hungarian higher education sector needs to address the new competitive challenges in an adequate way. The Hungarian higher education sector as the entirety of knowledge centres, was subject to a spectacular, however mostly extensive development (Fig. 2).

Name	2002	2003	2004	2005
Balance of trade	-2203	-1556	-2453	-1549
Balance of services	542	-202	-127	480
- there of Tourism, Revenue	3448	3029	3 265	-
- there of Tourism Expenditure	1819	1788	2 302	-
- Tourism Balance	*1629*	*1241*	*962*	-
Balance of Payments	**-4974**	**-3374**	**-6976**	**-6405**

Table 1: Regional University-Based Knowledge Centres Receiving Government Funding (Source [3])

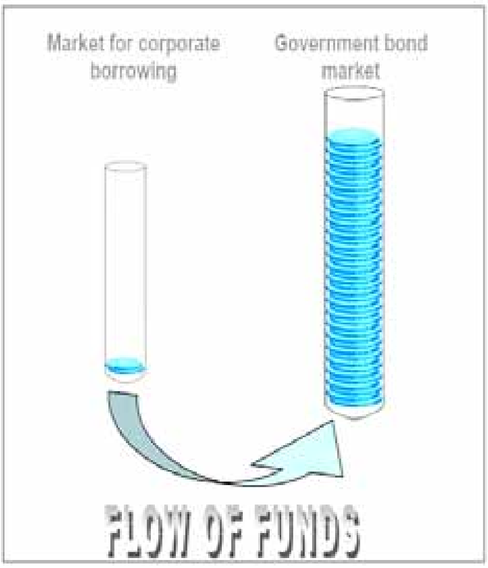

Fig. 1: The Communicating Vessels Effect: Desirable Situation to be Achieved in Future

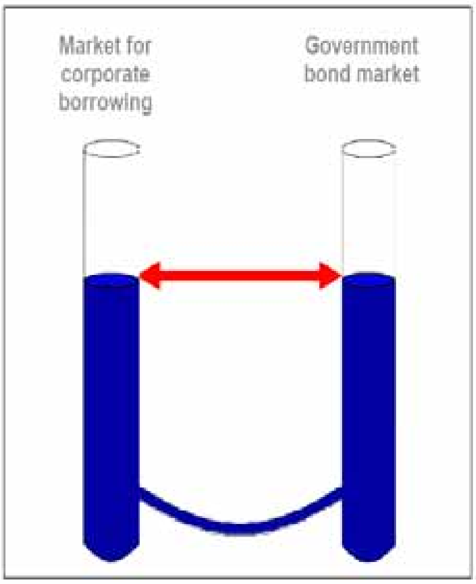

Fig. 2: The Crowding Out Effect: Current Situation

Increasing student numbers and institutional integrations have not yet yielded the desired quantum leap in quality, which would enable Hungary to join the vanguard of the global economy as far as devising and manufacturing high-standard goods and services are concerned. The only thing that merits positive assessment in the field of human infrastructure is that the number of students enrolling in higher education institutions increased threefold. Simultaneously, all other areas pertaining to human infrastructure in some way or another, such as day-nursery services or the consumption of "cultural goods", are exhibiting negative tendencies. The dynamic increase in the number of students was not accompanied by appropriate additional funding.

Choosing "new industrialization" as its centre of gravity, economic transition in Hungary neglected and could not promote a more intensive development of human infrastructure, respectively, thus losing ground relative to more developed parts of the global economy as far as competitiveness was concerned. Ever since the collapse of the Bretton Woods arrangement it has been a global trend that the development of human infrastructure is the driving force behind economic progress. The success of the American economy in creating jobs highlights that economic recovery may entail the creation of job opportunities in the private sector as well as in education, health care and social services. Well-educated and healthy workers are a real competitive force in the global competition of the 21st century. The protracted and continuing economic woes of the European Union may be traced back to the fact that all efforts taken in job creation remained more or less futile, above all in the services sector. Taking into account all these considerations it is an absolute must to invest heavily in the development of education, social services, culture and health care in the first couple decades of the 21st century. This may even entail a wave of job creation in the tertiary sector. As a consequence of such carefully implemented development strategies a new breed of workforce may emerge, who received the most modern knowledge from universities and are able to manage high-quality investments. Under the new scheme the workforce would be "maintained" by the health sector, whereby its positions on the labour market are further stabilised. As a result of the above processes there would be a workforce capable of managing and running technologically more advanced industries and services that correspond to the needs and expectations of the society.

3. Conclusions

Because of the fossilized disturbance of state budget is expected to be a bottleneck the resource endowment in operation of Hungarian higher education, so the abashments of higher education could be fossilized. Difficulties of financing enforce the marketalization in the organization-governance structure of universities. It is expected in medium-term the co-operation deepens between the high spiritual capital proportion claimant national sectors and searching supply of universities, leastways the universities will be forced upon from their position. Probably the acceptance of experiences of market based operating universities in the EU will be outrun in the future. The Hungarian universities have a key role in the alleviation of break away state of development between Hungary and 15 states of the EU. If the adjustment of Hungarian convergence program effect a source distraction in the finance of education and social net than the situation of Hungarian economy will be decline on.

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Hungarian Research Teachers Association

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Abstract. At the Talented Education conference a new initiative was launched, namely to establish an association for teachers supporting active research students, just like Hungarian Research Student Association. After a year of prearrangements, the Hungarian Research Teachers Associations were founded. The program has nearly 150 founders. Members are:

- teachers carrying out research, issuing scientific publications, taking part in conferences and other special scientific events. Students are often also involved in research work lead by teachers;
- teachers with high pedagogic experience supporting research students on special fields of science,
- teachers doing subject related research, developing education materials and methods, writing and editing learning materials and books contributing to a higher-level education.

These categories are not strictly separated, as there are teachers involved in all three categories listed above, since these activities are strongly related. Some of the founder members are not qualified as teachers but during their activities, they have close relation to education, so they are absolute supporters of the program and regularly contribute to students' research work. The main aims of Hungarian Research Teachers Association are to bring native and foreign researchers closer to each other through organized events, to provide them with help they need and establish an organisation to defend and represent their interests.

Keywords Hungarian Research Teachers Associations, Science Education

1. Introduction

In 1995 a new program has been established in Hungary helping talented high school students (in the age between 14 and 20) to find mentors who introduce them to scientific research in Hungarian universities or research institutes. The program gained an overwhelmingly positive response from the Hungarian scientific community. Since 1996, the number of the individually involved students has been growing steadily thanks to the intensive media support and the nationwide and international reputation. "Old students" indicates those youths who passed the age of 20 and quitted the HRSA Mentorship Program. Most of them joined research clubs and teams at their university. Some of them already finished their PhD studies and became a mentor of the Mentorship Program. Most of the students has his own topic or field of interest when he joins the Mentorship Program, some of them exactly knows what kind of research he want to do. In the past few years, there was a swift increase in the "Natural Sciences" topics, which is in line with the rapid development of bio and geno sciences.

The cooperation between talented students and the professors is helped by a book containing the list of our mentors who accept high school students in their laboratories. We are proud to say that nowadays there are more than 700 researchers who support our initiative. Many of these senior scientists are of the highest scientific merit: 118 are members of the Hungarian Academy of Sciences, including Nobel Laureate George Olah. The list of mentors is originally published as a book and it is delivered to each member also via e-mail containing a wide range of keywords (approximately 3000 from abortion to x-ray micro-analysis) to help the students decide what their field of interest really is. Every high school head teacher gets it in Hungary and in the surrounding countries as well, because we have several hundred ethnic Hungarian students from neighbouring countries (Slovakia, Ukraine, Romania, Serbia, Croatia and Slovenia). Since the beginning, we have been able to offer more than 7,000 students—not only from Hungary, but also from other Eastern European countries—a chance to work in a real research laboratory. It has been a great success so far, as many of these students become interested in pursuing a career in scientific research or teaching. All around the world there is an increasing number of initiatives that ensure research possibilities for motivated secondary school students.

These initiatives, however, work in isolation and in many places they work almost completely out of public knowledge. This is why it is deemed important that UNESCO and other sponsors ensured a possibility for the exchange of experiences among the best initiatives worldwide within the framework of the Network of Youth Excellence. More then 30 countries all over the world already consider joining to this network. The Network of Youth Excellence has only organizations as its full members, all regional, national and international organizations are eligible, which have an experience of at least two years in

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extracurricular education of young students - ages below 21 - in science and technology.

The Network is completely independent, and works closely with the UNESCO World Academy of Young Scientists to establish contacts with other young scientists working as university undergraduates, Ph.D. students or postdoctoral fellows world-wide.

2. First steps

Figure 1. Logo of the new association

At the Talented Education conference a new initiative was launched, namely to establish an association for teachers supporting active research students, just like Hungarian Research Student Association. After a year of prearrangements, the Hungarian Research Teachers Associations was founded in December 2005. The program has nearly 150 founders.

3. Members of the association

The presidency of the association is:

- Dr. László István Lagzi president,
- Erika Fodor vice president,
- Zsuzsanna Kolostyák Pljesovszki vice president.

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Members are:

- teachers carrying out research, issuing scientific publications, taking part in conferences and other special scientific events. Students are often also involved in research work lead by teachers;
- teachers with high pedagogic experience supporting research students on special fields of science,
- teachers doing subject related research, developing education materials and methods, writing and editing learning materials and books contributing to a higher-level education.

The association has members from Hungary and other countries (Romania, Serbia, and Slovakia).

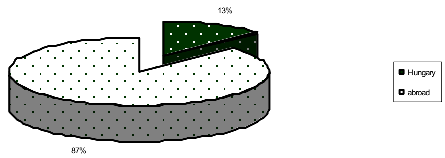

Figure 2. Distribution of the members of the association

These categories are not strictly separated, as there are teachers involved in all three categories listed above, since these activities are strongly related. Some of the founder members are not qualified as teachers but during their activities they have close relation to education, so they are absolute supporters of the program and regularly contribute to students' research work.

The patrons of both programs are László Sólyom, President of the Hungarian Republic, Bálint Magyar, Minister of Education and Szilvester Vizy, president of the Hungarian Academy of Sciences.

Figure 3. The II Conference of Hungarian Research Teachers Association

4. The main aims of the new association

The main aims of Hungarian Research Teachers Association are to bring native and foreign researchers closer to each other through organized events, to provide them with help they need and establish an organization to defend and represent their interests. The II Conference of Research Teachers was held at

Lánczos Kornél Secondary School of Sciences in Székesfehérvár this February.

The aim of the conference was to set the long-term concept of the association in form of a workshop.

Aims and ideas were formulated which contribute to make the program's aims and teachers' interests widespread known:

- Organizing the conference of Research Teachers – twice a year, in spring and autumn – with presentations and workshops that enforce building and keeping contact between teachers, and publishing research results and achievements.
- Creating an electronic journal on the net to provide the possibility for research teachers to publish their achievements.
- Establishing a database – like students' mentors list – containing the names of university researchers and teachers who make research work possible for secondary school teachers.
- Taking part in education of teachers at universities, which enable graduate teachers to acquire research methodology, setting up organizations for research students and supporting teachers working at public education institutions to attain PhD qualification.
- Providing research circumstances for teachers: a day for research, establishing science fund.
- Interest organization of research teachers: formulating proposals to Ministry of Education and research budget sector.

Figure 4. Website of the Hungarian Research Teachers Association

Making and keeping contact with Hungarians in other countries and international pedagogy associations.

Further information about the association is constantly available at website of Hungarian Research Teachers Association (www.kuttanar.hu).

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Spanish Science Teachers' Attitudes about Social Dimension of Science and Technology: First Advance

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Abstract. The most important goals of contemporary science education are related to an enlarged understanding of the nature of science and technology. Research of teachers' attitudes about the nature of science have acquired great importance, nevertheless, about the nature of technology have had less attention. In this way, the study analyze teachers' attitudes on the social dimension of science and technology One hundred and twenty four public secondary school Spanish science teachers were sampled. The initial results show that teachers' attitudes about science are better than about technology and revealed medium to inadequate understanding of the social dimension of techno-science.

Keywords. Nature of science and technology, Science Education, Teachers' Attitudes.

1. Introduction

As 1990's the scientific literacy consolidates as an important social challenge [1], and is recognized like the term that better expresses the goals of contemporary science education [2]. From there and through curriculum the scientific literacy supposes a continue development a diversity of objectives that culminate with students' achieve the multidimensional scientific and technological literacy. Although can seem an extremely ambitious objective, has a great relevance for the personal and social education. In summary, scientific and technological literacy is a part of long life education culture and a necessary theoretical-practice tool in order to live in today's society.

The multidimensional scientific and technological literacy make understanding the essential structure concepts about science and technology, making possible the better understanding scientific disciplines including their epistemological, historical and sociological nature. It also implies understanding the relation between science and the technology with the social problems [3,2,4].

To teach the social context of science means to give to students the idea that science and technology are a part of the culture and a part of his life. From this perspective science education acquires greater riches and realism and meaning allowing connecting the school science knowledge with the personal and societal issues [5]. Lack of this dimension hinder to learn the real science and development scientifically cultured citizens.

In this sense, we considered science teaching rarely includes the social dimension of science and technology in the classroom, among other reasons, for the teachers' misconceptions of the *nature of science and technology*. On the matter diverse authors indicate the most teachers' have a non–context, neutral and aseptic views' about scientific activity [6,7,8,9, among others]. In this case we assumed the hypothesis the teachers' cannot possible teach what they do not understand [10], or don't know.

Although the didactic research the science teacher views' acquired great importance [11, 12] specially, oriented to epistemological beliefs, nevertheless, the sociological beliefs has had less attention.

2. Objective

For that reason, and considering that the exposed is part of a extend study we have considered one's of the main objective to analyse with quantitative methods the science teacher's attitudes about the some aspects of the science and the technology social dimension. Concretely, science and technology definitions', society influence in science and technology, the influence of science and the technology in the society, the social construction of the scientific knowledge and the role of the public and private institutions on the scientific endeavour.

3. Methodology

The sample for this study consist of 124 sciences teachers' of Publics' Secondary School (PSS) of Barcelona, Spain. The data collected with questionnaire COCTS that as a model of multiple answers to measure attitudes in sciences, technology and society [13]. This questionnaire is an adapted instrument of VOSTS [14, 15, 16] and TBA-STS [17] unlike a unique answer.

This model of multiple answers allows maximizing the information available in each question. Persons has 9 options to indicate agree/not agree with each one of the phrases of the each questions. In addition there are three options that gather diverse reasons not to answer. From questionnaire diverse standardized attitudinal index (-1, +1) for each one phrases are obtained. Each one phrases was classified accorded to judge like, adequate, reasonable and naïve according to which the answers given by the participant in the study are valued.

4. Results and Discussion

Our results show a predominance of positive values for the averages have adequate and naïve global attitudinal index (GAI). Reasonable option has a low average and negative (Table 1). Also it is necessary to show that 21.3 % of total of answers correspond to the fixed options and that are scored like zero.

Table 1: Summary average and st. dv. global attitudinal index for each option

Options	Average GAI	Des. Tip.
Adequate	0,3047	0,27
Reasonable	-0,107	0,35
Naïve	0,1123	0,30

Analysis by questions the high global attitudinal index is for 10111 referred the science definition (0,27) and 20111 of the influence of the public and private in scientific and technology (0,23). The question 70711 about the social construction of scientific knowledge is positive but low (0,067). The index of 10211 about the technology definition has a very low and negative value (-0,030) (Table 2).

Table 2: Summary of attitudinal index for options (adequate, reasonable, naïve) and for questions (N=124).

Question	Theme	Adequate	Reasonable	Naïve	GAI
10111	Science definition	0,3861	0,0726	0,3639	0,2742
10211	Technology definition	0,0363	0,1702	-0,2964	-0,0300
10411	Relation S-T	0,3599	-0,2944	0,3014	0,1223
20821	Societal influence on science	0,3542	-0,0746	0,018	0,1146
70711	Cultural influence on science	0,1653	0,0524	-0,0161	0,0672
20211	Influence of public and private institutions on science and technology	0,5262	-0,1038	0,2702	0,2308

With these results is possible to affirm that science teachers' have greater facility to identify definite phrases in options adequate or naïve. Nevertheless, the reasonable questions that less exposes a defined idea on the subject present greater difficulty. The teachers shows better understanding about what science is, less for explain what technology is, and about the societal, cultural e institutional influence on science and technology.

The science teachers' has only a regular knowledge to deficient in most aspects of social dimension treated in this work. Without a doubt, it is an unfavourable situation to advance positively towards the contextual science teaching and to enhance the multidimensional scientific and technological literacy in the classroom.

5. Acknowledgements

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The Subject "Satellites" on Portuguese Primary School Development of a Pedagogical Model

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Abstract. The development of several activities aimed for the study of the subject "satellites" with Portuguese primary school children are shown here. The proposed activities are based upon different topics explored horizontally in the Portuguese Curriculum, in an interdisciplinary and unified perspective, promoting the integration of scientific interrelated concepts in diversified contexts. Thus, we advocate that this subject can be explored in a classroom context, although it can be reinforced when applied in other situations, such as class Projects, constituting a catalyst element for the processes of education for the lifelong learning process. The activities' methodology, in concordance with the Portuguese curriculum for primary education, intends, on the first hand, to focus science education on investigations, in order to achieve the activation of several processes related to learning. It is suggested that these activities be implemented as problem-solving in order to attain possible answers for the questions posed. Finally, the results of a case-study designed to elicit fourth-grade Portuguese pupils' ideas about this subject are shown. From the analysis of materials produced by pupils, it was possible to categorize pupils' ideas. As a main conclusion, it can be said that pupils reveal, in their majority, previous knowledge scientifically accepted. In addition, the questions raised by pupils show their motivation for research and future learning on this subject, justifying the suitability and the execution of the proposed activities.

Keywords. Satellites, Physics, Primary School Science, Teaching.

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1. Introduction

Following several discussions about the main objectives of education, quite often statements in the literature claim that education systems can be adapted and developed to deliver the basic skills and competences to everyone's needs in the knowledge society; to make lifelong learning attractive and rewarding and to reach out to everyone in society, however far from education and training they may consider themselves, with ways of developing their skills and making the best use of them [2]. In what concerns science education, it is quite well established that the goals for school science are to educate students who are able to: i) experience the richness and excitement of knowing about and understanding the natural world; ii) use appropriate scientific processes and principles in making personal decisions; iii) engage intelligently in public discourse and debate about matters of scientific and technological concern and iv) increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers [9]. This way, some views [6] recognised that the science curriculum for 5-16 should be seen primarily as a course to enhance scientific literacy. On the other hand, the importance of science education is acknowledged taking into account that Science involves using the knowledge that has been generated through process skills to create and continually refine testable models of nature that helps one to describe, explain, predict, and to conceptualise observable phenomena of nature.

More particularly, several authors emphasize the exposure to science in primary school in order to develop the notion that knowledge is based on evidence and that evidence is critical for sensible community decision making. This way, science in primary school tries to develop skills to make informed decisions on issues of science, technology, the environment and one's health and well-being. Moreover, it has been shown that science in the primary school is one of the most exciting parts of children's and teachers' work [5].

2. Low resolution satellite imagery reception systems in primary education

With the overwhelmingly accelerated growth of the satellite remote sensing community, data from satellite-based Earth observations is, nowadays, very simple and easy to obtain. With just a few mouse clicks, it is possible to have access to satellite images. Among others, it may be worth to mention products like Google Earth [4], or websites like [3], or [10]. However, the authors' conviction is that low-resolution satellite imagery reception systems can be operated in a classroom environment, enabling pupils to capture real-time satellite signal, processing it and obtaining their own satellite pictures.

Figure 1. NOAA-17 satellite image received by the Universidade de Aveiro APT reception station on July 6, 2005, at 11:57 (local time)

A simple satellite receiving station can be assembled, relying on the Automatic Picture Transmission (APT) mode of the Advanced Very High Resolution Radiometer (AVHRR), onboard the National Oceanic and Atmospheric Administration NOAA Polar-orbiting satellites. Historically, APT was initiated with the TIROS-8 satellite, launched in December 1963.The APT is a low-resolution analog transmission of AVHRR data. Two channels of reduced-resolution (4 km) data are continuously transmitted using analog Very High Frequency (VHF) signals (137 - 138 MHz) at reduced rates (120 lines per minute).[9]

The APT reception system comprises a VHF receiver (one can be bought for nearly €200), a 137 MHz antenna (a turnstile antenna can be bought for less than €100), a 137 MHz pre-amplifier (cheaper than €60) and a personal computer.

The processing system makes use of the computer's soundcard, and the demodulation of the satellite signal can be made with free software, like WxtoImg (free of charge, for personal, non-commercial purposes). With this system is possible to receive very interesting satellite images, like the one depicted on figure 1.

A closer look at figure 1 reveals all the marvels of the implementation of satellite receiving stations in the primary education classroom: the possibility of acquiring real-time satellite images establish a pedagogically rich experience, that contributes to the enrichment of the curricula, and can be viewed as an important pedagogical resource for promoting scientific literacy [7] and scientific culture.

3. Portuguese primary school curriculum and Methodological suggestions

The programme for the curricular area "Estudo do Meio" (Environmental Study) of Portuguese primary education gathers a few subjects on which several activities may be developed, in an innovative way.

Having in mind that the Portuguese curriculum points out to the fact that the learning experiences should emphasize the direct observation of reality, the use of instruments, the interpretation of data, the formulation of problems and hypothesis, the research planning, the prediction and assessment of results, the establishment of comparisons and the use of inference, generalization and deduction, the proposed activities aim to develop specific competences, in an interdisciplinary and unified perspective, such as:

- understanding current weather (2nd grade);
- recognising several weather conditions (windy, warm, rainy, cold) (2nd grade);
- relating the seasons with weather conditions (2nd grade);
- distinguishing different landscapes (3rd grade);
- finding locations in maps (3rd grade);
- using the directions (N, S, E, W) (3rd grade);
- observing aspects of Portuguese shore (Ria de Aveiro, Cape Carvoeiro, Cape da Roca, etc.) (4th grade);
- identifying and locating cities on a map (4th grade);
- using maps of different scales to locate Portugal in the Iberian Peninsula, in Europe and in the World (4th grade).

Thus, the activities with APT satellite receiving stations may begin on the 2nd grade in an evolutionary perspective along primary education to explore curricular subjects, integrating low-resolution satellite images, and all the underlying technology.

The methodology of these activities, in concordance with the Portuguese curriculum for primary education, intends to focus science education on investigations, in order to achieve the activation of several processes related to learning. It may be worth to mention, however, that the activities should consider all areas of the Portuguese primary education, not only just Science, Mathematics, or Geography.

This work relies on hands-on activities that should be implemented as problem-solving in order to attain possible answers for the central questions, in which the activities are based upon. Exchanging ideas in small groups or class group discussion promotes the use of language and social skills. This way, the contribution of each pupil will depend on his/her knowledge, but also on his/her language level, enhancing, thus, the importance of group work, even when pupils come from different linguistic and cultural contexts. Also, it should be considered as a proposed objective the effective implementation of satellite APT stations in the primary school environment as well as the establishment of a satellite reception schools network.

4. Some suggested activities

The proposed activities develop different topics explored horizontally in the Portuguese Curriculum, in an interdisciplinary and unified perspective, promoting the integration of scientific interrelated concepts in diversified contexts.

Five proposed activities for the integration of APT satellite receiving stations in primary education are shown above, according to [1].

4.1. Satellites: what are they? Where are they? What can they do for us?

This first, introductory-level activity intends to present pupils to this subject and some associated concepts, as well as creating the space for discussing the importance of satellites, nowadays. Thus, this activity can lead pupils to:

- understand the meaning of the word satellite, recognizing differences between natural satellites (like the Moon) and man-made satellites;
- distinguish polar-orbiting satellites from geostationary satellites;
- acknowledge the importance of using satellites in several fields of study;
- distinguish different uses of satellites, along different fields of study.

4.2. What and how does a satellite "see"?

In this activity, pupils would investigate, in order to attain a possible answer for this question. As a final goal, pupils should be capable, at the end of this activity, of:

- recognise that satellites with different orbits have different fields-of-view;
- understand de predictability of satellite orbits;
- distinguish, in a satellite tracking program, geostationary satellites and polar-orbiting satellites, in terms of the path followed;
- identify the most suitable satellite pass, in order to capture a satellite image over Portugal.

4.3. Where are we?

With this activity, satellite images and maps are used in order to develop, in pupils, competences related to map interpretation and critical analysis. It is intended that pupils, through group work, discuss ideas, produce conclusions and make use of geographical skills in order to:

- identify their location in maps and satellite images;
- identify neighbouring countries and their capitals;
- identify neighbouring cities;
- identify national boundaries.

4.4. What is a satellite image made of? How is a satellite image obtained?

The main purpose of this activity is to lead pupils to the comprehension of the nature of a digital image. Thus, the concept of pixel as the smaller element of a digital image, and the concept of resolution are introduced.

At the same time, pupils are put in contact with a satellite image reception station, understanding how the satellite APT signal can be recorded and processed, to obtain an image.

4.5. Clouds in satellite images

In this last proposed activity, pupils will use their knowledge about cloud formation in order to compare several representations of clouds in satellite images. Then, they would be asked to group clouds, in a satellite image, according to a personal classification scheme. Infrared images and their temperature-related properties will be presented, so that pupils can distinguish low clouds from high clouds, based on its brightness temperature. Additionally, pupils can be lead to correlate the rainfall occurrence with the fraction of high clouds in a satellite image, developing, thus, a rainfall map.

5. Preliminary results

In order to test the suitability of the proposed activities, a case-study was performed with an urban fourth-grade class, from Viseu, composed of 21 pupils: 16 boys and 5 girls. In terms of their performance, it is an average class.

The activity on which this case-study was based consisted on the elicitation of pupils' ideas about satellites, followed by the data analysis. Thus, "what is, in your opinion, a satellite?" was the main question of this preliminary study.

Pupils were asked to draw something related to their knowledge about this subject, without any previous explanations. This strategy gave pupils the sufficient concentration time, in order to represent their previous knowledge. There were no impositions for the drawing, so the limit of the activity was conditioned by pupils' creativity.

After this task, the drawings were gathered and pupils were asked for writing a few lines of text, stating what a satellite is, in their opinion. Additionally, pupils were invited to include in their texts some aspects of the theme "satellites" that they would like to learn. When the activity came to its end, all the pupil-produced materials were collected, and subsequently analysed. Extracted ideas from the written texts were independently coded by a Senior lecturer of the School of Education of Viseu. The analysis of the collected data was organized and represented according to systemic networks, revealing answers: i) scientifically correct answers (subdivided in partial and totally correct answers), ii) scientifically incorrect answers and iii) non-coded answers. In order to guarantee the anonymity of the children, their names were changed, being respected only their gender.

As for the representation of pupils' knowledge revealed in their drawings, the following figures show some of the results.

Figure 2. Ana's representation of a satellite

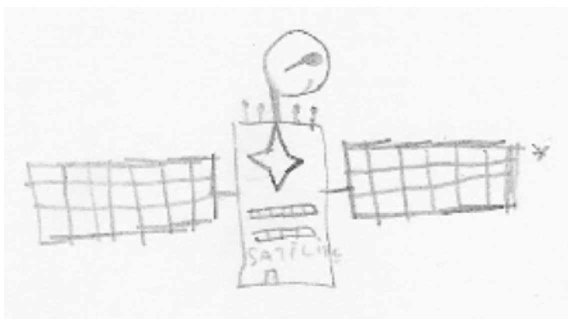

Figure 3. Bruno's representation of a satellite

From a first analysis of these drawings, it is utterly visible that pupils possess some previous knowledge about satellites, namely in what concerns to the satellite structure (in particular, the existence of solar panels, presented in the majority of the drawings).

Taking into account the previously described analysis of the texts written by the pupils, totally correct answers were considered the ideas which indicate a satellite as a receiver (R) and a transmitter (T) of information. Therefore, answers evincing the information transmission or receiving role of satellites were considered partially correct. According to figure 4, from the 21 analysed texts, 11 totally correct answers were found, 6 partially correct, and 3 pupils gave answers not accepted (O), from the scientific point of view. Only one answer could not be coded (NC) according to the network classification parameters.

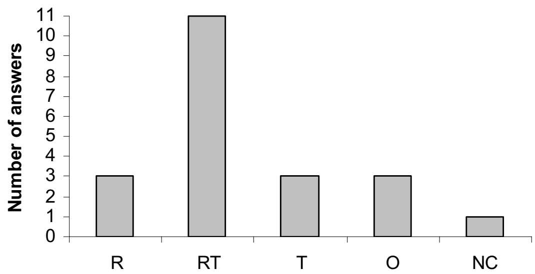

Figure 4. Distribution of pupils' answers

Having a detailed view of these answers, it is worth to mention a pupil's idea about the functions of data acquisition and transmission by satellites for meteorological purposes (figure 5) and another text, that evinces the important role of satellites in communications relay (figure 6).

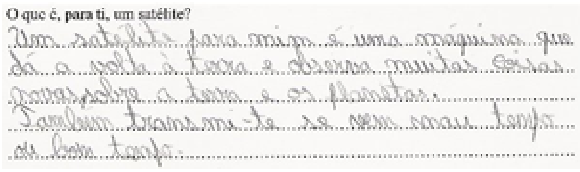

Figure 5. Carlos' answer: "to me, a satellite is a machine that goes around the Earth and observes many new things about Earth and the other Planets. It also transmits what the weather is going to be like"

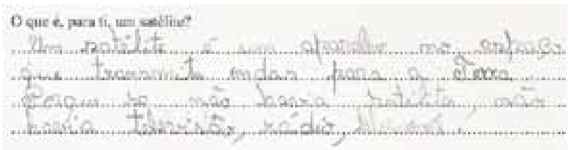

Figure 6. Diana's answer: "a satellite is a device in space that transmits waves to Earth. If satellites didn't exist, it wouldn't exist television, radio or mobile phone"

The pupils also point out several questions that they would like to discuss, showing their motivation for future or further learning on this subject, as figure 7 depicts.

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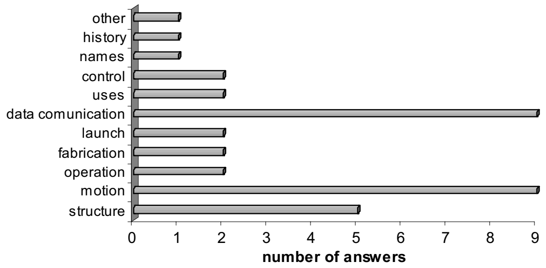

Figure 7. Pupils' interests about satellites

As a final remark, it should be noted the interest of pupils about the history of satellites and satellite communications, as well as satellite orbital motion.

6. Conclusions

This study reveals, as a main conclusion, the existence of a set of scientifically correct pupils' ideas about satellites. Therefore, the results shown justify per se, the suitability of the proposed activities in the classroom environment.

These results can, inclusively, constitute a vow of hope to teachers and to science education investigators: 4th grade Portuguese pupils have, in their majority, scientifically correct ideas about satellites, and their motivation is shown by the large quantity of questions that they desire to investigate.

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Inquiry Activities in Science Teaching: A Proposal for 8th Grade Students

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Abstract. Teaching science through inquiry activities has a long history in science education. Since the sixties, science curricula have been promoting inquiry for translating a useful idea concerning the nature of science and contributing to the development of skills. Recently, with the implementation of Curricular Orientation, after the Curricular Reorganization of the middle school, this strategy was promoted for the potentialities associated with it. In inquiry activities, the students' intellectual progression is based on problem-solving, allowing them to reconstruct their own way of thinking and to face new situations and challenges. So, these activities are many-sided and involve the students in engaging, planning, collecting and organizing data, recording evidence, drawing conclusions, communicating and evaluating them.

In this paper, we present a study carried out with 39 8th grade students attending Physics, and involved with inquiry activities, in the scope of subject sound. It aims at describing the difficulties felt by the students when involved in

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this kind of activity. The students constituted the first source of data. The data was collected through interviews in focus groups, written documents produced by the students and tape records of students while performing the activities, for trustworthiness. Content analysis of the different data was carried out to discover the difficulties. The findings point to difficulties in four different domains: attitudinal (working in group and developing autonomy), cognitive (writing previews, interpreting data, arguing, drawing conclusions), meta-cognitive (transposing what they have learned) and procedural (designing, executing). Besides that, it is possible to find that this kind of activity allows the student to construct their knowledge concerning the concepts underlying the thematic of sound, and reasoning, procedural, communicative skills inherent to scientific work.

Keywords. Teaching science through inquiry activities, Skills development, Learning difficulties, Inquiry activities.

1. Introduction

Teaching science through Inquiry Activities has a long history in science education. These activities began to have an important role in science curricula one century ago (Bybee, 2000). Before 1900, most teachers saw science as a cluster of knowledge that the students had to acquire by direct instructions. Meanwhile, in 1909, Dewey criticized this perspective saying that science is more than a mount-up of knowledge. Science must be understood as a process or method to learn. Between 1950 and 1960, the need to introduce inquiry activities in science curricula became evident. Schwab (1978) was the propelling force of this idea, arguing that, if the students want to learn the methods of Science, they have to be involved in their own process of learning. For Schwab, science is seen as a conceptual structure that results from new evidences, which constructed through exploration of the natural world. The works of Schwab, Dewey and others, including Bruner and Piaget, in the fifties and sixties, influenced the nature of the curricula developed in those decades, and they began to include inquiry activities (NRC, 2000).

When we try to clarify the concept of inquiry activity, we find variety of definitions to which each author contributes.

Inquiry activities, according to NRC (2000), are many-sided activities that involve: observation; questioning; research in books and other sources of information; planning investigations; reviewing what is already known about an experiment; using tools to analyze and interpret data; exploring, predicting and answering the question; and communicating results. Inquiry activities require the identification of the problem using logical and critical thinking, and considering alternative explanations.

The definition stated in the NRC is shared by Carlson, Humphrey and Reinhardt (2003). For these authors, inquiry activities involve the students dynamically in the search of the way to find one or more solutions. This methodology has the potential to promote the understanding of phenomena and the development of other capacities. These potentialities allow us to meet the demands of the current world.

For Ash and Klein (2000), inquiry activities are those that involve exploration processes of the materials and the natural world. This process is led by us through curiosity, interest and the perseverance to understand and to solve a problem. According to the authors, learning occurs by asking questions and making predictions, by formulating hypotheses, and by creating models or theories.

Miguéns (1999) also considers that inquiry activities allow the exploration of problems. The author enhances that these activities are an opportunity for students to build new conceptions from previous knowledge. According to Almeida (2002), these activities pick up students' student's previous knowledge and interests and so in turn the students assume activities as a personal project. Carlson, Humphrey and Reinhardt (2003) consider that kind of activities as contributing to students' greater knowledge and participation. However, it is essential to discover what knowledge the students have of the natural world and to use those ideas as the starting point for the inquiries; to use the students' ideas as a baseline for the growth of their knowledge; to encourage the students, during the investigation process, to display their ideas, interests, questions and suggestions; to help the students establish links between their ideas/questions and their ideas of the outside world; and to help the students reflect about their learning.

The potentialities of these activities allow us to respond to the demands of the current world, thus constituting an educational strategy established by the curricular guidelines of basic and secondary education. These guidelines state that the student's intellectual progression must be based on problem-solving, allowing him to reconstruct his own way of thinking and enabling him to face new situations and challenges: "the adjustment or elaboration of the subjects' programs must focus on the essential; more than memorizing large quantities of information, which nowadays is more accessible, what matters is to know how to look for it, to systemize it, to evaluate its relevancy for the problem in question, to explore it in its potentialities. Today, these skills are considered indispensable and must be properly valued and developed (DES, 2000).

Many times, in science education, inquiry activities had been equalled to the traditional notion of scientific method. Currently, this traditional version has been put aside. Several philosophers and science historians support that there is no single scientific method to describe how to make science. Many go farther, sentencing that there is no definition for the expression "scientific method" (Finley & Pocoví, 2000).

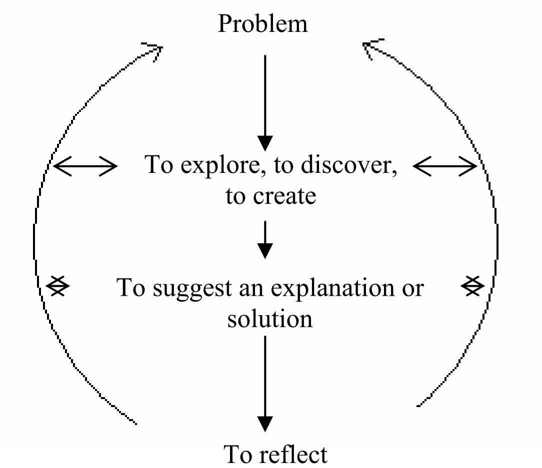

Figure 1. The cycle of the inquiry activities according to Carlson, Humphrey and Reinhardt (2003)

The presumed idea of the existence of a universal scientific method, with well defined characteristics, transmits wrong conceptions to the students about the process of science production by scientists. Thus, there is no unique model to carry out an inquiry activity, which is usually present in problem-solving (Almeida, 2002). For example, Carlson, Humphrey and Reinhardt (2003) propose a model that consists of the stages presented in figure 1.

According to this model, in the initial stage, students describe the problem that they want to resolve, and then they enter the stage of exploring, discovering and creating. Here, students explore the question, the materials and their ideas on the scientific phenomenon. In this stage, the students plan the problem's resolution, investigate the materials they need, collect and organize data, experiment and prepare future experiments. When the students propose an explanation and solution, they are building new knowledge based on their observations, data collection and conclusions. This construction occurs individually, though dialogue with colleagues and with the teacher is very important. In this stage, new questions may appear on the discoveries they have made, so it is necessary to give the students' time to think over their ideas. In the last stage, the students reflect on their knowledge and think about future investigations, formulating new questions. This cycle describes a dynamic process that reflects the way science is made. Like scientists, students do not necessarily have to go from one stage to another (Carlson, Humphrey, & Reinhardt, 2003).

Another instruction model that can be adopted is based on the constructivist vision defined by *Biological Science Study Curriculum* (BSCS) and is known as the model of the Five *"E's"* (Lorsbach, s/d.). This model is a learning cycle comprising 5 *"E's"*, as shown in figure 2.

Figure 2. Model of the Five *"E's"*

The cycle usually begins with the *Engage* stage, that is, with the attempt to motivate the students for the study of a certain subject. This stage intends to get interested and curious about the subject. For this, a problematic situation is presented, for example, through an inquiry activity. From here, the students' thinking is stimulated (in terms of questioning, identifying, and defining the problem) and they are encouraged to establish relations between the new learning experience and others carried out previously. At this point, it is important that the teacher gets an idea about what the students already know and identifies their alternative conceptions. During the *Explore* stage, the students are given the chance to work in group, without any direct instruction from the teacher, thus allowing for peer interaction and promoting the socio-cognitive conflict. The students have to question, predict, place hypotheses, design a way of testing them, test them recording their observations, discuss results with their peers, compare possible alternatives and organize the collected information. The *Explain* stage aims to create an articulation between the observations, ideas, questions and hypotheses. The students have to be encouraged to: explain, in their own words, the concepts that emerged from the learning experience; use the results (observations and measurements) to support their explanations; listen critically to their colleagues' and teacher's explanations. In this stage, the teacher must define the concepts, clarifying the text to be produced and using the learning experience of the students as base for the discussion. In the *Extend* stage, the students should establish relations with other concepts, and apply the concepts and capacities in a new situation, using their formal definitions. Argumentation, based on the known data and evidence can be stimulated. The strategies used in the exploration stage can also be applied here, as the students must use previous information to place questions, to consider solutions, to make decisions, to experiment and to record observations. The *Evaluate* stage should desirably take place during the whole learning experience, that is, throughout the different parts that constitute the learning cycle. In this stage, the students can evaluate their own knowledge and how they arrived at that knowledge.

In short, there are countless models to accomplishing inquiry activities. However, they present common structural elements, such as: identifying the problem; exploring, discovering and creating possible strategies to solve it; analyzing the data; evaluating the effect of the procedures carried through and learning from this evaluation. Underlying all the presented methods is the principle that any of the stages are not staunch, as it is possible to return to previous stages before arriving at the end of the cycle. Moreover, not all the activities require the students to cross all the stages.

The dynamics of a lesson, where the teacher tries to get his students develop inquiry activities, is very different from a traditional lesson. When we speak of the dynamics of a lesson this implies the integration of several aspects related to the teacher and to the student.

The teacher has a fundamental role in the inclusion of inquiry activities in the classes he teaches. When choosing them, the teacher has to take into account the specificity of each class, that is, the knowledge, potentialities and interests of his students. Mastery of the materials and resources that can be used as support to the activity is equally important (Oliveira, Ponte, Santos & Brunheira, 1999).

There are other important factors that influence the accomplishment of this type of activity, such as the time and the teacher/student relation. For an effective learning of a concept to occur, students need time and materials to actively explore their ideas and questions. Also, learning is facilitated when the teacher and the students create an atmosphere of self-confidence and mutual respect, allowing the teacher to: discover the ideas that the students have of the world and use them to initiate the inquiries; use these ideas as a driving force of the students' knowledge; construct inquiries, based on these ideas, and provide discussion moments; help the students to relate a concept to their experiences inside and outside the school; help the students to think, thus leading to the growth of the unknown (Carlson, Humphrey & Reinhardt, 2003). During the inquiry of the students, the teacher's role is above all one of guidance, possibly with an interrogative stance. Questioning the students is a good way of giving them feedback on the work that is being developed.

Thus, the purpose of this work is to know the difficulties students encounter when developing inquiry activities. We think that conveying to the teachers what the students' main difficulties are allows the teachers to help them in a more efficient way, when they carry out this kind of activity.

2. Methodology

The research reported in this study is qualitative, adopting an interpretative orientation (Erickson, 1986). An interpretative research provides us with a powerful tool for examining

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the work and thinking of pupils. A constructivist view of learning supports this investigation and considers that knowledge is constructed by individuals based on their interpretations of experiences and interactions with others (Carlson, Humphrey & Reinhardt, 2003).

2.1. Participants

Thirty-nine pupils' participated in this study. They attended two 8th grade classes. Table 1 shows the participants' age.

Table 1. *Participants' age*

Age	*13*	*14*	*15*	*16*
ClassA	14	5	4	0
ClassB	4	7	4	1
Total	18	12	8	1

Participants are 20 females and 19 males. The pupils belong to a rural area.

2.2. Data Collection

The data sources used in this study were the interactions among pupils during the lessons, group interview, at the end of the study, and written documents produced by the participants. So, a diversity of strategies to gather data are used (Patton, 1990). The conversations that took place when the pupils worked together to finish the task were audio taped. This kind of data is rich in detail because they included conversations among pupils (Bogdan & Biklen, 1994). The records that took place during the activities were very important because the pupils learn science when they are involved with the material, discussing ideas with colleagues and with the teacher, making predictions and testing their ideas. The conversations that occur among pupils while doing the tasks create the opportunity to understand pupils' thinking, how they learn and the difficulties they have during the process (Carlson, Humphrey & Reinhardt, 2003).

At the end of the study, a focus group interview was used to detect the difficulties that pupils had during the inquiry activities (Frey & Fontana, 1993). This technique is used in data collecting when several people are present, in a certain social context, where a simultaneous interview is possible and convenient. The group dynamics is used to retrieve information and to let participants present their ideas, feelings and knowledge about the topic selected by the researcher (Morgan, 1998). Data concerning different perspectives and opinions presented by the participants is then collected in an environment that promotes interaction among those sharing their ideas about the topic under discussion. The interview was tape recorded.

The written documents produced by the pupils after the inquiry activities are a powerful tool to understand the difficulties that they had when performing the tasks (Maykut & Morehouse, 1994). Also, the written documents are a powerful tool to encourage the pupils to reflect about their work and their learning, thus creating possibilities to build their knowledge (Carlson, Humphrey & Reinhardt, 2003). We use different tools to gather data for triangulation and trustworthiness in the findings (Lincoln & Guba, 2002).

All the tape recorded material is transcribed by the researcher. So, verbatim transcripts of the focus group interview and the conversations among pupils constitute the primary sources of data for this paper.

2.3. Data Analysis

The data analysis was inductive and ongoing (Bodgan & Biklen, 1994). This kind of analysis was the primary method for analysing the data. It occurred at two levels: first, the data from each individual participant were analysed; in the second level, a cross participant analysis was performed. Consistent with a naturalistic research paradigm, the data analysis consisted of repeatedly examining the data to uncover salient patterns, singularities, and themes associated with research questions. The analysis took place through asking questions and using the constant comparison method (Strauss & Corbin, 1990). The analysis involved reading the verbatim transcripts to develop a system of categories to codify and categorize the arguments (Fenstermacher, 1994) expressed by the participants. From this process, tentative categories developed as a coding system for sorting, organizing, and retrieving data. The following categories, concerning difficulties that pupils had when carrying out inquiry activities, emerged from the data, by using the inductive analysis process:

1) Attitudinal (Sharing ideas, respect for each other, becoming autonomous, collaborating within a group)
2) Conceptual (Questioning, interpreting graphs and texts, gathering evidence, formulating explanations from the evidence, arguing, drawing conclusions)
3) Process (Planning, designing an experiment, calculating physical quantities, carrying out investigations, building tables)
4) Metacognitive (reflecting about the work done, applying what they know)

Table 2 shows the conjugation between the tools to gather dates and the difficulties felt by participants while doing inquiry activities.

3. Results

The results obtained are organized so to show the difficulties the students encountered while accomplishing the activities, according to the above mentioned domains.

3.1. Attitudinal Domain

In relation to this domain, mainly three difficulties were observed: to share ideas, to work in group and to develop the autonomy. These were detected from the written documents and tape records.

In the tape records, were found dialogues among students that evidenced difficulties felt in sharing ideas and organizing themselves as a group. These facts are visible, for example, in the following work group:

Andreia *– I had an idea.*
Ana *– Then tell it! Andreia tell it, we're waiting! Tell us your idea, it might be good! If you don't tell your idea, we're not going to hear it, don't you think?*
(…)
Ana *– Andreia, do you mind to tell us your idea!? You are to be a child.*
Andreia *– I've learned with you.*
Ana *– I'm waiting the great idea. Tell us your idea, don't be such a stubborn! You don't come to say that we didn't listen to your opinion.*

Another work group felt the same difficulties and during the accomplishment of the activity they argue:

Tânia *– Wait! It's not only you working, if not say that I do not do anything.*

Ricardo *– It's all right.*
Tânia *–Don't be surprised later.*
Ricardo *– Calm down, I'm only writing things to don't forget. You'll write later.*
Tânia *– It's not well like that, because I also want to make.*

From the written records, this sort of difficulty was also pointed out by a group of students:

Francisco *– The difficulties that I felt was in working in group. It was the aid in the group.*

Yet, concerning to the attitudinal domain, the difficulty in developing the autonomy was also evident during tasks' accomplishment when they worked in groups.

Nelson *– I'm not understanding anything, professor.*
Marco *– I also don't.*
Nelson *– I'm not understanding anything, professor. Come over here professor, I do not understand anything of this.*
Marco *– Oh professor, comes here!*
Nelson *– But that material does we need? Professor, come here!*
Marco *– Why are you calling the teacher?*
Nelson *– To tell us the materials. Professor, come here!*
Marco *– You have that to say the materials that you need to make different types of sounds. Call the teacher!*
Nelson *– Let me see.*

These students weren't able to do task without teacher 'help. The constant presence of the teacher was very important so that the students gained confidence in the work that was carried out. There were also some students that demonstrated their insecurity in written documents. For example

André *– It's to be learning and a little to have doubts, if it is what we are to think or not, having always the insecurity and the fear to commit a mistake.*

These students need teacher 'support and constant feedback. It's important for them the teacher 'help to overcome their fears. However, in future activities they become more autonomous.

3.2. Cognitive domain

The students showed greater difficulties at cognitive domain. These were detected from the written documents, the interviews in focused group and the tape records. The difficulties observed are concerning with: to write, to place questions, to draw conclusions, to collect evidences, to interpret, to predict, to measure, to argue and to attribute a heading.

Concerning writing, some students, although knowing what they were asked for, they weren't able to express their ideas.

***Edgar** – In the material also enters sound meter.*
***Júlio** – How do we write that?*
***Edgar** – I do not know how I am going to explain this. To place the sound meter between the wood and the sound source!? How am I going to explain this?*
***Júlio** – I am waiting to see what you are inventing.*
***Edgar** – I mean, it's not between.*
***Júlio** – It's the wood that is between.*
***Bruno** – No. It's sound meter between.*
***Edgar** – No. It's the wood that is between.*

The same difficulty was reiterated by other students who wrote:

***Gustavo** – the difficulties that I felt was to justify my answers, not verbal, but yes in writing.*

The difficulty in questioning also was found in the tape records. For example, the dialogue transcript below evidenced this.

***Amélia** – I do not know how to place the questions.*
***Ana** – It's only to place questions.*
***Amélia** – Ei pal! I do not know.*
***Joana** – What am I going to ask? Tel me a question!*
***Amélia** – I do not know.*
***Joana** – Ana, come on, places the questions.*

And in the written documents:

***Marco** – The difficulties that we felt was to find questions.*

In what concerns, to draw conclusions was the difficulty mentioned many times by almost all the students. This kind of difficulty was always present, in written documents:

***Catarina** – The difficulties that I felt was perhaps to take off some of the conclusions from the works.*

And in the tape records:

***Fernando** – Take conclusions. Now, you take because I do not understand anything of this.*
***Bruno** – Don't you want to write a more complete answer?*
***Fernando** – No.*
***Bruno** – We do the conclusion then?*
***Fernando** – How is that? I do not know how to do.*
***Bruno** – Well, that is difficult. I am thinking to do like this… but you have to help me, right?*
***Fernando** – Yes, it is. The conclusions is not the same thing that the evidences?*

Collecting evidences, that allowed students to answer to the initial question, was another difficulty that the students faced. This has been revealed during the accomplishment of the activity and recorded by the tape recorder.

***Filipe** – What is it that is the evidences?*
***António** – The evidences I do not know, but the conclusions are: the sound covers 525,8 meters for second. Let's go to the evidences, you know.*
***Filipe** – I know?*

The students also found difficulties in interpreting the questions and also the text when they need to read them.

***Catarina** – Then, according to what I read, the properties of the sound is these: the heat and the light.*
***Júlia** – No. Here, it says: "as the heat and the light, the sound is a kind of energy".*
***Marina** – Then the sound is a kind of energy.*
***Júlia** – the properties of the sound is the instruments produce strong and weak notes, high or low notes.*

The difficulty in foreseeing was another. This kind emerged when listening to the tapes:

***Juliana** – "Predict in which medium the sound spreads better?"*
***Ana** – and now, do I know.*
***Juliana** – Ei pal. I don't know, it depends.*
***Ana** – In the open medium the wind takes, if you are in a closed medium ... the wind takes the sound. My answer is this.*

The measurements, like measuring the time and the distance, also constituted a difficulty for the students, as we can verify from:

***Cecília** –Sofia and Isabel chronometer the speed of the sound.*
***Sofia** – No, Cecília, the time. You chronometer the time.*
***Cecília** – How do I do to chronometer the time?*
***Isabel** – I shout and you stop when you hear.*
(...)
***Sofia** – How do we people measure the distance?*
***Cecília** – I do not know.*
***Sofia** – Distance in steps? No, in feet. Then, we have to count the feet. The time and more what?*
***Isabel** – The speed?*
***Sofia** – The time and the speed.*

More groups of students dealt with this difficulty and they wrote:

***Bruno** – I felt difficulties in the distance, to count and to measure the distance and to count with the chronometer.*

Besides that, from the tape records, two more difficulties were found: to argue and to attribute a heading to the activity.

From the interviews, in focus group, it was possible to confirm the difficulties that emerged in the tapes records. So, when questioning about the difficulties that they felt when they carried out this kind of activities, the students belonging to a one groups answered:

***Joaquim** – There is a thing that we said that all people lied, I think. That it was in the sheets saying that we didn't feel difficulties.*
***Hélder** – In the interpretation of questions.*
***Bruno** – Some.*
***Hélder** – Not all.*
***Joaquin** – in the experiences, the material that was necessary as it was carried through.*
***Bruno** – the procedures, really, in the third or fourth sheet we made all right, because we already knew how to do.*
***Andreia** – I, at least, felt more difficulties in the conclusions. In the conclusions that was such an uproar.*
***Hélder** – The conclusions was easy part.*
***Ana** – Oh, look but that was everything ...*

By the analysis of this extract of the interview, we can conclude that sometimes, when in the written documents the students were asked to report their difficulties, they didn't always answered with seriousness, being frequent the reply: "I didn't feel difficulties". Moreover, they felt, at the level of the cognitive domain, difficulties in: interpreting and drawing conclusions.

3.3. Procedural domain

In the procedural domain, the students have shown difficulties like: to plan, to execute and to construct tables.

In the extract from the interview in focus group, previously presented, it's evidenced the difficulty in planning. This difficulty, likewise the difficulty in drawing conclusions, was one of the most mentioned by the students. As so, this difficulty is cited in the written documents, in the transcriptions of the tape recordings and in the interviews in focused group. Next, we can see an example taken from the tape records:

***Cátia** – I don't know how to do it.*
***Judite** – Could we search for something in the Internet? Well! That's a complicated thing, but it's ok.*
***Maria** – It's not easy.*
***Cátia** – But let's go! Material that we need ...*
***Maria** –I don't know yet how were going to do this.*
(...)
***Maria** – Come on, let's see what we need.*
***Judite** – We cannot be stopped in that. First, you have in the activities that you're going to do. Try to write instruments.*
***Maria** – If you are having so many ideas, say anything ... We have to say materials.*
***Judite** – First, we have to say the activities.*
***Cátia** – Come on, then says the activities!*

After planning the activities, the students passed onto their implementation. Several times, in this stage, the students have shown some difficulties, as we can see:

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***Telma** – We are already seeing the results of the experience.*
***Rui** – What are we going to do with the bars?*
***Luís** – I didn't understand this yet.*
***Telma**– Strike with the ruler and I strike with the pen!*

From the situation previously presented, we can verify that, although the students have designed the activity, when the material was supplied to, they had doubts about how to use the material.

The difficulty in building tables to write down the values was found in the tape records.

***Marco** – And the table?*
***Joana** – Now, how do as we make the table?*
***Marco** – I do not know.*
***Joana** – Only if we do 1st activity and 2nd activity.*
***Marco** – I was thinking in 3 columns.*
***Joana** – And we put time of arrival and departure?*

The findings concerning the procedural domain allowed knowing that this kind of difficulty diminishes throughout the accomplishment of the activities.

3.4. Metacognitive domain

Relatively to this domain, it was noticed that students had difficulty in transposing the concept of speed, learned in 7th grade, for the concept of speed of the sound. This fact can be illustrated in the following dialogue between them:

***Carolina** – You run the km. Imagine 10 km. You make half hour or in fifteen minutes, for example.*
***Tatiana** – You have to do in the field.*
***Carolina** – If it was by car?*
***Tatiana** – In fifteen minutes you arrive at …*
***Carolina** –From my house, I get here in fifteen minutes.*
***Marta** – Me, it's six km and I take ten minutes.*
***Tatiana** – Carina, we run in the field a defined distance from one to the other.*
***Carolina** – I find that by car is better.*
***Tatiana** – Carina, you cannot carry out this activity.*
***Carolina** – Why?*
***Tatiana** – Are you going to get a drivers license?*
***Marta** – Do you have it?*
***Carolina** – Well! Then look! You go to the gymnasium, from it you go to the field and you see the speed!*
***Tatiana** – But it's the speed of the sound?*
***Carolina** – and isn't it the same?*
***Marta** – How is that?*

The global analysis of the results allowed identification a great number of difficulties that the students found when they carried out inquiry activities. It must be said that the interview in focus group gave a great contribution to the reiteration of the difficulties that the students had already revealed in the written documents and in tape records. At the beginning of the study, the students felt more difficulties than at the end.

4. Conclusions

The study showed that inquiry activities can be developed in science class and they can increase participants' interests and motivation. However, they felt some difficulties, but these are obstacles that promote learning. As pupils work in small groups, the teacher listens to them and learns about knowledge deficiencies and misconceptions. Allowing pupils to share their knowledge with others creates a student-centred environment that empowers them to learn more about a given topic. Pupils are constantly engaging in making sense of situations and are required to be reflective and revise their thinking. During the teaching of Sound through inquiry activities, self-assessment was used to help pupils reflect upon their own thinking. They spend a great deal of time collaborating with others to reach a consensus, and they learn from one another, as they learn content in a positive environment that values all learners' opinions. While performing the inquiry activities, pupils are developing knowledge competences related with sound and also reasoning, procedural, communicative and attitudinal competences as the National Curriculum recommends. It is important to communicate these findings to other teachers because they can plan their lessons with them in mind. The findings show that the pupils have difficulties in reading and interpreting the texts and writing the conclusions. So, it seems necessary to increase linguistic activities in science classes, allowing the pupils to read, to write and to communicate their findings.

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Interdisciplinary and Interactive Learning Environments in the Science Teaching-Learning Process in Secondary Schools

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Abstract. At the Universidade de Caxias do Sul (UCS), a project is underway whose objective is to enable and empower teachers of secondary education in the area of science, through an interdisciplinary, active and significant methodology. Within this project, workshops have been created using an interdisciplinary, interactive and experimental approach. The subjects developed in the workshops were the five senses and electromagnetic waves. Among the most important results of this project we can cite: the maintenance of a data bank of interdisciplinary educational information accessible to secondary school teachers, the creation of a research and extension environment that deals with subjects related to the science learning-teaching process, and the availability of the university in supporting the secondary school teachers in the preparation of support material to be used in their schools.

Keywords. Formation of science teachers, Instrumentation for education, Interdisciplinarity, Teaching-learning process.

1. Introduction

Lately university professors and instructors have become increasingly concerned with the quality of the students arriving from secondary schools. This concern has stimulated reflection on the preparation and formation of secondary school teachers as well as on how to give them a chance to use educational tools related to experimentation. Learning how to learn, to create, to administer and to manage information are some of the abilities expected of citizens in contemporary society. Knowledge of science has been indicated by technological researchers as one of the determinative factors in the formation of professionals who are capable of recognizing and caring for scientific and technological dynamics. Interdisciplinary became a mandatory element in the discussion of methodological aspects of the science learning-teaching process, aiming at a broad and integral formation of the educator. It is necessary to prepare the secondary school teachers so that they will have a strong theoretical and experimental background that favours a broad and clear vision of the interdisciplinary context in science. So, the role of interdisciplinary in the context of secondary and education, due to its dynamic nature, must be the subject of permanent discussion.

The improvement of secondary school teachers is necessary since the opportunities for recycling them are scarce. The acquisition of knowledge, the active and significant learning, the participation in the teaching-learning process and the relationship with his/her environment come together for the formation of the professional. In this process arises the necessity of a continuous professional improvement, with reflections on his/her pedagogical practices. The teacher must participate in discussions of epistemological and pedagogical content that give basis to what, how and why to teach a certain subject, make possible knowledge and reflections, carry out conceptual reworks, transform the knowledge in science, and aim at an active and significant learning. The formation of scientific attitudes and the logical structuring of the teachers thought will gain new directions when the scientific methods are employed related by means of observation, organization of ideas and the comprehension of scientific principles aiming at using knowledge in the solution of day-to-day problems. For this to occur, teaching must be prioritized, promoting learning with the other teachers, aiming at changes of pedagogical practices, by means of research on the teacher's role, sharing his/her inquiries, the production of his/her work and committing him/ herself to the construction of knowledge.

An interdisciplinary vision of course content must be guided by a theoretical foundation and scientific procedures that seek the resolution of problems in the interaction of the citizen with his/her environment on a daily basis. This vision emphasizes the role of the different areas, in the interaction of the environment and in the broadening of the understanding of the concepts as a whole, providing the development of abilities and the preparation of useful materials and instruments for learning in the consolidation of the reconstruction of the knowledge.

Many schools use commercial didactic material, i.e., experiment kits. This material has the objective of stimulating the student to try and to test physical laws and principles, mathematical relations etc., and can be an excellent support. However, for a creative teacher, the commercial experiment kit is only one starting point, since it will never substitute his/her own experimental assembly, his/her own text, his/her own experiment, etc…. The main idea is in the alternative dynamics that the search for materials can motivate, mainly in terms of making the lecture a collective initiative, of all students, including the teacher. Instead of the traditional teaching ritual (i.e., traditional lecture, chalk and talk lectures) and of the learning passivity, one tries to create a space and a moment of joint work in which all are collaborating for a common objective. The University, as an integral part of the community and considering its responsibility in relation to education, must be active in teacher's qualification, arranging systematically relevant information in the innumerable readings of the world as a whole, proposing alternative actions for the teacher's role towards the reality.

At the Universidade de Caxias do Sul (UCS), a project is being developed with the objective of better qualifying secondary school teachers in the science teaching–learning process. This project is being carried out by UCS faculty members in the areas of physics, chemistry, mathematics, biology and computer science jointly with UCS´s Museum of Natural Science. Within this project, that takes into account the new curricular guidelines of the Ministry of Education and Culture, workshops have been created using an interdisciplinary, interactive and experimental approach. For these workshops, support material has been elaborated to be used in science classes of the secondary schools. In this paper, we discuss the subjects developed in the workshops, the participation of the secondary school teachers in the workshops, the activities developed, the support material conceived and the results obtained up to this moment.

2. Methodology

Science education cannot continue to give priority to the teacher's lecturing, the presentation of contents and the fulfilment of the program. This sentiment is constantly being exchanged between in science educators, emphasizing the importance of informal learning environments, such as science and technology museums, for the construction of scientific meaning for the students.

The methodological proposal of this project considers the experience of the teacher and the knowledge that he/she possesses. Within this project, that takes into account the new curricular guidelines of the Ministry of Education and Culture, workshops have been created using an interdisciplinary, interactive and experimental approach. The subjects to be developed in the workshops were chosen by the participating teachers of the secondary schools and the UCS faculty members in the areas of physics, chemistry, mathematics, biology and computer science. For the first set of the workshops, twelve participating teachers were chosen: five from the area of sciences and biology, four from physics, three from mathematics and two from chemistry. The subjects chosen took into account their attractiveness and the scarcity of available material in these areas. These subjects are: the five senses (vision, touch, hearing, smell and taste) and electromagnetic waves.

Figure 1. Reproduction of a tongue and its tastes buds

UCS faculty members worked so that in interactive and interdisciplinary learning environments the teachers interacted with playful materials, potentially significant objects that could generate discussions at theoretical, practical and interdisciplinary levels. Once the subjects were chosen, UCS faculty members and their monitors developed texts, materials and

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interactive and interdisciplinary activities. In Fig.1 part of the material developed for one of the workshops on the five senses is presented, where one explores the sense of taste.

In Fig.2 the material developed for the workshop on quantum jumps is presented. The quantum jumps experiment is one of the workshops on electromagnetic waves, where one explores the visible part of the electromagnetic spectrum.

Figure 2. Material developed for the workshop on quantum jumps

The texts and the activities were developed based on the methodology of active learning. According to the active learning methodology students will discover new phenomena and concepts on their own, link them to previous knowledge, reflect and generalize to acquire conceptual and significant understanding [1-3]. Traditional teaching through lectures can be successful in knowledge transfer, but do not necessarily permit the acquisition of competencies that require the active participation of the learner. In contrast, active learning is an inductive bottom-up approach. It transfers the onus from the teacher to the student and makes the student the prime actor in the learning process.

3. Workshops

Once concluded the development of the material (texts, experimental material, support material, computational infrastructure, etc...), the workshops were prepared and applied to the secondary school teachers. A total of 60 hours of activities was developed in the workshops. Of these 60 hours, 36 hours were on the five senses and 24 hours were on electromagnetic waves.

Short expositive lectures (i.e., 15 to 20 minutes), with the largest possible amount of demonstrations and audiovisual resources, were used for the introduction of the subject. Among the audiovisual resources used with the participating teachers, one can list: demonstrations using the computer (applets), videos commercially produced for use on DVD players or computer, overhead projector and data show for better exposition of figures and complex images.

The videos presented are never longer than 5 minutes, to guarantee that the participant teachers will not have their attention dispersed. At this point, it is important to mention that the majority of the planned activities tend to be of short duration, in order to respect and to dribble the well-known lack of concentration that grows every day among the majority of children and teenagers due to an overexposure to television in first infancy [4].

Figure 3. Workshop on the sense of taste

In the sequence, the participating teachers developed the experimental activities in group (see Fig. 3 and Fig. 4). Stimulating group work is also one of the goals of the proposed activities. Results obtained with students working in group have shown that the active exchange of ideas between the components of the group not only increases interest among the participants, also promotes more critical reasoning [5, 6]. According to Johnson and Johnson [7], there is persuasive evidence that students that work in groups reach more complex levels of reasoning and retain information for a longer time than students who work individually. Shared learning gives the students a chance to engage in discussions, taking more responsibility for their own learning process and thus becoming more critical [8]. In this context, with the group activities developed in the workshops, an objective was to stimulate the participant teachers to increase significantly the group activities in their own lectures in secondary schools. Besides carrying out group activities, the analysis of the results is also carried out in group, as well as a critical analysis of the

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activities of each workshop, where the participant teachers give a first opinion on the work that was developed.

The participating teachers were constantly stimulated in the direction of interdisciplinary education. For all activities they were questioned on new ideas and suggestions. As workshop activities, the participating teachers were asked to propose interdisciplinary and interactive activities that could be developed in the context of their secondary schools. These activities were evaluated and developed in the workshops with their colleagues or directly with their students.

Figure 4. Workshop on spectroscopy

The participating teachers were also allowed to deal with environments on the internet, identifying ways to program learning environments for their students, to demystify the use of computer to assist students in their learning process, and to reflect on the possibilities of the internet as a source of information and interaction to further the learning.

4. The application of the material in the secondary schools

The activities, texts and support material developed in this project are already being applied by the participating teachers with students in their schools of origin. Some workshops already had their support material produced in great quantity and are available for the participating teachers. In the particular case of the workshop on quantum jumps, the participating teachers had already applied the activities to their students and had made the reports of their experiences, as well as an analysis and evaluation of them. In the case of this workshop, modifications of some points of the experimental activity had been proposed and incorporated in the search for more significant teaching-learning methods. In Fig. 5, we present a group of students from a secondary school developing the quantum jumps experimental activity at their school.

Figure 5. Students developing the quantum jumps experimental activity at EEEM Danton Corrêa da Silva in Canela, RS, Brazil

The application of the activities developed in this project to secondary school students has led to the conclusion that the physical conditions of the school environment do not matter much, but the methodology adopted and the learning environments created are very important since. The activities had been applied in schools with quite different financial resources. In all schools, the participating teachers had observed that these activities had made the classroom environment less formal, meaning that the students had felt more relaxed, more confident, participating more actively and asking many more questions. The students were more satisfied also as they understood why they were learning that content and how useful that content was. The students from schools with less contact with modern technologies (i.e., internet, chat rooms, MSN; cell phones; electronic games as PS2, X-Box, World of Craft, Tibia; parties in LAN Houses, etc...) had shown results as good as the students from the "technologically" more "rich" schools.

5. Conclusions

The main objective of this project is to enable and empower teachers of secondary education in the area of science, through an interdisciplinary, active and significant methodology. The results obtained up to now shows that it is having reasonable success. A collection of support materials to be used in courses and workshops for secondary school students and teachers, another collection that will be available to the secondary school teachers, as well as support material with bibliographical references, and material for use on the internet, has been produced. The creation of a group of interdisciplinary courses in other subjects of interest has been proposed with the objective of capacitating science teachers from secondary schools on a regular base. The activities developed in this project are in tune with the projects developed for the itinerant museum from the UCS Museum of Natural Science, whose first stage deals with phenomena involving light. The methodological proposals, interdisciplinary activities and the instructional material developed by the UCS faculty members and the teachers participating in this project will be made available on the homepage of the project (http://www.ccet.ucs.br/pesquisa/projetos/cienciadetodos). In this context, one expects that the participating teachers realize the advantage of learning and teaching by means of situations and/or subjects that give more meaning to the concepts and to the ideas. One expects also that the teachers will be encouraged to use other educational methodologies in sciences, based on the discussions and illustrations proposed during the activities programmed during the workshops.

6. Acknowledgements

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Teachers and Children Exploring Their Worlds Together: Working with Children's Ideas in Early Science Education

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Abstract. This paper offers an analysis of a two year project working with about 30 teachers from 12 schools developing science education for children aged 4-5. We used an open structure with the teachers to be coherent with what we proposed in the classroom. The idea was to liberate the energy and enthusiasm of the children as they worked with and explored their ideas in science. This approach goes beyond hands-on activities to minds-on and hearts-on activities. The paper will explore the way that these approaches were developed and extended through the primary schools where the teachers were working.

Keyword. Children's ideas, Teacher development.

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Development of optical experiments for blind students

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Abstract. In many countries, we have observed that the number of students with special conditions in the schools and/or universities is very significant. However, there are specific difficulties to integrate them with the others students in the same classroom and, in some cases, to transmit the knowledge. As we have a great possibility of physical disabilities, we have begun our work with blind or visual handicap people. In a first moment, it seems impossible to teach optics to them. This idea was a challenge for us. Consequently, in this work, we present some traditional experiments of optics that were developed for blind or visual handicap students. These experiments were chosen in order to exemplify some of the physics concepts that are worked during High School (reflection, refraction, focal distance, interference, light spectrum and diffraction). The involved theories and the methods of reading in the Braille language have permitted the adaptation of these experiments. The information that generally is "visuals", in this type of experiment, was transformed into sonorous signals, allowing more independence of these students. These changes have provided a better exploitation of the high tact and hearing sensitivities of the visual handicap carrier. Moreover, a handbook of all practices, with the right inserted adaptations, was written in the Braille and conventional languages, to be manipulated by teachers and students in a same way.

Keywords. Visual handicap, Optics, Physics Education, Special Education.

UNESCO SchoolNet: ICT-based teaching and learning of science and math in Asia-Pacific Region

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Abstract. The UNESCO SchoolNet project, "Strengthening ICT in Schools and SchoolNet Project in ASEAN Setting", was initiated in recognition of the need to assist teachers in integrating ICT into teaching and to facilitate participation of teachers and students in the Asia-Pacific region in SchoolNet telecollaboration activities. The project was launched in July 2003 and focuses on three subject areas, mathematics, science and languages. SchoolNet activities have been piloted in 24 schools in eight participating countries of the ASEAN (Association of South East Asian Nations) region: Indonesia, Malaysia, Philippines, Thailand, Cambodia, Lao PDR, Myanmar and Viet Nam. The UNESCO SchoolNet project aims to: Explore and demonstrate how ICT can be used in schools to improve the quality of education and better prepare youth for the demands of knowledge societies; Test innovative models of ICT use and of ICT-based teacher education; Encourage use of ICT in teaching-learning and materials development in schools and other educational contexts; Improve connectivity and expand access to the wealth of educational resources available via the Internet; Establish and promote SchoolNet in the Asia-Pacific region.
Via the UNESCO SchoolNet project, students engaged with ICT tools to learn science and mathematics in two main ways: Innovative ICT supported pedagogy using resources offered by the SchoolNet project via a CD-ROM of interactive resources, lesson plans and associated directory for teachers to explain optimal use; Telecollaboration between schools in the SchoolNet participating countries, dealing with mathematics and science topics such as measurements, environmental indicators by carrying out similar procedures in each country; sharing data gathered and discussing results/conclusions.
In this paper I will describe and demonstrate in more detail these two key aspects of the SchoolNet project.

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The Challenges of EU Enlargement on Science Literacy and Development

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Science Literacy and Development in the European Union

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Abstract. In March 2000 the Lisbon Agenda set as new strategic goal for the European Union to become "the most competitive and dynamic based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion".

Science and Technology have a major increasing role in today' society and in the lives of everyone of us. No further substantive and sustainable development of our economy and society may be foreseen without a leading enlarged and improved scientific and technological research.

Improving science education throughout the European Union is fundamental as well as effectively setting as major priority to raise the levels of scientific and technological literacy at all levels of our society and in all EU' countries.

The establishment of a science culture in our societies, as steady basis for the improvement of Science and its technological applications, should also constitute a way of promoting a fast full and sound integration of the new country members (and foreseeable future new members) in our enlarged European Union, prosperous and solidary.

Keywords. Science Literacy, Development.

Scientific Literacy and Citizenship

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Abstract. Scientific research has social and moral implications that can no longer be disregarded. Educating students in science involves more than understanding scientific knowledge and carrying out investigations. If students are to grow to become tomorrow's responsible citizens, they need to understand scientific issues as well as their impact on society in economic, social and moral terms. An argument will be put forward in favour of a science education that considers the social implications of scientific activity on both a local and global scale. Science education needs to give more attention to activities placed in contexts and include the social and ethical aspects of the scientific enterprise.

Keywords. Science, Social issues, Ethics, Citizenship.

1. Introduction

This century is characterised by the advancement of media where we can now follow, often live, whatever is happening in any corner of the world from the comfort of our homes. Such commodity, however, also brings with it a new responsibility. If, as active citizens, we are aware of actions and decisions with which we do not agree on social, ethical, and/or moral grounds, we are now responsible to respond and take action. Citizens thus need to be empowered such that they can exert their right to express their opinions. They should be able to use any available channels to try and bring change when they disagree with what is happening in the world around them.

New scientific advancements are also now part of this public knowledge transmitted by media. Scientific research keeps pushing the boundaries. We have experience this in two particularly sensitive areas: cloning and genetically modified organisms (GMOs).

Advances in cloning have moved on from DNA cloning involving the transfer of a DNA fragment from one organism to a self-replicating genetic element, to reproductive cloning where an animal that has the same nuclear DNA as another currently or previously existing animal is generated. There has also been work on therapeutic cloning also called "embryo cloning," involving the production of human embryos for use in research. The goal of this latter process is not to create cloned human beings, but rather to harvest stem cells that can be used to study human development and to treat disease. There have been requests by scientists to governments to allow research in this area. The main area of research is within therapeutic cloning where scientists want to study the possibility of using stem cells to clone human organs which can then be used for transplants. This would do away with the problem of finding a matching organ and increase the percentage success for transplants as the probability of rejection would be much less.

Work in biotechnology has led to the production of genetically modified organisms produced by a special set of technologies that alter the genetic makeup of living organisms as animals, plants, or bacteria. Genetically modified products include: medicines and vaccines; foods and food ingredients; feeds; and fibbers. Consequently, farmers have improved the size and quality of their crop. There have been however, concerns on the effect of such products to human health. The effect of cross pollination between genetically modified organisms and natural organisms is as yet unknown as is their impact on the ecosystem. GMOs also bring with them a socio-economic impact – a dominance in the market by industrialized countries, introducing monopolies making developing countries uncompetitive, thus contributing to increasing global inequalities of wealth that already exist.

As more and more journalists report on the advancement in science and the everyday person is informed of developments, the responsibility for scientific research shifts from the scientists to the layperson. It is through science education that the normal citizen can be prepared to tackle and face this new responsibility. Citizens today should feel empowered and consequently should hold opinions about issues. They should also be able to take action if necessary. This can be achieved in different ways in order to influence activities and initiatives being taken locally and globally.

2. Theoretical Framework

What is science for citizenship? Science education across the world has long moved away from the simple transmission and acquisition of scientific knowledge. Students now are also taught and trained the scientific method through laboratory work and investigations. However, process and content do not encompass all that science education is and what it should provide. Many proponents in science [1-4] agree that the public understanding of science involves at least three aspects:

- An understanding of some science content. This refers to scientific facts, laws and theories that make up scientific knowledge and are often found in scientific textbooks;
- An understanding of the scientific approach to enquiry. This does not only involve an understanding of science investigations and the process it involves but also of the role of theoretical and conceptual ideas in interpreting outcomes of investigations;
- An understanding of science as a social enterprise. This includes the human and institutional aspect within which science develops. It also involves an understanding that scientific knowledge is socially constructed by the community of scientists [1].

Mary Ratcliffe [5] represents these three aspects as three areas with their specific aspects but which also overlap to provide a holistic scientific education. She describes the three main components of science to include: scientific concepts (content); practical processes, observational, experimental skills (process); and values and beliefs, cultural and historical contexts, social and environmental issues (attitudes). These are separate but overlap. The intersection of the three components provides students with a view of the nature of science. Science education has tended for a long time to focus on content. The process of doing science has only found its way in the curriculum in these last few decades. Alas, the third aspect, focusing on values and beliefs, has not as yet received the attention it deserves. Although the concept of Science and society, known as STS curricula [6], have been around for some time, the emphasis was more on linking science to its impact on society as a useful tool rather than on the social and ethical implications of scientific research.

How is science related to citizenship? Isin and Wood [7] state that citizenship can be described both as a set of cultural, symbolic and economic practices as well as a bundle of rights and duties. They argue that it is important to recognize both aspects and that many rights often arise from practices which later earn the status of laws. Schmitt-Enger [8] defines active citizenship as the capacity of citizens to self-organise in a multiplicity of forms for the mobilization of resources and the exercise of powers for the protection of rights to achieve the end of caring and developing common good. It is within this latter statement that citizens may be called to act with respect to scientific research. When governments are called upon to give permission for certain research to take place, the normal citizen has the opportunity to express his/her opinion and to exert pressure in order to influence governmental decisions. Citizens today should thus be empowered such that they can take action about issues. This requires that they possess particular skills and attitudes. It is not possible to expect such skills to develop automatically but they must become part of the compulsory curriculum. Science education can provide a valid contribution as it can be the medium through which youths are enabled and empowered to understand social issues related to scientific activity and research, and to learn about what action they can take and how.

How do citizens use science? Jenkins [9] identifies a number of features in an individual's approach to science: These features include:

- Interest in science that is differentiated by science, social group and gender: Different groups show different levels and inclinations of interest. For example, women tend to be more interested in issues related to medicine. Men, on the other hand, tend to be more interested in the physical sciences. Likewise, people of different ages and with different hobbies and lifestyles may hold interests in different branches of science;
- Interest that is linked to decision-making and action: Individuals may only be interested in science simply because it happens to be related to their personal life. For example, they may become very knowledgeable about some medical problem because a member of the family may suffer from it;
- Understanding that is just adequate for its purpose: Individuals tend to be happy with a level of understanding that serves its purpose, without questioning its validity. This often leads to individuals often holding misconceptions about scientific issues. As long as ideas about particular scientific concepts serve their purpose, they are not questioned or challenged;
- Knowledge that is considered at a same level as other types of knowledge: Social, and psychological types of knowledge are usually considered to be on the same level as scientific knowledge;
- Scientific knowledge that is considered alongside its social and institutional connections: Citizens value scientific knowledge depending on its source. Knowledge issued by well known and established institutions tend to be considered more valid than findings from other institutions with not as high a status;
- Attitudes to considering risks associated with scientific and technological issues: Citizens tend to carry out risk assessments related to scientific issues by considering wider aspects such as social, psychological and contextual factors;
- Informed citizens make more discriminating judgments about science and technology related issues: The more informed citizens are about scientific issues, the better they understand the implications and consequences of science-related issues. They will also be able to make better judgment. However, this does not automatically mean that they would necessarily make more rational decisions.

3. Implications to the Science Curriculum

Science education needs to recognize the need to prepare scientifically literate active citizens. It is for this reason that the social aspect of science needs to become part and parcel of students' science education. If the vision of a Europe with empowered active citizens is to be achieved then a great challenge awaits science educators. Science educators now need to prepare students not only with the necessary basic scientific knowledge, but also with the skills needed to evaluate, analyse and be critical of the scientific work. They also need to develop attitudes towards science and sustainable development (moral, social, economic and ethical) in order to be able to make informed and independent choices with respect to scientifically related issues when they become adults. Science curricula need to be changed such that social

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issues become an integral part of teaching schemes. This demands that science education needs to change and to become 'more value laden than content laden' [10].

So, how do we teach about social and ethical issues in science? This definitely cannot be achieved through adopting the traditional transmission view [11]. The transmission approach considers the learner to be passive, receiving information which she/he stores in his/her brain without necessarily understanding the implications to everyday life and society. If one wants students to develop skills, attitudes and values, a different approach has to be adopted. Teaching needs to be organised in a more context-oriented way. Unfortunately, there is still too much science teaching which tackles many scientific concepts in an abstract de-contextualised way.

Teaching within contexts requires active learners who interact with the context being presented. It is thus necessary to have active learners who would make the issues being discussed their own and who can consequently understand the implications – developing attitudes and values in the process. One learning theory that considers learning as an active process is constructivism. Most of the work done in constructivism looks at how students interact with scientific concepts. There has been little work in how it can be adopted to help students understand and develop values and attitudes. In this paper I intend to look at how constructivist approaches may be adopted to tackle the social aspect of science.

What is constructivism and what are its implications to teaching? A lot has been written about constructivism and many educators have tried to develop different strands. However, there is always one common premise, whatever the approach, the belief that every human being needs to put together thoughts, interpretations and explanations which are personal to him or herself in making sense of his/her experiences and situations. The implication is that one needs to think and reflect in order for learning and understanding to take place. In the current context, it is also important for students to stop and think and construct the possible social and ethical implications that may result as a consequence of advancements in scientific research. Rather than considering the construction of knowledge, there can also be construction of implications, consequences and impact on individuals and society within a social, ethical and moral dimension.

How do students make sense of experiences? Windschitl & Andre [12] argue that students construct their knowledge from individual and/or interpersonal experience and from reasoning about these experiences'. The learning process thus involves active interaction between the learner and the content to be learnt. Duit and Glynn [13] 'view constructive learning of science as a dynamic process of building, organising, and elaborating knowledge of the natural world. Although in this case, reference is made to content, there is also an understanding that learning is an interpretative process involving individual's constructions in meaning making relating to specific situations.

The constructivist theory, whatever the approach, holds that individuals construct for themselves a unique picture of the world, and that in constructing this picture they must understand the concepts which, in the case of science, the scientific community accepts as being true. We are now questioning whether this theory of understanding knowledge can be extended to understanding social aspects. If one were to focus more on the process of meaning making than on the meaning of concepts, then it is possible to consider that learners can construct visualizations of possible situations as a consequence of actions. It is in such situations that one can understand the implications of decisions taken with respect to scientific research. If one accepts that constructivism also allows the meaning process beyond that of content, the question for science teachers then becomes how to help students conceive and understand implications and impacts rather than just concepts. Hence the argument is being put forward is that in favour of adopting the constructivist approach when teaching science for citizenship.

Constructivism has been widely adopted when developing teaching schemes aiming at improving students' understanding in science and specifically in targeting students' wrong ideas, known as alternative frameworks. Examples of the main approaches included conceptual change [14], Driver and Oldham's [15] constructivist approach adopted in the Children Learning in Science (CLISP) project, concept mapping and mental models. Common features which emerge are the use of cognitive conflict, metacognition and the application of

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scaffolding in promoting students' active participation in learning.

Duit and Glynn [13] suggest that a constructivist model of science instruction demands that teachers need to encourage students to think metacognitively (thinking about their own thinking) by activating students' existing mental models. This can be achieved by supporting the process of constructing mental models, helping students to transform conceptual models into physical ones and to think out loud. Teachers need to encourage students to represent a problem in a variety of ways and have students assume the role of learners, employ reading, writing, discussion and debate. They also need to begin lessons with simple concepts and problems to foster motivation and question students 'who, what, when and where', encouraging students to pose their own science problems. These are approaches that fit in well when considering social implications. This approach is discussed in more detail further on.

These aspects emphasise the need for learning to be stimulating. One can achieve this through the use of challenge or cognitive conflict, reflection or what is known as metacognition, and the ability to build patterns [16]. It is important to provide children with opportunities where they can work out their ideas in their own language [17] and to look at the implications of such issues.

What type of constructivist learning activities can teachers adopt to teach about the social aspect of science? Central to any activity that targets teaching about the aspects of science is that students need to have ownership of the issue being considered. It is only through ownership that students can empathise and understand the various implications of scientific issues. In order to give students ownership, it is important that the issues being considered are relevant and of interest to the students. This can be achieved by choosing themes that are close to their lives, or that is a current debate on the media locally or internationally. Teachers often tend to steer away from what are considered 'hot' issues. If one is to be seriously committed to equipping students with the skills to become active citizens, then it is such issues that need to find themselves in the curriculum. It is through tackling the difficult issues that students learn, both through their input but also through the teacher's example about how to develop opinions and how to voice them appropriately in exercising their rights as citizens.

So what type of activities can teachers organise? Attitudes and values that promote social issues related to science can only be dealt with within a holistic approach. Whatever the teaching methodology, there needs to be space for students to research, learn, share opinions and consider ways in which they can take action. It is through such approaches that students can be empowered to become active citizens. Here are some approaches that teachers can adopt.

Discussion:

At a very low level of interaction, teachers can organise a simple discussion of an issue. What is important is for the teacher to give students the space and the confidence that their opinion has the same value as anybody within the class. Children can thus give their views about the implications of the scientific issue without any fear of ridicule or value judgements from the teacher or their peers. Promoting discussion is quite a low level of active engagement. However simple this approach may seem, teachers still need to have specific skills. They need to know how to think up a relevant and debatable situation; how to ask questions that provoke discussion; as well as how to create an atmosphere where students feel that their opinions are valued and provide a valid contribution to the discussion. Teachers have to be careful to remain impartial, act as chairs and steer discussion on the issue without taking over or imposing their position about the issue. In short, the teacher needs to be well prepared in terms of content background to the issue, but also possess the necessary social skills to promote and create a constructive discussion which would help students learn how to reflect, express an opinion as well as be able to build a logical argument which they can back if challenged. Examples of topics which one can choose for discussion may include controversial issues such as 'What if you are exactly like your mother/father?' in considering the implications of cloning, 'Would you want the government to build an incinerator 100m away from your home?' in considering air pollution; 'Would you allow scientists to carry out research on human embryos?' and many others. A common aspect of these examples is that they do not have clear cut answers and thus easily give rise to debate.

Poster production:
Part of teaching about the social aspect of science involves teaching students how to express their opinions in different but positive ways. Children can be asked to draw posters to send messages about the issues that they have discussed. Posters are usually designed to send out messages to specific groups. Teachers can help students research and decide on the implications of the scientific issue being discussed, and to find ways of expressing their opinion through drawings, catch phrases, statements. In doing such activities, it is important to specify the target audience. There is a difference between a poster prepared for fellow students to one with which one protests in front of the Prime Minister's office. When one changes the audience for which a piece of work is designed, it promotes understanding of different perspectives of an issue to different interest groups;

Language activities:
Most of the activities in schools involve practice in one form of the language, it being talking, listening, reading or written work. Teachers can utilise these language activities to include a particular social issue. Teachers can take the opportunity to include social issues related to science as contexts for language activities. Students can be asked to read texts from newspapers, scientific journals, or any other literature about an issue and asked to consider the implications and write about it, or make an oral presentation. This makes students pay attention to what they have to say and in what way, leading to active reading, writing – knowledge construction and understanding. In fostering understanding of different perspectives, students can be asked to take up various roles, such as the government's position, the activists' view, the local authority etc. It is a way of helping students realise how the same issue impinges on different interest groups in different ways, how different groups may have different agendas and how these can influence the way in which people interpret situations and take standpoints with respect to scientific issues;

Research Projects:
A social issue can be tackled within a research project which would allow the time and space to go in depth into the issue, understand the scientific concepts involved as well as the implications on society from an economic, social and ethical aspect. The research project can focus on a social issue that is of current concern. A newspaper cutting, news report or some other form of contribution in the media can be used to spark off the discussion. However, in this case, students will be asked to look up some scientific information about the issue. It is important to try and elicit differing ideas and opinions so that cognitive conflict would be present. Cognitive conflict is one way of promoting meaningful learning. Getting students to disagree will motivate them to look up information and to formulate arguments in favour of their belief. It is a strong learning tool that makes learning a lasting experience. One particular example within the context of Malta would be that of fish farming – what it is, how is it managed, what are the implications to the marine environment around it, how does it affect the economy in such a small island, will it affect local bathers, will such abundance of food attract big fish towards the island, what is the effect of all the fish excreta beneath the fish farm, are there any adverse effects on human health when people consume artificially grown fish. These are just a few of the issues that students can go into in just one topic. It would require that students learn how to find knowledge, be it through the use of the internet or talking to experts. Students need to learn how to be critical of the information gathered, to understand that different players may have hidden agendas and consequently present a biased picture of the situation, how to size up things for themselves rather than accept all that is said to them. In short, one such project would probably give students much more skills and scientific knowledge than the long hours of de-contextualised knowledge that is usual practice in schools;

Role playing:
Teachers can ask students to go beyond learning and understanding issues. They can ask students to take different roles and act out by simulating situations. Role playing is one way of getting students to understand how people in different positions view things according to their personal or corporate agenda. One may not necessary share the attitudes and beliefs that the different parties may take in such situations, but it will definitely help students to understand the undercurrents and motivations which may at times be behind decisions and actions taken.

Let's consider one example where students are asked to consider the case of cloning and the decision put forward to government to allow research in a particular type of cloning. Students can be asked to represent different groups, for example, the government, the Health Minister, the research institute proposing the study, the anti-cloning lobby, the normal citizens etc. All students will need to understand the same scientific concepts, but each group will have to look at the issue from a different point of view and with a different agenda. They will learn how the same concepts can be used to put forward different arguments which may be in conflict with each other.

There are a number of common features on which all of these types of activities are based. In fact some of such examples have been already written about by Lock and Ratcliffe [18]. The one single significant common factor is that children are actively involved in the learning process. When one deals with values and attitudes it is difficult to transfer these by simply 'telling'. One needs to place children in a position where they can understand the implications and how different groups may have different agendas that may not be the welfare of the population or the world. Understanding such aspects can be achieved through getting students to disagree by holding different points of view.

All the activities listed involve the use of language in some form or other. In the same way as one understands a problem in the process of formulating a question about it, will language, similarly, facilitate the understanding of the intricate issues involved when one considers the environmental and ethical issues related to science and scientific research.

Teachers too often assume that students are able to reflect on the activity that they are doing at school and to appreciate the intention behind such educational actions. However, this is often not the case. Metacognition, one's awareness of one's own thinking process, is essential to empower learners and help them gain conscious control over their own learning processes. Teachers, therefore, need to find time to ask students to reflect on what they have been doing, why, they have been doing it and the value of doing it. They should encourage students to trace how their level of knowledge, opinion, and attitude has changed as a result of the learning activity. Students do not automatically reflect on the activities that they do. Teachers need to promote this reflective process until it becomes internalised.

Obviously, the methods suggested are not exclusive. Whatever the type of activity, what is most important is to get the students involved. However, there is a changing view of what doing science in schools involves. There is a strong argument in favour of introducing the social aspect of science as an integral part of the science curriculum. There are also implications for changes in the way that science curricula are designed and what that they are taught. Many times, science involves the understanding of concepts that are detached from their implications to everyday life and society. Laboratory work is used mainly for the illustration and understanding of these concepts and to train students in the process of doing science. This new approach to science being advocated involves a more holistic view of science where case studies about relevant current scientific issues are considered such that students have the opportunity to appreciate the implications of science to everyday life, society and the environment. Teachers need to change their view of doing science and to adopt different teaching methodologies to those that they have been using up to now.

4. Implications to Practicing Teachers

These new approaches require different teaching capabilities than those for which teachers have been trained during their pre-service training. This demands that teachers be provided with training to equip them with the new sills required to deliver a different approach and curriculum. Teachers need support at different levels: technical; planning; pedagogical and management level. At the technical level, teachers need to become familiar with ICT and have good working knowledge of basic programmes. Proficiency in ICT is crucial as students would be required to carry out most of their research on the internet. In today's knowledge society, it is impossible for teachers to keep abreast of all the content knowledge that is required for teaching, particularly if one is considering new technological advancements that are being conquered every day. Teachers, rather, need to possess the technical capability to use ICT in their teaching to enable them to help their students search and find information about the issues being discussed.

Teachers require new competences to tackle open-ended activities which lead to more than one possible solution, Teachers may feel insecure as to how to plan and prepare their lessons. One way of overcoming this insecurity is through good planning and preparation. Rather than preparing the one correct possible method leading to one solution, teachers need to learn how to plan resources which would enable students to look up relevant information. Teaches need to know how to deal with the possibility of different outcomes and how to plan processes rather than products. Such skills are not easily acquired as they always bring with them a degree of uncertainty as how lessons would proceed.

Good planning is only possible if teachers have good pedagogical background knowledge. Recent years has seen great research providing contributions and insight about the teaching and learning process, and particularly with respect to how this applies to the learning of science. New modern approaches, mainly within a constructivist framework are being advocated by many researchers. Teaching about the social aspect of science falls within these new trends. Consequently teachers are required to possess new pedagogical skills that they may not possess. It is therefore necessary to help teachers develop, either through in-service training or in-school support, these new and up to date skills such that they will be capable to respond to these new demands in the teaching of science. In addition, there also needs to be a cultural change as to how teachers view learning and how teaching in schools should be. This cultural change is crucial as it is only when teachers are convinced of the efficacy of the approaches that they adopt that they manage to deliver the curriculum effectively.

These new teaching approaches demand that teachers have different management skills than those usually required in the traditional teacher-centred approach. Having students working on projects where different groups of pupils may be at different stages in their work and carrying out different activities concurrently requires particular management skills. It is useless to have good pedagogical planning and delivery but bad management. Teachers can only provide quality experiences if they possess all these capabilities combined. The role of the teacher has evolved in a much more complex way than that conceived a few years ago. As the world becomes more digitized, complex and intertwined, the same can be said to what should be taking place in schools. It is ultimately the schools' responsibility to prepare students for a productive and independent life in the world and they consequently have to mirror the present expectations and demands rather than yesterday's reality. This means that teachers carry a great responsibility in ensuring that tomorrow's citizens would be capable of being truly active citizens that ensure a better future for humankind.

5. Conclusion

We are living in a fast changing world with new knowledge and practices generated every day. The science education provided to students should mirror this change. Rather than aiming to cover all the content generated, it makes more sense to aim to develop independent learners who can understand scientific issues and their implications to everyday life. This calls for a radical change in the way that we view science education. It is essential that this change is brought about, and quick, as otherwise we would end up with a future where citizens will not be able to handle appropriately the scientific processes that our scientists have developed. Such great power in ignorant hands would be dangerous to the future of our world. It is thus essential to act now if we want our future generations to enjoy a better quality of life than we have today.

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The Path to European Integration as a Mechanism for Quality Improvement in Science and Technology Education

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Abstract. If the European Union is currently under-performing in the knowledge-driven economy, in relation to some of its main competitors, this is due partly to an overall level of investment which places inadequate emphasis on education and human resource development. With respect to Science and Technology Education the efforts to develop a set of educational objectives have identified three key issues:

- The importance of Science and Technology Education to the future of European Society; closing the gender gap; raising the level of interest in choosing to study science and in engaging in lifelong learning; broadening the constituency for science, and developing a scientific culture.
- Teaching and Learning in Mathematics, Science and Technology: differentiating the educational objectives in relation to age, relevance and future priorities. Teacher preparation and support. Informal and non-formal learning opportunities. Strengthening, sustaining and spreading good practices. Encouraging a culture of educational innovation with emphasis on improving the quality of learning outcomes.
- Career guidance: enhancing partnerships between schools and Universities and between schools and industry.

In many European countries there are marked changes in the proportion of students choosing to study science related subjects in school at the point where these become optional. At the same time, the educational objectives across Europe, as well as the development strategy outlined in Lisbon, have substantial implications on the changing expectations of society from the European educational systems and increase the projected numbers of required personnel in science related careers. Such trends demonstrate the crucial importance of education in policy

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making. On the other hand, it is not always made obvious that there is a quality deficit in science and technology teaching and learning. In my presentation, I will illustrate the meaning of quality in educational systems and I will seek to demonstrate that the only sustainable approach to addressing the policy goals in education is through a process of quality improvement.

Keywords. Science literacy, Development.

WEB Resources on Science Literacy

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Abstract. The paper refers to our investigation carried out through the Internet concerning the subject of "Science Literacy". A reach web-based literature was scanned and classified, as we tried to highlight the important aspects related to this concept, which can play a major role in the long term development of our society. Our main goal was to offer to the newcomer to this debate a basic background on this subject. The main themes available on the Internet are: the definition of "science literacy"; the aim of the "science literacy"; the role of the scientific education in modelling the young generation; the teacher-parent partnership; the community fingerprint in approaching science; the active participation of the student in the teaching process by direct experience; the standards and benchmarking in science education; the use of the science history in teaching science; the evaluation of the impact of science on every day life; the science literacy policy in several developed countries; some examples of scientific literacy in various teaching fields; reference to some successful implementations; the major players; the means to achieve the goal. For the above mentioned topics relevant links will be provided during the paper presentation.

Keywords. Science literacy, Development.

Developing Scientific Literacy by Laboratory Work and its Reporting

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Abstract. Basic skills, like numeracy and literacy, are developed during elementary compulsory school. For centuries, society considered these skills sufficient for almost all its members (with the exception of for a small, leading segment of the society) to ensure its wealth and its (rather slow) progress, in a world where interaction was limited to the neighbours and where natural resources were not seeming to be limited. Later on, the development has been being traditionally based upon: labour force, skills, capital and research. The contemporary European society, in co-operation but in higher speed competition with potentially the whole world, a world with seemingly more and more limited natural resources, realises that the human creative resources are essential for a sustainable growth and competitiveness and, consequently, E. U. needs citizens with more evolved skills or competencies, sometimes apparently contradictory. Physics, based upon its three pillars: experiment, theory and simulation, may contribute essentially for forming and developing these skills, essential to a careful and comprehensive preparation of a competitive and successful career. More or less, all these skills may be developed during the Physics Laboratory Work and its Reporting. The laboratory work may become more efficient to develop particular skills. As an evidence of the laboratory work performed and a basis for assessment, the report has to be started and be mentally and physically prepared simultaneously with the start of the preparation of the laboratory work. The student is to be taught that, sometimes, reporting becomes as important as working. The students must be advised, at the beginning of the lab module, to choose an adequate structure of their reports. Quality assessment and evaluation of the supplied education must consider the development the reporting.

Keywords. Science literacy, Development.

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Science Teaching in Teacher Education. Dilemmas and Possible Solutions

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Abstract. Science teaching in schools experiences some difficult situations today: On one hand science has a most important influence on our human existence providing and threatening this existence at the same time. On the other hand science lost its traditional acceptance in schools and some major parts of society.

This contribution shows in a first part the reasons for the actual situation discussing historical roots and identifying important dilemmas in science teaching today, such as differentiation vs integration, natural science vs science, science vs technology, cognitive vs. instrumental goals and the use of different notions of the term "nature". In a second part these dilemmas are discussed as chances for science teaching and the importance of social processes in the classroom is pointed out. Finally a third part shows some possible examples to handle these dilemmas in a productive way discussing experiences made with teacher students and teachers in testing and evaluating integrated science teaching. These units are part of a research project concerning the establishment and the control of learning processes in science teaching in Swiss secondary schools.

This will be shown discussing the experiences made during a teaching sequence in the context of "open university days" held in May 2004 at the University of Bern, Switzerland. In this example, secondary school pupils were confronted with concepts and methods of modern molecular biology and learned about PCR and cell biology embedded in the story of the identification of a hypothetic criminal who was to be found among several suspected people.

The evaluation of the project resumes factors that are important for creating a positive attitude towards science and points out the importance of clarifying previous knowledge and as well as introducing new concepts. Through this a better understanding of complex scientific contents can be achieved.

Keywords. Science literacy, Development.

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Promoting Scientific Literacy in Malta. A Practical Perspective

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Abstract. Science education at primary level has been part of the curriculum for a long time, although it was usually treated at a superficial way. With time governments are recognising the importance of promoting scientific literacy from a young age. In Malta, the Education Act of 1988 allowed the Minister of Education to draw up a National Minimum Curriculum which stipulates the minimum level of education each and every child in Malta is entitled to.

The first version of the National Minimum Curriculum which was published in 1989 regarded science as part of the primary curriculum. Focus, however, was on content. The second and updated edition of the National Minimum Curriculum shows both further recognition of the importance of science within the primary curriculum as well as a more complete and holistic view of science. One finds reference to the content, process and attitudes to science and an emphasis on how students should be given grounding in content as well and understanding of the way science develops and is applied in our society. In addition, with this

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added responsibility on primary teachers, teacher training has been reorganised to ensure that graduating teachers have the necessary pedagogical skills to teach science in a modern and innovative approach. Schools have also had the need to adapt their structure and teaching approach to be able to deliver the National Minimum Curriculum.

This paper will outline how the delivery of science classes at a particular primary school in Malta has evolved so as to ensure that children receive a scientific education in an appropriate and creative way which will help them relate scientific principles to their everyday life.

Keywords. Science literacy, Development.

The Management of a Hands-on Design and Technology Competition for Students

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Abstract. In the current scholastic year, Erin Serracino Inglott Girls Area Secondary school in collaboration with the Malta Council for Science and Technology are organising an Inter school Design and Technology (D&T) competition. This competition is open to all schools that have D&T classes, mainly area secondary schools. Groups of students from each school have to design a container according to rigid specifications that will protect an egg from a sharp fall of about 6m. The projects submitted by the school will be judged according to set criteria which, besides the actual effectiveness in reaching their scope, include economic viability, environmental impact of materials used as well as participation of all the students in the work involved in the project. Awards will be given in all of these fields as well as in the aesthetics of the project. As the event will take place in April 2005, it will not be possible to make a definite balance on the final outcomes however; the students in each participating school would have already begun actual work on building the project. Thus, this paper will outline the planning of this event and the logistical, financial and practical problems encountered with the organisation. The objectives of the competition will be summarised and an analysis of the initial stages of it will be presented. The enthusiasm of participating schools, students, teachers and sponsors to back up this event will be also considered.

Keywords. Science literacy, Development.

Hands-on Activities in Science Education

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Abstract. The recent research of subject-pedagogy (inland an international) reflects the changed social demand expected from science education. The necessary knowledge for all of the pupils to give orientations to this modern world (curriculum), the unfavourable pupils' opinion on science subjects (attitude), the changed learning milieu, the radical change of teacher's role (reforming teacher and pupil strategies) stands in focus of researches. From the many new approaches of science education we would like to present in more detailed those procedures (based on our investigations), which give preference to pupils activity (so-called outdoors science). The purpose of the pupils' creativity developing method to link the curriculum and the everyday objects, everyday effects and to give the explanation their functional principles on different level. The outdoors investigations are diverse both in subject and in methodology. Beside the directional monitoring of natural and of technical environment, and the direct qualitative and quantitative experiences (measurements on field, try it, measure at home), the outdoor investigations show up the possibility to apply the games (constructive tasks), the pupil's accumulation work, the presentations, the project work, the performances in the science education. High-level mental and manual pupil's activity can be achieved by the non-traditional and pupil's ability pupil's skill developing method, which is the requirement of the interesting, „living" science for pupils.

Keywords. Science literacy, Development.

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Exploring Learning Processes in the Informal Context of the Exhibit "Games, Experiments, Ideas"

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Abstract. Contexts of informal education, such as hands on exhibitions and interactive scientific museums, play a role in children's' learning which requires the singling out and studying of the cognitive processes which they activate.

To enquire into the role of operativity and interaction between peers in the scientific learning of children of age from six to eleven, we have carried out studies in the informal context of the exhibition "Games Experiments Ideas" (GEI), designed for didactic activity. We have used different instruments and working modalities, lasting no more than 2 hours: exploration in small groups of single experiments on the basis of the incentives coming from open question sheets, with the purpose of collecting the spontaneous ideas activated on single disciplinary knots; guided explorations of the exhibition with conceptually homogenous groups and/or classes and building of spontaneous conceptual knots, to collect the first stages of the organisation of the various concepts; activities in small groups and in class groups in cognitive laboratories in which an interview protocol is followed, so that, starting from the analysis of the observation grids filled in during the carrying out of the activities of the cognitive laboratory, from the audio and video recordings, from the documents in which the children summed up in half a page "what they had learnt", it was possible to identify the ways in which children and teenagers build conceptual micro-paths and formalise them, and the reasoning stages which characterise their way of thinking.

The instruments used in our research have made clear that to build a scientific knowledge which is closely related to the sensorial and daily dimension it is important to create an operative context, in an atmosphere of game - challenge in which each personal hypothesis can be compared with the experiments' outcomes. To obtain a significant contribution to the formation of scientific knowledge, it is necessary to offer in informal contexts the opportunity to fix the concepts, reflecting on each experience, getting used to distinguish between operatively doing something, and describing not only the qualities of a phenomenon but also its formal dimension. They have also made clear that, even if in brief activities – especially when using on-line sensors with the computer, children and teenagers spontaneously activate their formalisation capacities to build knowledge. This dimension is motivating and allows overcoming the dimension of simple game, observation and stupor.

Keywords. Science literacy, Development.

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The communications presented at the 1st International Workshop on "Science literacy and lifelong learning. Europe towards a knowledge-based society" in Bucharest-Romania, May 2006, are also herein published.

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Formation of Young Scientists. The Educative Mission of the Senior Scientists

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Abstract. The scientific research is a creative activity, which means a continuous effort of improving the professional level by very different means: first of all is the ever increasing responsibility for your own professional condition to follow the steps of the hierarchy, to be faithful to your profession and finally to become more and more generous to transmit the skill to the young generations. The mission of education of new generations is not only a need, but is a way of improving your own condition, since the dialog between professor and student is always reciprocally fruitful, inciting, creative, ever a miracle.

The paper is discussing the very subtle relationship between senior and young scientist in this creative process of formation. The very specific activities are described.

Keywords: Responsibility, Professional mission, Senior and young scientist

1. Introduction

The scientific research is a field of activity in which there are special conditions to be fulfilled by those who decide to devote to it: first of all, it is a creative activity and to develop such an activity it is necessary some natural gift and also, let say passion, since there is a long way to obtain the satisfaction of some “grains of truth”, any humble contribution to the world scientific patrimony. There is not a spectacular career as concerns the material income, but for sure there are different other satisfactions mostly at the moral level. To reach the level of a true scientist there is no more the condition of the scientist isolated in the “ivory tower” but the open friendly relationships, since to the scientific activity is added the activity of formation of young scientists.

The mission of a senior scientist is that of transmission the scientific information but also of building a scientific personality, which means to discover the natural gift, or not, to advice towards a different other career. The process of formation of a young scientist is a long one in which the senior scientist could be, or not, a model for the young people, taking into account the very strong personality of the new generation, much earlier matured, because of the larger information system.

To be a model for the young scientists means to be a professional, to impose professional authority, but in the same time to know to collaborate, to encourage to stimulate the creativity of each member of the team, according own gifts. The formation can’t be proper, if there is not an appropriate atmosphere of fair cooperation, confidence, respect and stimulation.

Jean Piaget[1] showed that the transmission of the information is just one of the meaning of the school, since there are, as well, many other important tasks to achieve in order to prepare the young people to be integrated in the society, such as:1) to have the habit to a daily working program, useful later when integrated in the activity field, 2) the responsibility feeling; since the specific school procedures: marks, control works, examinations, periodical evaluations , even the score at the end of each scholar year will prepare the future employee to accomplish the duty at the working place and accept the criteria and steps of the promotion in the professional hierarchic scale.

2. Romania experience in the last years

The quality of the society depends on the quality of the education and a high level education is obtained in a serious school with professional teachers and professors.

Unfortunately, now in our society towards a democratic system we could notice the consequences of the communist education, when politics based criteria have been promoted.

The qualification of the scholars is different: for gifted scholars there is a special training, in which there are involved even the university professors and such scholars are able to

Jean Piaget (1896 – 1980) psychologist, professor at Geneva and Paris Universities founded the genetic epistemology

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participate in the international contexts and obtain good results, since they are highly motivated. I'd like to mention that last year 2005 at the International Physics Olympiad held at Salamanca the Romania team scored the 4-th place after China, Taiwan and Russia. It is worth to notice, that all the teams provide from countries with a high motivation of the young people to be accepted for study abroad. All Romanian laureates have been invited by the US universities to continue their professional accomplishment.

The other scholars less gifted receive in the school a level of information that has to be improved by private activities paid by parents in order scholars to be accepted in better universities. The education in the school is no more so severe, since the teachers are not motivated by attractive salaries, the authority of them is much decreased by a false understanding of the democracy and to be frank because these teachers are produced in the ex communist system. There are plenty of private universities, but the competition with public universities is not in the favour of the first.

The graduates in physics are no tall absorbed by the education - generally the graduates in physics are absorbed by IT. The schooling is not attractive since of unmotivated earnings and the often reforms, the lack of authority of the teachers.

Our research institute [1] absorbs yearly a number of graduates in physics and engineering, since the policy of the government is favourable in this respect (half of the salary was paid by the government and only half by the institute).

Unfortunately Romania did not adopted the Timberger model[2] (the planning of the education in respect to the economical development) probably because of the huge transformations of the economy after the collapse of the communist time and the long time planned economy in the ex totalitarian system. In the last years the quality of the graduates decreased very much as compared with about 8-10 years ago. In this respect those students selected to work in a scientific institute have to continue to improve the professional level; generally, they follow MS and PhD. Some of the students prepared their thesis in our laboratories and continue their activity. The MS topics are related to the activity in the laboratories of the institute, where they are selected to work. The benefit of these PhD students consists in the opportunity to be integrated in complex working team with people already specialized in the field. Due to the international projects, in which the senior scientists are already involved, the cooperation with scientists from other countries, there are activities in progress and the new graduates could easily be useful and accomplish their practical gift. The common work with experts in the field is a privilege for young scientists to be promoted, since they have to face different steps of the professional promotion: present the results of their activity in seminars, attend national and international conferences, work together with students from other laboratories belonging to the same network This is an impressive opportunity to start the career in a specialized team, which task is the scientific progress in optics and photonics.

Fig. 1 Students working in the international project LASERACT

The topics of the projects are ever up-dated according the last results in the world. This is a very stimulating and favourable environment for a young scientist [2].To develop experiments all together, to find solutions, to project new set-ups, to comment and discuss the results this means not only get expertise but it is an opportunity to take responsibility, to manage in unpredictable situations to improve the working style, to be more motivated to face new situations, to be able to report upon the contribution in a complex team work.

There are many different other opportunities students have to rise their professional profile:

[2]Jan Timberger scientist from the Economic Institute from Rotterdam Denmark

The "Module Franco-Phone" had been organized during 1993-1996 between Ecole Normale Supérieure des Arts et Inginiérie de Strasbourg, France and the University Bucharest with the National Institute for Laser, Plasma and Radiation Physics and between 1996-1999 with "Politehnica" University Bucharest MS. In the frame of this bilateral cooperation French professors held intensive courses, prepared questionnaires for evaluation, interviews with students to know the level of knowledge the motivation and the best students had the opportunity to develop six months working stages at Strasbourg. These stages had been determinative for the career of all the students. It was the beginning of the next co-tutelle PhD to be defended in France and Romania, as well.

It could be say that it was an important experience not only for the students but for Romanian professors and scientists, as well because of the opportunity to discuss upon the methods to work with students, to compare the level of French and Romanian students. The French professors found Romanian students better than French students, because the last ones had a higher motivation.

Romanian scientists held courses in French for Romanian students and each time a meeting at France Embassy in Bucharest with the cultural attaché took place in order to strength the cooperation. Some of the students after defending their PhD in France and post doctoral stages left for Canada.

3. Romania SPIE Student Chapter

In April 2001 the board of Society for Photo-Optical Engineering (SPIE) approved the first SPIE Student Chapter. To be member of a professional society is a pride and a sign of professional recognition.

Besides this moral benefit the contacts with this society opened new privileges for young scientists: to be able to attend international conferences sponsored by SPIE having some facilities as travel and accommodation, to apply for grants, to receive books and journals donations, to pay reduced membership fees, to attend the SPIE Annual Meeting and establish contacts with students from other countries.

In July 2004 on the occasion of the visit of SPIE President James Bilbro and Executive Director Eugene Arthur in Romania a meeting with Student Chapter was organized in NILPRP. It was the opportunity of SPIE staff to present the strategy of the society to promote the interest for optics and photonics, to encourage student to take profit from all the opportunities offered.

Two Romanian students attended the SPIE Annual Meeting a special occasion to attend a large conference and many members from different countries.

Fig 2. The SPIE President James Bilbro with Romania SPIE Student Chapter in Bucharest July 2004

There is not an easy task the formation of a young scientist and very often due to the large opportunities the young people has to develop mobilities, many of the young scientists once defended the PhD prefer to be employed abroad. The fluctuation of the personnel in the last 15 years is very high and the activity of formation of new scientists never ends.

The national and international conferences are other opportunities for training the young scientists, the occasion to present their results in front of a specialized audience, to select and process the scientific information, to elaborate a scientific paper. The young scientists have to be encouraged to work on the problem of "how to attend a conference"? This could be improved by presentations in the seminars and all kind of scientific events.

In our institute an international conference on optics and photonics is organized at every 3 years since 1982. As young scientists we had the opportunity to meet Nobel Prize winners Charles H. Townes, Alexander Mihailovici Prohorov, and many scientists, who attended the conference in a time, when Romania was a bridge between east and west. The schools, the conferences have been an opportunity to learn the secrets of the profession: how to make an attractive presentation, to organize the material to be presented, how to select the most important information, how to be attractive for the audience, how to react at critique, which is, or which are not a good presentation and many other things.

The organization of a conference is another step in the training of a scientist, which belong to the art to establish scientific relationships, to preserve contacts, to change the information, to learn to be useful in any occasion. Every thing is important and more disposals you are the higher is the gain in the profession of a scientist- it is impossible to be a good scientist without having a large culture.

In the education of young scientists it is important to involve them in the different events for science promotion: consisting in conferences, exhibitions, demonstrations, visits in the laboratories, "open doors" days, etc. This activity is a form to strength the pride and respect for profession transmitting the right scientific information toward the civil society.

Fig. 3. Program of "Science Week" held in April 2005 in Bucharest coordinated by the French Institute

4. Conclusions

There are some suggestions about the mission of a senior scientist that accomplish even its personality. Of course this is not an easy mission since the relationship between senior and young scientist is different from the conventional didactic one, but rather a close friendly one.

Probable the most important thing for a senior scientist, in order to be able to create a new generation of young scientists is to be generous, open to ever learn and receive information.

Serban Titeica a famous Romania physicist said: "There is no education, what there is… just to be a model".

We had some models of real scientists, gentlemen in the science, in the culture and education. Shall we be a day the same? Will be the new generation content about what kind of scientists have we been?

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Scientific Literacy versus Carbon Monoxide (CO) Poisoning: A Case Study

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Abstract. Scientific literacy is a very desirable skill for any citizen who wants / needs to be involved in real life. Our media bombards everyone with science and nowadays anyone is constantly called to understand, to interpret, to give opinions, to participate. Our schools must teach and form our present students and future citizens and one way to accomplish this objective is put them in contact with science through news. This work reports a case study about CO intoxication / poisoning which aims to contribute to a more scientifically informed society.

Keywords. Carbon monoxide (CO), Gas poisoning, Science and real world, Scientific literacy.

1. Introduction

The world we are living in is simmering with science problems and concerns ranging from the environment to medicine or population health care and risks, from pollution to sources of energy, etc. Our present days´ society suffers from the media a true bombardment of news related to science, or having implicit science, on a great variety of subjects.

The easy and fast understanding / de-codifying of the science news is limited by the level of scientific knowledge and education/instruction. Then if informed citizens, environmentalists or industrialists, capable to be involved in the different facets of democratic processes are needed, scientifically literate people are wanted. How can this be accomplished? One of the first steps passes through keeping, at the same time, our students interested and excited about.

Among the main objectives of the Portuguese School Programmes for the 3rd Cycle of Basic Schools is their contribution to the students´ scientific formation. And, as not all of them will go on to Science Areas further in the Secondary School, clear objectives has to be defined to allow them to achieve a basic scientific knowledge.

News about science deal normally with Biology, Medicine/Health and Astronomy, but that does not mean that Chemistry is put aside, mainly when interdisciplinary subjects are concerned. It is so desirable that in front of a newspaper any 3rd Cycle of Basic School person is able to make an interpretation, at least in a reasonable mode, of the contents and the meaning of any science news.

2.General Objectives

To enhance the interest, in the students, by the reading of news dedicated to Science matters (the majority of the newspapers include, if not daily at least weekly, separated sections about science).

To test specific skills about reading and understanding news about science.

To evaluate the 3rd Cycle students scientific literacy.

To identify the scientific contents in the news and to detect eventual mistakes.

To provide opportunities for the students to learn how scientists think and work.

To extrapolate the interiorized contents to interdisciplinary approaches (ScTS).

3. Specific Objectives

To identify the scientific area of the newspaper news.

To identify the content keywords of the news.

To use the identified keywords to explore other ScTS applications.

To utilize the identified concepts in Risk prevention/ Health perspectives.

Helpdesk for Older Women Caring for their Mothers or Mothers in Law

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Abstract. Elder abuse is a growing problem which occurs daily in every community.

Abuse can involve physical harm, financial exploitation, emotional or verbal abuse, neglect (including self-neglect) or abandonment.

All forms of abuse are devastating and often occur in isolation making it difficult to identify the need for help.

Family situations make it often difficult for an older adult to ask for help. Up to a high degree nursing is done by older women within the family. As there are great difficulties in encountering abuse within family care a study has been launched which involved the very old women as experts. Qualitative interviews made it possible to get answers of the very old women concerning abuse and violence. The outcome has been the basis for developing a help desk for older women living together on the basis of care giving and care excepting.

This helpdesk serves as a tool for successful prevention of abuse, violence or discrimination. Promoting the issue is of high value and it is important that civil society becomes aware that the number of older women reaching high age is increasing and that family care is up to a very high percentage in the hands of women who are 60 years and older.

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Reading and Writing for Critical Thinking. An Opportunity for Scientific Literacy

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Abstract. This paper presents a cooperation project designed by the representatives of the three educational institutions in our town: the County School Inspectorate, the Faculty of Psychology and Science of Education from "Babes – Bolyai" University and the Teacher's House Science the authors represent also a training NGO "Reading and Writing for Critical Thinking - Romania". The aim of this project was to build a learning community for the science teachers in our town in order to improve their teaching strategies and to help them to design more active learning activities to their pupils in the new educational reform in Romania. First we identified the teachers willing to attend this in-service training, and then we started two training stages with them on a topic suggested by these ones: adult learning strategies, critical thinking methods used in order to facilitate the pupil's understanding of science concepts, principles and theories. We propose an interactive workshop where we want to perform a training activity for science teachers; this workshop will be focused on RWCT teaching strategies and methods. Also we may present resource materials created by the teachers during and after the training stages, some portfolios of the pupils in secondary and upper secondary schools, as well as a longitudinal study concerning life long learning opportunities before and after the implement of the Educational Reform in Romania. Also, we refer to the main evidences and results mentioned in the inspection rapport about the efficiency and achievements obtained by the teacher which applied these new teaching strategies. A summary of teacher's opinions about their feelings concerning the training course is also presented.
Our project implied more than 200 science teachers (physics, biology and chemistry teachers) in its different phases. Since 1997, in the Romanian Educational system it was implemented the new curricular and evaluation reform which imposed an important change in in-service training activities. Our project is a new and challenging activity and it tried to build-up relations and communication networks between institutions which, until now, didn't cooperate at all. We think that our experience, resource materials and results would be interesting and helpful for many of our colleagues.

Keywords. Cooperative learning, Constructivism, Active learning, Reading and writing for critical thinking.

1. Introduction

During the 1990s, the field of adult education has faced the challenge of improving the quality of the services it provides to adult learners. Thus, in Romania, the new Educational Law (1997, 2002), together with the other rules and normative emphasizes the importance and the increasing role of in-service training of teachers in order to built new democratic, autonomous schools. Central to carrying out these requirements is the state' capacity to work with local adult education programs in providing training on new teaching methods and attitudes, in motivating programs to consider the adoption and the development of new practices, and in promoting the role of adult education in the work force development and human services delivery system.

The educational reform started since 1997 in our country focused on the following main problems:

i. systemic changes in the school management

⇒ new approach of school'management (school as educational services provider accordingly to the community needs and interests)
⇒ schools'inspection (as support for improving school performance and development without the straight control before '89)

⇒ the education quality (quality indicators and criteria built in order to improve school ethos and results)

ii. **facilitating professional development**

⇒ in-service training for teachers, head-teachers and inspectors

⇒

iii. new curricular approach which ensure the pupil centered teaching and learning

⇒ five curricular areas: Language and communication (Matern and Modern languages), Mathematics and Sciences (Mathematics, Physics, Chemistry, Biology), Man and Society (History, Philosophy, Psychology, Economics, Religion, Civics), Arts and Technologies (Sports, Painting, Music, Technological Education) and Counseling

⇒

iv. new approach of pupil and schools assessment and evaluation

⇒ new design of K-8 and K-12 national examinations

⇒ new structure of academic year (2 evaluation period of time, each during 3 weeks at the end of each semester)

As a consequence of changes induced by the above approaches, an challenging educational project aimed to implement the educational reform in the schools in our country have been designed by representatives of County School Inspectorate, Teachers Training Department of "Babes – Bolyai" University and Teachers' House from four counties. This project has six main program lines: School improvement, School and community, Interinstitutional communication, Pre-service and In-service training of student teachers, respectively of teachers, Development of educational support for pupils from rroma communities and Public information, so we stated the following aims: <u>to build a learning community for the science teachers in our town in order to improve their teaching strategies and to help them to cop with the challenges of the new educational reform in Romania.</u>

While it is true that there are teachers whose attitudes are positive towards the promotion of good science teaching – learning situations, the reality of schools still consists of lessons where their teachers transmit science, at best, as a set of facts, laws and data. The results brought by physics education researchers' pedagogical experiments have good consequences only when rooted within the school as an institution (teacher, curriculum and defined pedagogical practices) and within a particular context (culture, program, country). We conclude that there are no universal methods to modify this situation, that is, there are a variety of sciences teaching styles as a result of the strong interaction between teaching attitudes and competencies, school and society, as suggested by the diagram shown below. (Fig.1 Model)

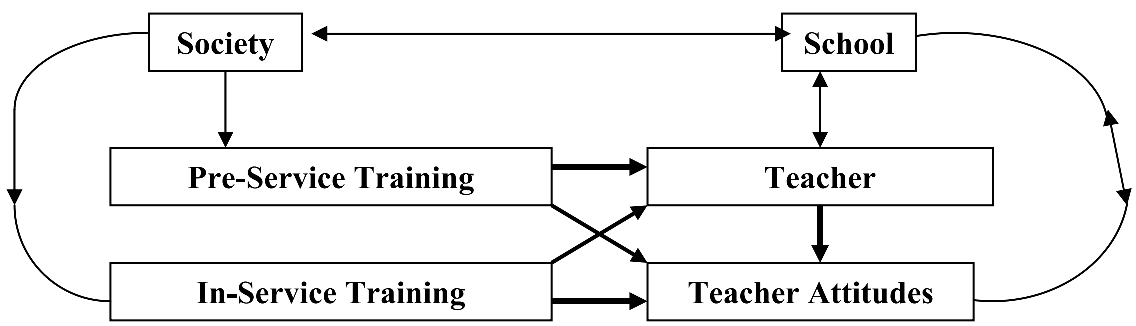

Fig. 1. Model

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2. Teachers training stage program and results.

At the very beginning of the project implementation we started with a needs analysis of the teachers both from the pilot – schools selected (10 schools- 2 high schools, one vocational/industrial high school, 3 secondary city schools, and 4 secondary village schools), as well as from other schools (2 high schools and 2 vocational/industrial high school) in our town in order to have enough responses and opinions from science teachers (especially physics teachers).

131 teachers (primary school teachers, secondary and upper secondary teachers, teaching engineers), 959 pupil (410 secondary school pupils, 549 upper secondary school) and 40 parents (from 2 upper secondary school) answered to the questionnaires applied, with interest and concerned in order to ensure the best practice they can. The questionnaire structure comprise both teaching – learning items (methods, techniques, strategies most applied or wished), as well as issues concerning the school – parents relationship, respectively the school – community partnership in the close future.

The teachers'answers allowed us to identify their main needs and interests, as well as their knowledge and uncertainties concerning the educational reform:

- ✓ class management when working in group;
- ✓ using reading and writing for critical thinking techniques in teaching different subjects (does it works in science lessons? What do we do with the very dense and large scientific content?);
- ✓ learning styles and teaching styles how to improve them?;
- ✓ portfolios and projects as evaluation instruments;
- ✓ participative teaching methods and national evaluations and examinations (to implement active, participative methods in teaching science is nice and pleasant for pupils, but what happen with the examinations? Will they be changed accordingly?)

Consequently we designed a training program – for mentor teachers, respectively for methodologist teachers, that are secondary school teachers assigned to realize promotion inspections - organized in four stages of two days each as follows:

First stage' program:

Day1	S.1 Introductory session: Good teaching what it is?	S.2 R.O.D.I.S. & M.A.R.O.D.I.S general presentation	S.3 Teaching Quality and Pupils educational standards achievements criteria	S. 4 Teaching Quality and Pupils educational standards achievements criteria
Day2	S.5 Lesson Observation File. Video lesson 1	S.6 Lesson 1 analysis & discussion	S.7 Performance indicators for K – 6 to K –12 physics learning	S.8 Stage overview and evaluation

Obs. "Homework": Observe a real lesson using "Lesson Observation File", evaluate and notice how did you feel when using it.

Second stage' program:

Day1	S.1 Introductory session: Sharing lesson observation experiences	S.2 Pupils' learning styles. Multiple intelligence	S.3 Assessing physics learning using performance criteria	S. 4 New evaluating instruments design: portfolio, projects, essay
Day2	S.5 New evaluating instruments design: portfolio, projects, essay	S.6 Evaluate a portfolio / project / essay	S.7 Teaching styles – overview of main teaching styles for physics classes	S.8 Stage overview and evaluation

Obs. "Homework": Start to apply portfolio / project / essay evaluation. Bring your best and your worst one.

Third stage program:

Day1	S.1 Introductory session: Sharing products, analyzing them	S.2 Team work – characteristics, roles, implementation	S.3 Lesson Observation File. Video lesson 2	S. 4 Lesson 2 analysis & discussion
Day2	S.5 Performance criteria and indicators for process / products	S.6 Performance criteria and indicators for process / products	S.7 Lesson plan – different teaching techniques, different learning styles, different team work settings	S.8 Stage overview and evaluation

Four-th stage program:

Day1	S.1 Introductory session: Good teaching what it is?	S.2 COSA standards for primary and secondary school teachers	S.3 COSA standards for primary and secondary school teachers	S. 4 COSA & R.O.D.I.S. comparison
Day2	S.5 The School Decided Curriculum design	S.6 The School Decided Curriculum design	S.7 The teacher'portfolio	S.8 Stage overview and evaluation

The main results of the training stages (Table 1) as they appear from the evaluation questionnaires applied were the following:

- ✓ positive appreciation about national criteria used in order to evaluate teaching quality;
- ✓ valuing of individual ideas and solutions induced increased self esteem;
- ✓ differentiate and accept difference between product and process evaluation;
- ✓ defining performance criteria and indicators as a function of specific competencies of different subject, and of pupils age;
- ✓ using accurately portfolios, projects and essays in evaluating periods of each semester;
- ✓ design of a quality S.D.C. program for a subject, interdisciplinary theme and crossdiciplinary theme;
- ✓ improving of class teaching – learning process;
- ✓ improving of class ethos;
- ✓ improving pedagogical practice process in real school.

Table 1: Accomplished teachers

Teachers are committed to pupils and their learning	❖ Accomplished teachers are dedicated to making knowledge accessible to all students; they act on the believe that all pupils can learn, they treat them equitably, recognizing the individual differences and taking account on these differences. They adjust their practice based on observation and knowledge of their pupils' interests, abilities, skills, knowledge, needs, and family circumstances.
Teachers know the subjects they teach and how to teach those subjects to the pupils	❖ Accomplished teachers have a rich understanding of the subject they teach and emphasize how knowledge in their subject is created, organized and linked to other subjects (from the same curricular area, or from different curricular areas) and how is applied to real world settings. Accomplished teachers are aware of the preconceptions and background knowledge that pupils typically bring to each subject and of strategies and instructional materials that can be useful. They understand where difficulties are likely to arise and modify their practice accordingly.
Teachers are responsible for managing and monitoring pupils learning	❖ Accomplished teachers create, enrich, maintain and alter the instructional settings to capture and maintain the interest of their pupils and to make the most effective use of time during their teaching hours. Accomplished teachers have a rich repertoire of teaching methods and techniques, know how and when each of them is appropriate and can implement them as needed. They know how to engage groups of students to ensure a disciplined learning

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	environment, and how to organize instruction to allow the schools'goals for pupil to be met. Also, they are adept of setting norms for social interaction among pupils and between pupils and teacher. Accomplished teachers can assess the progress of individual pupils as well as that of the class as a hole. They employ multiple methods for measuring pupil progress and understanding and can clearly explain pupil performance to its parents.
Teachers think systematically about their practice and learn from experience	❖ Accomplished teachers are models of educated persons, exemplifying the virtues they seek to inspire in pupils: curiosity, tolerance, honesty, fairness, respect of diversity and appreciation of cultural differences, and the capacities that are prerequisites for intellectual growth: the ability to reason and make multiple perspectives to be creative and take risks, and to adopt an experimental and problem – solving orientation. Their decision is grounded not only in the literature but also in their experience; they engage lifelong learning which they seek to encourage in their pupils.
Teachers are members of learning communities	❖ Accomplished teachers contribute to the effectiveness of the school by working collaboratively with other colleagues and professionals on instructional policy, curriculum development and staff development; they find ways to work collaboratively and creatively with parents, engaging them in the life of school.

3. Teacher training and school as learning community

John Dewey (1916) argued that schools should be more like the rest of life – that they should be places where people learn by engaging in meaningful and purposeful activities rather than places where pupils rehearse abstract content transmitted by teachers and textbooks. Also, in 1929, Whitehead complained about schools producing too much *inert knowledge* – with pupil knowing definitions of concepts but not being able to use the concepts when appropriate. More recently, Lauren Resnick (1987) argued that "as long as school focuses mainly on individual forms of competence, on tool – free performance, and on decontextualized skills, educating people to be good learners in school settings alone may not be sufficient to help them become strong out – of – school learners".

The theories of situated cognition assume that knowledge is inseparable from the contexts and activities within which it develops. These theories posit that the physical and social context in which an activity takes place is an integral part of the activity and that the activity is an integral part of the learning that takes place within it. Thus, every cognitive act must be understood as a specific response to a specific set of circumstances. How a person learns a particular set of knowledge and skills and the situation in which a person learns become a fundamental part of what is learned. The impact of social influences on learning and the social contexts in which learning takes place have received increasing recognition in recent years; learning – especially learning in school – is the result of individual effort of each pupil, not alone, but, as a result of the great variety of interactions in class; "what we take as knowledge and how we think and express ideas are products of the interactions of groups of people over time" (Soltis 1981).

Individuals participate in numerous types of discourse communities ranging from scholarly disciplines such as science or history groups of people sharing a common interest to various workplaces and professions. These discourse communities provide the cognitive tools – ideas, theories and concepts – that individuals appropriate as their own through their personal efforts to make sense of experiences. An important part of what it means to become competent in a particular domain is to learn the forms of argument and discourse – the accepted ways of reasoning, acting and valuing – within that disciplinary community. Learning science, for example, entails "entering into a different way of thinking about and explaining the natural world; becoming socialized to a greater or lesser extent into the practices of the scientific community with its particular purposes, ways of seeing, and ways of supporting its knowledge claims" (Driver et al. 1994, p8).

The research on the situated, social and distributed nature of cognition has important implications for classrooms and teachers.

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Viewing cognition as situated implies that pupils should learn knowledge and skills in meaningful contexts. Two models for transforming classrooms into meaningful contexts or environments for learning are authentic instruction and cognitive apprenticeship. The implication of the notion of cognition as a social activity is that pupils must be prepared to participate in various communities. The implication of research on the distributed nature of cognition activities is that classrooms environments should be more reflective of the distributed cognitive activities that occur outside the school environment and prepare pupils to work with the people, tools, and technologies encountered in the modern workplace.

The opportunities offered by the new active, participative methods and techniques observed in the teachers training stages described above, have been implemented in the classroom contexts and as it could be seen from the inspection rapport the teaching – learning process did improved in the schools involved. The teacher's role in a classroom designed to foster and take advantage of these methods as well as of distributed cognition differs from that in a classroom emphasizing independent, individual learning. For example, when classroom tasks are designed to incorporate a view of distributed cognition; the teacher cannot be expected to claim expertise in the entire information domain explored. Gone is the image of the teacher as one who imparts knowledge; in its place is the image of the teacher as a guide for pupils' inquiry into multiple domains. When assuming the role of a guide, a teacher teaches, as pupils become ready to learn rather than prescribed by a set curriculum or rigid lesson plan. The shift away from a conception of the teacher as all – knowing being also creates opportunities for teachers to model the kinds of inquiry desired for pupils – to become "the master craftsperson of learning whom (pupils) must emulate". (Brown et al, 1993, p.207)

The conception of knowledge, expertise, and thinking as distributed across persons shifts the focus of discussions about teachers' work lives from considering teachers as "self – contained" individuals to looking at the overall "system" or community in which teachers work and interact. From this perspective, the competent teacher is not a person who can "do everything" and "know everything" in isolation but rather an individual who can work well within a broader system of expertise. An issue for preservice teacher education, then, is how to establish discourse communities in which prospective teachers can be thoughtful and reflective in constructing their practice.

For this workshop we propose a training activity that illustrates the RWCT strategies in a specific scientific literacy learning activity. We will bring handouts, scientific texts from different topics and sources (textbooks, newspapers, magazines, TV news etc. These materials will be used in practical training activity of about 45 min.

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LENA: Learning in Post Professional Phase

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Abstract. Life Long Learning is a key issue of well being in old age. It should be recognised as such by the public, stakeholders, persons involved in care and by the older people themselves. The gerontological research has identified education as one of the most important factors of stabilising health. "LENA – Learning in post professional Life", a transnational European project has been developing an empowerment curriculum for older people. It runs from October 2004 to September 2006.

Methods: The research work focuses on creating modules which are dealing with activities that contribute to the individual`s ability to make the right choices; to engage; to improve self-esteem and self-confidence; to sustain own physical and mental well-being into later life. Via focus groups older people themselves have been integrated in this research program.

Results: Learning modules concerning older people´s issues will be available and part of integrated care. Older people should be aware that taking part in LLL Life Long Learning programs is an essential part of healthy aging.

Conclusion: Specific learning programs for older people will enable them to participate fully in the social life of modern society and by the same time will ease the multiple arising difficulties in old age and thus improve the quality of integrated care.

References.

www.lisa-net.info
www.seniorweb.at
www.altgegengewalt.at

RIPE APPLES: Social Intervention and Health of Older Women

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Abstract. Getting older women are confronted with changes in their developmental tasks. In order to overcome health problems that occur with age related changes in their way of life, solutions have to be based on the available resources, and adapted according to each situation. From the view of the various social situations, health awareness interventions have to orient themselves closely within the context of real life situations.

Methods: In the project Ripe Apples regular encounter groups have been established for older women in small communities where they can converse and participate in health related activities. The project intends to strengthen the personnel resources and structural development in rural regions in the long term, as well as facilitate the understanding of the specific needs of older women.

Results: Ripe Apples groups have been established in rural environments in Austria. The interest in and the frequency of regular meetings is still very high. An evaluation of the process and of long term effects has been carried out.

Conclusion: By actively taking part in educational efforts within environmental setting health resources of older women will be strengthened.

References.

www.lisa-net.info
www.seniorweb.at
www.altgegengewalt.at

Education, Training and Participation for and with Senior Citizens

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Abstract. The growth of the older population has significant policy implications for all nations across the EU, and much debate regarding the ageing population centres on imminent increases in health and pension costs. However, people are not just living longer; for the most part they are also healthier and many are in a position to actively contribute to society. Great opportunities thus exist as future generations of older people are expected to be healthier, more skilled and educated, and remain more active in the workforce than their predecessors. Positive attitudes to ageing and expectations of

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continuing productivity challenge the notion of older age as purely a time of retirement and withdrawal from society. The focus is on lifetime experiences contributing to wellbeing in older age, and older age as a time for ongoing participation in society.

Older people are important members of society and have the right to be afforded dignity in their senior years. They possess the skills, knowledge and experience to contribute positively to society. The expected increase in the elderly population during the coming decades will provide EU with a valuable resource. Furthermore, continued social participation of the elderly holds benefits for the individual concerned, the community, and society as a whole. Unfortunately, for some older people, their full participation in society is hindered due to a low sense of worth or due to restricted opportunities. Social exclusion may occur through one, or a combination of, a range of circumstances, including a lack of access to personal, community or state resources and facilities, insufficient personal capacity and opportunity, as well as negative attitudes to ageing. The ability to age positively is assisted by good investment in education throughout life, to provide individuals with a repertoire of skills and abilities to set and achieve goals. It is also dependent on an environment that provides opportunities for older people to remain actively involved in society and offers opportunities for continuing participation, something which is often times lacking in modern society. Retirement from the paid workforce should not mean that people cease to contribute to society, rather opportunity exists for participation in a range of different roles: as volunteers, special employees, family members, neighbours, caregivers, committee and trust members, business mentors and advisors, and members of communities.

The choice to work later in life is important in meeting the challenge of positive ageing. Evidence suggests that those who work longer enjoy better health in their old age. However in order to achieve this, more emphasis needs to be placed on life-long learning (LLL) for workers of all ages, so that they maintain and increase their skills and productivity as they grow older. LLL makes more sense if it is followed by society participation and contribution. This involves a radical change in attitudes towards ageing and older workers. The benefits of positive ageing for individuals are multiple: good health, independence, intellectual stimulation, self-fulfilment and friendship being just some of the valued outcomes. Society as a whole has a lot to gain from such outcome: a healthy, happy and confident ageing population contributes a wealth of expertise and skills to the community and the workforce, places less demand on social services, and provides positive role models for younger generations. People should be supported as they grow older, in leading productive lives in the economy and society. It is important to allow and encourage older people, and future generations of older people, to experience ageing as a positive and productive phenomenon.

The Relationship between Learning and Social Participation

In many European countries various surveys data show that the more learning activities a senior citizen engages himself/herself in, the more he/she is an active participant in social and community activities. Particularly highly popular voluntary activities among active learning participants are cultural, social, health promotion, and medical care.

Programs designed to promote intergenerational relationships are of high value. SCs volunteer tutors working in public schools in the United States and similar other innovations from other countries seem to convince us that older people and young people can effectively interact with each other.

- SCs' enjoys teaching, interaction, and communication with younger generations;
- pupils enjoy learning with elderly teachers who possess expertise and life experiences;
- pupils from a nucleus family (without grandparents) can learn from the elderly experts;
- young teachers particularly profit from SCs' teachers' life and professional experiences, particularly from their knowledge on historical and cultural aspects of the local community; and improved coordination with the overall school curriculum and reinforced;
- efforts should be made with a view to enlightening teachers about lifelong learning, voluntary activities and the meaning of "open" schools; and
- methods of teaching and guidance by the elderly teachers to promote the pupil's self direction and initiatives in learning activities.

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Why is education and training of Senior Citizens of a high value to the society?

- Education and training is an investment, which can help to reduce the budgetary pressure on pensions and medical care of the aging society.
- ET about and for senior citizenship can start early in life as an integral part of the human developmental scheme of learning and teaching;
- ET for senior citizenship needs to be focused on the unique need and empowerment of the individual learner: each senior citizen is unique and may aspire to different needs, and when each senior citizen feels empowered with self-efficacy, self-direction, and self-control,
- ET for SCs' become an effective course of action.
- SCs' and younger generations need more opportunities to learn about the importance of self-management of free time with and without employment: techniques of how to use and apply multimedia technologies to the benefit of their life, work, leisure, and social activities. Developing learning and social networks with the aid of such technologies opens up unlimited horizons of their life;
- While meaningful and enriching partnerships between women and men are essential ingredients of active aging, gender disparities in learning and social participation of SCs can be narrowed, particularly by encouraging more the participation of female SCs in higher level of education, employment, professional training, and health management.
- The childcare facilities should be improved and other institutional obstacles can be removed to make both female and male SCs' learning and social participation easier and more accessible;
- ET about and for health is an important priority concern for active aging. Self-directed ET for health care starts early in life and can be sustained throughout life. People are more and more convinced by the idea that active learning and social participation do improve our health, which, in turn, make possible more active learning and social participation of SCs;
- Effective and flexible partnership and resource mobilization efforts among different individuals, bodies of SCs, different public bodies and ministries, between national and local bodies—is a key to promote acting aging scheme of the society and any assessment attempts of such partnership and coordination must be learner focused;

Current practices and innovations designed to promote intergenerational interactive communication and cooperation, pleasurable and mutually beneficial intercommunity programs, curricula, and learning opportunities, are key ET issues for active senior citizenship. Finally, international comparative studies, exchange, and dissemination of information is a useful means to promote, stimulate, and review innovations and practices of senior citizenship of one's country from a global perspective.

More about GEFAS

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Abstract. GEFAS has its roots in a program set up in 1988 at the University of Graz, Austria, to assist older students. In 1991 Rosemarie Kurz and other senior students at the university founded the non profit organisation, GEFAS Steiermark, The German acronym stands for Gesellschaft zür Förderung der Alterswissenschaften und des Seniorenstudiums, the Association for the Promotion of Gerontological Science and Higher Education for Elderly People. The head of GEFAS Steiermark was and still is Dr. Rosemarie Kurz.

From the beginning it was a largely volunteer organisation. Broadly speaking, Kurz and other older volunteers conceived and carried out GEFAS' programs, while younger people gave management and technical support. GEFAS works on culture, health, gender, violence, intergenerational, social and participatory issues www.seniorweb.at

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Since 1994 GEFAS gained 13 rewards concerning one or the other issue. Since 1993 GEFAS is involved in various transnational innovative projects concerning post-employment phase as coordinator, partner, expert and evaluator.
2005 – 2007: Justice and Social Affairs: “DAPHNE - Helpdesk for older women against everyday violence”
2004 – 2007: SOKRATES / GRUNDTVIG 1: “LENA – Learning in the post-professional phase”
2005 Contactseminar: „Lifelong Learning for Senior Citizens”
2004 – 2005: Justice and Social Affairs: “ABAD - Arbeit - Bildung – AltersDiskriminierung“
2004 – 2005: Justice and Social Affairs: “PHARE – Implementing Intenet Cafes”
2003 – 2005: Research: “MERI – Research for older women”
2003 – 2004: SOKRATES / R3L: „LISA – Learning in Senior Age”
2000: Partner in the EU project: "Equal opportunities for older women”
1997 EU project: “Housing for Help”
1996 EU project: “Changing Track at Third Age”
1993 EU project: “Older people and public traffic”

About the Elephant Symbol

Elephants are said to be symbol of old age and wisdom, they walk in a flock with the young. When water is short, the old animals are the ones to point the way to the water holes, but they drink moderately. In turn the young stay with the old when they die.

The Reading Crisis in the Context of Education Turning Virtual. Approaches and Possible Solutions

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Abstract. Having in mind the idea that the “informational revolution” tends to configure the vast field of education and change the paradigm of creating and transmitting the knowledge, school must flexibly adjust the new information and communication technologies-guide marks according to which priorities and resources in this field should be established. Our paper wants to offer a few approaches and possible solutions to the “reading crisis” among young people, a crisis to which sociologists have tried to find the causes.

Keywords. Interdisciplinarity, Information and communication technologies, Lifelong learning, Pleasure of text, Reading crisis, The reader.

1. Introduction

We cannot speak about lifelong learning, lifelong formation, learning to learn and moral freedom of the educated person without accepting and acting in the spirit of revising the learning process. Learning to deal with enormous information, showing critical power and productive competence, learning to use the principle of change and live in an open-ended environment, learning to cooperate in order to achieve team work tasks[3], all these are priorities of the educational process, of the school that is forced to revise its purpose of offering the student a mind free of ideological conditionings[4]. In the context of education becoming virtual, the new information and communication technologies have become essential to all the activities where the student is the direct receiver. Such a revision of the educational system brings forward the major advantages of using the new ICT, but at the same time it starts disputes.

2. “The reading crisis”- reality of the contemporary Romanian school and society

Recent studies (“The Cultural Barometer 2005”[5] made by the Center for Studies and Research in culture and the study[6] made by the Center of Urban and Regional Sociology

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[3] Cucoş, Constantin. Aspecte ale virtualizării educației, in „Tendințe contemporane în metodologia de realizare a lecției”. Iaşi; Tehnopress 2006, p. 23.
[4] Thellen, Stephane. L’école aux prises avec les idéologies de l’informatisations sociale, in www.er.uquam.com.
[5] Dilemateca, nr.1, Bucureşti, 2006, p.21.
[6] Cercetare privind analiza comportamentului de consum de programe audio-vizuale al elevilor. Bucureşti, 2005, in www.curs.ro.

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together with the Center of Media Studies and New Technologies of Communication Bucharest) show an alarming situation:

- Favourite pastime activities and places to spend the free time of the EU citizens are ranked as follows: cinema, library, visiting monuments, museums, exhibitions, musical shows. In Romania the situation is the following: taking part in holidays and events, entertainment and musical shows, museums, cinema, theatre. The library is not among their favourite.
- Among students with ages between 15 and 18, their preferences chart looks like this: 46.6%(out of 2300 students) have fun in the open air, 13% practice sports, 9.1% play on the computer and only 8.6% read or study; 6.9% watch TV, 4.9% listen to music. Thus, using the computer (but not for educational purposes) is preferred to reading.
- In what reading preferences are concerned, the same source shows: the subjects mentioned they prefer only the Romanian writers they have studied in school. In their top 10 there is no contemporary writer. 8.5% of those questioned couldn't mention one Romanian writer. Out of the 2300 students questioned, 44.7% don't read novels, the others, in minor percentages (up to 7%), mentioned only titles from the compulsory bibliography for the baccalaureate exam; in poetry, 9.1% refuse to read poetry, Mihai Eminescu being the only poet in the list of favourites of 34.2% of the students.

In such a situation, phrases like "reading crisis", the virtual-fiction tension/conflict, and the "death" of the young reader are highly justified. These are realities to which school and all major factors involved in education should find realistic and flexible solutions.

If school doesn't form reading competences and doesn't induce students the idea that reading can be satisfying, the match is lost: the same number of readers who entered school will exit it. That means students with intellectual curiosities, whose parents supervise and coordinate their reading process. Teachers have the capacity to stir their interest in reading and to develop the esthetical taste of those students who are not part of the 8% of the study- students "destined" to reading through affective and intellectual willingness.

3. The pleasures and discomforts of reading

The seductive effects of the literary text have been named differently; they illustrate the passionate nature of comprehension and interpretation. These names are: fascination, delight, pleasure, voluptuousness, enjoyment, euphoria.

How and when do the seductive effects reach us, what kind of reader and what type of reading generates them? These are questions with no precise answers, questions to which we answer evasively or with approximation or, as Roland Barthes said, "in a dilatory manner".

The ideas that we intend to present refer to the pleasure of reading, or better said of re-reading. The joy of reading cannot be expressed by formula; it comes and goes and it depends on the quality of the open space opened between the reader and the text: a space where there is "the possibility of a dialect of desire, a space where the dice have not been rolled, where there is a game." [7]The making of such a space depends not only on the text, on its seductive potential; it greatly depends on the reader's eye, on his ability to predict the promise of joy, to recognize the beauty, to wish for its presence, to learn and play the game.

Being guided, students will understand that in the writer-text-reader relation, the reader takes the position of a collaborator, if not the one of an accomplice; in this way the meaning of the text is "predicted by the reader", "built" and not discovered, and the reading becomes a production activity that invites the young reader in the pleasure of (re)writing (mentally) the text. Phrases like pleasure of text or the joy of reading define the affective element of the encounter with the book or its positive side. Naturally, there are negative aspects of reading, such as effort, discomfort, boredom and pains. Through a questioning step and well articulated the teacher can get students on his side and even get their complicity which the active, creating reading involves.

Our research carried on 800 high school students from the north east part of Romania gives some approaches/solutions to the inertness shown towards reading and their preference for

[7] Iser, Wolfgang. The Implied Reader, Patterns of Comunications in Prose, from Bunyan to Beckett. Baltimore, John Hopkins U.P, 1998, p.225.

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using the computer, the internet, solutions found in our own research.

We had 800 people questioned, and these were students with ages between 15 and 18, attending high school on different departments: mathematics-informatics, philology (intensive English/French classes), vocational (kindergarten and primary school teachers, orthodox theology, roman-catholic theology). The selection method was the random one, keeping to the stratification pattern- urban schools (big cities)/rural schools.

The questionnaire was answered to in two different ways: students in the urban areas, who have access to the Internet in schools, answered to it electronically; those in the rural areas, where there was no possibility to answer online, took part in face to face interviews in schools.

Form the answers we got, we analyzed the preferences/needs to read of the students, the causes that determine them to read or not read, the time they spend daily/monthly on reading, their preferences according to the literary genre, their preferences according to the Romanian/ foreign writers, canonist/no canonist writers (not studied in school), contemporary writers, willingness for an (in) formal dialogue, constructive/open/sincere with the contemporary writers from the native town/country/Diaspora.

The answers to the questionnaire have been represented graphically, as it follows:

Q1. Compared to other activities that you do at home, reading is for you an activity? (Fig.Q1)

Q2. If you had to choose between reading a book or watching a screening of that book, what would you choose? (Fig.Q2)

Q3. How many books did you read last month? (Fig.Q3)

Q4. What books did you read last month? (Fig.Q4)

Q5. How much time do you spend reading daily?

Q6. What else besides books do you read?

Q7. What do you like to read? (Fig.Q7)

Q8. What literary genre do you like? (Fig.Q8)

Q9. What writers do you particularly prefer? (Fig.Q9)

Q10. Do you read Romanian writers?

Q11. Indicate, in order of preference, five Romanian writers:

Q12. Do you read foreign writers?

Q13. Indicate five foreign writers that you have read:

Q14. What discourages you from reading more?

Q15. Did you take part in a meeting with writers from your city/country?

Q16. If you had the possibility to take part in a meeting-debate with contemporary writers, you would go:

Q17. The questions you would ask the writers in the debate, would be about: (Fig.Q17)

Q18. Do you consider that the dialogue with the contemporary writers will determine you to read their books with more interest? (Fig.Q18)

Q19. Will the meeting with the writers be a subject of discussion with your friends/ class mates?

Q20. Do you wish to meet personally, on such debates, contemporary writers which you have heard about only through the Romanian Language and Literature textbook?

Q21. Name five writers you want to invite to the school where you study to meet and talk about your literary preferences:

Having analyzed the results, we present a series of conclusions (partial) which we have reached by processing the questionnaires. We would like to mention that we have not yet made a difference between their preferences on the basis of gender (boys/girls) and class they study.

a) Reading is an activity to which students don't show a particular interest, being overcome by the use of the PC, Internet surfing, watching TV programs and spending the free time with friends.

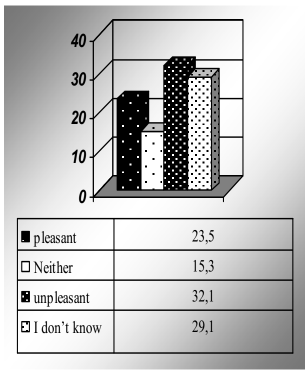
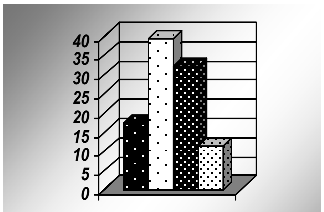


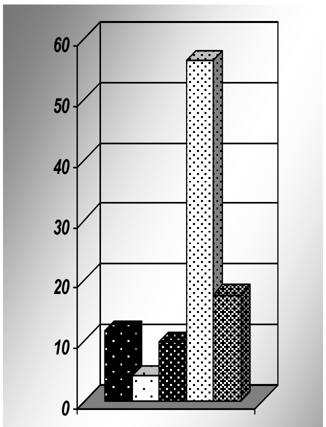
Figure 1 (Q1)



None	17,3
one	39,2
two-three	32,2
four	11,2

Figure 2

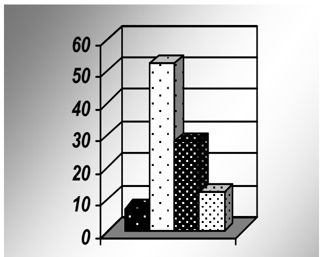
b) For 58% of those questioned, the books they read daily/monthly are part of the compulsory bibliography indicated by the teacher for continuous learning or for the national examinations; only 13% of the students read something else besides the compulsory bibliography; 11,6% refer to the supplementary bibliography. 17,3% of those questioned did not read anything in the last month. We can say that students read because of an outer motivation, being forced by the pressure of the examinations (graduation/baccalaureate exams). Only 13,1% shows an interest in reading for pleasure, to actively take part in the construction of the message by (re)reading.



newspaper	11,7
magazines	4,3
electronic books	9,8
internet sites	56,5
don't read	17,7

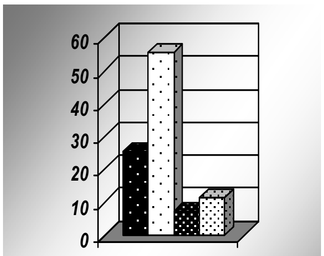
Figure 3 (Q6)

c) The research shows that, according to the literary genre, students prefer reading fiction (52,3%) and drama (28,2%), while only 7,2% prefer poetry , the lyrical text being considered more difficult, with a hidden message, that requires a lot of effort and special abilities of comprehension to discover it. As a literary species, the novel is better positioned than the others, 55,6% of the students prefer to read novels, 25,4%-memoirs and diaries, 7,3%-esseys. 11,7% are not sure.



poetry	7,2
fiction	52,3
drama	28,2
don't	12,3

Figure 4 (Q7)



diaries, memoirs	25,4
novels	55,6
essays	7,3
don't know	11,7

Figure 5 (Q8)

d) If they had to choose between reading a book and watching a screening of that book, 68,5% of them would watch the film, only 30,2% would read the book. 1,3% do not know. Thus we can say that image has a great impact on the student-reader, the film facilitates the meeting with the characters that come to life on the screen, while reading, the student has to make a conscious effort to visualize "the paper beings" (Gerard Genette), the characters around which the plot runs. Students who prefer to read the text have said that it would be ideal if there were a reading from the book towards the screenplay, because the film represents a new stage-director reading of the text itself.

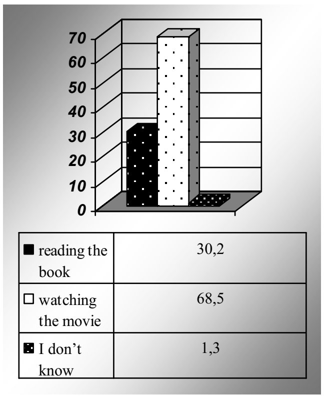


Figure 6 (Q2)

e) About the Romanian/foreign writers, the students prefer the Romanian writers (73%), the foreign writers being read only by 21,1% of those questioned. 5,8% did now express their preferences. We have noticed that in the top of the Romanian writers they placed writers studied in school, such as: Mihai Eminescu (64,5%), Liviu Rebreanu (14,3%), G. Calinescu (7,2%), I.L.Caragiale (7,7%) and Ion Creanga (6,3%). When asked about foreign writers, we noticed a preference for the French literature (H.de Balzac- 38, 6% and Stendhal- 21,3%), the English literature (W.Shakespeare-19,2%), Spanish literature (Mario Vargas Llosa-11,6%) and German literature (Tomas Mann- 9,4%).

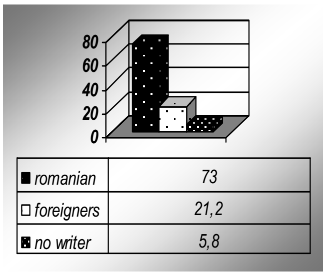


Figure 7 (Q9)

f)Although the number of contemporary writers studied in school is very small, students show interest in a (in)formal dialogue with the national writers, those who live abroad and foreign writers. 31,5% are interested in biographical aspects; 34,8% would ask questions about their reading experiences when they were teenagers; 21,3% are interested in their literary role-models; 12,4% would try to find solutions to the problems they faced (re) reading the works of those writers.

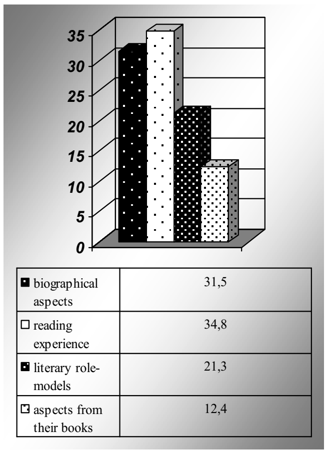


Figure 8 (Q17)

g)53,5% of the students would be motivated to read contemporary literature after an/a (in) formal dialogue with the authors; 18,3% think that such a dialogue would interest them but wouldn't necessary invite them to reading; 16,9% did not express their opinion; only 11,3% were absolutely sure that such a meeting didn't interest them. 62,3% have expressed their strong desire to take part in this type of meeting/debate; 28,2% are not interested and 9,5% did not answer.

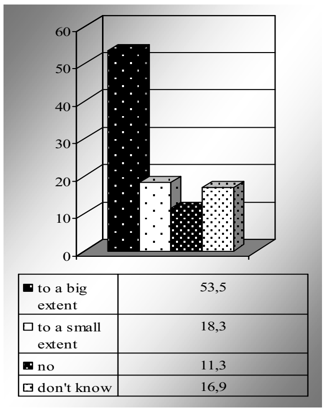


Figure 9 (Q 18)

4. Temptations and changes of the (non) literary text

We understand to turn to good account the NICT and the students' abilities and competences in this area, with the purpose of

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starting an inner motivation for reading. The ontological status of the book will be changed and it will step from an objective reality to a living beauty.

Our solutions offer two directions:

4.1. Canonic or non canonic writers and the transformations of fiction in the virtual space. Creating and presenting multimedia CD's by interdisciplinary teams (students-teachers) starting from the works of writers not studied in school and in their curriculum.

The encounter with the work of the Romanian writer I.P. Culianu, disciple of Mircea Eliade, gave us the opportunity to a reevaluation of the reader-text. We have stepped in the "texture" of I.P. Culianu's fiction which revealed how the multidimensional universe works and we understood that art is nothing else than " the technique of overcoming the dimensions that bound you" (Mircea Eliade).

Challenged by reading, students have tried to catch themes and symbols of Culianu's fiction: the mirror (metaphor of the mind), the erotic couple, the dream, the space and time and breaking their boundaries, the labyrinth. His fiction, seen as a palimpsest, hides various allegories, myths and symbols (religious, romantic, occult) that communicate and converge.

Decoding the "diaphanous parchment" of the text belonging to Culianu, students have joined the "puzzle" game of the book, realizing that the text, as Roland Barthes said, "intertwines" constantly. The 3D space helped them fill in the laces, become witnesses to the making of the text and consequently of a new continent: Ioan Petru Culianu.

The I.P. Culianu multimedia CD represents the result of the interdisciplinary project *The Journey. Reality-Fiction-Inner Universe*, part of an optional class for Romanian literature and Informatics. This media product is the result of a collaboration of a mixed team from the perspective of the students' capabilities: verbal-linguistic intelligence, logical-mathematical intelligence, visual-spatial intelligence. The I.P. Culianu CD wants to present the personality of the philosopher and writer from Iasi, a name not showing in the school curriculum but which has a hypnotic force on the eyes of the young reader. Because Culianu's destiny intertwined with that of Mircea Eliade (a writer studied by the students), the one who influenced the evolution of the young philosopher, we have introduced in the CD a section entitled *Mentor-disciple* , which is meant to open the circle of literature, from the national to the universal literature.

The structure of the I.P. Culianu CD is the following:

- Biographical and bibliographical elements;
- Mentor-disciple-photo gallery;
- The mentor Mircea Eliade-spiritual profile, spiritual path (Bucharest-Calcutta-Lisbon-Paris-New York), stages of evolution (Bucharest stage, Hindi stage, Portuguese stage, French stage);
- Diaphanous parchment- Challenges of Culianu's text;
- Second degree escape by two- cinema essay;
- I.P. Culianu and the novelty of his work-interview (professor Nicu Gavriluta-"Al.I. Cuza" University-Iasi);
- I.P. Culianu's text and the theory of fractals;
- Short dictionary of symbols;

The resources used in this project are:

a) informational: "To know in order to do- A guide for trainers in media activities for young people", The Media Center for Young People, Chisinau, 2006 (coordinator Veronica Boboc).

b) specialized bibliography (the bibliography offered by the teacher of Romanian and of English)

c) used software's : Ulead Video Studio 9(Trial) and Flash 8(Trial).

The CD was designed for future virtual lessons that offer a quicker and diverse use of the teaching/learning methods and aids. For the teacher as well as for the student, the presentation of the information can be done using images, a personalized and attractive design. The interactive feature of the debates is much more appealing, due to the image, sound and moving images.

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4.2. Constructive dialogue with and about contemporary writers. We plead for the literary forum or blog.

The research done highlighted the students' willingness, intellectual curiosity to take part in a constructive dialogue with contemporary writers. Their biography, their literary role models, the reading solutions to their works, all these are problems that stir the interest of young readers. The students that usually show a small interest in reading contemporary writers have understood that, taking part in an/a (in) formal dialogue with poets, playwrights, critics, essay writers, they can check their reading competence; they have also understood that the message of a text can be rebuilt only by individual reading or reading-debate author-reader.

We present hereby two effective, interactive and productive methods of organizing such (in) formal author-reader dialogues, both having the same meeting point: challenging and involving the student in the process of discovery and construction of the literary text message by (re) reading; developing the esthetical taste; placing the reading student in (intra) (inter) communicative texts following the meeting with the text-open work (Umberto Ecco), with different messages.

4.2.1. Readers and writers-meetings in a virtual space

Original, refusing pre-conceived ideas, showing great ability in using the computer, as the research showed, our students were involved in projects that brought out their abilities and competences and which, in the same time, challenged them to read and to a dialogue with and about writers and their texts, a dialogue carried out in a generous and motivating space-the virtual one. The blog and the literary forum facilitate the reader-writer (inter) communication. The motivation to write a literary blog is the need to get in touch with young people that share the same literary interests. The motivation to read such a blog, beyond the psychological and social aspect, could be that of obtaining different opinions about successful publications, getting information about a writer and his work from a professional (a literary critic), communicating on themes of mutual interest.

The great advantage of a literary blog is that it facilitates the formation of readers and writers communities. The reading diary on the Internet, the literary blog is supported by a group of teachers and students, using elements like: calendar, archives, comments, permalinks, blogrolls, trackback. The literary blog becomes for students the efficient way to communicate and interact with their favourite writers, to meet them in a virtual space.

One of the themes that stirred interest was "Books and Films- hidden literary message/obvious cinema message". The debate dialogue was carried out on the subject of some literary works of authors studied in class, works that have been turned into movies ((G. Calinescu-« Enigma Otiliei », Liviu Rebreanu-« Ion », Ioan Slavici-« Moara cu noroc », Mircea Eliade –« Domnisoara Christina). The debate in which students, teachers, literary critics and film critics took part, focused on the relation « empty spaces/full spaces » of meaning (Wolfang Iser) in the literary text/ the film. Students realized that the message can be perceived only through a close, competent and interdependent reading: the reading of the text/ the reading of the film.

For an active readers-writers dialogue, we have started a partnership with the Faculty of Informatics of the " Al.I.Cuza" Iasi, which will facilitate every 3 months the organizing of videoconferences with writers in the country or living abroad. These videoconferences will take place according to a schedule which all those involved have to respect. After having gone through the suggested bibliography, students will write down possible questions in the literary "diary"-blog that is available to them. The writer invited, will periodically consult the blog and in the videoconference will answer to the questions posted or new ones in the face to face dialogue. All the information/comments will be stored in order to be used as learning resource, that can be transferred/adapted in different contexts or as material for a segment of a future multimedia CD. A first videoconference is scheduled for September 2006 with the writer Simona Popescu, lecturer at the Faculty of Letters in Bucharest, her name being mentioned in the top ten of contemporary writers the students want to meet, as they said in the questionnaire.

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4.2.2. Dialogues in the space of playfulness

The same research showed students' preference for the drama. Trying to meet their demands, we have started a project that wants to promote the intercultural dialogue and socialization amongst students in the european space by classical and contemporary drama. The project Orpheus 2006-National Theatre Festival for High School Students (with international participation)[8], third edition has the following objectives:

- to develop a good relation between the actors involved in the cultural and educational process: students, teachers, playwrights, actors, editors, mass-media;
- to lead the students' interests towards the true values of the national and international heritage;
- to develop and strengthen national and transnational cooperation in these matters, by joining in activities (workshops and the Festival itself) meant to allow students to interact and communicate with culture as an instrument;
- to design an active national/transnational and European map with the purpose of making possible a continuous transnational/European cultural exchange between the participants to all the three editions of the competition even after the Orpheus Festival 2006 ends;
- in 2006 we intend to create the Orpheus Festival website in order to offer information regarding the course of the project's activities and with the purpose of keeping in touch with all the countries involved in the festival as well as being part of a permanent cultural dialogue; the Orpheus site will display presentations of all the theatrical companies (700 students involved) from our country which took part in the first two editions of the Festival. These editions were very much appreciated by the jury, critics and the mass-media. The organizers' intention is that, by making the festival European, they can expend the activities held between 2004 and 2005 thus opening the way for new partners to play a role in a vast and active network of intercultural exchanges. This network is based on a paradigm which brings to light the two geo-political poles- We and Europe –from a new and necessary perspective: We, together in Europe.
- to organize the 3rd edition[9] having in mind a few new ideas different from the previous editions (2004 and 2005):

a) Traditions Night- *Echoes in the european multicultural space* – this is due to happen in the opening night of the Festival. Prior to this there will be a costume parade.

b) Theatrical workshops –debates on the subjects of the playwright-text-reader relation and of the play-performance-dramatized text relation. We will have as guests at these workshops young playwrights, stage directors, professional actors, high school students and university students from Iasi and all over the country. We are hoping that this dialogue will be an active and a productive one.

c) Museums Night – getting to know the cultural side of the city of Iasi.

By becoming active members of the intercultural network, the participants will have the possibility of finding new partnership opportunities for important and far-reaching projects.

5. Conclusions

These two approaches are part of a underway project, both having the role of showing that the teacher can challenge and direct the young learner towards a good quality reading of canonic and contemporary literature. The two projects are, in our opinion, arguments for our belief that the virtual space has multiple possibilities that can be creatively used. Following the guided reading, meetings/on-line conferences with writers, critics, film and theatre directors, students will accept the "pact of alliance and complicity" with the writer (contemporary or not) and discover the passionate side of understanding and interpreting the text, the "pleasure of reading", in the words of Roland Barthes, the pleasure introduced, mediated and supported by the NICT.

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[8] Organized by the Normal School "Vasile Lupu", the Sports High school Iasi, the Arts Secondary School "Octav Bancila" and the National College Iasi, under the patronage of the Ministry of Education and Research and the County Board of Education Iasi.

[9] Festival Chairs: prof. dr. Miorița Got, prof.dr. Camelia Gavrilă; Organizing Committee: prof. Mihaela Apetroae, prof. Petru Apachiței, prof. Elena Mănucă, prof. Fănița Cepoi, prof. Dana Barnea, prof. Gabriela Petrache.

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Science and Arts. The Sc-Art Project

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Abstract. Traditionally art and science are regarded as opposite poles of the educational spectrum, although in practice they often combine effectively. The SC-ART Comenius 2 project aims to develop an in-service teacher training package exploring ways of combining art & science in the curricula of tertiary and higher education, involving appropriate industrial and community partners, whilst helping to overcome the shortage of science teachers by encouraging arts specialists to get more involved in delivering science subjects..

Keywords. Science, Art, Drama, Scientific Literacy, Scientific Method.

1. Introduction

Science and arts have been regarded as opposite parts of the educational world for many centuries. Nevertheless in many areas the two approaches combine effectively. Music for instance has close ties with mathematics and physics, many dramas explore the wider issues of scientific choice (Bertolt Brecht's 'Galileo' for instance), whilst modern developments in the visual arts often arise out of the latest scientific and technical innovations.

The recognition of this brought together the coordinators of two successful Comenius 3 networks, one focused on the arts – The Big Picture Network – and the other on science – Hands-on-Science. The idea of creating an in-service teacher-training program was developed that would encourage links between the two disciplines in the syllabuses of secondary and tertiary establishments in selected European countries.

At the same time it is stated the importance of involving appropriate business and community partners from the fields of arts and science in this process through the need to "develop partnerships between teacher-training institutions and the wider world", a key feature of the Lisbon strategy. Such partners would help both to show how the two disciplines combine in practice and to support the need for multi-skilled multi-disciplinary learning, especially using ICT. The transnational partners will therefore establish networks of industrial and community partners from the fields of arts and science, e.g. local theatre and cultural groups, museums, environmental organization, regional forums. Attention will be paid to ensuring an integrated contribution from these local partners in the development, evaluation and dissemination of the teacher-training material produced, for the benefit of both the educational and the wider world.

Another major problem identified at the Lisbon Meeting is the shortage of scientists and technicians but also of science teachers across Europe.

This project can will also help to address this both by encouraging innovative and exciting methods of delivering the curricula but also by involving arts teachers in the teaching of science in a new exciting interdisplinary way with permanent resource to hand-on experimental exploring of science fact and issues.

2. Pedagogical approach

Theory and practice underpin every aspect of this project. On the one hand, the structural approach of identifying and analyzing current theory and practice in arts and science teaching forms the basis for combining these disciplines in the classroom and workshop; on the other, arts and science teacher trainers and educators will be working closely with representatives of the wider world in which they are applied. A key aspect of this is the need to change attitudes within in-service teacher training programs, especially with regard to science teaching, towards the encouragement a multi-skilled multi-disciplinary hands-on approach, with a strong focus on using the new technologies. This process should also encourage more arts teachers to take responsibility for the delivery of science subjects.

3. Target groups

The main target group is secondary and tertiary education staff, who – through a suitably focused in-service teacher training program - can be made aware of the need and provided with the strategies and material to promote a more positive attitude towards combining arts and science in the syllabus. In particular encouragement will be given to the involvement of arts specialists in the delivery of science subjects. To support this, there will need to be a greater awareness of interdisciplinary practices in the outside world, which the project will provide.

Other important targets are the students in the various partner organisations who will directly benefit from the application of the material and approaches developed, as well as gaining a flexible multi-disciplinary active and hands-on approach to art and science.

Local, regional and national education organisations will also benefit from clearer strategies as to how to combine arts & sciences in the education curricula.

The project outcomes will also be important for the professional partner organisations, who will benefit from flexible, multi-skilled and creative prospective employees.

Internationally the strategies and material developed by the project will prove useful in informing educational policy relating to the synthesis of art and science within the curriculum.

4. Outputs

An examination of current practices of delivering art and science within the secondary and tertiary curricula with examples of how they are combined, plus details of current practice in the arts and science industries & communities of the partner countries

Partners will identify current theories and practices for delivering art and science in the classrooms of their own countries, focusing on any guidance or examples as to how they are or might be combined. In addition current practice regarding interdisciplinary approaches within the art and science industries of each partner country will be identified and evaluated, paying particularly attention to any educational links. This material will be collated primarily in written form, supported by audio, video and electronic examples and will form the background to the learning strategies and teaching package for use by teachers and teacher-trainers. This will be presented, discussed and evaluated during the Year 1 transnational partner meetings, before being collated, published and distributed in printed and electronic format locally, nationally and internationally.

This background material will be presented in three parts: Part 1 = current educational theory and practice for delivering arts and science education; Part 2 = specific examples of how arts and science are currently linked in the curricula of the partner countries; Part 3 = current theory and practice of how these disciplines combine in the arts and science industries & local community. Part 4 = A critical evaluation of the current status of arts & science teaching and suggestions as to how they could in future be more closely linked.

An in-service teacher-training learning package “Learning strategies (models) for combining art & science in the classroom” will be prepared and delivered.

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The SC-ART website will play an important role in the project, not only for the ongoing dissemination of the outcomes, but also as a means of presenting interim proposals for comment and suggestion.

5. Membership

The project involves seven institutions from 6 Countries (UK, Portugal, Italy, Latvia, Malta and Romania) being coordinated by the Liverpool Hope University.

6. Conclusion

By promoting links between arts & science teaching arts teachers will be encouraged both to develop imaginative and effective techniques for delivering science topics and even be attracted to undertake the teaching of science subjects themselves.

7. Acknowledgements

The authors would like to acknowledge the contribution of all partners in this project.

The Role of Information Technologies in Changing the Attitudes of Adults in the Period of Transition towards a Knowledge-Based Society

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Abstract. With more than two millennia of European History and a neo-Latin language, language preserved in a surrounding sea of other origin languages, but, too, after centuries of oriental influence during Middle – Age, interrupted by only one century of European modern culture and unfortunately, followed by half a century of a command society, the attitudes of Romanian, at the time of their bloody anticommunist revolution (end of 1989), were very different of what is to be expected from the members of a Knowledge-based Society. For many of the adults with a basic vocational training or elementary education, these attitudes have changed only a little, lately.

The author considers the Information Technologies (IT) to be used in Long Life Learning (LLL) as one of the main solutions for the adult segment not highly educated, to conveniently change attitudes and behaviour patterns, in due time for the rest of their career.

Some typical attitudes inherited by adults to be changed:
A. The survival behaviour during communist oppression has generated attitudes like: - "it even goes like that!" (when making short work of something); - "standards observance is not as important as the chief order and the plan provisions"; - "quality assurance does not regard me"- "what it is yours it is also mine"; - "social deviation must be tolerated".
B. Social and professional recognition and promotion were not based upon improving competencies, progress in knowledge, work efforts, honesty and modesty, but considered to rely upon wangles, relationships and networking; good knowledge of international languages was considered of not much utility; self-investing in education meant wasting resources; learning to learn was not useful in a society in a very slow progress, deprived of competition among producers and disconnected from the wave front of world progress; private entrepreneurial approach was forbidden; being punctilious and punctual were not very prized.
C. Obedience citizenship was more important then democratic active citizenship: - "the chief (particularly a Party one) is a law unto himself"; - "do not contradict the hierarchy"; - transparency of public decisions not thought as being possible; - public control of leading bodies was not possible; - the vote of the citizen has no importance; - punishment for breaking law might be avoided by negotiating with public officers and bodies charged to apply the law; - the organisation you belong protect you when infringing the law; law-fraudulence is respectful;
clear (individual and of the team) responsibility is to be avoided.

Information Technologies available in 1989:

The totalitarian regime did not like IT because, by their inherent objectivity, IT could interfere with the subjectivity of the party leader decisions and discredit the command structure of the totalitarian communist society. Particularly, social applications of IT were forbidden. Some

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electronic digital computers were existing in the state institutions and in some faculties. Rarely, some industrial equipment was computer driven. Power industry was much advanced in using computers. Rarely, a PC was to be found at party leader offices. Pocket second-hand small computers were available. Personal printers were not allowed. The possession and utilisation of rare typing machines were to be authorised and checked yearly (copies of all sign prints preserved). Mobile telephone were only for party leaders (less than 10 000 in all Romania and could not be accessed from the fix telephones net). A small part of homes had connection to the fixed telephones net. Some of the local calls were intercepted as well as almost all international calls. Travel abroad was subjected to exit visa, which were rarely and selectively granted. Talks with foreign citizens were to be made in the presence of a third person and reported to security, in writing. No access to INTERNET, no E-mail, no soft libraries available. TV – only official emission - 2-4 hours daily. News Agencies – only one, distributing the same controlled information to all news papers, of 4 – 8 pages.

Teaching Information Technologies was mostly done in Higher education, in some faculties, f. e.: Automatic Control, Mathematics – Informatics, Economical Cybernetics, without PC. IT were not used in the decision and selection processes. Information technologies applied in physical and mathematical modelling were permitted for some state bodies, sometimes.

I. T. for active citizenship: there was not the case.

Evolution between 1989 –2006

The evolution of different segments of population, in attitudes and in the access to IT has been very different, leading to a polarisation of the Romanian society.

Now, the major part of highly educated active people has PC and is connected to Internet. They have different attitudes with respect to work, promotion and democracy, due to international contacts, at home or abroad. A large part of the people finishing vocational and secondary schools about a decade around 1989 are working abroad (~ 2 millions) and probably, they change there their attitudes. The pupils in schools, in the large towns, are taught to use IT.

The disadvantaged segment of population is the adult one, particularly the former workers hired by the communist inefficient industries, which were obliged to stop obsolete and expensive production and the inhabitants of villages. The State or the trade unions have done not too much to efficiently increase their employability. IT equipment was subjected to custom fees. IT are not taught to those adults. IT local facilities are not used by them and they are tributary to old attitudes.

What is to be done? What is to be avoided?

In the paper there are investigated the ways and means, at different levels, to use IT to improve the evolution of this disadvantaged people: the adult workers and farmers, by changing, at the same time some of their attitudes, into the desired sense oriented towards a knowledge-based society.

There will be discussed: - the use of the promised by the Government new elementary generalised school infrastructure in IT to attract adults toward knowing and using IT; - the use of TV to disseminate IT knowledge into adult media; - the use of IT to improve knowing and observance of standards, directives, laws and regulations; - the role of IT in developing scientific literacy, knowledge of foreign languages, in building other key competencies, - the possible contribution of IT in stimulating, partnerships, entrepreneurial attitudes, career self-management, learning to learn schemes, in increasing employability and in inducing active citizenship.

Keywords. Science Literacy, Information Technologies, Adults.

About ICT in Education and Lifelong Learning

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Abstract. Information and communication technologies (ICT) consist of the hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (voice, data text, images), as well as related services. In the third millennium education, the problems related to the ICT use are the following:

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- In Education Technology - (a) supplying computers and connectivity, (b) building school computer labs, (c) enabling instruction in computer programming and computer literacy, (d) developing and disseminating new curricula in electronic format and (e) using ICT as tools for presentation for learning to promote and develop skills related to critical thinking, information evaluation and reasoning, collaboration and intentional awareness.
- In Distance Learning - Planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, instructional techniques, methods of communication, and organizational and administrative arrangements.
- In Educational Management and Information Systems - Aimed at increasing efficiency and effectiveness of administration of educational programs through improved information and planning systems.

Educators and policymakers alike agree that ICT in education initiatives contribute to meeting to the following Millennium Development Goals:
Increasing access through distance learning
ICT can provide new and innovative means to bring educational opportunities to greater numbers of people of all ages, especially those who have historically been excluded, such as populations in rural areas, women facing social barriers, and students with disabilities.

- Enabling a knowledge network for students
  With knowledge as the crucial input for productive processes within today's economy, the efficiency by which knowledge is acquired and applied determines economic success. Effective use of ICT can contribute to the timely transmission of information and knowledge, thereby helping education systems meets this challenge.

- Training teachers
  Large numbers of school teachers will be needed to meet the Millennium Development Goals for education. The use of ICT can help in meeting teacher training targets. Moreover, ICT provide opportunities to complement on the job training and continuing education for teachers.

- Broadening the availability of quality education materials
  Network technologies have the potential to increase the availability of quality educational materials. Their interactivity and global reach allow for customized sharing of knowledge, materials, and databases, quickly and cheaply over long geographic distances. Furthermore, online resources offer teachers access to a vast and diverse collection of educational materials, enabling them to design curricula that best meet the needs of their students.

Enhancing the efficiency and effectiveness of educational administration and policy
New technologies can help improve the quality of administrative activities and processes, including human resource management, student registration, and monitoring of student enrolment and achievement.

Keywords. ICT, Science Literacy, Development.

Opportunities and Limitations of the Interdisciplinarity in Possible (Non) (In) Formal Contexts

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Abstract. In the context of the postmoderm world, the new type of education must be perceived as a trans-relation between four defining perspectives: learning to know, learning to do, learning to live with the others and learning to exist. Learning to do becomes the major perspective which justly articulates our project, with a real applicability.

We are trying to demonstrate, using certain teaching solutions (some of them already practiced), that school and teachers can and should show a higher interest in opening the formal circle of education to other (non) (in) formal concentric spaces and also to information that is and can be obtained by students outside the school and the formal dialogue in classroom.

Keywords. Formation, Formal, Informal, Interdisciplinarity, Nonformal, Trans-relation.

1. Introduction

In the context of the post modern world confronting inherent questions that are referring to the opportunity and changes in education, the acceptance of concepts such as **formation**, **formal**, **non formal** and **informal education** must be placed in a new paradigm.

Continuous formation, **development** are concepts that organize in a concentric way the three types of education which, once applied in teaching, must be articulated so that we could speak of necessary areas of interdependence and connection.

Our work, with real practicability, started from the premise that the new type of education must be viewed today as a trans-relation between four defining perspectives: **learning to know**, **learning to do**, **learning to live with the others** and **learning to exist.**[10] (Fig. 1)

The UNESCO report of The International Commission of Education for the 21st century (the Jacques Delors report) emphasizes these four poles of the new educational system, which are considered by the same theorist fundamental for the complete education of a person.

2. Opportunities of the interdisciplinarity

Our teaching experiment was from the beginning designed having in mind the connotations of the previously mentioned perspectives. Without any doubt we do realize the growing interest of the students in the use of the computer in studying. Research has shown the advantages offered by the computer and the students who use it at home or at school are graded with better marks.

In such a context, teachers of Romanian and foreign languages have to creatively and flexibly adjust the teaching strategies to persuade the students to enter the world of fiction and books which is in danger of being nothing more than a reality connected only to the object.

By our scientific and methodological research we wish to offer possible examples and teaching contexts in which we see **interdisciplinarity**[11] as an effective method of making clear the formal, non-formal and informal relation in education.

The working group, made up of teachers of Romanian, English, French, Informatics, Religion, Philosophy, Drama, are trying to identify opportunities but also limits of interdisciplinarity and to come up with solutions to overcome them. Some of the teaching examples we intend to present are part of a future educational software program, designed for different students' level: primary, middle and secondary school

We are trying to demonstrate, using certain teaching solutions (some of them already practiced), that school and teachers can and should show a higher interest in opening the formal circle of education to other (non) (in) formal concentric spaces and also to information that is and can be obtained by students outside the school and the formal dialogue in classroom.

Our project was motivated by the results of a study on 100 students of ages between 11 to 14 and 15 to18 which revealed the fact that, in certain teaching contexts, a student can be **inert** and not interested and in others he becomes **active**, **creative** and motivated to get involved in the teaching- learning process, an idea which should be viewed from the perspective of opportunities to turn to good account multiple intelligence and students' availability.

"To know in order to do" becomes the **general objective** which coherently articulates our project, structured on two main components.

2.1. Comprehension and production of the (non) literary text, using the ITC

The project has the goal to make students aware of the necessity of **reading** as a creative act, to prepare in stages the logistics conditions, required for the development of the abilities

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[10] Nicolesco, Basarab. Transdisciplinaritatea. Iaşi: Polirom; 2001. p .72.

[11] Chevalier, Marie-Cristine. Description et interdisciplinarité. http://www.chevalier.fr.

which are supposed to be connected to the activity in the (in) formal environment and, later on, to any career: coherency in ideas, ability to support opinions, overcoming barriers and complexes in communication by **strengthening linguistic competences** (the mother tongue and other languages: especially English, but also German and French) and abilities to use ICT in **science and culture.**

Although most students find Internet services easy to learn and use, they will find themselves isolated on the Internet if they are not familiar with English. There are important challenges and opportunities presented by the computer technology that make it an important part of English in particular. These may include: new kinds of texts and the need to teach students to create and use texts correctly; teaching students to make judgments about appropriate use of different ways of communication; the need to teach students to be critical readers of such texts.

Acquiring and developing these abilities and skills place the student in the centre of the teaching activities with a formal or informal character and establishing the teaching-learning process in fundamental issues, such as: **linguistic pragmatism**[12] (with an emphasis on the use of the language rather than on the linguistic system itself), **theories of reception** (it deals with the comprehension process during the reading and the production of the (non) literary text[13]), and **cognitivism** - as a stream in psychology, oriented towards the mental processes involved in the approaching of the speech.

In the author-text-reader triad, our intention as teachers is focused on the third element of the relation, meaning the reader/receiver and consequently on the (re)reading, viewed as a controlled **creation**.

Even if the text doesn't respond to the "expectation perspective" (Erwartungshorizont)[14] of the student reader/receiver, the teaching activity must be organized in such a way as to stimulate students, getting their support and **complicity** which the active, creative (re)reading involves.

Our interdisciplinary experiment wants to prove that the reluctance that young readers show can be stopped by understanding the relation between the Guttenberg galaxy and Marconi galaxy not as separate concepts, but as constructive and creative ones.

The aims of our projects are:

Initiation and training in journalism is an additional component of the project, carried out by an active partnership with local network of papers, radio and TV stations ("Lumina" newspaper, Radio Trinitas, TV Trinitas Iasi). By this, we hope to achieve the following:

- organizing training courses where professional journalists will be invited to attend to, workshops for the students involved in the project but also to the students and teachers from other high schools that offer journalism optional classes.
- founding the Media Center for Teenagers (C.M.A.)- a chance for young people to understand that each individual has a meaning in life, that there is a place for all. This way we offer our students the possibility to identify it.

- getting students familiarized with working techniques in the media, after having acquired a number of general notions about journalism in the training courses.;

-presenting the right conditions for news, interviews, news reports;

-the development of the skills that involve the use and editing of image with the help of ICT;

-creating abilities to access various means of information in order to write and edit journalistic texts for all media;

-developing abilities to use the web and its tremendous resources (sites, advertising, blogging, polls, albums, forums, etc.).

- discovering the self voice and image beyond the camera;

- turning to good account skills and abilities of producing (non) literary text: news, news reports, audio/ video commercials, plays on radio, general debates on teenagers' problems, a good time to question and challenge;

- starting a **virtual library**, giving students access to all the multi-media products that they will create during the teaching experiments in which they took part: newspapers, school magazines, audio/video materials, educational software, multimedia CD's;

[12] Pamfil, Alina. Structuri didactice deschise. Cluj-Napoca: Paralela 45; 2003, p. 10-22.
[13] Adam, Jean Michel. Les Textes: types et prototypes. Paris: Nathan; 1992.
[14] Jauss, Hans Robert. Experienţă estetică şi hermeneutică literară. Bucureşti: Univers; 1983, p. 7-11.

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- organizing media contests to challenge young people to produce media works (written or audio, commercials, photo slides, short-reel films) which should have a wide range of topics: social, cultural, tourism, everything evolving around the subject: "My Romania". The students will have the opportunity to present their own image of Romania.

C.M.A. becomes an opportunity for formation and information, for expressing personal opinions, for solving age related problems and for getting students involved in taking decisions.

C.M.A. must be understood as a generous context, a(n) (in) formal environment which broadens and where young journalists make an attempt of creating **a better world.** Journalism needs young people who live themselves what they say and what they expect from the others.[15]

2.2 Initiation in documentary research

The founding of a research and information centre C.D.I. We see it as an environment to teach students to use correctly the information, especially the information which is the acquisition of school knowledge is based on. C.D.I. is, for the students, the image of the future places he, as an adult, will attend: university libraries, specialized research centers, video-conference centers. There are no C.D.I. centers in schools at the moment. The designed, interdisciplinary activities will motivate the student to actively get involved, so that, when they graduate, they could master elements of ranking, getting, correcting, processing, researching and delivering the written, audio or video information. Such activities held in the C.D.I. will be supported by **modules** of training in libraries and museums.

We know the essential role of the communication and information technology formed the base of the revolutionary step for the European Union, at the 2000 Lisbon conference, which had as goals:

- a knowledge-based, dynamic and competitive economy within the E.U.
- a long term and fast economic growth
- a modernized social security system.

[15] Nieder-Mayer, Hans Peter. Jurnalismul: profesie sau vocație. Cluj-Napoca: Limes; 2003. p.83.

In order to create the path for the founding of some centers of research and information, structures which can be described as multi-disciplinary resource centers that offer the students, the teachers and the community information on different types of technologies (books, magazines, cassettes, videos, CD's, the computer network, etc.) and which have the role :

- to put into practice projects of cultural animation;
- to carry on pedagogical activities;
- to carry on activities of professional development of the teaching and auxiliary staff;

Workshops for the managing staff and for the researcher-teachers have been organized in our country and in France. To bring together all these efforts of the teachers and of the students in order to be better informed and prepared for the research work, there is a strong need of a Research and Information Center (C.D.I.). The researcher teacher is the one who should initiate the students in:

- categorizing the book or information;
- making a data base;
- up dating the data base;
- looking for information using a search engine;
- downloading information;
- selecting the information;
- processing and using the information in:
    - research activity
    - producing complex papers
    - advertising
    - commercials and free time

So that by graduation, they should become independent in learning and acquire real qualities as active readers and great future cultural event planners.

On the other hand, as future bibliographer that train to work with books (in libraries, museums), they must master these elements in order to attend to researchers, visitors or readers. In the center of these resources there should be the computer as an instrument and the Web as a means of communication, information and dialogue.

Every bibliography should acquire working skills which serve the Research and Information Center and also use a whole system of book administration and master such procedures:

- selection of documents on demand

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- providing accurate elements of research information
- giving a more or less elaborate answer on reader's demand, answer which should lead to a certain research product
- making abstracts of all the articles from the magazines that the institution subscribes to.; these abstracts must be categorized , stored in the data base which gives quick access to the subject , the magazine where the articles was taken from, the issue and the page, all with the purpose of facilitating the access to the information necessary
- using the GIS access platform for virtual libraries and museums

There can also be consolidation activities by establishing partnerships with institutions in the field in (inter)disciplinary projects.

General abilities to be fulfilled:

- discovering the CDI as a resource center;
- acquiring some methods to learn and master the information (the informal role);
- developing cultural curiosity and civic duties.

Values and attitudes:

- developing formative skills of identifying, selecting, organizing, processing and transmitting the information;
- developing critical abilities;
- raising interest in reading and showing a positive attitude towards reading;
- accepting cultural values;
- showing initiative, creativity and availability for team work to accomplish certain tasks.

Specific abilities:

- discovering the CDI as a resource center;
- organizing and running a center of research and information: regulations to be followed in its activity, organizing the space for the CDI;
- organizing the documentary data base of this center: types of resources, numbering the articles, organizing the collections, access instruments to the CDI collections;
- acquiring certain methods to learn and master the information;
- developing cultural curiosity and civic duties;
- promoting CDI resources by: exhibitions, displays;
- cultural activities: shows, screenings, audio performances;
- activities meant to encourage reading: reading contests, workshops, meetings with writers, editors.

The optional class "Initiation in documentary research" will be held in the Research and Information Center, one year long, four classes a week.

The achievement of the abilities can be done mainly by using formal or non formal activities:

- making charts
- matching exercises (question-answer, text-image)
- selection exercises
- multiple choice exercises
- true or false exercises
- selection of documents on certain criteria
- marking documents
- placing them on bookshelves
- identifying documents according to their marking
- creating a bibliography
- identifying a document with the help of the traditional records of the Research and Information Center.

The emphasis will be placed on interactive work strategies: brainstorming, debate, questioning, role play, simulation, critical thinking, everything that represents giving up traditional techniques: demonstration, theoretical delivery, exercise, conversation, observation, etc.

The contents will be approached from a practical perspective by involving the students in research and orientation activities. The lessons are to be completed with workshops, competitions, exhibitions and shows, meetings with personalities, visits, screenings and audio performances.

It would be advisable for the teacher to correctly use the educational purposes, such as continuous evaluation and lesson-focused evaluation.

3. Conclusions

As a conclusion, we should say that this process of using informatics in every work field cannot avoid the educational system. Being fascinated by virtual reality, both students and teachers ought to understand that

interdisciplinarity (mother tongue/English-informatics/social-human studies- informatics) creates the necessary background for the student to get involved as a stable partner in the teaching/ assessing process. We see this as an efficient way to improve student's productivity. The theoretical characteristics of the humanistic disciplines tend to become more practical ones. All the work designed in an inderdisciplinary manner offer a better use of the teaching methods, procedures and instruments, no matter if they are old or new, but always finding a flexible way of using them in the same teaching context.

Ignoring the time and energy consuming features of these interdisciplinary projects, also the disputes they start among those who don't trust the ITC resources, we believe that such approaches are meant to challenge the students to have an active role in their own teaching process from a real inner motivation: that of (re)discovering themselves and their skills and abilities which justifies their individuality.

Hereby, the indirect beneficiaries, teachers who will take part in this project, will fully understand that in the present educational context, **the active and motivated learning through interdisciplinary experiment** alone can ensure a higher ranking for education within these important perspectives: **to know in order to do** and **to understand**.

From our position of teachers who show a real interest in the improvement of the teaching quality and performance using such inter-trans disciplinary approaches, we set a goal in expanding our research by offering some training courses for teaching based on Informatics, also putting an emphasis on the possibility and necessity of adapting the information of every school subject to the teaching environment based on Informatics.

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The IT-Based University-Language-Learning - Some Reflexions

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Abstract. Why is the IT-based university-language-teaching practiced only by a small number of teachers? In this paper we will not give an answer to this question – we will only raise some reflexions.

According to our 8-years-long experience, e-courses reach a larger geographical area and thus more students, they offer a higher level of flexibility, they run financially more reasonably, they may even be more efficient – arguments for a new pedagogical-model: the e-language-learning?!

Keywords. E-learning, online-/IT-based courses, Campus-courses, Course-material, Interaction, Flexible learning.

1. Introduction

The IT-based university-language-learning seems still to be at its beginning. Only a small number of university-teachers have welcomed this pedagogical model. Why? We will try, in our paper, on the basis of an 8-years-experience, to actualize some reflexions within this item, primarily based on our online-course-programme in Romanian.

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2. Why e-learning?

Let's start with the key-question, namely «*What is the purpose of online (-university)-courses? Do they offer a more flexible teaching & learning, a higher quality-status, a modern, more efficient and more financially reasonable educational-system?*

3. A completely new pedagogical model?

Is e-learning a completely new pedagogical model? Without a doubt – the central problem we face now is the *distance* between the teacher and the students. Maybe this is one of the reasons that *persuades* the other teachers to non-adopt this new pedagogical model?!

We think, though, that this problem may be solved, at least partially, if the teacher, while elaborating the course-programme, takes into account – from the very beginning - a few essential items, which we call the *5-how-questions*, that we initiated as our working-frame when we started to elaborate the IT-based university-courses in Romanian, in 1998, [4], [5].

The *5-how-questions* are as follows:
1) How can we present an efficient didactic course-material? *2) How* can we create an efficient exercise-material? *3) How* can we verify the student's level-increase? *4) How* can we communicate with the students and how can we do the examination? *5) How* can we create an efficient administrative-material?

We tried to build up the course-programme as an answer to these questions.

3.1. The course-material

Below we will try to summarize our way of answering at the 5-questions.

On an IT-based course the material ought to include both the didactic and the administrative sections.

The lectures ought to be very detailed – thus we avoid misunderstandings. The exercises, even those based on audio-files, ought to include keys – thus we facilitate the independent-repetition-exercising.

The pedagogical-didactic material ought to present, from level to level, a gradually higher difficulty status, including the focus on more and more independent work/tasks.

Different types of fora are to be created in order to facilitate communication both between the teachers and the students and also between the students. On the other hand, fora are one example of efficient tool for group-tasks, debates and discussions.

The examination, as to time and room, ought to give large flexibility. The students ought to be offered the possibility of taking their exams in another place than the university-town that gives the course. The students living abroad may take their exams at the Embassy representing their country. Even the date of exams may be flexible in order to suit the student.

The administrative material (i.e. the registration- or evaluation-forms, the course-programme, the term-schedules, the instructions of miscellaneous types) - they ought to be all electronic, included in the body of the course.

Home

- Course-description
- Course-literature
- Exam-info
- The teachers
- Technical-info
- About LUVIT
- Romanian courses-view
- Chat-room
- FORUM: questions & answers
- The students-presentation
- Frequent questions
- TERM-1
- Exam May/June-Registration
- Exam Aug/Sept-Registration
- TERM-2
- Exam Nov/Dec-Registration
- Exam Jan-Registration
- Evaluation
- Registration-new course

Figure 1. The Navigation-tree

Our IT-based Romanian-university-courses (i.e. four levels, from the beginner's-level up to the pre-ph.d.level) might be an example of how one can present a language-course-programme. The courses are published on the internet by means of LUVIT (Lund University Virtual Interactive Tool) and have a similar technical structure-basis, that is the Navigation-tree,

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representing the main body of the course, Fig. 1 (the figures in this paper present some samples from the beginner's-course, in a summarized, simplified, non-authentic shape).

From the Navigation-tree the student goes over to the actual Term where he finds both the administrative (Fig. 2) and the didactic material (Fig. 3).

TERM-1

- Introduction
- How to register
- Registration-form
- Tuition-info
- Modules-timetable
- Homework-timetable

Figure 2. The administrative section

TERM-1

Module 1. Oral proficiency

- Lessons

  ¤ Dialogue 1 (text-file)

  ¤ Dialogue 1 (audio-file)

- Exercises

  ¤ Dictation + Key

  ¤ Writing dialogues + Key

  ¤ Pronunciation + Key

Module 2. Written proficiency

- Lectures/Lessons
- Exercises

  ¤ Translate + Key

  ¤ Answer the questions + Key

  ¤ Grammar + Key

Figure 3. The didactic section

The student follows the modules-studying-timetable and mails his homework (i.e. text- or audio-files), according to the homework-timetable, to the actual so-called *homework-teacher* (our term, see below) for feed-back.

The Forum-for-questions-&-answers, is the central *meeting-point* of the class and the teachers.

The student has uninterrupted access to the course throughout the studying-year.

3.2. Any pedagogical-didactic problems?

Are there any pedagogical-didactic problems on an IT-based language-course? We have met with some problems – below we shortly mention a few of them.

- *Conducted or flexible learning?*

E-learning is often referred to as flexible learning. Our courses offer both "conducted" and "independent/flexible" learning. Yet it seems that the latter increases the rate of studying-motivation, the results being immediately more positive. The teacher faces then the question: to what extent can the course-programme be flexible?

- *Web based or physical course-material?*

The profile itself of e-learning creates the expectation of dealing only with web based course-material. As we know, one has nowadays complete access to web-newspapers, web-books and a large amount of web-corpuses [1]. The teacher, and even some of the students, may yet think that "physical" books should not be totally rejected. We must still think of those students whose computer-/internet-work-ability is yet not very advanced. But, then, how can we solve the problem of accessibility of a certain (physical) book (i.e. the same edition), for all the students, for instance needed for group-homework in translation?

- *Part of a "classroom" or lonely behind the computer?*

The student may experience, at least at the beginning, the role of being the only student in the class, lonely behind his computer. He may not feel himself as a part of a classroom with 70-80 other schoolmates! He never meets them! He maybe never meets the teachers either!

The feeling of loneliness may be accentuated as soon as the first technical impediments arise. These two factors, often in combination with

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different successive difficulties along the language-studying, such as more and more intricate grammar-rules, difficult, new, heavy vocabulary in the independent-studying of novels – all these aspects may contribute to turn out the online-studying into an impossibility.

It is, therefore, our utmost task, as teachers, to form out the shape of our courses in such a way so that they can create an evident "classroom-atmosphere".

Thus, we must work hard to make the student address to us, not by means of mails (the fastest and the most convenient way of communication – the latter especially for those individuals who "wish to be *publicly* unseen") – mailing invites to isolation, but to make them communicate in the Forum (for questions & answers).

Once persuaded to communicate by means of the Forum, the individual realizes quite soon that there are other individuals coping with other or the same problems – life becomes immediately lighter! The individual sees himself as a member of a larger community – a student, part of a classroom.

Very soon the students give each other advices, suggestions and answers to different problems. We have experienced courses where we, the teachers, were nearly not needed, in a large part of the topics brought to the Forum! And more than that – the teacher on an IT-based course learns a great deal from the students and the open interaction in the Forum.

- *The "classroom"-dynamics?*

The teacher may ask himself how to create the "classroom"-dynamics at the level of different kinds of study-activities, for example group-homework, debates and discussions, while preserving the flexible shape of studying.

We have experienced two kinds of "classroom"-related activities: on one hand we offered the "static" way of participating to the debates, i.e. the participants were not depending on the time-factor – they contributed to the debate, at any time, within a given period, and on the other hand we offered the "dynamic" way of participating, namely in the chat-room.

In our opinion the students choose in the first place the "static" model. Maybe in order to avoid making blunders, in public?! By choosing the "static" way of participation the students have a larger possibility to control their language-production. But this means that we can not easily stimulate to the spontaneous language-production?!

We know that there are various ways of reaching the "dynamic" participation. There are teachers [2] who warmly recommend the "Conversation-world" model, where the participants are seen on the screen as a kind of geometrical figures, moving around *in this world*, while speaking.

In our opinion, this model does not solve but preserves the problem of the anonymousness of the individual, easily connected to online-courses (i.e. the individuals "hide" behind the computer) - thus it does hardly contribute to create the "classroom"-community-atmosphere.

We would rather choose another model, for instance the computer-to-computer-interaction, that openly creates and shows "the classroom" – the participants been seen on the screen.

We have not yet adopted this interaction-channel, as it may implicate a certain rate of expenses, not possible for all the students – but we intend to do it within a near future. Maybe this will solve the item of the "classroom"-dynamics?

- *The online-student - the anonymous individual?*

As we mentioned in the paragraph above we find that only few students participate at the dynamic-debates, that is debates taking place at a given time. Now, we wonder – what is the reason?

The non-participating students, do they request the flexibility that we have automatically promised by this type of studying, via internet? Or do these students want to be anonymous, unseen, unheard – by fear of making blunders? Maybe many of these individuals attend the online-courses just because they think that this studying-model preserves the anonymousness?!

If the two latter presumptions would turn to be true, we probably face a big problem. "Probably" – because we may very well run online-courses with participants who want to preserve the anonymous-label on themselves. We have only to be aware that this requests more teacher-assistance because it takes place on the individual basis, in order to keep these students' studying "alive" - even if they feel at ease working "outside the group", they may, in the long run, not be able to cope – alone - with other difficulties along the course-programme (such as the frequent technical impediments or the accelerating course-tempo).

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Some teachers [2] make clear that we have to accept a huge amount of mailing-communication, as an important part of the teacher's job.

We do not part this opinion (apart from the case of the "unseen" students) – mailing-interaction invites to isolation, it does not avoid it. We insist in recommending trying to conduct the communication towards a central, open interaction-channel – the Forum, even in the case of the "anonymous" students.

- *The oral language-production?*

During a long time, there has been a clear tendency to underestimate the IT-based language-courses. The main reason seems to be the impossibility to give feed-back to the student's oral proficiency.

Nowadays, supported by highly-developed technical tools, we have succeeded in solving a great part of this item.

Yet, the feed-back – in order to obtain an optimal result – requests a higher number of teachers and in this case the course-running is no longer a financially more reasonable way of teaching. In our opinion, it is – the number of online-teachers will hardly reach the number of teachers requested for the campus-teaching.

Some of the teachers [2] check the student's oral proficiency still by telephone. We think that this model can, on one hand, be misleading – another person can be on the phone!? On the other hand, how can we handle the regular feed-back for a class on 100 students, every week, in different parallel oral-proficiency-activities? It seems unrealistic.

We find the feed-back by voice-mail, practiced since a few years, as being very simple and easily handled by the student – and at no costs. Even more – the student saves the feed-back-files received from the teacher and can use them in his repetition-exercising, in continuum.

- *Live-lessons or only virtual?*

As we know, most of the IT-based-courses include a certain number of compulsory live-lessons.

Our course-programme included also, the first years, compulsory live-lessons, but soon we had to admit that our students preferred to work from the computer – the live-lessons became facultative.

At last, after 8 years, we understood that the live-lessons have to be dismissed from the course-programme – to meet the teachers and the other students seemed to be a superfluous activity.

Yet, we do assume that live-meeting is essential – it invites to higher study-motivation. Thus we initiated, experimentally, the so-called "student-annual-conference" (our terminology).

We figured out that this could be an appropriate occasion to combine the examination –opportunity with a scientific conference. We invite well-known scholars, from Scandinavia and Romania – their communications and the seminars provide live-course-material with the latest research-results.

The students enlarge thus their knowledge – on the internal level, namely within the Romanian-sphere but also on an interdisciplinary level, coming into contact with students, teachers, researchers and experts from other departments, working on projects with Romanian profile.

This new type of live-meeting seems to be much appreciated.

- *Attend the course entirely – a problem?*

It is generally known [2], [3] that students who complete an entire IT-based course represent only about 20%. This is not a positive sign – we know that the budget of every department is usually related to the number of students who complete the course.

On our courses the fully examined students have usually reached the rate of around 70%. How come?

From the very start we assumed that the non-fully-attendance may be a result of the loneliness-behind-the computer beside the technical problems, often combined with difficulties successively arisen in the progress of the language-learning.

Therefore we thought that the continuous following-up-interaction with the student was a major task within the teacher's job.

Thus we have initiated regular individual following-ups of the *student's situation* led both by the so-called "homework-teachers" (our term that is the teachers who deal with the feed-back on the homework, written/oral week-/month-tasks, debates a.s.o) and by the head teacher.

- This "task" takes a lot of time and energy, it is true – but our experience shows that this moment encourages essentially to full course-attendance.

When the teachers reach the level when they, regularly, do the "following-up-work" and at the same time succeed in maintaining the

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"classroom-community-atmosphere" – beside interesting, capturing course-activities - we are sure that the student experiences a stronger studying motivation and thus will both present interest and have strength in attending the course entirely.

These are some of our reflexions around the pedagogical-didactic items connected to online-language-courses. They clearly show that this type of learning embraces a new pedagogical shape.

4. E-courses better than campus-courses?

The opinions are still different. Let's see our results gathered from an-8-years-long-evaluation-material.

We think that it is of great value to see both the teachers' and the students' opinions [6]. Below, we will yet focus more on the teacher's view (by lack of space within this paper's limits) mentioning only some of the main points.

The teachers' opinion

- *Reach far more students and a larger geographical area*

Our Romanian section was during decades represented only by a tiny language-section: 3-5 students, all living around Lund respectively Copenhagen. Only one level was offered – the beginner's-course.

Since 1999 (the start for IT-based Romanian) we reach Scandinavian students throughout Sweden, Denmark, Norway, and Scandinavians in other European countries, the USA and Canada.

The number of students increased immediately, from the very beginning (from 3-5 students, on the campus-beginner's-course, to 27 students (the first year), on the IT-based course). The number of students increased steadily each year - now we have, each term, 110-130 students [7].

- *Several levels - fewer teachers*

Nowadays, thanks to the e-learning-model, we run four levels parallelly (from the beginner's-level up to the pre-ph.d.-level).

We have a team of only 1½ teachers - which is too little, we admit, but our hope is that the budget of our section will soon give the possibility of having a few more teachers.

- *Flexible teaching and learning*

Neither the teachers nor the students are depending on the factors of time or space.

The teachers, once he has created the main course-modules, he can easily combine the supervising of the students' activities with, when necessary, research-travels/séjours.

The teachers, and the students, can "go into the classroom" at any time from anywhere.

- *Independent learning*

The shape itself of the IT-based course, invites the student, from the very start, to practice self-discipline, initiative-taking, independent learning. This increases, undoubtedly, the studying-motivation.

But this can, of course, raise problems for the students who respond more awkwardly to this model of learning. Yet, with the teacher's extra help a great number of the students belonging to this group succeed quite fairly in attending the course, even if only partially.

- *Nearer though the distance*

We are nearer though the distance – a paradox – yet true!

Let's mention only one example – in a campus-course, the student "sees" the teacher in the classroom, only twice-thrice a week, a couple of hours and, by that occasion, the student (i.e. every student) may not have direct contact with the teacher. The online-course ensures the student's steady contact with the teacher(s), on one hand through the sending of the week-homework followed by the individual feed-back and on the other hand the interaction in the Forum. The teachers are *nearby* in continuum.

- *Better supervising, better interaction*

On the IT-based course the teacher seems to have better control both on the individual and on the class. He seems to have better, more frequent, interaction with the student (every student) than on the campus-course.

The students' opinion

As mentioned above, in this paragraph we will only list a few points.

- *Flexible learning*

The flexibility (i.e. the non-dependency of time and space) is largely appreciated. It makes possible, for instance, the combination of full-time-work with studying or of studying of head-subjects with the online-course, creating an interdisciplinary basis of the studying and thus enlarging the motivation for studying.

- *Non-stop access to the course-material*

The students highly appreciate the non-stop access to the course-material, i.e. lectures, lessons, exercises and keys, and especially the audio-files - this is less possible in the campus-course.

This facilitates, on one hand, the access not only to the course-didactic-material but also to the entire course-activities (the Fora etc). On the other hand it gives the possibility of the students' self-repeting-practising in continuum, with direct feed-back, without the teachers' active participation.

- *The teacher – only a coordinator*

Especially the students keen on working on a self-initiative-basis, feel very much at ease within the online-course. They work independently - the teacher is a coordinator.

On the basis of the above-mentioned points we think that the online-course is undoubtedly more convenient than the campus-course.

5. Towards a conclusion

The university-education (as well as the education in general) ought to focus more on *the modern student – i.e. the nowadays «IT-based individual»*.

E-learning seems to be the solution for this individual. It facilitates flexible teaching and learning, a more efficient and financially more reasonable pedagogical-system.

E-learning may even reach a higher quality-status than campus-learning, thanks to the technical equipment, in constant development, which may find solutions to many of our pedagogical-didactic problems.

We do believe that the IT-based-university-language-learning is the future!

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Strategies on Lifelong Learning

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Abstract. The paper will address the lessons learned form the organization by the Comenius 3 Network "Hands-on Science" of the 1st Workshop on Science Literacy and Lifelong Leering (LLL) held in Bucharest in May 2006. The diversity of the approaches proposed by the participants concerning the LLL process as well as the existing strategies will be discussed. Emphasis will be put on the participation of various players in the field and on their particular contributions (university professors, school teachers, vocational training tutors).

Keywords. LLL strategies.

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Slovenia Experience Using Videoconference Technologies in Long Life Learning

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Abstract. The paper presents some examples of continuous education and training of Slovenian teachers that use or teach computer technology in the Slovenian elementary and secondary schools. The underlying research was granted by the Slovenian Ministry of Science, Education and Sport. The first example explains organizational and technological details, problems and advantages of videoconference supported summer schools. The second experience is based on periodic tutorials, scheduled on local TV and accompanied by videoconference supported workshops for the same learning community.

Keywords. Videoconferencing, Internet, Long life learning, Teachers training.

1. Introduction

One of the projects of the Slovenian Ministry of Science and Education is dedicated to the computer literacy in Slovenian schools. Part of the project is focused to the problems of continuing education of the teachers. Every year they should participate to various seminars and workshops.

Faculty of computer and information science, University of Ljubljana plays as a specific role as an educational and R&D institution that follows the trends of the information technologies. It acts as a disseminator of the acquired knowledge to other members of the educational community and also to the teachers of elementary and secondary schools that should implement computer supported solutions in their everyday activities.

The obvious way for such dissemination is seminars and workshops that are organized in a classical way with regular presentations in classrooms. In the last years some other more advanced ways of such education were investigated.

Every year the members of the faculty organize on behalf of the Slovenian Ministry of Education so called Summer school for teachers and some selected scholars. This event is mainly dedicated to new Information technologies in education. The participants are mostly Slovenian teachers. The summer school is organized as a workshop consisting of interesting presentations and practical hands-on work in computer supported classrooms.

In the past years the attention was focused into Internet compliant technologies and into the conceptual learning of sciences, supported by these technologies. The participants gained the first experience in using and creating hypertext materials supported by advanced Java, 3d graphics and video examples. The first steps into videoconferencing technology were also accomplished. In the first years the summer school was limited to several 10 participants

In the Year 1999 we introduced a decentralized approach supported by means of ISDN multipoint videoconferencing technology. 11 different Slovenian cities were interconnected into a single virtual classroom. More than 230 participants could follow the lectures without travelling to a common location. The basic idea was to interconnect the involved locations, to have common videoconference lectures given by some experts and to combine these lectures with accompanied hands-on experience within the computer supported classrooms that were allocated at the involved locations. The whole system is represented on figure 1.

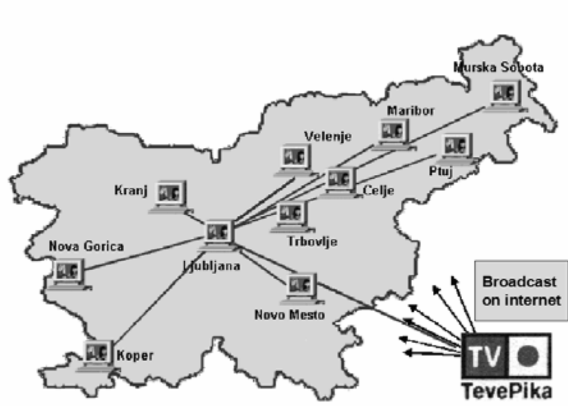

Fig. 1. The interconnected virtual classroom in Slovenia

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Considering spatially distributed community the effective interaction between all the participants had to be implemented. According to this requirement several technological and organisational problems have to be solved before and during such events.

2. Technological details

First of all several computer classrooms in the involved Slovenian schools were equipped with videoconference computers that permitted the interconnection through ISDN. Every videoconference computer was equipped with particular hardware and software that permitted 2 video inputs and ISDN or IP connection towards the central Multipoint Communication unit (MCU). One video input was connected to the required video camera; the second video input was used for the connection to a presenter's computer (usually a notebook). The multilateral cooperation of these videoconference points was enabled through the multipoint communication unit located in the capital city of Slovenia-Ljubljana. All classrooms were also equipped with usual computer projectors.

A particular attention was paid to the videoconference point at the Faculty of Computer and Information Science which was organized according to its central role. In the first years practically all lectures were given from this point. The lecturers have had the possibility to connect their personal notebooks to the videoconference system by means of appropriate SVGA to video converters. At the time of the first the summer school only the central location at the faculty had such facility. In the following years every location was equipped with such converters and therefore the lecturing was enabled from other locations according to the scheduled time-table.

The guidelines from more experienced sites suggested involving not more than 4 videoconference points. In our case we decided to connect first 8 and later 11 locations. This represented a risk in the case of the communication problems. Therefore we decided to double the technology with the support of the local TV station. A parallel videoconference point–to-point interconnection with this station was established. The whole event was broadcasted on the local cable TV and also as streaming video on Internet. Such approach gives us the needed backup link in the case of communication problems and enables also an individual follow of the tutorials on domestic computers by means of usual browsers and with Real player plug-in.

The complexity of the technological infrastructure and the crucial role of the faculty required also more staff involved in the support. At each moment at least 4 people were active in the videoconference. Besides the lecturer the second important function was the moderator who supervised the timing of the presentations and monitored the feedback from other sites.

The additional interaction possibilities were achieved by the establishment of an internet portal dedicated to the summer school. The participants had the possibility to send to the lecturers their remarks, questions and links to the accomplished assignments by e-mail.

3. Organizational details

The implemented technological infrastructure permitted multipoint collaboration between the involved videoconference points. However the first experiments leaded to the conclusion that a more structured approach should be used. Every lecture had 2 distinct phases: presentation and discussion. In the first phase every lecturer had 40 minutes for his presentation. After that the discussion phase was started and up to 3-4 remote locations had the possibility to ask questions. The technology of multipoint permitted even more active locations but in order to avoid chaotic discussion on one side and too long turnaround the number of interacting videoconference points was limited to 3-4.

From the logistic point of view each videoconference site a local administrator supervised its infrastructure. All administrators were prepared through several preliminary technical videoconference sessions before the official opening of the school. They also received a CD with instructional materials that permitted them the establishment of the same working environment in their local computer classrooms.

From the organizational point of view one of the problems is immediate, real-time interaction between administrators of the involved videoconference points. In the first year the cellular phones were used for such interaction. In addition to this, in the following summer schools we established a parallel communication system that was used by videoconference administrators but it was transparent to the regular participants.

We implemented classical simple internet chat between the administrators. They had in such a way the possibility of immediate reports concerning the technological problems (mostly with bad sound).

In order to give to the participants the feeling of a well organized school a WEB portal was established with all data concerning the organization of the school and links to instructional materials.

A particular care was paid to the quality of presentation materials since the quality of streamed video image requires bright and large fonts on possibly dark background. Unfortunately not all lectures followed the prepared PowerPoint templates and guidelines.

Considering the problem of the possible communication failure some lectures were prepared in advance with the technology of interactive video on demand. In such a way a complete tutorial dedicated to the 3Dgraphics was prepared. Typically each lecture was composed by a PowerPoint presentation with various video clips and combined by lecturer's talk and video. The characteristics of such lectures are that they are much more intensive and personalized since each participant can stop, step back, and skip parts of the interactive streamed materials according to his own previous experience and knowledge. The advantage of such tutorials is also high resolution of presentations, much better than with videoconferencing, combined with video clips. However according to the guidelines each lecture should be no longer that 10-15 minutes.

Remarks were that this technology can act as a complement to the regular lectures but it cannot be a good substitution for live presentations because there is missing immediate live feedback from the instructor's side.

4. Engagement of the participants

The participants had the possibility to follow the videoconference lectures and to put the questions to the instructor in various ways:

Giving the questions by regular e-mail. In fact the moderator located near the lecturer continuously monitored the incoming e-mail and forwarded it to the lecturer. The lecturer could decide to answer immediately or to postpone the answer after his presentation.

Asking for attention: The moderator annotated the requests for questions and enabled the connection with the corresponding remote locations immediately after the presentation.

Part of the participants' activities was the accomplishment of their individual assignments. At the beginning of the summer school every participant received a CD with the corresponding courseware. The contents mainly consisted of the additional didactic stuff and some software tools that were required to solve the assignments. They were able to do this in the local computer equipped classrooms and had the support given by local administrators. Besides this they were motivated to ask some additional questions to the experts by means of regular e-mail. The experts had also the possibility to see and assess the assignments accomplished by the individual participants.

For this purpose, each involved location established a local WEB page, which was linked to the central portal of the school. The basic idea of these local WEB pages was decentralized broadcasting of the solutions of the "domestic" assignments, prepared by the participants.

At the end of the every summer school the expectations and the reality of this event were analyzed and suggestions for further improvement were given. The best solutions of the assignments, prepared by the participants were also presented by means of the videoconference.

5. Analysis and remarks

After the first summer school one of the observations was that there were too many lectures (one week, at least 5 hours per day) and the participants did not have enough time for their assignments. But such intensity of videoconference lecturing was also problematic from the lecturers' and organisational point of view. We concluded that in the future we should limit the lecturing to 3, in any case not more than 4 hours per day and give more time to hands-on experience.

One conclusion of this event was also that the technological infrastructure was too complex. One reason was also doubling of the communication technology. In fact more than 30 people worked on background of the summer school. We concluded that it should be simplified. However a communication backup is needed in any case because of the possible communication problems and of the large number of participants, sparsed in different

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cities. In the worst case the local administrators should be able to activate some substituting activities in the local classrooms.

Another remark was that only the central point (faculty) had the possibility of giving lectures accompanied with didactic materials from personal computers (notebooks). According to this observation now all videoconference sites are equipped with converters which permit the connection of a separate teacher's computer to the videoconference computer.

Another conclusion was that the multipoint concept is maybe attractive with its interaction possibilities but is not adequate since it could lead to chaotic problems because of too many locations involved. In any case the experience show that the lectures should not be interrupted at any moment and it was better to give to participants the permission for questions only on request, approved by the conference moderator. This means that instead of multipoint is better to use multicast or sometimes even broadcast concept.

Certainly the success of the summer school was represented by the involvement of more than 230 participants from different cities without the need of their travel and accommodation. Despite the distance between them they really acted as a virtual classroom. The technology also permitted the remote involvement of experts without the need of their travel to the central location.

6. Experience with continuous distance learning

The learning community participating in the experimental phase of mentioned summer school consisted of secondary and elementary school teachers who should get or refresh the basic knowledge of computer literacy and multimedia technologies. In the teaching and learning process also several experienced teachers of computer engineering were included. At least one such teacher was present at each location. Their role was to help their colleagues on particular sites during the practical hand-on workshops that followed the lectures.

The success of the first videoconference summer school encouraged the involved partners to activate one experimental school organized on distance learning concepts. Instead of a single, one-week long seminar, the planned school had to last several months and had to be more focused to particular topics. The idea was to try a new concept of continuing distance learning. The already mentioned communication technologies were used for distance lecturing and for additional explanations during the additionally introduced domestic assignments. The first experimental course was dedicated to the Java programming language.

In order to permit better interaction and to give more time for domestic assignments the following didactic scenario was used:

The lectures were limited to 30 minutes per week and were broadcasted through local cable TV and through Internet. The broadcast of each lecture was repeated 3 times, once in the afternoon and 2 times in the late evening.

Again, a WEB portal was dedicated to the experimental school, which contained links to the tutorial used during the lecturing. Some links were pointed to the additional didactic materials. The "Program" page contained the structure and schedule of the course. The "Videoconference points" page contained useful contact information concerning all involved locations (e-mail addresses of local administrators, links to local WEB servers.) The "Assignment" page was dynamically updated every week. It contained the definition of the particular exercises for the participants and (with the delay interval of 1 week) the possible solutions of these exercises. The "Didactic materials" page contained the link to the hypertext lessons used by the lecturer, links to some interesting WEB pages on Internet and links to some useful downloadable software tools.

Every week a new domestic assignment compliant with the current lecture was published on WEB. The next week the solution of the exercise was also published and explained.

Once per month a virtual, videoconference supported workshop was organized. The participants obtained a new assignment that integrated the already acquired knowledge. They could also ask the lecturer for any additional information. The basic idea was again that they could use the computer facilities at their classrooms during such workshop and share their experience between them. In addition they could interact with lecturer by means of usual Internet services.

In order to permit as much as possible the same working conditions for all participants regardless of their location a separate working meeting of all local administrators and the lecturer was organized before each videoconference workshop. All administrators obtained a CD with instructors' didactic material. This enabled them to prepare each local computer classroom with the same didactic tools. This approach permitted them to act locally in the case of communication problems.

A separate CD was prepared for each registered participant. This CD contained the hypertext lessons which were used by the lecturer during his performance. The CD contained also some accompanying useful didactic material.

7. Conclusions

Both experiments, the first videoconference supported summer school and the experimental introduction of continuing education supported by such communication technologies had some common characteristics. First of all the habitude of the participants is just to follow the lectures and not to use the combined videoconferencing and Internet communication technologies for one immediate feedback with the lecturer. Therefore such lectures had more broadcasting than interacting character. The participants preferred to interact with the teacher in the days following such lecture by means of usual Internet services, mostly e-mail. Most of the participants also preferred to work on their assignments alone at home and to interact with the lecturer after, and not during the periodic videoconference.

Another interesting experience was using the public services of the local TV station. The limit of 30 minutes per lecture opens for the lecturer new challenges because his explanation should be more efficient, compact and at the same time attractive because it is usually followed also by some less experienced listeners. This is even more difficult in the case that the lectures are "on line" and no corrections are possible as this is the case of "playback". From the technological point of view practically all didactic materials had to be adapted considering the guidelines how to use colours and fonts (big and simple fonts, bright and could colours on black background) in order to guarantee a better readability on TV.

One of the side effects of such lecturing are well prepared didactic materials which are recorded and can be published on video-servers for repeated training seminars.

Another positive side effect of this experience was the increased link and communication between participating teachers and professors and other experts at the university. The personal communication between participants and university lecturers often continues also after such events. In fact we obtained the model of the learning community represented on the figure 2. At the top of this community are involved faculties, on the second level are the schools equipped with videoconference technology. Their personnel can also act as co-organizers and multiplicators in the case of repeated seminars and workshops. On the third level are the elementary and secondary school teachers from various schools, interested in the continuous refinement of their knowledge and skills.

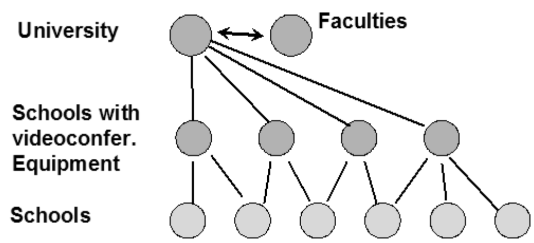

Fig. 2. Model of the learning community

The achieved experience and the followed analysis lead to the conclusion that such kind of education should remain traditional. One of the primary reasons is that the participants do not have to spend money and time for travelling. In fact they can join one of the nearest videoconference points which are established overall the country on the basis of the regional level. This approach is also appropriate for short lectures or presentations lasting just a couple of hours. This is particular useful for knowledge-refreshment seminars that are a never ending story in the field of information and communication technologies and their application. In the near future this type of education will continue with periodic videoconference seminars accompanied with hands-on workshops. Further development of this activity will be in a more structured and focused organization of videoconference based seminars which should consider the preliminary knowledge of the involved participants and their personal skills and interest.

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Who – or What - Is the Teacher? How Artificial Intelligence Will Control Lifelong Learning

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Abstract. Lifelong learning is becoming progressively more significant, both economically and as a leisure activity. The Internet is a prime source of material that can be used in online learning, but the huge size, and semi-random organisation, of this data inhibits its effective use.

This paper considers the use of Artificial Intelligence to make sense of web-based data. The incorporation of such techniques into tools used to develop materials for learning presents both opportunities and challenges, some of which are discussed here.

Keywords. Artificial intelligence, Data mining, Expert systems, Lifelong learning, Neural networks, Web-based learning.

1. Introduction

The title of this paper, "How Artificial Intelligence will control lifelong learning", sounds ominous. Indeed, the word *control* suggests that the extent of any future engagement in Lifelong Learning might be determined not so much by the needs of learners, but more by some apparently intelligent piece of software, which one can imagine might have its own agenda. For those people who are concerned about the suggestion that Artificial Intelligence (AI) might control *any* aspect of human activity, the prospect of it influencing how we learn must be particularly worrying.

However, the situation is less threatening than the word *control* might suggest. In the present state of Lifelong Learning (LLL), AI plays an insignificant role. As this paper argues, this is destined to change, but the use of AI to guide how we learn should be regarded as an opportunity, not a reason for concern.

An assessment of the challenges that will face consumers or developers of learning materials in the future depends of course upon how one believes that the field will develop in the coming years. With increasing leisure time in the future, the demand for education should grow, so that within a couple of decades a far greater number of people of all ages will continue learning into and through adulthood.

The present proportion of adults taking advantage of opportunities in this area is comparatively small, and were that to remain the situation, their needs could probably be met by using current resources. However, if demand for learning grows, the way in which facilities and information are made available will need to be reassessed.

We speculate here about how LLL might develop in the next couple of decades, and consider what will be necessary at that stage to meet the needs of a large population of learners.

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2. Information

There are several fundamental requirements for successful LLL. Firstly, it is obvious that sufficient relevant source material must be available to those who wish to learn. There is little point in encouraging people to engage in continuous learning if there is not sufficient material to meet their needs, or if it is of inadequate depth.

A large quantity of readily-available material covering a wide range of topics is therefore a prerequisite for a successful LLL program. The Internet is the obvious place to be used as a repository of this data, with access to it provided through a computer, a mobile phone or other personal mobile device. Information about most topics one might want to study is in fact already available through the Internet and the explosive growth of web-based material makes it virtually certain that, within a few years, encyclopaedic information about all significant topics will be available through the web.

However, mere quantity is not enough. Anyone who expects to learn over a period of several decades will require a depth of material well beyond that to which they had access at school or even at University. The issue for the learner will then be not so much the task of locating information on a given topic, but that of finding ways in which trustworthy, structured and complete information can be provided to them.

As the quantity of information available through the web grows, issues other than the mere availability of data have become more pressing. There is no reliable mechanism on the web by which the veracity of the information that it contains can be checked; verification can at present only be done by experts in the appropriate field, but the capacity to check is swamped by the rate at which new information is being put in place. Furthermore, the ease with which it is now possible to deposit information on the web (a process which, if anything, is destined to become even simpler), and also to prepare web pages that look professional in appearance, has made it very difficult to be sure that data one retrieves from the Internet are reliable.

It is hard to identify any mechanism that, in the short term, can provide assurance of the quality of data on the web. Pruning the contents of the web severely and restricting the ability of people to put into place their own web pages so that manual checking of individual pages again becomes possible (as it was in the earliest days of the web, in the few publicly-accessible web sites that then existed) is not feasible.

It is therefore clear that the present situation, in which the value of unattributed web-based material is hard to determine, will continue in the short term.

In addition to the question of how much reliance can be placed on web-based data, the organisation of that data is often poor; at worst, the data may be an unsorted mixture of unproven assertions and unsubstantiated opinions. Without active direction or hand-holding, learners will struggle to make sense of this information because of its unstructured and unsubstantiated form.

The ultimate goal of LLL – that of providing opportunities for any person, whatever their background, to learn about any topic – is thus almost impossible to satisfy unless tools are available that can select information and structure it so as to allow effective learning, rather than just feeding random, disordered (and therefore ineffective) grazing by the learner.

The need for some sort of "overseer" to organize the information is obvious, but who will perform this role? This is the central issue that this paper addresses

3. Programmed learning and tailored learning

In the 1960s and 1970s programmed learning texts flourished briefly, most notably within science education, where it was thought that they could be an effective tool in student teaching. In a programmed learning approach, the learner works through a mixture of exercises and instructional material, completing multiple-choice questions as each new topic is covered.

On the basis of answers to the questions, the learner is directed to take a specific route through the book, which, it is intended, will provide extra instruction and practice about topics that have apparently been poorly understood, while encouraging rapid progress through topics that the learner finds more straightforward. In this way, subjects are tackled in an order, and to some extent at a speed, that is determined by the responses to the multiple-choice questions. This ability to provide instruction that is individualized through the simple use of

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feedback was thought to be of value both as a way of improving learning and as a means to maintain interest.

The growth of programmed learning texts was brought to an abrupt halt, despite the early hype surrounding their development, by the arrival of computer-aided learning (CAL) software. The philosophy of CAL had much in common with programmed learning approaches.

In the development of CAL software, developers took into account experience gained in programmed learning and recognized how valuable it was to be able to adjust the user's route through material in response to their answers to questions. The principle that each learner should be taken on a different route through the material was the key design feature of programmed learning and the advent of CAL materials allowed this to be put into practice in a far more flexible way than was possible using printed materials.

The huge quantity of information available through the web now allows this individual routing to be developed much further. The quantity of web-based information is so great that the number of routes that might be followed in exploring a topic new to the learner, such as relativity or the history of native North American peoples, is effectively limitless. However, it is not sufficient to have just a wide range of learning material. In the absence of a suitable route map to guide the learner through the flood of data, the chance that the learner will, without suitable guidance, chose the optimum route - or even a tolerably good one – through that material, falls away towards zero.

It is clear that the number of people who might wish to take advantage of LLL may become so great that it will be impossible to provide the level of resources and the number of teachers necessary to meet a demand from a population whose learning needs extend for sixty years rather than sixteen.

If the Internet is to be the basic source of information for future LLL, an automated system that can digest this material and restructure it in a format appropriate for learning is required. In other words, the web itself should provide the means to locate and structure the necessary information.

4. The role of artificial intelligence

In order to provide a well-structured route through web-based information, taking account of the difficulties that arise both because of the volume of information and its dynamic nature, some sort of intelligent system that can locate and identify suitable on-line material, assess appropriate routes through it, and then control the way in which material is presented is needed. This system must deal effectively with queries from large numbers of people with disparate needs, must be able to recognize and respond appropriately to requests from users of different ages and backgrounds, and must be able to adjust continuously to the changing database of information to which it has access through the web. Any such system must be sophisticated, and this implies some form of Artificial Intelligence.

5. What sorts of AI tools will be needed?

At the most basic level, an automated teacher for on-line learners should include a Data Miner. Twenty five years ago Data Mining was predominantly an academic pursuit, used by researchers working through very large datasets, such as those provided by census data.

More recently, the commercial value of the technique has been recognized and Data Miners have been used to identify interesting or valuable correlations that exist in the data within very large pools of corporate information, such as those provided from laser scanners at supermarket checkouts.

Data Miners can provide detailed information about the shopping habits of customers, and sophisticated algorithms have been developed to allow supermarkets to piece together customers' preferences and buying habits. Such information can then be used to target customers with offers that they will find tempting. Similar software could be used to seek out data on topics selected for on-line learning, gathering together a set of resources based around the topic of interest.

The role of a Data Miner will be to locate information that relates to a particular topic, but while these tools are effective at locating data and noting correlations, they are not designed to sort or to structure data so that a learner can be presented with an ordered and logical sequence of sub-topics. For this purpose we might use an Expert System (perhaps combined with a Neural Network – see later).

An Expert System (or Knowledge-based system), is a computer program that is built around a set of logical rules. These rules are typically cast in the form of

If … and … and …(not) … then … and … statements.

Current web search engines employ an array of Expert Systems, amongst other tools, to try to provide users with the most relevant data following a web search. In the context of online learning, we might envisage a rule such as:

IF material has been sought by the learner on the topic of Nuclear Energy,
AND IF material containing appropriate key words has been located on the International Atomic Energy Authority web site
AND IF the learner is aged less than ten,
THEN categorize this material as being too advanced to be used
BECAUSE I.A.E.A. is known to be a highly technical web site.
A second rule might be:
IF material has been sought on the topic of Nuclear Energy,
AND IF the profile of the learner shows them to be aged between 8 and 12,
AND IF a semantic analysis of the data that has been found shows that this information is suitable for a reading age of ten,
THEN categorize this material as being useful.

A key role of an expert system, then, will be to filter the information that has been returned by the Data Miner, and to assess its quality, trying to gauge its linguistic complexity (by a semantic analysis), its reliability (perhaps by checking the source of the data and some of the data itself against similar information held within a list of "trusted" sites), its relevance (by comparing key words with those identified for data required at the current stage by the learner) and so on.

Once suitable data have been identified, the expert system will then, as a minimum, have to decide upon an appropriate order in which data should be presented to the learner. A more advanced system would be expected to be able to blend together data taken from a number of different web sites, perhaps suggesting to the learner how data extracted from different sources might be compared against each other.

6. Further AI components

Users of tools such as these may learn by working through data gathered by the Data Miner, then sorted and structured by an Expert System, but more sophisticated blending of data for learning is possible.

Neural networks have the ability to discover previously unrecognized correlations within datasets and report these to the user. For example, by inspecting data on the food buying habits of customers at a supermarket, and relating those to information about medicines purchased by the same customer, a network might be able to discern links between a customer's diet and their health.

Rule discovery networks are already widely used, although they suffer from a "black-box" syndrome. That is, although such networks are able to detect correlations buried within a dataset, and derive rules that describe those correlations, they are less effective at providing a meaningful explanation of the correlation.

Nevertheless, the ability of a network to explain its understanding of a data set in an intelligible way is improving, and this offers intriguing possibilities for on-line learning. For example, a user might wish to test the theory that the severity of hurricanes correlates with the levels of carbon dioxide in the atmosphere. It is simple enough for a Data Miner to locate on the Internet data on the frequency of hurricanes and on the levels of carbon dioxide in the atmosphere, but a neural network could be asked to investigate whether any such correlation actually exists; in doing this, the user would be both learning and performing research.

7. How far can such a scheme extend?

At present the route taken through a dataset by a LLL is likely to be largely determined by the learner, or by a teacher who has decided on a particular topic order. However, especially in the understanding of complex topics, there may be other routes which might be more successful in teaching a topic to a learner with a specialized, perhaps unusual, background.

These topics may not have been considered by the teacher, or may be suitable for a large proportion of learners, but not a small number with more specialised needs. One can imagine a sophisticated software system being able to first set its own route through a dataset, then

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incrementally adjust that route on the basis of the performance of the learners who have followed a particular route, thus gradually optimizing learning for a particular class of learners.

8. Dangers of AI-mediated learning

An intelligent system to devise and control on-line learning seems inevitable. An effective system could be of great help in providing just the sort of customized learning environment from which remote learners could most readily benefit. But there may be difficulties, or even dangers associated with such software.

The problem of determining the veracity of information is undoubtedly the most challenging task for any intelligent system. It used to be common for people to accept uncritically what they read in books, because of the perceived authority of the printed word.

A similar situation is developing with the web. On the one hand Internet users accept that there may be much disinformation on the web, and yet still readily consult the web for answers to a huge variety of questions, apparently trusting that the data they find is meaningful. Automatic checks on veracity of information are difficult, but work in this area is advancing, and methods such as checking consistency among data, comparing data with known reliable sources, and spotting the tell-tale signatures of deliberately faulty information promise to yield trustworthy tools in the future. It would appear that neural networks will have an important role to play in this connection.

There is also a risk that an automated system might create a distorted view of a subject because the AI software that filters the data has taken a particular "stance" on the topic. It is not yet clear how an AI system will ensure that the view of the data that it presents to the learner is a fair reflection of the real world. The AI system will undoubtedly be very complex, and will process vast quantities of information in a way that would be impossible for a human to reproduce. Non-automated checks on the way the data have been presented will at very least be difficult therefore. If the software is very complex and decides that a certain subset of all the available data represents a balanced and fair view of a subject, it may not be feasible for humans to test this view.

Finally, the complexity of the AI approach could lead to collapse of the searching system in a way that would be impossible to fully diagnose, and therefore impossible to avoid. Building the kind of system described here would be a technical challenge and the level of complexity involved brings with it its own dangers.

The Internet itself has developed into a system which is simultaneously robust and vulnerable. Large-scale hardware redundancy allows the system to cope gracefully, indeed essentially invisibly, with loss of routers or servers. However, the complexity of the network has grown to such a level that it may be reaching the point at which a catastrophic failure could occur which would not only be difficult to repair, it might not even be possible to understand what had been the cause of the failure, because of the hugely interconnected and interdependent nature of the web.

A similar problem could arise in online learning. As systems for accessing and structuring data become more refined, the way in which the interconnected components work may well become so complex that a complete understanding of the operation of the software becomes impossible.

9. Conclusion

Lifelong learning is a desirable goal, and one that is becoming progressively more significant. Because of the volume and detail of data that it contains, the Internet is the obvious source for material that can be used in online learning. Searching this information already requires use of sophisticated software, and the level of sophistication will grow as we try to use the web in more challenging ways.

The use of AI to act as an assistant in learning offers great opportunities, but the sophistication required also presents notable difficulties, both in terms of creating the software and monitoring it so as to ensure that it meets the needs of the user. Work in this exciting area is making considerable progress and, with caution in implementation, the opportunities for LLL in the next twenty years will act as a huge boost to education using automated data retrieval from the web.

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How to Increase Attention's Efficiency in the Learning Process

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Abstract. In this article, I go from the idea that the students' attention depends strongly on the teacher's work.

Some guidelines about how to increase attention's efficiency in author's opinions are discussed.

Keywords. Attention, Efficiency, Lifelong Learning.

1. Introduction

Reception without attention has no persistence. If a student (pupil or adult person) is not attentive when you teach him something, the learning process is slowly and difficult. It is need a lot of repetitions. The learning process becomes superficial, instable, understanding's efficiency is diminished and the number of errors increases. When the attention is faint, the forget phenomena grow.

2. How to increase Attention's Efficiency

Here are some guidelines about how to increase attention's efficiency [5]:

2.1. Permanent admonitions of the students have a little success.

Here are some proceedings without any success: permanent invitation to attention doesn't produce the desired effect. When you say: "Quiet please!", "Attention!", "Don't talk!" you may be ridiculous. The expression "You must to do this, you must to do that!" has little educative value. Your personality like teacher is essential of the quality of your lessons.

2.2. Strive to introduce democratic relations between you and your students!

Many conflicts from education result from tensioned social relations between teacher and adult or young students. Adult students put more accents on the necessity of a methodical - psychological training of the teacher comparative with younger students. A teacher must be a model for their audience. Between his words and actions must not be discrepancies. He can not be capricious or cynic. Teachers which prefer only to read their lecture or have an unsystematically and uninteresting teaching will be not accepted.

2.3. Make your teaching method more efficient and interesting!

It is evident that the teacher must not accept to be droved only of the adults' interests. Any teaching form will be determinate in the first place of the social-economical needs [2]. This thing not constitutes a reason that the teacher not structures the content in an interesting one.

"Interests are both premises and the result of the instruction process." [7]

With this end in view it is necessary that student be attracted in an active way in the instruction work, not only by exercises but by lecture too. The linear teaching, especially the simply reading of the lecture, causes tiredness and encourages the tendency of "escape".

By psychological point of view, it is essential to introduce different chapter of learning content by a more stimulating approach of problems, linking them with life experiences. Attention is a secondary phenomenon of the interest. They depend essentially of the way by which the teacher succeeded in motivates his teaching activities. The best motivation is the link with practice [4].

2.4. Use multimedia learning instruments!

By multimedia instruments we understand television, Internet, photos, didactic movies, retro-projector, Power Point presentations or e-Learning [8]. Using this learning instruments make the teaching process easier and more pleasant. For the student the learning process becomes more efficient because the multimedia instruments help him to an intuitive understanding and he can use them after the classroom too, in his individual work at home.

Technology makes possible multimedia activities such as Web quests, virtual field trips, subject samplers, multimedia scrapbooks, and treasure hunts. These activities span the curriculum and encourage higher-order thinking skills. They have their roots in real-life discovery and exploration.

Technology provides acquisition to greater volume and depth of information than was ever possible before.

Even today, in technology era, continue to be teachers which know any multimedia instrument or consider that by introducing these pedagogical means should take to much time to preparation [1].

2.5. Use purposely the rhetorical rules!

This didactical part is too little respect by teachers. There are many teachers who have a deficient technique of speech because of an incorrect expression habit [9].

Here are some elementary rhetorical rules:

2.5.1. Choose your words carefully!

This means that each expression must to be rigorous. A teacher must choice the most expressive, suggestive and intuitive words. The scientific language must to be use, but also explained and illustrated by examples.

2.5.2. Don't abuse of some expressions and typical phrases!

A typical word or expression used too many times seems ridiculous for any body. In this case, the students' attention is turned off from the learning content. Every teacher should correct their verbal tics with a self-critical look.

2.5.3. Do deliberate pauses and change the rhythm of your speech!

Verbal breaks and speaking rhythm must contribute to a clear presentation of teacher's ideas. Deliberate variation of speaking rhythm has a substantially contribution to maintain the students' attention. Also, a teacher must change purposely his voice's strength. A speech in a low voice is more efficient for attention's focus.

2.5.4. Use moderately behaviour and orientation impulses!

Orientation impulses like: "Think again!", "This is the problem!" are similar with rhetorical questions: "Can we agree this?", "Shouldn't we think again?". There are very useful to focus psychical processes to a wishful direction for develop an active think.

Behaviour impulses like: "Do participate actively to the lesson!", "Be more attentive!" can have beneficed effects to regulate the students' conduit.

2.5.5. Use natural mime and gesture!

The teacher's voice power is complete by their gesture and mime. Is often enough a gesture or the face expression to obtain the desired effect? However, the teacher must avoid a very expressive mime, because that is a great danger for the efficiency of the teaching success and for the attention focus.

2.5.6. Look your audience in the eyes!

In my opinion, this rule is very important. Some teachers have the bad habit to look to the window or to walk about the classroom while teaching. Such behaviour diminishes the students' attention. Contrary, every student must feel that the teacher speaks to him personally. Visual contact is very important to attract the attention of any participant to the course. The lesson must be prepared carefully and the dependence of the written text must be minimized. Otherwise, the students' attention will be reduced.

2.6. Concentrate upon your teaching because on that depends the audience's attention!

If teachers complain upon lack of attention from auditorium, sometimes is, partially, their fault too. That because their own lack of concentration. An irritable teacher must not be surprised if their students are agitate, inattentive or, sometimes, even bad-disciplined.

The teacher must be rested, in good shape, confident and calm so that the students are very attentive, well-disciplined and enthusiastic even after a long day of work. That's very important as a teacher uses the breaks between the classes for recover his tonus.

2.7. Teach your lessons with enthusiasm!

This is a very important rule too. Even a subject is treated for a hundred times, the teacher must comport like the first time. If the teacher cannot be enthusiastic about his lesson, there is no “spark”. This enthusiasm must be authentic, not exaggerated and to be expressed by voice and mime. A good teacher must avoid the routine [2].

2.8. Your lessons must have a gradual increasing level of difficulty.

A teaching process too static and boring leads to students’ monotony and passivity. On the other way, a teaching process too agitated, with a fast rhythm produces a non-cooperative auditorium [6].

When teachers and students too, complain about the density of the learning contents, this is because on not analyze and not resume efficient the content.

You must introduce moments of relaxation in a lesson because the attention is an intermittent process. That’s mean the attention is temporary diminished and must be animated. This is a good advice especially for a teacher implicated in the adults education.

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Learning for Life

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Abstract. As European citizens we all share an interest in protecting and improving the environment around us, because, it became clear that our global environment is under serious threat as a result of human activities. Environmental pollution causes a range of human health problems, the overuse of natural resources, the destruction of animal and plant species and their habitats creates important anomalies in our life style. That is why we believe that people and the environment can work in partnership to each other’s mutual benefit. We realise a study based on these real problems. These are challenges for us, teachers, and for our students. Our work contains some simple and ingenious experiences realised in our laboratories and some radioactivity measurements in the field, proposed in order to demonstrate the impact of pollution on man’s life. We try to explain that natural resources, such as fresh water, soil and minerals cannot be replaced once they are used up. We try to demonstrate that our young generations have a great potential for creating a better and healthier environment in the future.

Keywords. Sustainable development, Ecological education, Natural radioactivity, Experimental activities.

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Environment used to be thought of as a minority interest for well- managing nature-lovers, but nothing could be further from today's reality. In fact, the environment concerns all of us, because it relates to every aspect of the world we share and depend on for our survival.

Sustainable development is now a central principle of EU policy. The term „ sustainable development" refers to the effort to ensure that economic growth takes place in a way that can continue in the future, without exhausting resources, or harming any section of society.

On our country agenda, needs to be a strategy in order to protect the environment. We must understand that all countries will have to work together in order to safeguard our environment, because the air we breathe and the water we drink are not restricted by national frontiers. Creating a national awareness on long run it is not possible without an ecological education of young generation. They must break the link between economic growth and environmental damage. That's why the knowledge of environmental protection must be studying in the gymnasium and continues throughout high school.

The word „ ecology" comes from Greek, „ oikos" means „ all the house", „ all the inhabitants" and „logos" means „the science". So, the ecology is the science based on organisms, plants and animals' relations and their life.

The pupils must understand that men occupy an important place in ecosphere, among the other species. First, we have to evaluate the effect of our actions among the environment and how we minimize the damages and only than must we carry on our industrial and agricultural activities. The pupils must be taught to think in this way. They have to realise that the costs for ecological protection are an investments for a better life and for our future. Ecological education represents an „education for health", a permanent dialogue between man and nature. Finally, our action on the environment aims to improve the quality of life for everyone, by focusing on the steps that can be taken more effectively through cooperation.

Attaining this goal presupposes devising a strategy, starting with defining the specific objectives and ending with the results evaluation.

Defining the specific objectives must take into account a series of principles:

Creating Awareness. By means of diversified experiences, they must acquire a profound understanding of the global environment, of the problems it faces, of the responsibility of human kind as well as the role it can play in relation with it. The students will be encouraged to pass this awareness onto their parents, other adults or even the local authorities.

The Attitude. Becoming motivated so as to actively participate in protecting and improving the environment is the outcome of the acquisition of certain social values and a deep feeling of commitment to the environment. The students must be consulted about their ecological education and their suggestions must be emphasized by concrete measures.

The Competences. Ecological education requires the acquisition of certain qualifications so as to be able to help solve environmental issues and encourage the dialogue between different groups.

The Participation. For an action to be guided into solving a certain problem, an active and effective involvement is essential.

In order to achieve ecological education in high school we have used the experiment-based method, also known as "lab learning", which consists in: analysing an experiment, drawing conclusions and using them for a new experiment whose final purpose is a change of behaviour.

We have applied this model by means of a series of modern didactic methods: the experiment, problematisation, the discovery, modelling.

The experiment stimulates the students to devise and practice themselves certain operations with the purpose of observing, analysing, demonstrating, verifying and evaluating the results. It is an intentional challenge, in determined conditions, to observe the evolution of certain phenomena, to study the cause-effect relationships, to discover the laws that govern them and to verify some hypotheses. The experimental method needs an active participation of the students who will learn the scientific research technique: raise the problem, formulate the hypotheses, perform the

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experiment, analyse and synthesise the data, verify and apply the results.

Throughout the experiment the teacher must intervene to draw attention to the more difficult moments and guide the students' activity.

We conceived the worksheets in keeping with the operational objectives and the students had to write down the hypothesis as well as the data obtained after the experiment was carried out, they then processed these data and formulated the conclusions.

Problematisation is an educational method that proves useful when there are problem situations. The problem situation is the expression of an unexpected, surprising contradiction that appears in the student's mind, between the knowledge already acquired and the new information, between two or more hypotheses, between the theoretical information and their own observations of the real world or between the theoretical approach and the practical solution.

In the ecological education on soil, water and air we raised a series of problems:

- What happens to the ground water level when you take out water from a well and how is this water replaced?
- What do you do to find the right location for digging a well?
- How can soil pollutants contaminate well water?

Water is another vital element that raises numerous questions:

- Which are the determining factors in polluting drinkable water and what are some possible ways of diminishing them?
- How can we prevent urban and ground water contamination?

Problematizing air issues envisages:

- What are the causes of the increasing incidence of hurricanes or the global temperature increase by 1-6 ^{0}C in 2001?
- Which are the structural modifications of the ozone layer as a result of the industrial fume releases?
- What are the effects of acid rain on the life of plants?

Learning through discovery involves a system of operations regarding the organization of didactic activity so that the students can discover the new characteristics, principles or laws themselves. This method stimulates creative thinking as much as the problematisation method does. But, whereas the latter means that the students must solve an apparently conflictual problem, the former implies that they focus especially on the solution of the assigned task.

Learning through discovery is a highly formative method; it stimulates curiosity and interest, will and perseverance.

With this purpose in mind we organized activities at the end of which the students discovered, for instance, the way a well works or some microorganisms that live in the soil.

Modelling involves studying natural phenomena with the help of material or ideal models, when direct handling of the subject is not available. In the case of the theme proposed for the ecological education, we used analogical artificial material models which simplify and systematise the representation of a structure or biological phenomenon. For example, we made a model for soil washing, for the functioning of a well and its relationship with ground water, for the construction of a dump.

Knowing of the composition and the properties of the environment factors facilitates a better understanding by the pupils of the polluting effects and of their impact on the environment and on human health. That's why the students from the Ecological club "PRONATURA", guided by their teacher, have made a series of experiments, through which they have demonstrated properties of the soil, water, migration processes and transformations of some pollutants, and the influences of some pollutants on living organisms:

- The demonstration of some soil properties (permeability, porosity, density, moisture, pH);
- The discovery and identification of some organisms that live in the soil;
- The demonstration of processes of soil percolation;
- The demonstration of the influence of some pollutants of the soil on plant growing;
- The study of the way in which deposited garbage can bring soil polluting and can affect the qualities of underground water;

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- The knowing of the positioning rules of some wells;
- The demonstration of the properties of water and the presentation of some methods of analyzing these properties (distillation, filtration);
- The identification of some new methods of treatment of waste that can allow a considerable decrease of pollutants in water;
- The emphasise of the influence of acid rains on crops;
- The emphasise of the negative role of acid rains on plant growth.

Every experiment has been accompanied by a paper which comprised:

- The objectives of the experiment;
- Materials;
- Time;
- Subjects, focusing on interdisciplinary ;
- Background information, with the emphasize of the terms;
- Activities.

Aside from the paper the students received worksheets, in which they wrote the experiment results and the formulated conclusion. At the end of the experiment, the teacher has verified the way of completion of the sheet and the answer correctness.

The evaluation of the student's activities followed:

- The student's abilities to execute the experiment paces according to the experiment paper.
- The data recording correctness obtained in the sheet;
- The correctness end clarity of the answers.

Our research has continued in the field. We have been collaborating with NGO Hobby Club "Jules Verne" from Timis County, together with who we went to the Poiana Rusca Mountains.

The geographical structure of the PRM has allowed for ore deposit exploitation since the earliest times (the Dacians). The underground exploitation of ore deposits has led to the formation of numerous waste landfills. They are very large in the case of exploitation mines and smaller in the case of exploration ones. Most of these are unconsolidated and subject to constant erosion, representing a permanent threat to the inhabitants of the area. The old landfills have suffered a gradual regenerating process, which led to an increased stability.

In Romania, pitchblende, the main uranium ore, sometimes associates with sulphurs (pyrites, chalcopyrite, lead sulphides, etc.) or iron oxides. The uranium deposits are found in lenticular layers of reduced thickness.

That is why the exploitation of iron oxides and sulphurs has led to an increased radioactivity in the area. All the more so as, unlike the uranium processing process where the main concern is minimizing uranium losses, in these cases when uranium is not the finite product, there is uranium left in the waste. In general, no radioactivity measurements were performed for these mines. Rocks with traces of uranium are found in the waste landfills increasing the level of ionizing radiation exposure.

These considerations point out the need for locating these mines and landfills in the Poiana Rusca Mountains and making some radioactivity measurements in the respective areas. We used for our measurements a radiometer MIP 21, with NaI (c/s). Some conclusions must point out:

- ✓ Mine exploitations have led to an increased radioactivity through the extraction of ores.
- ✓ The increase in radioactivity depends on the type of ore exploited:
  - between 3-12 times for magnetite
  - the processing of magnetite in Flotation "917" has led to a significant pollution of the area, the concentration being over 35 times higher within the flotation and 22-25 times higher in the decantation tanks.
  - the roads may be even more radioactive than the natural surroundings, since mine waste was used in building them.
- ✓ Considering the polluting potential of these mine exploitations, an urgent evaluation of the real situation is required because a proper reconstruction of the abandoned mining areas is needed since they pose a real danger to the human and animal population of the area.

The students have demonstrated their ability to use the computer and internet by making a site which includes information regarding the environment factors and the pollutants which affect them and also the results of their research: schemes, photos, animations. Thus, the students can share the results with other students from the school but also with the students from other schools.

We considered that the ecological education made in school is essential for arising ecological awareness, for long life learning concepts of the modern human.

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Learning from Forum Theatre Experiences - Tools for Practitioners -

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Abstract. This paper reflects the lessons learned by the seven partners implementing the GRUNDTVIG1 project "Forum Theatre (FT) – a method for adult civic education".

The idea of testing FT method in different communities, different countries, and transfer it through experiential methods - appeared as a challenge; experiences in adult education and active citizenship were common elements and provided the coherence of this cooperation project.

We worked aiming to develop a strong instrument to help people become more involved in community life. We hope the Methodology Guide will offer a substantive aid for community development practitioners working with marginalized/ disadvantaged groups.

Keywords. Forum Theatre, Active citizenship, Fight against oppression, Informal adult education.

1. Theatre of the oppressed

The Theatre of the Oppressed was developed by Brazilian theatre director Augusto Boal during the 1950's and 1960's. In an effort to transform theatre from the "monologue" of traditional performance into a "dialogue" between audience and stage, Boal experimented with many kinds of interactive theatre [1]. His explorations were based on the assumption that dialogue is the common, healthy dynamic between all humans, which all human beings desire and are capable of dialogue, and that when a dialogue becomes a monologue, oppression ensues. Theatre then becomes an extraordinary tool for transforming monologue into dialogue. "While some people make theatre," says Boal, "we all are theatre."

FT is a way through which adults explore their needs and possible solutions by acting the situation (oppression) they feel and face. It is a way through which adults build understanding of their situation and explore in a creative and flexible way the needs and potential solutions. FT provides the participants/adults an opportunity to "act-out" the problems in their life and seek solutions.

Forum Theatre is an emancipatory method of gathering analytical research and evaluating where information becomes active for the participants.

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If standard research practices can be affirmed to be contemplation, emancipatory research could be considered to be always presenting a vision of the world in transformation [2].

The act of experiential emancipatory research facilitates thinking as a form of action. It facilitates the participating citizen to discover, by themselves, that which they carry within them. Experiential emancipatory research can be a transitive process. Researcher/animator and participant are learning together, establishing a dialogue, just as all human relations should be a dialogue. If such dialogues are not carefully nurtured or energetically demanded, they can rapidly turn into monologues, in which one or two of the interlocutors, i.e. researcher and the contracting organisation, have the right to speak.
This reflects a Paulo-Freirian concept of the oppressed, dialogue that turns into monologue and research information that is taken from disabled participants into the ethereal of documentation eating technocrats. The task implies that the emancipatory researcher does not just gather disabled participants in an accessible room in order to induce information [3].
As with conventional qualitative & quantitative research, conventional theatre is governed by an intransitive relationship [4].

Everything travels from the stage to the auditorium. Information and stories are transported and transferred in one direction. As with conventional analytical research methodology, the staged performance portrays emotions, ideas and even morality, all moving in one direction and nothing goes the other way. The tiniest noise, the smallest exclamation, the least sign of animated life displayed by a spectator, is the equivalent of being drunk on your first day in a sheltered workshop. Strong reactions during a performance or research process can be seen as dangerous and emotions such as anger are directed towards therapy.

Conventional theatre, and likewise conventional research methodologies, relies on an individual's behaviour in society being a matter of following rules and conventions.

By contrast, the use of experiential methods such as Forum Theatre, in drama or during a research process, encourages dialogue to flux back and forth.
Transitivity is not merely tolerated it is actively sought. Only dialogue, which requires critical thinking, is also capable of generating critical thinking [5]

The use of Forum Theatre in an emancipatory research process, asks its audience active questions and expects active answers.

As a research methodology it facilitates information to become active within a group of disabled people who will ponder issues and make choices. Such experiential methodology begins with questions of power and what is the relationship between a disabled person's motive for imagining power and the images created through Forum Theatre.

That is, the participants create the images and narrative to think about power in relation to: showing what they could do if they had power; speculate about what they would do if they had power; arrive at some assessment of what power they would need in order to improve current circumstances; postulate a range of narratives that cannot be achieved by power structures that exist at present.

However dominant a social system may be, the very meaning of its domination involves a limitation or selection of activities it covers. In terms of standard research practice, this leads to the dominance of correlation and documentation whose validity depends on the approval of established regimes of thought [6]

Therefore, experiential Forum Theatre does not accept that all social experiences have been exhausted. It potentially contains space for alternative acts and alternative intentions, which are not yet articulated as a social institution.

Through non-verbal images and narrative primarily created by the participants, with the researcher as facilitator, the action of thinking perceives reality as process and transformation, rather than contemplating the status quo.

The experiential nature of Forum Theatre, in a research workshop setting, proceeds to investigate such contextual realities by means of abstraction through coded dramatic situations created by the group as a whole.

The decoding or deconstruction of images and narratives requires moving from the abstract to the concrete. This requires participants to move from the part to the whole and then returning to change the part.

The actors are always acting out the characters they roughly imaged, but it is the active audience, the whole research workshop group, that supply a narrative.

Forum Theatre participants in the audience are asked to identify character and power relationships in the image and how they are related to the wider social construct.

This is followed by the audience identifying education, social, employment and life-skill needs for all characters in the image of a transforming narrative. This, in turn, requires that the disabled people, the research subjects, recognise themselves in the narrative of the abstract image and recognise the image as a situation in which they find themselves, together with other disabled people. It is not in the tragic characters of the image that pity and fear manifest themselves, but rather in the spectators [7].

According to Aristotle's Poetics, something underserved happens to a character that resembles ourselves.

This flux and reflux of active-information from the abstract to the concrete occurs during an analysis of a narrative image and leads to the supersedence of the abstraction by the critical perception of the concrete [8].

2. Background and state of the art

2.1. Starting the project

The cultural interventions as a method of adult learning (using art, theatre, drawings, etc) to explore and understand civic behaviours is an important tool towards creative communities and build adults' awareness about their role within society and their personal and community developmental needs.

It is a tool that helps people to explore local needs in a creative and constructive way; increases creativity - a key ingredient for positive strategic thinking - and increases the sense of local identity (which is basic for deeper involvement in community life).

This project brought together partners from six European countries who had no previous similar experiences to work together in order to test an innovative methodology different contexts aiming to develop civic competence in adults and create an awareness about their role in society and their developmental needs.

FT is a specific technique designed to help people take an active role within their community, both through their local government and through directly exploring solutions to a problem in their particular community, whether it be environmental, social, political or economic.

As a method, FT encourages learning which offers people the possibility to communicate easier, to see things in a new way and liberation from stereotypes. It also promotes equality and the possibility to create a vision. It is our aim to positively influence the associative local bodies to analyse local problems. We also hope that through this method a stimulant and flexible working environment will be created so that new methods and new kinds of relationships can be explored and harnessed to respond to the needs of the oppressed/powerless members of the community.

2.2. Objectives and target groups

The project's main objectives were the following:

- To test and adapt F T as a method of working with adults in order to develop civic competencies and increase their capacity to play an active and responsible role within the local community.
- Develop a network of co-operation among European organizations using cultural methodologies to promote civic competencies.
- Improve organizational capacities to develop information, guidance and counselling services for adult learners and adult education providers and marketing the organizational competences at national and European level.

The project's target groups:

- The partner organizations developed and market their capacities in the filed of adult education through the FT methodology
- About 1200 adults have been involved in the piloting stage of the methodology and gained understanding of their role within society and their individual and community developmental needs.
- Other adult education practitioners and institutions attended international and national workshops and receive the FT brochures.
- Other beneficiaries are the institutions/ organizations which intend to use FT in their programmes that can receive information about it from the specific dissemination methods proposed in this project.
- The project aims to make the representatives of specific target groups more aware of the situation they are living in and to make them (the key actors) more responsible. The marginalized

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people become able to express their problems and theirs feelings without inhibitions and become "heard voices" (their opinions are taken into consideration).

Applying this method at the European level, we can develop a strong instrument for helping people to be more involved in community life influencing public policies. This can be an example for all marginalized or disadvantage group to demonstrate that they have the power to change situations and solve problems.

The main innovative part of the project and methodology consist in using the FT at community level with a focus on building awareness about individual and personal needs and on developing understanding of the European dimension of community life.

This project is innovative in relation to each partner organization's former experience as it develops a new method and enriches their approaches.

2.3. Outcomes and outputs

The partner organizations developed their organizational capacities to provide adults education services - through FT methodology.

More then seventy four social development practitioners from the five countries in which the method was tested (the Maltese partner having the role of the expert and consultant) develop competencies in using this method (learned the theortical basis and applied it).

Figure 1. The priest and teachers rehearsing

Workshops and conferences were organized in the partners' countries for experience sharing and promoting the FT methodology and partner's organizational competencies

A Guide of Forum Theatre Methodology and a Best Practices visual material - both materials are available in both the national languages and in English.

A web site dedicated to the F T Method as an adult learning tool, with an english version and versions in national languages of the partners.

The first steps towards a European network of FT practitioners: the web site and a new project proposal for supporting the development of this network

Photographic exhibitions in all partners' countries, presenting images from all the steps made in the project

3. Why use FT?

A definition of oppression made by Boal: "Oppression is a relationship in which there is only monologue, not dialogue."[9]. Theatre also provides a group venue for the operation of collective thought, judgment, and application of cultural values.

Boal himself has used the techniques of Forum Theatre in a series of innovative social-change projects around the world – from mental health in Calcutta to legislation in Brazil where he was elected Mayor of Rio de Janeiro. Extensively used all over the world this form of participatory theatre is today widely employed not only by artists but by NGOs and institutions to spread their messages.

This interactive theatre is also a tool to analyze and explore solutions to problems of the oppression that can arise everywhere – in families, at school, in local communities, in the workplace, as well as problems connected to all sort of society "dysfunctions" like unemployment, domestic violence, racism, poverty, homelessness.

This will be an interactive (Forum) theatre show which invites audiences to demonstrate their ideas regarding what choices we have in our civic structures and in our daily lives to address the gaps created by the cuts to welfare.

Forum theatre is an interactive one, where the audience gets to come on stage, replace a character and try to resolve a situation.

The goal of forum theatre is also to make people more aware of some problems/ solutions that they may have not considered previously. Forum theatre scenarios are designed to stimulate audience participation through discussion, interactive role-playing and shared experiences.

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Considering all the information available today about FT, we can say it had a big impact in all sorts of communities with high and low educational level as well. Dressed up as fiction, situations from every day's life are more easily accepted by people, no matter educational level. During the shows it have been noticed that people wouldn't talk under normal circumstances express themselves, react and that the message sticks in spectators' minds.

Figure 2. Alcohol problems in family

Most important, we work with people in communities who are experiencing, both as individuals and as a collective, their own perceptions of life. Forum Theatre role is to facilitate a "true voice," reflecting those perceptions and stimulating community-based dialogue, so that, having articulated the present, the theatre creators and the collective community can rehearse the present but also can invent and rehearse the future.

More specifically, it is a rehearsal theatre designed for people who want to learn ways of fighting back against oppression in their daily lives. In the Theatre of the Oppressed, oppression is defined, in part, as a power dynamic based on monologue rather than dialogue; a relation of domination and command that prohibits the oppressed from being who they are and from exercising their basic human rights. Accordingly, the Theatre of the Oppressed is a participatory theatre that fosters democratic and cooperative forms of interaction among participants. Theatre is emphasized not as a spectacle but rather as a language designed to: 1) analyze and discuss problems of oppression and power; and 2) explore group solutions to these problems. This language is accessible to all. Bridging the separation between actor and spectator, the one who observes but is not permitted to intervene in the theatrical situation, the Theatre of the Oppressed is accessible to "spect-actors" who have the opportunity to both act and observe, and who engage in self-empowering processes of dialogue that help foster critical thinking. The theatrical act is thus experienced as conscious intervention, as a rehearsal for social action rooted in a collective analysis of shared problems of oppression.

Why to use Forum Theatre? Because this theatre method proved its efficiency as tool in raising awareness, in community building, in education both for young people and for adults, in personal development, in empowering people and as an important tool for generating change.

In our project the focus was on using Forum Theatre as a tool, an educational setting, creating a learning format that gives people the opportunity to „rehearse reality" in their way of rising awareness to their communities about the existing problems as well as existing solutions to the problems. We use Forum Theatre as learning tool because one of the objectives of this method is to liberate participants from both internal and external oppression, so as to make them capable of changing their reality, their lives, and the society they live in. The plays presented by the partners involved in the project were sometimes at least an awakening for indifferent communities.

From our organizations' points of view (the 7 partners working in this project) the aim for which FT is used can be express directly through the play (to solve a problem that is ours) or to serve a higher goal of our organizations, as one of the tools we use to produce social change and development.

Examples of the organizational aims we tried to fulfil: 1) RO (ARDC) – testing FT as a tool for improving sustainability of community development processes; 2) HU (IKE) – enrich organization's approach with an effective tool for facilitating group processes; 3) RO (MASE) – to rediscover participation and dialogue in rural communities; 4) PL (AHE) – to test and perfect FT as one of the methods in the trainers' tool kit, to develop abilities in creative thinking, to put pressure on hot issues and come to Legislative Theatre[10], eventually, learning to use FT as a tool able to solve problems in different trainings and as a method to teach a foreign language; 5) IT (Colleferro) – to offer the

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community more complex services, incorporating FT as a tool for exploring specific problems and finding solutions; 6) BG (WCIF) – as a community development tool and for improving communication inside the organization and with the partners.

4. Practical application of the forum theatre techniques and methods

The basic history and theory of the Theatre of the Oppressed will be taught within the context of a practice of Image Theatre, leading to Forum Theatre.

Oppression, according to Augusto Boal, is when one person is dominated by the monologue of another and has no chance to reply. Boal's life is devoted to giving those who are in this one-down position the tools with which to express themselves and discover a way out of their powerlessness. That's why the method is helping activists to develop their organizing skills, and make them more effective, by:

- training them as facilitators of group dynamic techniques designed to enhance democratic group process, community-building and solidarity;
- stimulating reflection on, and discussion of, both the structure of organizing models and strategies, and the changing nature of political organizing;
- provides them with the opportunity to work with other people in a safe space in order to explore and confront issues of power and oppression that concern them;
- provides a collaborative structure designed to enable people to directly apply and adapt, within the context of ongoing on-site group facilitation, elements of the training they will have received in intensive forum theatre workshops.

The key to Boal's theatre is the "spect-actor," an audience member who is invited onstage to take part in the drama. Working mostly in poor communities, Boal serves as a facilitator to help volunteers create dramas around problems that affect their lives. At the performance, audience members are free not only to comment on the action, but also to step up on stage and play roles of their choice. In doing so, they discover new ways of resolving the dilemmas that the play presents. In follow-up exercises, community members learn how to translate these insights into social action.

4.1. The learning partnership project

Following the steps described above let's have a look to the challenges and changing that people confront in working within communities in various cultural, social and economic backgrounds: from Poland to Italy, from Bulgaria and Romania to Malta.

Activists' testimonials:

Hungary –…..” in one project, when they repeated the play after presenting the model they said only the most oppressed character can be changed. Nobody wanted this. The second time the same and the third time, when the joker said everybody can be changed, then all the characters were changed (including the most oppressed one)”.

Romania – “In Ocnita a man went on stage to replace the mother and although the audience laughed in the start, he's performance was so good that in the end everybody was convinced by his attitude”; “In Ogra in one project a Mayer appeared in the play. The real Mayer was in the audience and he went on stage to change the character, but instead of playing the Mayer he used this change to make a political speech”.

Poland – “…from both projects' sites experience it is important to make clear from the beginning that when replacing a character the task is to represent the problem not to try to imitate a person.” …” [the people] had from the beginning the dilemma subject from the community/not because they were not actually from the group which had the problem they worked on. To solve this they explored the problem from different points of view (young people, television, church, elderly people, etc.). This way the students got to know the problem”; “…in the project issuing abortion they didn't come to a solution, but it was already a big step forward because they discussed about an issue that is a big national taboo.”

Italy – “…the group of young people wanted to be exclusive and they didn't want to accept any outsiders, although they were not as much a real group as the other three …”.

4.2. Forum theatre and social change

“The conviction that there is an actor in each of us is the driving force behind a form of drama

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that seeks to awaken consciences and change lives" Augusto Boal

Mario Azzopardi - consultant

Forum Theatre always has this tension (which Boal was aware of): the balance between the esthetic and the social. What it looses in the esthetic it gains in social power. In this respect the very styled project in Poland (abortion as issue) suffered because it was very difficult for the spectators to relate to the actor's presentation ('how can I go there, I can't do something like that'). So, they remained passive. Boal said the limit Forum Theatre should consider is the surrealism, but if the audience is of simple people, then even the symbolism can be a bad idea (as too much for them to handle).

Poland (AHE) – a performance (abortion issue) was design more as a documentary film and this created a distance to the audience. But there were more causes for the distance: the actors were too good, the issue was extremely sensitive. As people from the audience are afraid to intervene into a play that is too perfectly prepared it may be a good idea to leave/ allow sequences of improvisation during the play.

Hungary (IKE) – Although the actors improvised continuously (so the performance looked accessible for audience), because of the tension it was difficult for the spectators to take action. Another reason was that the play had just one long scene and some people didn't feel able to go and stay on the stage for 10 minutes. Although many spectators finally went on stage they couldn't make real changes in the situation presented. We now consider changing the play into one with a couple of short scenes, presenting different moments in time or different places.

Romania (MASE) – in Valcea the spectators involved themselves in the Forum Theatre, but in a very similar way. Although they tried different approaches nobody succeeded to change the final situation.

Bulgaria (WCIF) – In **Koprivshtica** everything was ready for the play and in the last moment the actors appeared not in their costumes, but in folk costumes and they said they just want to present a few sketches and not the Forum Theatre play. The facilitators talked to them and convinced them to play the forum. This happened because some people from community convinced them not to go on stage for the Forum Theatre play.

Romania (ARDC) - In Lipovu, as the core group anticipated that it will be quite complicated and difficult to determine people to go up on the stage, they decided to have a team of three jokers (a main joker and too assistants, helpers). After the end of the play the three jokers tried to convince people to go on stage, acting in parallel for enhanced efficiency. The strategy proved useful, as they manage to convince two persons to go on stage. The weak point of the joker's performance was that during the debate the main joker wasn't able to pint point sufficiently the consensus areas and didn't fructified the spectators' engagement and interest to draft some future actions for solving the problem

4.3. The lessons we got in applying forum theatre

Education is often initiated from outside and requires an external agent such as an animateur, popular educator, social mediator... Programs begin with an attempt to identify the problems, expectations and daily needs of [the community] and have a commitment to help them.... The main goal of the popular educator should be to help the people reclaim their collective history so that they can bring about the structural changes that ensure the fulfilling of their needs and wishes, both in their daily lives and on a broader cultural level. This is the building up of popular power.

We can see here the concern for a key feature that is acceptance of the principle of ***cultural democracy***.

Here there are two interconnected ideas. First, that 'culture' is not simply some separate compartment of life dealing with 'art' but is 'the whole way of life' of a community. Second, that in any society there will be many cultures - and that we have to recognize the 'co-existing plurality'. The concern is less to bring high culture to the masses, than to stimulating local cultural expression.

5. A Step by step Methodology Guide

The experience gained during the project implementation is a first step in enlarging the area of method's application both territorially and conceptually. This is possible because the partners explored the method in areas were no previous similar experiences existed.

The guidebook we developed is neither an operation manual nor an alternative to Boal's books. This is an important aspect to be clarified from the very beginning: Boal's work is the milestone of any FT experience.

This book can be best described as a journey, offering social development practitioners both information about the theoretical basis of the method and tips regarding the implementation process, based on the project's real life situations.

Of course, we learned by doing, but we had the help of our experts. Our experience will be truly fruitful only by sharing it so that others will have the possibility of understanding the steps in applying this method.

We see this methodological guide as a practical tool at the European level for organizations interested in developing the FT methodology.

Its structure reflects real-life experiences described in brief which make them easy to read. It also includes the theoretical fundamentals of FT methodology.

A 'Theory' chapter offers an overview of the method, its origins and history. The first questions are then when and why can somebody use this method – our answers are based on field experiences.

Once you decide to apply the method, the following seven chapters will guide you through the steps leading to a FT presentation - 'Building the core group', 'Selecting the issue', 'Build the script', 'Management and PR', 'Rehearsing the play', 'The joker', 'The moment of truth'.

Once one have read all the materials about the method and applied it, s/he will realize that FT is more than a method. It is a live idea, a learning experience constantly challenging the people involved. It is good to reflect on the experiences gained and on the literature one reads. That is what we did and sometimes found the answers required (some of which are included in this guide). However there were times when answers were too hard to choose. That is why we included a chapter about 'Dilemmas/ Challenges'.

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Scientific Literacy as Part of Lifelong Learning

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Abstract. This paper gives a historical review of some of the different interpretations of the term 'scientific literacy', with respect to the concept of lifelong learning. It then reports the results of a study conducted in Malta, with an adult community who are active participants in the lifelong learning process. The aim of the study was to probe how adult learners view of scientific literacy in the 21st century and whether they consider scientific literacy as part of their lifelong learning process. The study found that adults assign different levels of scientific literacy. However a minimum level of scientific literacy is indispensable in today's knowledge based society.

Keywords: Lifelong learning, Scientific literacy.

1. Introduction

"Scientific literacy has become an internationally well-recognized educational

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slogan, buzzword, catchphrase and contemporary educational goal" (Laugksch, 2000, p.71). The term 'scientific literacy' is usually regarded as being synonymous with 'public understanding of science'. A simple search on the Internet Google search engine reveals more than twenty-one million instances of the term 'scientific literacy'. Despite all the attention that scientific literacy has received over the years, this concept is frequently recognized as being controversial (Jenkins, 1990). What is meant by 'scientific literacy'? What kind of scientific literacy is needed by adults in today's knowledge based society? How do adults acquire the scientific literacy needed in the 21st century? A brief historical overview of the concept of scientific literacy is helpful at this stage in the discussing of the issues raised.

2. A Brief History of 'Scientific Literacy'

The debate about the scope of science education can be traced back to the beginning of the twentieth century, mainly to the educational philosopher John Dewey. He believed that society would be better served if its educated individuals were reasonably schooled in science (Dewey, 1909). John Dewey had set 'social literacy' as one of the purposes of science education. He believed that civilization rested so much upon applied science that no one could really understand civilization unless he/she grasped some of the scientific methods and results that underlie science.

Dewey argued that the primary aim of science teaching was the formation of 'scientific habits of the minds' (1910, p.127). He believed that the preparation of students for active citizenship was not the only role of high school science education. Dewey believed that science was the means for the public to develop attitudes of open-mindedness, intellectual integrity, observation and interest in testing their opinions - all these are characteristic of scientific attitudes. He argued that these scientific methods produced a logical mind capable of transferring these skills to other areas of life.

Dewey disagreed with the dualistic view of education i.e. a content-specific education for the selected few who performed well or were highly motivated and a general education for the rest. Instead he called for a type of school education that facilitated a future lifelong learning, for when the children became adults. He believed that the ultimate goal of science education was to enhance the learners' intellectual independence, as a potential link between science learning and responsible citizenship in democratic societies. These ideas are not much different from the concept of schooling and life-long learning in today's world.

During 1920s and 1930s most science educators favoured the development of scientific habits of the mind rather than training for good citizenship, as the main aim of science education. The difficulty which, however, existed was how to translate this preference in the classroom. Champagne and Klopfer (1977) concluded from a study of literature since 1916 that despite the acceptance by many science educators of Dewey's belief in the value of scientific thinking to the student outside the field of science, these educators never managed to effectively translate this doctrine into actual classroom practice.

During the 1940s and 1950s a rapid growth in American peacetime industry was experienced. This produced a need for more scientists, engineers, science teachers and other scientific professions. During this period, there was a notable increase in public funding towards the development of curricular projects intended to improve the quality and content of science and maths instruction at schools. There was great emphasis for more students to enrol into science-related careers. For the other students who never made it to the science related jobs, the teaching and learning of science was seen as suitable for 'effective citizenship'. Following World War II, many scientists, having witnessed the horror brought on by one of their major scientific/military achievements (atomic bomb), believed that the best way to avoid such catastrophic use of science in the future was to educate the public about the use of science for good and for bad motives, and to seek civilian control of such issues. Robert Openheimer, the physicist who directed the development of the atomic bomb said, "The physicists have known sin, and this is a knowledge which they cannot lose" (Shamos, 1995, p. 76). Many scientists believed that with the atom bomb, science and technology had brought civilization to the edge of a precipice and that unless a more reasoned decision-making process regarding the use of such destructive technologies was introduced, civilization might well push itself over the edge.

Thus was born a loosely structured but highly visible movement which came to be known as

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the scientific literacy movement (Shamos, 1995, p.76). Consequently 'science literacy', as a major goal of science education, became increasingly popular. 'Scientific literacy' was intended to prepare students to cope intelligently with 'science-based societal issues'. This meant that individuals were to become sufficiently sophisticated in science so as to reach independent judgements on those issues that were brought to public notice by special interest groups or through the mass media.

Then came October 1957, with the shock produced by Sputnik, the first artificial satellite build by the Soviet Union to orbit Earth. The response by the American government was to multiply funding at all levels of school science, in an effort to provide all students, and the public generally, with a broader understanding of science and technology. Science became a major feature of all the general pre-college curricula in the US and other highly industrialized countries. As a result the public became more sensitive to science-based issues. However it is debatable whether this really led to better understanding of the basic principles underlying such issues.

Recent reviewers of historical and contemporary meanings of the term 'scientific literacy' agree that the term was first used in the 1950s, by James Conant (1952). He used it to describe the ability of individuals to evaluate the advice of experts. Paul Hurd and Richard McCurdy (1958), then adopted it as a label to describe a primary goal of science education. Conant (1952) concluded that making everyone expert enough to reach independent judgments on science-related issues was futile, and that a better approach would be to instruct them in how to communicate and obtain the best advice possible on technical matters from experts. Rather than understanding all the science themselves, he argued that it was better if individuals learn how to identify the proper experts whom they can trust to deal with the specific issues related to science.

The period of the late 1970s and early 1980s was characterized by a multitude of varied definitions and interpretations of scientific literacy (Roberts, 1983). This persistent lack of consensus diminished the usefulness of this concept (Graubard, 1983). At around this time America faced two challenges: the emergence of the economic power of Japan and other Pacific Rim countries; and its poor standing on an international level with respect to scientific achievement. In addition, it was experiencing a declining number of scientists and engineers. As a consequence, a renewed interest in scientific literacy developed in the early 1980s.

Today, 'scientific literacy' may mean various things: from mastery of basic knowledge to national technological superiority; from science viewed as a cultural imperative to social responsibility; and/or from science content to science attitude. In spite of the hundreds of publications concerning scientific literacy, one may conclude that at the beginning of the 21st century there is still 'a view that scientific literacy is an ill-defined and diffuse concept' (Laugksch, 2000, p.71). Consequently, Laugksch (2000) provides an overview of the concept of scientific literacy. He identifies five different factors that can influence interpretations of scientific literacy. These are:

- four different interest groups (science educators, social scientists and public opinion researchers, sociologists of science, and informal and nonformal science education community);
- the way scientific literacry has been defined in different contexts in the second half of the 20th century;
- the nature of the concept of scientific literacy in terms of the interpretations of the term 'literate';
- the macro/micro benefits of scientific literacy to the nation, science or society, and to the individual; and
- the different methodologies used to by science educators, social scientists and public opinion researchers and sociologist of science to measure scientific literacy.

The outcome of the permutations of the different facets of each factor is that the concept of scientific literacy remains a controversial one.

3. What are the characteristics of a scientific literate person?

The American Association for the Advancement of Science- AAAS (1989) defined a scientific literate person as "one who:

- is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations;
- understands key concepts and principles of science;

- is familiar with the natural world and recognizes both its diversity and unity; and
- uses scientific knowledge and scientific ways of thinking for individual and social purposes" (p.4)

One can see that this definition requires that the individual understands the nature of science, has basic conceptual understanding of the main scientific content, and is also able to use the scientific method.

In another publication, Benchmarks for Science Literacy (1993), the AAAS suggests that:

"People who are literate in science …are able to use the habits of mind and knowledge of science, mathematics and technology they have acquired to think about and make sense of many of the ideas, claims and events that they encounter in everyday life" (1993, p.322).

This statement implies that scientific literacy goes beyond a state of understanding and knowledge, but that it becomes part of the individual's processing. These statements by the AAAS have a lot of implications to the teaching in science in schools. Content oriented courses do not reach the targets set for scientific literacy. School science needs to have activities aimed at promoting the scientific method as well as instilling attitudes towards science as part of their curriculum if they are to aim for scientifically literate citizens.

The Scottish Consultative Council on the Curriculum adopted the term 'scientific capability' instead of 'scientific literacy'. It defined 'scientific capability' as:

- *possessing* "scientific curiosity - an enquiring habit of mind;
- having a scientific competence - ability to investigate scientifically;
- involving scientific understanding - understanding of scientific ideas and the way science works;
- promoting scientific creativity - ability to think and act creatively;
- instilling scientific sensitivity - critical awareness of the role of science in society, combined with a caring and responsible disposition".(1996)

This definition adds further features to meaning of scientific literacy. It includes a more attitudinal perspective, where it emphasizes the need for creativity as well as sensitivity towards the moral and ethical implications of scientific research and development. Although such definition may be more comprehensive, its implementation in school science becomes an even greater and harder task to achieve.

In the report by Millar and Osborne (1998): Beyond 2000, it is stated that

> "School science should aim to produce a populace who are comfortable, competent and confident with scientific and technical matters and artefacts. The science curriculum should provide sufficient knowledge and understanding to enable students to read simple newspaper articles about science, and to follow TV programmes on new advance in science with interest. Such an education should enable them to express an opinion on important social and ethical issues with which they will be increasingly confronted" (p.9).

We find here again a strong reference to the social aspect of science. Today, science education has gained a degree of insight into the processes involved in the understanding of concepts. Science educators, however, know much less about how students develop attitudes and values. This opens a whole new area of research for science educators if they want to achieve what they themselves state is needed in order to help society to have scientifically literate citizens.

Another major document is that produced by the Programme for the International Student Assessment (PISA). The PISA report defines a scientific literate person as one who has:

> "The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity". (PISA, 2000, p.133)

Like all the other major documents reviewed, the PISA report holds a similar view of scientific literacy. It appears that there is general consensus to a certain degree that scientific literacy goes beyond the simple understanding of scientific concepts.

One viewpoint of the level of scientific literacy with the general public has been that they lack the background understanding of scientific concepts and all that is needed is additional scientific information. Aspects of scientific literacy such as evaluating expertise,

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deciding which information sources to trust and considering risks and benefits are important for adults, but not enough. Layton et al.(1993) state that 'practical science knowledge in action' has to fulfil the criteria of being of obvious relevance, helpful and useful, from a trustworthy source, relatable to other social knowledge, and in accessible communication rather than the formal language of science. Jenkins, (1997) argues that for most citizens, interest in science and technology is linked to decision-making and action. The notion of 'functional scientific literacy' as proposed by Shamos (1995) is perhaps the closest to this perspective of how adults behave. Miller (1989) suggested that 'functional scientific literacy should be viewed as the level of understanding of science and technology needed to function minimally as citizens and consumers in our society'. He suggests that scientific literacy requires:

1. a basic vocabulary
2. an understanding of science process
3. an understanding of the impact of science and technology on society.

An aspect of scientific literacy that is to date missing goes beyond an agreement of what scientific literacy means. The major challenge that science educators are facing in the 21st century is that of developing curricula that fulfil the requirements of scientific literacy as described in the various definitions.

4. Aim of Study

With these definitions of scientific literacy in mind, a study about some of issues of scientific literacy within the adult community in Malta was conducted. The main aim was to identify how adults in Malta view the importance and role of scientific literacy within the concept of lifelong education. The specific aims include:

- To probe how adults view the meaning of scientific literacy;
- To study how these adults see the relevance of scientific literacy to their everyday life;
- To see if these adults would consider furthering their knowledge of science in order to become better active citizens or only as a means of increasing their opportunities of promotion at work.

5. Methodology

Ten adults were chosen at random from amongst adults who attended evening classes in ICT as part of their lifelong learning programme. They had all volunteered for these courses and were held in the evenings after their normal working day. Semi-structured interviews were held with the participants. The participants consisted of six males and four females. The identity of the interviewees was kept anonymous.

The first part of the interview focused on the meaning of a scientifically literate person. They were thus asked to give their opinion about the meaning of scientific literacy and to describe how they use science as part of their personal experience in everyday living. In describing the characteristics of a scientific literate person, they were asked whether they considered themselves as scientific literate. The interviewees were also asked about the sources of scientific information that they trusted most; their level of understanding of media reports which deal with scientific content; and the way they deal with science related issues in everyday life. In the second part of the interview the interviewees were asked to name some of the advantages of being scientific literate in today's society and about their willingness to enhance their scientific literacy as part of their lifelong learning programme. They were also asked if they were ready to invest their time in enhancing their scientific literacy or whether they would invest in further training only if this led to better work opportunities. All the interviews were audio-taped.

6. Analysis of results

The study showed that all interviewees acknowledged the need for a basic knowledge of science in an increasingly technological and knowledge-based society. One interviewee argued that a basic knowledge of science is needed, "*because whatever happens around us responds to basic scientific laws"*. Others expressed their opinion that, "*If one stops enhancing his/her scientific knowledge then one grows old*". Another respondent mentioned the importance of being scientific literate, "*to understand and help my children in their studies*". Scientific knowledge content was seen as important to understand the world, to keep up-to-date and to help the future generation acquire

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such knowledge. It appears that scientific literacy is being viewed as part of the lifelong learning process.

Nearly all those interviewed claimed to be scientific literate. Some justified this claim due to the science subjects that they studied at secondary school or at university. Others gave their ability to judge scientific statements, their type of work and their general knowledge as the main reasons for their claim. One respondent said that, "*Besides studying science up to 'A' level standard in my youth, I also had the opportunity to see science applied at Malta Drydocks for seven years during my apprenticeship there*". It appears that most of the respondents seem to have a restricted view of scientific literacy, in that it refers mainly to scientific content and its practical application. They are not that aware of the skills, attitudes and values that are also related to scientific literacy. They feel that having studied science has equipped them to understand scientific issues related to the content aspect. In fact, the respondents did not bring up any ethical or social issues as examples.

Nearly all maintained that they were interested in hearing/reading scientific reports in the media, were able to understand most of the reports and usually took up the suggestions or recommendations included in the reports. As one of the interviewee said, "*the whole world is being governed by new scientific developments all the time and not keeping up to date, would be as if stopping time*". Another interviewee said, "*It helps me to lead a better and more informed lifestyle".* These statements, however, reflect an assumption that these respondents view science as absolute and infallible. They readily accept any scientific knowledge that is issued by what they believe are reliable scientific institutions. They do not seem to appreciate that science may be fallible.

These findings are similar to those in other studies, such as a Danish survey, that found that 89% of the respondents claimed that they were well or very well informed about biotechnology (Roy et al., 1991). However in another survey in Ireland, 89% of the respondents confessed that they knew nothing about biotechnology. It seems that there is a disparity between what average adults claim to know and what they actually know. This may also be the case in Malta where individuals may not be aware of missing aspects of their scientific literacy. This reflects a simplistic view of scientific literacy that many 'ordinary' citizens may hold. It thus becomes important to first educate people about the meaning of scientific literacy, and then to try and achieve all the aims which have been identified in the definitions of scientific literacy that have been reviewed.

The respondents were also asked to name a scientific literate person (other than themselves) and to list the characteristics of such a person. Most respondents named doctors/nurses/pharmacists as exemplars of scientifically literate people. One respondent said, "*My three children are scientific literate as they have all studied science up to tertiary level*". Another respondent claimed that his wife was scientific literate as she was *"never happy with what she already knows but is always eager for more"*. Other characteristics of scientific literate people included being intelligent, good at mathematics, curious, reasons things out objectively, understands different sciences and different aspects of life around us. These assertions imply that only a few people can be considered to be truly scientifically literate. The respondents, actually, seemed to equate scientifically literate persons to scientists. This is related to the assumption that scientific literacy is related mainly to content rather than also to attitudes and values. Shamos (1995, p 87-90) defines three such levels of scientific literacy, based on known 'content' of science. These are the 'Cultural', 'Functional' and 'True' levels of scientific literacy. He argues that according to this criteria, only about 5% to 15% of all adults are scientifically literate.

Shamos (1995) claimed that not everyone can become scientific literate. He reviewed the history of the last 50 years of science education in America to show that the universality of science literacy is a myth. Instead he proposed 'scientific awareness' as a more realistic goal. However our respondents do not seem to agree. Nearly all insisted that scientific literacy was within reach of everybody as, "*there are lots of opportunities to learn*". Another respondent argued that, "*If any person is taught in a way which suites his abilities then everyone can become scientific literate*". "*Everyone can grasp basic scientific principles…obviously this depends on the willingness of the person concerned*". These statements are in contrast to sheer reality where only a small percentage of society has good scientific knowledge content. It

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might be that respondents are thinking in terms of different levels of scientific literacy. They seem to suggest that a continuum of scientific literacy exists, from that within reach of everybody at one end to the more sophisticated level, available to professional scientist at the other end.

Respondents were asked to cite instances where they applied science in their personal life events. One respondent stated as an example the instance when she had "*decided to use printed papers as rough papers instead of throwing them away, to safeguard the environment*". Another respondent said "*I was adamant to use unleaded petrol in my car and I would greatly prefer to use an electric car, due to environmental issues*". A third respondent claimed that he decided "*to further my science knowledge for career enhancement*". Another respondent declared that her most recent scientific decision was, "*taking a first aid course which involved quite a bit of science knowledge*". This shows that interest in enhancing scientific literacy is partly for personal development and partly for career advancement. There is little awareness that they may need to be scientifically literate as scientific research may involve ethical and moral issues on which they will be required to express their opinion or to take action upon as citizens.

Participants were then asked to identify everyday instances where they took personal decisions that involved scientific issues. Most participants referred mainly to "*health issues*" which they considered to be their primary concern. For instance, one respondent said that he "*would not buy a type of domestic using paraffin fuel as it was considered to emit poisonous gases*". Another respondent claimed that "*she always searches the Internet before deciding what to buy, especially when it comes to domestic appliances*". Others claimed to take such decisions depending on the costs involved and other logistics. All participants claimed that they were never influenced by their friends when such issues were decided. This shows how people look up and use scientific knowledge when they have particular personal needs. They acknowledge the importance of being able to understand knowledge as well as decide on the implications. However, they failed to provide examples that had implications beyond their immediate environment. Unless scientific issues are directly related to their everyday lives or interests, the respondents do not seem to feel that they need to follow what is happening in the field of science. This means that there needs to be initiatives to raise awareness among citizens about their responsibility with respect to national and global issues involving scientific research and advancement.

This aspect has been included in the UK Beyond 2000 report, which argued that two of the aims of the science curriculum are that learners can:

- Feel empowered to hold and express a personal point of view on issues with a science component which enter the arena of public debate, and perhaps to become actively involved in some of these; and
- Acquire further knowledge when required, either for interest or for vocational purposes. (Millar & Osborne, 1998, p 2012)

Other studies of adults showed that adults accessed detailed and complex science knowledge for their own purposes when they had a particular problem or question - often related to their lifestyle.

The adults interviewed were also found to actively discriminate between the sources of scientific information available. They mostly trusted the Science Department at University and the Non-Government Organizations (NGOs) which specialize in particular fields. They least trusted the political parties, whom were, "*assumed to be unreliable in their science related statements which tend to be politically motivated*". Irwin et al. (1996) claimed, that public understanding of science is more problematic than it seems. It was not simply a matter of public ignorance, but more of public trust. The public trusted the NGOs more but felt that they did not have enough knowledge. On the other hand public did not trust the industry, but knew that the knowledge lied with the industry.

Participants were also asked to name one national organization that they trusted to take scientific decisions which would have consequences for all the citizens. Most of the participants again stated great faith in the Government Departments and the Science Department at the University of Malta. None of the participants wanted such decisions to be taken either by all the citizens or by their representatives in parliament. Their response indicated that it was important to leave such decisions to be taken by people who are experts in the field and thus would know what would be

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best. Again this declaration reflects Shamos' (1995) argument that the average person would never be able to judge issues independently and dispassionately even though he/she acquired a reasonable amount of science education. He emphasized the proper use of scientific experts when scientific issues were to be decided (p. 217). He further stated that sometimes not even scientists could be relied on to vote with their heads instead of their feet! Shamos emphasised the need for learners to be taught to recognize and value scientific experts, particularly in determining social policy, rather than the actual science content, hence his advocacy of 'scientific awareness' rather than 'scientific literacy'. None the less, the debate in today's democratic society is the degree to which active citizens can provide an input into policy direction. Even if decisions are left to be taken by experts, citizens should be capable of understanding the alternatives available, the implications of the decisions taken, and how to take action if they do not agree with the decision taken by these chosen experts. Thus, active citizenship goes beyond the claims made by Shamos (1995), that is, to leave the decision taking to those that know best, as there may be other agendas beyond scientific ones when such decisions are taken.

7. Conclusion

Trefil (1996), a contemporary scientist, claimed that "a person was scientifically literate if he/she had enough of a background in science to deal with the scientific component of issues that confront him/her daily". Many of the respondents would subscribe to this definition of scientific literacy as it broadly summarizes their everyday experiences in the 'knowledge' society we live in. Moreover, to a large extend, this knowledge is based on scientific and technological knowledge. As one participant in our study articulated in a very descriptive way,

> "*Everything is more and more becoming technical. Most machines/appliances already have, and more in the future will have a micro chip to control their function. In the near future even we human beings will have chips inside. Further on chips will be so interactive that they will be able to make baby chips themselves. Our only activity on this planet will be as pets to these chips. So science/technology is of utmost importance for us to try to understand these chips and keep them happy, at the same time not letting them know that we are controlling them*".

This situation leads to the ever increasing urgency of having scientific literate adult communities for personal and collective decision making on issues related to science.

The first step towards scientific literacy is that of making people aware of the social and ethical implications of science and the responsibility of active citizens to see that scientific research and development is regulated for the benefit of mankind. We believe that scientific literacy and lifelong learning are fast becoming essential elements of adulthood. It is now the challenge that science educators need to face in developing a science education for the 21st century.

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Learning How to Learn

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Abstract. Learning doesn’t stop at the school steps and it continues throughout life. A teacher must teach students how to learn. Perhaps the most valuable skill we can give children during their formal school years is the ability to use information to construct knowledge.

Teachers must encourage students to pose questions, communicate and reflect upon their own learning. The teaching process must become from teacher-centered to learner-centered.

Available sources about learning-how-to-learn schemes are referred to and author’s opinions on Science teaching are discussed.

Keywords. Lifelong Learning, Self-instruction.

1. Introduction

Today knowledge means, in the first place, technology. The rhythm of scientifically knowledge’s materialization has increased fantastically, what justify the remark that science has become a production force. This rhythm has passed from an arithmetical progression to a geometrical one to attain an exponential function. Hence appear the necessity of the individual and the community to adapt to this rhythm. Before this dramatic situation, ancient conceptions and structures about education were braked down.

The traditional school’s ambition to transmit knowledge and skills valid for a human life has become illusory and out-dated. In this way, has come out the concept of permanent education or lifelong learning.

This is not a new concept. For the first time, in 1919, The Committee of Adults’ Education from U.K., putted forward this idea.

Which is the present meaning of the concept of lifelong learning? What part is school supposed to play in lifelong learning? And adult education? Which methods can be effectively employed in the process of lifelong learning? How should one consider the educator's role in the new circumstances? How does Lifelong Learning become operational in modern Romanian society and what are its prospects?

Lifelong learning is an ensemble of means putted at the disposal of humans of any age, sex, social or professional condition to never stop their lifelong formation, with the end to personal development and efficient participation to the society's progress [4].

In order to persuade the public among the benefits of lifelong learning and to consolidate the cooperation between education's structures and business community, the European Parliament and the European Council established 1996 as the "European Year of Lifelong Learning" (Decision No. 2493/95/EC). Following the communication "Let's do that Lifelong Learning becomes reality in the European Space" (COM 2001/678), permanent education is now development's main directory of education policies and professional training.

Lifelong Learning takes various shapes by growing apace inside or outside the traditional systems of education and training. Lifelong Learning implies the increasing of the investments in people and knowledge, the promoting of a qualification's acquire and new opportunities toward new shapes of learning.

Making lifelong learning a reality for all lies at the heart of the Lisbon strategy for making Europe a prosperous and rewarding place to live and work in the 21st century world. Everyone should have equal and open access to high quality learning opportunities throughout their lives. These opportunities should be provided in a variety of ways to suit their differing situations, needs and preferences [5].

2. Steps in self-instruction

The possibilities of formation to self-instruction and self-education are multiple: to get students into the habit of working with the text-book or other books, to draw out a bibliography for a required subject, to write a paper, etc. Generally, both young students and adults must learn how to constitute a data base, how to process it and how to use it, in order to obtain an information, how to find a known information in a book, in a library or in a computer, how to use various learning strategies and techniques.

First, the student must recognize the need for information. Next steps are: identify and locate appropriate information sources, access information contained in those sources, evaluate the quality of information obtained, organize the information and use the information effectively [3].

The student who possesses the information literacy skills is the master of his own learning. He goes from simply finding and learning facts to the process of creating new information. Knowledge creation includes:

- Prospecting – discovering relevant information. Skills required are selection and navigation, and then sorting, sifting and selecting pertinent and accurate data.
- Interpreting – translate data and information into knowledge.
- Creating new ideas - showing insight and understanding, as new knowledge is developed, not a rehash of old information [1].

3. Methods of Lifelong Learning

Lifelong Learning can use both traditional education methods and modern methods by adapting and renewing them according to its specific goals and tasks.

The system of Lifelong Learning is a comprehensive system having a structure and a dynamics of its own, and open to continuous innovation and improvement.

The system provides a broad range of various projects for all citizens and therefore an opportunity to make one's choice (in relation to one's interests and wishes, aspirations and needs) of goals and programs concerning professional or cultural training, the cultivation of certain skills or artistic talents or the meeting of specific needs deriving from the requirements of social adaptation and integration.

The option is not passive, for the recipients are in a position to take part in the elaboration of the program and in carrying them out, in designing the forms, methods and means of the educational activities.

Because information is growing and changing so rapidly, it is unrealistic to rely solely upon a static, text-based delivery system for learning. The textbook can best serve as a map suggesting a direction for resource-based

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learning where students are put in charge of the process of learning. The primary goal of resource-based learning is to provide the opportunity for all students to develop independent learning skills, in conjunction with the acquisition of a basic body of knowledge which will enable them to become life-long learners.

We must provide a structure to the information discovery process of our students. When left to their own devices, students often become confused and distracted, especially when confronted with the bells and whistles found on a typical web page or interactive CD-ROM. If we expect students to do more than copy information word for word and create the traditional one-dimensional traditional "report," we need to give them more direction. Establishing a school-based model upon which to base their inquiry insures consistency in approach throughout the grade levels, while still allowing the teacher to tailor activities and expectations to the individual class and student. Research models create the framework within which research takes place.

4. Shifts in the ways educators and students engage in teaching and learning

Technology provides acquisition to greater volume and depth of information than was ever possible before. In Tapscott's view, it enables students to acquire and communicate their findings in more authentic ways. This has necessitated shifts in the ways educators and students engage in teaching and learning. These shifts include:

- From linear to hypermedia learning - Students move back and forth between information sources in an interactive and non-sequential way.
- From direct instruction to construction and discovery - Instead of absorbing knowledge as it's delivered by a teacher, the student constructs new knowledge. He learns by doing.
- From teacher-centered to learner-centered. - Focus is on the learner, not the delivery-person. Instead of transmitting information, the teacher now creates and structures what happens in the classroom.
- From absorbing pre-selected facts to discovering relevant information - This demands higher-order thinking skills such as analysis and synthesis.
- From school-based to life-based learning - A learner's knowledge base is constantly revised through life experiences, and schools can prepare students for this eventuality.
- From uniform instruction to customized learning - Students find personal paths to learning.
- From learning as torture to learning as fun (the student is motivated to learn, and feels more responsible for his progress).
- From teacher as transmitter to teacher as facilitator [2].

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Life Long Learning and Science in Portugal

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Abstract. The level of academic, technical and scientific, qualification of Portugal's workforce is probably the most important obstacle to the development of the country. Development that

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needs to be effective sustainable and occur in an extended decided and fast way. Because the Portuguese society needs and requires it but also on view of EU' goals of economic and social development set by Lisbon Agenda in year 2000.

In this communication we will present a broad view of the recent evolution and actual situation of adult education and life long learning in Portugal. Projects and actions promoted by the Portuguese government will be briefly presented as well as the efforts of industrial companies, local governments, schools associations and the civil society. The particular experience of the first authors will be reported as a positive example of fruitful cooperation between a business company and a public school. Although the project aimed the achievement of better general literacy levels, scientific and technological literacy was also addressed and students' competences and other skills, not just related to their profession, as social intellectual and self-developing abilities, were improved by their devoted commitment and personal effort.

Keywords. Science Literacy, Development.

The Scientific Literacy and EU' Development. The Importance of Lifelong Learning

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Abstract. The importance of scientific literacy is nowadays widely recognized as we could verify at the European Workshop "The Challenges of EU' Enlargement on Science Literacy and Development" the Hands-on Science Socrates/Comenius 3 European Network organized last year in Malta.

The improvement and generalisation of the scientific literacy among our European citizens demands science education. Beginning as early as possible in an active and hands-on experiments based trend that may effectively enrol voluntarily and in a self committed way both teacher and students. However we can no longer wait one, or several, generations more. We need "immediate" actions and results. Otherwise the important, and decisive to EU' future, goals set by the Lisbon Agenda will not be achieved in due time or even shortly after. Adult education should also be a priority. The impact of life-long learning on the development of scientific literacy in our days and societies is certainly of utmost importance. In fact lack of adequate policies and immediate systematic and reasoned actions in this field may preclude the improvement of the basic scientific knowledge that should be generalised in our societies, crucial to the sustainable development of our enlarged European Union.

Keywords. Science Literacy, Development.

Supporting Hospital Distance Learning Activities: Some Theoretical Aspects

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Abstract. The modern Hospital emerged gradually and successively, during a very long historical development, from a religious philanthropy Institution to the contemporary managed care Establishment. The civil structure, the social demands, and the individual performance were always and are still reflected, on the Hospital, throughout the centuries. An attempt follows, to deal with a specific process in the professional and scientific context of the contemporary Hospital, that of its transformation into an important interdisciplinary Open and Distance Learning Facility, within the framework of the emerging "networked Society". This long scale educational procedure, beyond the employment of on-line training means, completing the traditional student and professional continuous education, is gradually including a large patient audience. Further, it is also informally addressed to the general public, in an effort to "keep them healthy" and consequently out of the Hospital. This transformation creates a new patient-hospital relation and raises some important ethical and social issues, related to a different aspect of the mission and of the social role of the 21st Century Hospital.

Keywords. Continuous Medical Education, Hospital Distance Learning.

1. Introduction

The emerging society is characterized by the availability of information beyond traditional means. A cardinal feature of our era is the translocation of precious information from the books to the Internet, and this fact result in that knowledge and professional skills are not based on memory anymore, but rather on the ability of effective and efficient navigation through the available Information Ocean. Hypertext and multimedia courseware is gaining importance in University education. Transforming conventional lectures or textbook material into an electronic format, offers limited benefits thus, the structure and the content of a course should be changed in order to take advantage of the technology. HTML or XML etc. based teaching tools interact both with teachers and students and they may influence our understanding of the scientific subject matter under consideration.

Distance education using Web-based and other emerging technological alternatives promise to reach various groups, offering them post-graduate and continuous education services. These groups may comprise of those who are already engaged in professional work, such as physicians, nurses, engineers, physicists etc. and of those isolated from such opportunities, due to other social conditions. These groups are not likely to receive the same educational experience as traditional, on-campus students. The concern that technology-based distance education is inferior is probably not unwarranted. However, the new electronic media may offer a cost-effective way, to enhance post-graduate education alternatives.

2. Background

The experience accumulated during elongated traditional and on-line educational activities has led us to the creation and application of an extended series of on-line training means, focused mainly to the field of the employment and the management of contemporary Biomedical Technology by health-care students and professionals, in the modern Hospital. The most important issues addressed, have already been reported elsewhere [1], [2], [3] and include, first the structure and the function of equipment and methods, according to the hospital departments, such as the Outpatient and the Accident-Emergency Departments, the in vitro Diagnostic Laboratories, Medical imaging, the Operating Room, the Intensive Care Units and the Wards and some other Therapeutic and Supporting Facilities.

HTML was mainly used to develop the various educational means, to enable use on any platform, and numerous objects in commercially available digital document, audio and video formats, have been also included, resulting in on-line lessons, lecture-slides, lecture notes, digital video material, self-evaluation quizzes etc. The content of the presentation is a combination of theoretical knowledge and practice oriented information and the languages used are Greek and English.

An academic course primarily consists of a mutually interacting group. "Digital alternatives", such as email, electronic discussion groups, virtual classrooms etc., are very useful, not only for individuals, but even for Institutions, which are not able, nor willing to create an adequately high academic environment. Presently, it seems likely that distant post-graduate courses will not develop into a total substitute for in-person education, but rather an appropriate combination of traditional and on-line educational activities will follow. On-line instructional material accessed by the students, may also partially release the teaching staff, and offer them more time to concentrate on more substantive tasks improving their interaction with the individual student. The new educational technologies are likely to force us, to re-examine our educational policies. University education is not just about mastering knowledge, but rather developing the students' personality and their special abilities, in a given social context. The cautious application of the emerging information technologies in Education may contribute towards this goal.

3. Continuous education and Guideline - Based Medical Decision-Making

Continuing Medical Education (CME) constitutes a specific kind of education, and nowadays it is a requirement among practicing physicians to promote continuous enhancement of clinical knowledge to reflect new developments in medical care. Lifelong learning is critical to current physicians who are being held to high levels of accountability to patients, health-care payers, and society at large. Continuing medical education (CME) attempts to address these needs of practicing physicians by reinforcing clinical knowledge and presenting new developments in medical care. Traditional CME activities have included self-study by employing journals and textbooks, participation in medical groups, and attendance at lectures and conferences.

In general, these types of formal learning, have limited impact on clinical practice, since activities that target a specific need of the participants and actively engage the target group in the training process, seems to result in better outcomes. Programs that simulate physician work conditions, such as diagnostic role-playing, with data drawn from actual patient cases and feedback from medical experts, have been shown to have the best results. The employment of information technology constitutes appropriate means of providing active learning, and practice oriented CME content. The effort of the last years, to adapt computer software and patient information systems to continuing medical education, has resulted in, the creation and the development of numerous on-line CME sites, covering a wide range of medical specialties. A major problem in CME is that research is producing increasing amounts of important new evidence for health care, but there is a large gap between what this evidence shows can be done and the care that most patients actually receive [4].

An important reason for this gap is the extensive processing that evidence requires before application. A method for bridging research evidence to management of clinical problems is first, getting the evidence straight, second, formulating evidence-based clinical policies, and third, applying evidence-based clinical policies at the right place and time. This model provides a framework for coordinating efforts to support evidence-based medical care, and contemporary information technology allows for the coordination of the roles of all the key players, including health care researchers and practitioners, health care organizations, and the public.

Health Informatics has already made important contributions to bridging research to practice, by first, improving evidence retrieval, evaluation, and synthesis; second, by developing new evidence-based information products, and third, by offering computerized aids that facilitate the use of these products, during clinical decision making. However, much more innovation and coordination are needed concerning first, the quality of evidence embodied in information innovations, second, the performance of technologies and systems that retrieve, prepare, disseminate, and apply evidence, and finally, the fit of information tools to the specific clinical circumstances, in which evidence is to be applied. Therefore, effective interdisciplinary teams are needed to achieve the optimization needed.

An important role is assigned to the employment of Medical Records for the CME procedures. Medical records are used in a variety of ways and they serve a multiplicity of purposes. Beyond the explicit involvement of records in the therapeutic process, there are several other discernible uses, such as in research, in teaching, in the allocation of resources, and in the construction of the patient's personal history. The technological substratum of records, on the one hand, constitutes itself knowledge and, on the other, it plays a decisive role in forming the character and the extent of the knowledge, which the records themselves represent at each particular stage of their mutual interaction [5].

Most clinicians in the U.S.A. [6], [7] feel that the Electronic Medical Record has improved the overall quality of patient care. They feel that the Electronic Medical Record has also improved the quality of the patient-clinician interaction, the ability to coordinate the care of patients with other departments, the ability to detect medication errors, the timeliness of referrals, and the ability to act on test results in a timely fashion, i.e. clinicians perceive an overall improvement in patient care as a result of using an outpatient Electronic Medical Record system. However, less than 15% of respondents used computers for continuing medical education (CME). Respondents reported they wanted to increase their general computer skills and enhance their knowledge of computer-based information sources for patient care, electronic medical record systems, computer-based CME, and Tele-medicine. While most respondents used computers and connected to the Internet, few physicians utilized computers for clinical management. Medical organizations face the challenge of increasing physician use of clinical systems and electronic CME.

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A further important issue related to CME is the elaboration, adoption and dissemination of appropriate Medical Guidelines, as well as, the development of computerized procedures, associated to their employment. The development and implementation of enabling tools and methods that provide ready access to knowledge and information are among the central goals of medical informatics. Given the immensity of the challenge, the need for multi-institutional and multi-national collaboration in the development of such tools and methods is increasingly being recognized. The electronic modalities for communication, and other related technologies can play an important role, in supporting collaboration, especially when the participants are geographically separated. However, it is still important to match carefully the content with the mode of communication, identifying for example, suitable uses of email, conference calls, and face to face meetings. The role of leaders in guiding and facilitating the group activities can also be seen, regardless of the communication setting in which the interactions occur. Most important is the proper use of technology to support the evolution of a shared vision of group goals and methods, an element that is necessary before successful collaborative designs can proceed [8], [9], and [10].

Another important aspect, related to CME and the day to day clinical education of trainees, is the creation and employment of various types of Guideline-Based Decision-Support Services. Interesting classification schemata and Task-based approaches to define guideline-based decision-support services have already been reported [11]. On the one hand, they can categorize uses of guidelines in patient-specific decision support into a set of generic tasks, such as decision-making, specification of work to be performed, interpretation of data, setting goal, and issuance of alert and reminders that can be solved using various techniques. Based on the tasks and the guideline model, a guideline-execution architecture is defined, as well as, a model of interaction between a decision-support server and clients that invoke services provided by the server. These services use generic interfaces derived from guideline tasks and their associated modelling constructs. Thus, a well-defined specification of guideline-based decision-support services facilitates sharing of tools that implement computable clinical guidelines [12], [13].

On the other hand, developing guidelines that are specific to an organization is expensive, and limits the ability to share guidelines among different institutions. Methods have been employed [14], [15] that separate the site-independent information of guidelines from site-specific information, and that facilitate the development of site-specific guidelines from generic guidelines. These methods allow for developers to create generic guidelines that are sharable across different sites. When combined to site information, generic guidelines can be used to generate site-specific guidelines that are responsive to organizational change and that can be implemented at a level of detail that makes site-specific computer-based workflow management and simulation possible. What features will be important to encode in the site model will, in part, depend on the application for which the guideline will be used. For example, if the generic guideline is to be specialized for use in a clinical information system or workflow environment, the site model would need a detailed description of resources and resource constraints, which this particular site and application requires. A different institution might use the same guideline for education and training, but their site model then should contain information about supporting reference material.

In recent years, guidelines and protocols [16], [17], [18], have gained support as the vehicles for promulgating best practices in clinical medicine, and many researchers have proposed frameworks for modelling them in a computer-interpretable format. Some projects use computer-interpretable guidelines to provide patient-specific decision support for chronic-disease and clinical-trial therapy planning. In these uses, criteria that test for specific patient situations are paramount. Other projects, however, study communication and coordination problems involved in implementing clinical protocols in an organization, using information-processing approach that abstracted away specifics of individual patients that are important for patient-specific decision support. A third way is modelling reporting and meta-analysis requirements of clinical-trial results. However, how computer systems use computer-interpretable guidelines has not been fully studied. Health care providers are more likely to follow a clinical guideline if the guideline's recommendations are consistent with the way in which their organization does its work and it is still an active research issue to define the features of a site model that would facilitate these customizations.

Finally, it seems that the best opportunity to improve the efficiency, the cost and the quality of patient care is by including organizational factors in guideline development. If the site-specific guidelines are valid and consistent with respect to the intentions and goals of the guideline authors, attention should be focused on the process of care and ways in which it might be changed to improve patient care quality. Thus, the adoption of an appropriate procedure contributes also to CME improvement and to the achievement of an overall best practice.

4. Informal Patient Health Education

The use of computer-based education had a positive impact on clinical outcomes, knowledge acquisition, self-care management, and skill development. As the focus of health care delivery environments moves toward health promotion and the management of chronic disease, it appears that computer-based patient education will have a greater role in supporting patients' understanding of their personal disease management plan.

Technology is providing innovative ways for patients to extend their world. Online communication offers connection between patients and health care providers, and online support groups expand the team approach to include other patients facing similar health challenges. Patients who are dealing with disabling conditions are able to use technology to ''virtually'' participate in activities that would otherwise not be possible. The social integration and sharing of knowledge that occurs through these new connections may increase involvement in learning and expand patients' understanding of their medical conditions.

It is important to understand how the patient is processing the information and translating this understanding into action. To individualize patient education materials, developers must consider the unique needs of the target audience to include culture, age, race, gender, and social issues and physical and psychological or cognitive disabilities. Internet-mediated triage systems can facilitate access to electronic and human information resources [19], [20].

Concerning the validity of this information, it is profound that the Internet has fundamentally changed the dynamics of publication, and in particular, it is clear that there is no effective way to control the release of any web-based publication [21]. The scientific and lay literature is now accessible to the public with unprecedented ease. This certainly suggests that there is a need for a change in how the process works.

This is already occurring, in newsgroups, on mailing lists, and among communities of information consumers and information providers. Patients, care providers, and other participants are describing, summarizing, rating, applauding, recommending and condemning websites, newsgroup threads and printed paper articles. At this time, the process is ad hoc and the efforts of one community are not easily communicated succinctly and reliably. However, this process is happening, and the scientific community needs only to decide whether to participate in or ignore it.

5. Concluding remarks

Medical data, disseminated in the Web or available in other digital forms, on the one hand, constitute cost-effective and practical means, augmenting equality in medical training, on the other, they result in a new type of fragmentation and compartmentalization of the patient's body and personality, thus endangering the interpersonal relation between him and the physician.

Obviously, this new "networked" environment has an influence on the health-care professional codes of conduct [22]. These codes appeared together with the emergence of socially recognized groups of specialists in various fields of practice, and they set the framework, within which the professional-client interaction is carried out. The 21st Century Hospital will provide a radically different professional and educational activity environment and a quite different professional-client interaction modus. Although modern medicine is still based on people memorizing scientific knowledge, the elimination of limitations to access medical knowledge is already an irreversible procedure.

Virtually, everyone has access to medical information, independent of the validity and the value of such information.

This fact creates a new type of a self-confident "over-informed" patient and, on the other hand, a critically judged physician. What remains to be seen, is whether this arising "medical landscape" of tomorrow, will help the Physician to reinstate the holistic approached, individual patient in the compartmentalized Medicine of today.

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The Permanent Education. An Ideal of the Democratic Society

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Abstract. The opened society has in it's fundament the concept of permanent education which follows the forming and the perfection of the human being during his entire life. For realizing this type of education it is necessary to renounce at the traditional forms of teaching, education. This work presents the ideal of permanent education materialized in new school programmes centered on values, motivation, independence, responsibility and critical self-analyze. Also there are evident the demands of some educational programmes for life. This type of education leads not only to the individual development, but to the progress of the society.

The experts in the reform systems in the education affirm the idea that the promotion of a modern education system, prospective, flexible, opened to a market of work and continuous adaptable at the demands of the changing and complex development cannot be realized today, without a rethought and a structural-systematic renovation of the teaching system from the perspective of an integrating conception of the permanent education. The permanent education follows the forming and the perfection of the personality of the human being during his entire life.

Besides preparing the person for surviving the responsibilities which will come during his entire life like self-controlled human being, as a member of a family and of a community, the education must be an integrating factor, unifying the previous experiences, which can help him evaluate his resources and performances, objectively identify his position in a medium which is in a continuous change.

The permanent education has become necessary because of the rapidly progresses recorded in science and technology, because of the democratization of the day by day life and because of the increase of the appreciation of the cultural and spiritual values of the society.

The traditional teaching system cannot prepare its students for these changes.

In this way the educational process must not be associated only with school or the intellectual qualities, he must be related with all the experiences of life and of human activities, the development of sentiments, the power of imagination and capacity of the intellect, the curiosity which accompanies the search of the answer at questions, the sentiment of responsibility in opinions and actions, of human interrelations ,of hopes and of wishes of the respective persons, of the extra scholar influences.

In the permanent education, books does not represent the only instrument of education because the theatre, the radio, the television, the cinema, the computer are more and more used.

Also, it is underlined the process of individual learning and the professor must advise the students because the permanent education must be based on the development of some personalities with responsibility , capable of carrying out their individual and collective obligations in relation with the multiple options which they confront in a society in a rapidly continuous change. There cannot be education in an opened society without a responsible option, not even a responsible option without self conscience and adequate information on the nature of diverse occupations and possibilities.

The process of permanent education is (in it's fundament) a process of positive selection because inside of not letting a candidate continue it's studies, it shows him where he is and how to choose with conscience of all the factors of the next level for which he is the most capable and motivated to touch, realizing in this way a pyramid after abilities. The ones who are on the

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top are in fact the products of the selection. In the permanent education the orientation assures a real equality of chance for each person (student) to realize his career in accordance with the personal and social coordinates, very well defined.

Receiving a baggage of knowledge becomes an encyclopedic exercise which proves to be more and more useless by the time the science and technology develop. In this way it is necessary to be controlled not only the knowledge but a general tenacity, which will represent the intellectual instrument for the solution of some types of personal problems.

Also, through the permanent education, the student develops his own identity, he develops the image of himself, gets the conscience of value, a moral and an ethic. He learns how to refuse some behaviour and to admire others. He develops a system of interior values which guides and stabilizes his behaviour. He gets ideals and aspirations, he learns to make effort for accomplishing some purposes, he learns to take control on the success and the insuccess on the fundament of his own experience of life.

The permanent education exists today , in the sense that people develop and adapt in the present as a result of experiences of life and from outside the school and not only as a result of their own experiences from the scene of the school buildings or from the time of the school process. Even though, the ideal for which the sustainers of the permanent education fight is the one that the educational experience, the total sum of all the experiences which stimulate the development of each person can be organized in a way in which the actual process of permanent education becomes more self-controlled, with more value, for the society and for the person (student).This is obvious an ideal objective. In his shape, the advanced one, there could be possible that this will involve the renounce at the school institutes, an impossible thing to realize in the present. It is necessary the development of a move (a complex process of actions) in the school institutes which exists in the direction of the promotion of the permanent education , the influence on the people in the sense that they have conscience on the necessity of change and self-development and the school offers a real support in realizing these wishes (purposes).

This means the transformation of the school programmes in the demanded sense by the development of the human being, the development and education of independence , the responsibility and critical self-analyze. These particularities must be centered on values and motivation.

The purpose of this form of education will be to make conditions for the development of people in a way in which they welcome the change with interest, not with fear or resistance. If people are orientated with trust to change, they will send the need of being educated for confronting with success the new types of professions. The failure in the development of the capacity of reaction at changes can attract with this actions the passivity and alienation.

In line with the new theories of the permanent education a school programme must contain the following elements:

- To have information or to be capable to locate the information;
- To have intellectual skills, abilities which can be generalized at a high level;
- To have general strategies for resolving problems;
- To stabilize the own objectives;
- To evaluate the results of the own learning process;
- To be motivated in an adequate manner;
- To have an adequate image of your own person.

Adopting the permanent education as educational fundament behaves some implications regarding the role of the teacher. He will live in a changing society, and in the first line of the change, in a way in which he must adapt, he must accommodate and be in a continuous perfection. He must behave in a way in which he represents a model of permanent education for his students. So, in a way, the teacher and the students must be "mates of learning". The role of the teacher is the one of orientation and coordination in learning. The teacher shall not divide the knowledge in a resumed form, the knowledge which has been selected by the computer because this knowledge contains exactly what the student needs for a precise action of learning. He will help the students learn in the best manner (way) for them.

But the permanent education cannot be realized only through the simple intellectual development. It is important also the necessity of education for life, all that generates interest and knowledge. Realizing this idea is a major element in the theory of opened education.

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The demands of some educational programmes for life presume:

- To teach people how to use the thinking process in life;
- To make people want to apply the knowledge in practice;
- To teach people how to apply the knowledge in practice;
- To help people to know how to think in interaction with others;
- To teach people how to realize the change of social and cultural experience with others;
- To teach people how to think not only after the rules of science, but also after the demands of life;

So, we see that the objectives of some orientations in the permanent education are changing the accent put only on school and indicating the implications of this theory for other resources of educational experience, like: work, extra school medium, etc. The permanent education is, in this way a major director principle of the educational regeneration in an opened democratic society.

The characteristics of the opened, permanent education concept are:

- The three fundamental terms on which it is based the signification of the concept are: life, the length of life and education. The signification of these terms and the interpretation given to them determines in a great measure the domain and the signification of the permanent education.
- The education doesn't finish at the end of the institutional school process, it is a continuous and permanent process. The permanent education is extended during the life of a person.
- The permanent education is not limited only at the education of the adults, she contains and unifies all the stadiums of education: preschool, primary, secondary, superior, etc. In this way she searches to take over education with all it's resources.
- The permanent education includes formal models of education, non-formal and informal ones.
- The family plays the first, the most subtle and crucial role in starting the process of permanent education. Having this role continues during the life of a person, through a learning process in the family.
- The community plays, also, an important role in the permanent education system ,even from the moment in which there are stabilized the first interactions of the child with this particularity and it's educational function continues during the entire life, not only in the professional domain but in general.
- The educational institutions such as schools, universities and centers of instruction are important only as one of the factors of the permanent education. They don't have the monopoly on the education and cannot exist isolated from other educational factors from the society.
- The permanent education follows the continuity and the articulation during it's vertical dimension.
- Also she follows the integration at the level of it's horizontal dimensions and of depth for each stadium of life.
- In opposition with the elite forms of education, the permanent education has a universal character. She represents the democratization of education.
- The permanent education represents a dynamic approach of education which allows the adaptation of materials and of ways of learning at the new conditions of development.
- The permanent education allows models and alternative forms of receiving education.
- The permanent education has two major (big) components: the general one and the professional one. These components are not completely different one from the other, but through their nature, they are in interrelation and interaction.
- The adaptation functions and the innovation ones, of the person and of the society are in a perfection process through the permanent education.
- The permanent education accomplishes a corrective function, she is occupied with the deficiencies of the existent system of education.
- The final purpose of the permanent education is to maintain and to improve the quality of the person's life in an opened society.

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- There are three preliminary conditions for the permanent education: opportunity, motivation, and educational character.
- The permanent education is an organizing principle for all types of education.
- At an operational level, the permanent education gives an integral system for all types of education.

Seeing all these characteristics of the permanent education it can be observed that this system of education creates a plurality of alternative models or complementary opened during the entire life, flexible and in process of perfection.

In an opened society, for all the people to use their right in education and to participate at the conception and planning the educational activities stabilized to satisfy the own demands and the ones of the community, the permanent education is the one which follows the focalization of the contain of the education on the contemporaneous problems and stimulating the wish and the will of changing the world, making a contribution in this way at the important contemporaneous problems (peace, development, the administration of the resources of the planet, the cooperation between nations).

In this way, the permanent education is a process of perfection of the personal development, social and professional during the entire life of the persons for the purpose of improving the quality of life not only of the respective person/persons but the entire collectivity. This is a comprehensive idea and unifying which includes the formal learning, the non-formal one and the informal one for getting a horizon of knowledge which can allow the achievement of the best level possible of development in different stadiums and domains of life.

The permanent education is in a direct relation with the individual development and the social progress. From this cause, ideas like: <to learn to be> and <a society of learning> or <an education society> are associated with this concept.

Keywords: Lifelong learning, Scientific literacy.

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Attribute Decision Making Field's Promotion

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Abstract. The decisional process is a multitude of human activities, consisting mainly in the realization of the existence of more than one possible course of action in a certain given context, the analysis of their consequences with respect to the envisaged goal, the choice and the implementation of the action that is considered optimal in the axiological perspective that has been adopted. Every person currently makes decisions in his / her social live, "from the preschool years to post-retirement". The problem is: are these optimal?! The paper presents a set of tools for enhanced learning of making optimal decisions using the Multi-Attribute Decision Making paradigm.

Keywords. ICT for content, creativity and personal development, LLL and key competences, Enhanced learning technology, Multi-attribute decision making.

1. Introduction

"Education and Training 2010" European Work Program [1] has a strong support in Romania. The rulers of the National Excellency Research Program encourage the e-learning domain. As an example, the project named "Excellency Level Tools for Multi-Attribute Decision Making [2, 3] Field's Promotion", belonging to this national program, opens a new era in the instrumentation of lifelong learning process [4, 5, 6]. The project benefit from the work of National Institute for Research and Development in Informatics – ICI Bucharest (two research workers, three programmers and other specialists), University of Bucharest - UB (two professors and three three students programmers) and Bucharest Academy of Economic Studies - ASE (five professors and four students programmers).

The project objective supposes a research of fundamental nature in the Multi-Attribute Decision Making (MADM) field, a sub-domain of Operations Research's domain, that will represent an achievement itself, but, at the same time, a precompetitive research through the elaboration of the tools for MADM's enhanced learning. As you will see yourselves in the folowing, the tool set is designed at the exellency level.

2. MADM – short history

In order to make an almost complete presentation of the MADM theory, the technique of proxy type and specific difference is used to structure the domain. Moreover, the evolution of this domain, from beginning to our days, will be emphasized. During the decade 1941 – 1950, two scientific results obtained in the mathematical area of Operations Research are proved as extremely important for what will later be the Decision Theory. The first result refers to the Utility Theory, developed by J. von Neumann and O. Morgenstern. The second result refers to the Linear Programming problem solving, revealed by G. Danzig in the Simplex Algorithm. On this base, strengthened by subjacent developments, an important domain of Operations Research evolved: namelly the Multiple Criteria Decision Making (MCDM).

The researchers (mathematicians, engineers, economists) took into consideration the problem to use the previous mentioned scientific results in decision making that supposes multiple criteria. It is to notice that, simultaneously with the Information and Communication Technology (ICT) development, MCDA (Multiple Criteria Decision Aids) is more frequently used instead of MCDM. This means that the mathematical models and solving methods of the problems generated over models are instrumented using informatics. Software tools are created to mediate decision making. From the beginning, in the MCDM domain, two sub-domains had differentiated: Multiple Objective Decision Making (MODM) and MADM. MODM refers to those models whose decisional variables are not explicitly presented; therefore they must result from an algorithm. MADM refers to those models whose variables are explicitly presented. As a consequence, MADM involves design and choice, and MADM involves directly choice. The Multiple Objective Linear Programming (MOLP), sub-domain of the MODM, knew a fast development: the P.L. Yu, S. Zionts, M. Zeleny and R. Steuer works had decisive contribution to the stabilization of the research results; so that P. Korhonen could put in circulation the first multi-criteria linear programming software called VIG. After that, the research extended to the cases of integer, Boolean, fuzzy, stochastic numbers, both for linear and non-linear models. Even shy at the beginning, MADM sub-domain development registered remarkable results; in our days these results vies with MODM as width and depth. The works belonging to K. May, E.W. Adams, R. Fagot, D.B. Yutema, W.S. Torgerson, R L. Keeney and H. Raiffa from the American School used the value theory for MADM problems solving, defining in this way the future well known American paradigm. On its basis, other methods has been developed, the most prominent one, belonging to L. Saaty, is the Analytic Hierarchy Process. French School, represented by B. Roy, P. Bertier, B. Mareschal, J.P. Brans and P.H. Vinke used the partial ranked sets, specifically some graph types, in order to offer a new vision and a different solving to the same sort of problems. Thus, in the MADM area, French paradigm appeared. Electre and Promethee methods became famous beside the American School elaborated methods. In Romania, the MADM preoccupations appeared very early. Among the first people ones can mention O. Onicescu and A. Rusu, because each elaborated their own methods, and also Gh. Boldur-Lățescu who sets up around him a real MADM school.

Until '70 years, knowledge in this domain was ahead in development, and ones tried to apply the specific principles and theoretical results in nearby domains, like multi-objective mathematical programming. On the other hand, a reverse flow happened; methods and techniques belonging to game theory, fuzzy sets theory, mathematical statistic, stochastic processes etc. came to enlarge and improve qualitative the gamut of the problems solving methods taken into consideration, creating very interesting hybrids of mathematical nature. Finally, during last fifteen years, the research field is reactivated in the context of using of some instruments specific to artificial intelligence in order to approach more complex and more shaded difficult MADM problems. Three successful paradigms in the artificial intelligence frame stated in MADM: first genetic algorithms, then feedback type neuronal networks and, finally, inferential computing based on production rules.

MADM gave and give significant results in practical applications. Every human practice domain supposes optimal choice problem, or related problems: hierarchy, evaluation etc. The papers published in reviews, the debates at the conferences and congresses and the software market are showing the continuous domain effervescence. Today, such kind of optimal choice problems are solved using general use software. When a problem has a high degree of specificity or if it is not wanted that the user knows the domain specific mathematical knowledge, problems are solved using the general use software embedded in the software that is treating the entire problem.

3. MADM taxonomy

Taking into consideration the modality to combine the computing and the decision process, in order to find a solution, MCDM methods, and implicitly MADM, are divided in three classes. The first class, named with a priori preferences articulation, contains those methods in which the decision maker directly uses an aggregation function that combines individual objectives in order to transform the multi-criteria problem in a mono-criteria one. The second class, named with a posteriori preferences articulation, contains those methods in which a solutions set, usually mono-criteria ones, is offered; on this basis, the decision maker selects / elaborates a compromise global solution. The third and the last class contains those methods in which, in an iterative process, the optimization and decision steps are iterated, conducting to the solution improvement based on the information accumulated at each step. Another MCDM methods classification can be made taking into account the processed information nature. Thus, there are methods that process certain or uncertain information. Uncertain information can come out from stochastic type models (models with risk) or from fuzzy type models (linguistic models). An important models classification can be made taking into account the validity of information processed by the methods. Thus, there are methods which process valid or invalid information. Information invalidity refers to its syntactic/semantic incorrectness, incompleteness or incredibleness. In relation to the decision theory needs, methods can be classified in those that are treating mono or multi decision maker problems, and those that are treating mono or multi state of nature.

As ones can notice from above presented classifications, the domain benefited, during its existence, from many developments in the theory's frame but also from the hybridizations which appeared from practical necessities. The MADM actual development supposes a well done theory for the model containing a decision maker and a state of nature and over 20 solving methods, more or less diverse, which can solve decision problems generated over this model. Speaking about the possible attributes types to consider in the model, these can have Boolean, ordinal, cardinal, fuzzy, random variables and diverse functions (more often time function) expression but it is requested to work only in real numbers arithmetic or only in a fuzzy arithmetic. Also, a method offering a global optimum doesn't exist; it is known that different solving methods can provide different results because they are implementing different conceptions on problem treating. Although a lot of mathematical modeling methodologies exist but a MADM specific one doesn't exist. This is the reason why we decided to solve these problems having a fundamental research character, because we noticed that both at national and international level, no one is daring to do this.

4. Classical /modern promotion of MADM

Let's make some considerations regarding MADM domain promotion. Let's start with the years '50-'70. During those years, an enough number of papers treating the beginning period have been published. It is to notice that the MADM results appeared as Operations Research results, meaning that the promotion area wasn't very well structured. In order to cover the entire field, starting with those that use to have a large coverage till those with European, regional, national coverage, it is to mention here journals like: Mathematics of Operations Research, Annals of Operations Research, Journal of the Operational Research Society, International Transactions in Operations Research, Computer

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and Operations Research, Operations Research, European Journal of Operational Research, Central European Journal of Operations Research, Yugoslav Journal of Operations Research etc. Beginning with the '70 years till our days, domain promotion became specialized through the specialty paper. International Journal of Management Science, Journal of Multi-Criteria Decision Analysis, and Multiple Criteria Decision Making appeared especially in order to encourage the MADM domain developing. The same phenomenon took place at international conferences and congresses level. If, at the beginning, each conference / congress included a small dedicated section afterwards appeared the domain's conferences / congresses.

International Conference on Multiple Criteria Decision Making is the most important one in this domain and organizes International Summer Schools on Multi-Criteria Decision Aid to encourage young researchers. Today, most papers are not referring MADM theory but they cover its practical applications in the most various domains. If we are talking about the book referring the domain, ones can say, going through the years, that a real explosion took place. Almost all publishing houses are in competition for MADM books, one of the most important one, which housed the domain, is Springer Verlag. It is to notice that the books price is big enough, and thus a brake in the rapidly spreading of the respective knowledge is made. With the Internet appearance and development, it starts the democracy of the domain promotion. It can be founded electronic reviews, proceedings, books / software libraries, courses, discussions forums etc. offering, free or at low prices, MADM knowledge. This way, a strength competition appeared to promote the MADM domain.

In conclusion, nowadays, talking about the MADM domain promotion, it means to take into consideration the newest ICT type techniques. All Operations Research and MADM scientific forums, and we are referring here: IFORS – International Federation of Operational Research Societies, EURO – The Association of

European Operational Research Societies, INFORMS – Institute for Operations Research and the Management Sciences, ISMCDM International Society on Multiple Criteria Decision Making, consider that only electronic promotion methods, some of them enumerated above, can ensure the domain's know-how successful spreading. That's the way we choose too.

5. MADM promotion tools

The project proposal addresses three levels of instruments to promote the MADM domain.

5.1. MADM electronic book

The electronic book, will contain the entire know-how achieved, during the years, by the team members involved in the MADM research and applications projects. The book will constitute the expression of the fundamental research in the MADM domain. Putting together the entire knowledge, harmoniously correlated, solving the observed unsolved problems yet and producing eloquency using examples, a book situated over the domain state-of-the-art will result.

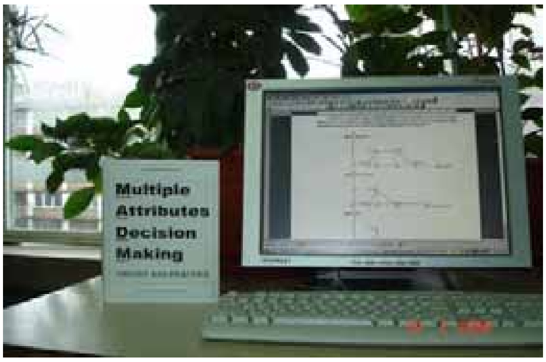

Figure 1. The electronic book

"MADM - Theory and Practice" will be situated over the domain state-of-the-art through:

- The mathematical defining and substantiating of a model that includes structured information (which are defining the common knowledge) concerning the sets of decidents, states of nature, objects / decisional variables, attributes / characteristics, connections between objects and attributes, relative / absolute importances etc. and unstructured information (which are defining the expert knowledge) concerning the sets of production rules over the model data and facts; - The inferential computing standard procedure defining, which is treating the model possible inconsitence (incompleteness / incorrectness / incredibleness) [7];

-The extension of the problems solving methods, which are generated over a MADM model, by treating the cases "more decidents"

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and "more states of nature". Concerning the solving methods with more than one decidents and states of nature, the extensions will be made according to the priciple: "keep the spirit of each method". An extended version of the following methods will be presented: analyse of objects dominance, MAXIMIN, MAXIMAX, lexicographic, with ordinal preferences, conjunctive, disjunctive, elimination by aspects, permutation, linear attribution, simple additive weighting, hierarchical additive weighting, diameters, Onicescu, TOPSIS, TODIM, Pareto, Saphier-Rusu, mimization of deviation, scores, hierarchical combinations, LINMAP, multidimensional scalling with the ideal solution, ELECTRE, Saaty etc.;

-The inferential computing procedure defining, which determines the global optimum if multiple optimum exists. Production rules are easy to use, even without mathematical and informatics knowledge, because of their simple structure: If condition then actions [8]. Artificial intelligence software available on the market, are used to treat them. This justifies the orientation to inferential computing, which, in order to build the global solution, operates on the model data and the facts that are generated by the solving methods;

-The elaboration of MADM modelling and solving methodology;

-The presentation of real examples with high complexity in which optimal choice problem intervenes. Speaking from the practical point of view, MADM domain contributes today to e-applications development. A dedicated software avalanche is registered, both in our country and abroad. This is the dominant trend in the applicative plan. In order to attain a superior level, the theory must fit. On its turn, theory is assimilated in order to use it in practice.

The book will be written in Romanian and English and will be included in ICI, UB and ASE electronic libraries which are containing mathematical sections. At the same time, all the necessary efforts will be made in order to include it in The Electronic Library of Mathematics that is the library of EMS – European Mathematical Society, library administrator beeing FIZ Karlsruhe / Zentralblatt MATH.

5.2. MADM electronic course

The electronic course will follow the electronic book contents, the chapters becoming modules. It is not designed for the international scientific community, like the book, but for the people having high economical / technical / mathematical education or well prepared students wanting to rapidly assimilate [9] this area of knowledge. Because of this fact, the presentation will be made different: the explanations will give careful attention to details, much more examples will be gradually presented, connections with the assumed known basics will be presented, the approaching means of the novelties will exist, the interactivity technique will be used with predilection, most frequently formulated questions will appear at the end of each module, the questions for knowledge verification will be in large number and the design will be different. The course graduation exam and the proving certificate granting will also be made by electronic means. The MADM electronic course graduation will be on 3 levels (beginner, professional, expert). The random selection algorithm from tests base, models and problems base, with collisions minimization, the up-loading mechanism of the students proposed problems and the up-loading mechanism of the theoretical considerations concerning MADM domain made by the students will be another strong points of the electronic course.

Figure 1. The electronic course

The interactivity, housed by a content expressed in an attractive design, will be the didactic technique that will constitute a guarantee for course success. A context sensitive *Help* will lead the user during his / her working sessions, making easier both the modelling and solving activities.

Afterwards a student cumulatively passes the tests, solves the proposed problems, and makes pertinent course amendments then at the course's

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graduation he / she is declared beginner / professional / expert correspondingly.

Electronic course will be presented in two versions. First one will free function on the UB and ASE Intranet, having the goal to contribute to the education of the students in the both institutions. Second one will function, in economic regime, on the Internet at ICI, having the goals to increase the number of MADM experts all over the world and to bring an income for the institute.

5.3. MADM electronic pervasive service

The modelling and solving pervasive MADM service (i.e. a free service available on the Internet to anyone, from any place and any time [10]) will cover the necessity to define optimal choice problems in the MADM paradigm.

It will allow to a user, registered in the system, to define classes of MADM mathematical models and models of real dimension. In order to solve the decision problems generated over these models, the user will have at his / her disposal 15 solving methods that can treat any kind of problem, no matter what is the application domain. It is also important to notice that entire contents of the book will be reproduced in the software. MADM service elaboration will start from *OPTCHOICE* (Optimal Choice), experimental software which is already designed and it proved that such kind of software is possible to transform into a pervasive service.

The user will work with the software carring out the service like this software is installed on its computer. *Internet Computing* techniques will be used to allow to hundreds users, at the same time, to access the modelling and solving service in conditions of high informatic performance. Graduating the electronic course can be a favourable premise to approach the working on the Internet with *OPTCHOICE*, because the last module of the course will be a tutorial on this pervasive service. The software will be strong and robust, both from informatic and mathematical point of view.

The service will run on performant computers, administrated through the agency of ICT modern techniques. It will be installed on the UB's and ASE's Intranet and on the Internet at ICI. The man-machine interface will be written in Romanian, French, Italian, Spanish, Portugese, English and German languages.

The endowment equipment, powerful servers and dedicated computers, is strong enough in order to accomplish the service tasks. The software instruments, minimally presented, will be: MySQL, PHP, MSVC, Macromedia Dreamweaver MX, Flash MX, SnageIt, Voice, Mathematica etc.

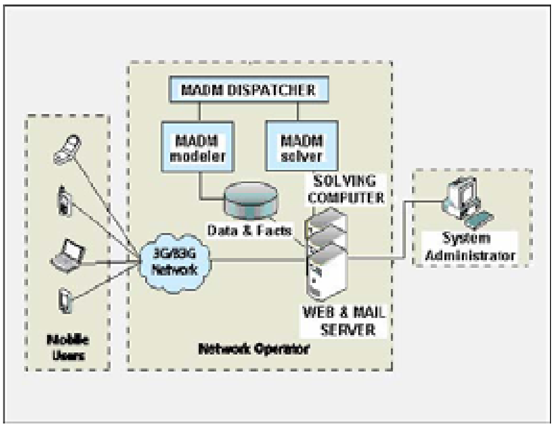

Figure 3. The electronic pervasive service

This kind of service is not available at this time anywhere in the world for none of Research Operations branch!

6. Conclusions

Any hands-on approach claims that the students become, from passive learners, very active participants. This fact is possible only if the learning system is designed by very good professors which known the teaching domain, the pedagogical art and the modern means that comes from ICT. The use of computer and the Internet, in the modern form of the hands-on learning, is essential.

As the project stated, the first beneficiaries of the project yields will be the advanced applications' designers. MADM is always necessary in *Decision Support Systems'*, *Expert Systems'* and *E-applications'* design. Do remark that, in the most of cases, the theoretical MADM methods are informatics instrumented. This fact shows that the MADM theory interests the people who want to make optimal decisions and in consequence a modern management.

It is to say now that the researchers, university professors / students are interested as well and, why not, the managers without high education, which are very well represented, numerically speaking, everywhere on the globe.

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From the point of view of efficiency, the income problem, in money, is on secondary plan. However, in this case, the electronic book can generate income in libraries that will host it, the electronic course will bring an important income at ICI, and MADM modelling and solving pervasive service will attire a large number of consulting contracts for the specialists which worked at the project.

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Science Museums and In-School Science Education. Bridging Formal and Informal Learning of Science.

Socrates Comenius Education and Culture

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Indoor Interactive Science Museums in School

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Abstract. Interactive museums are an important part of informal learning as it establishes a playful link between Science and Technology. Amongst the resources that teachers have to facilitate the learning of scientific contents in formal learning is the possibility of taking advantage of interactive centres in our surroundings or even importing the philosophy of an interactive science museum to the school itself, in a process in which teachers and students carry out the corresponding tasks in a cooperative and coordinated manner. In this essay the necessary methodological criteria for carrying out this process is presented.

Keywords. Hands-on Science, Interpretation, Science Education, Science Museum.

1. Introduction

New educational tendencies consider the importance and influence that informal learning has in the constructing of scientific knowledge [1], in which various interests, agents, values and actions come together and interact, and this is why it necessarily entails a balance of all this system, which is directed towards growth and development. Amongst the various intervention strategies that exist to bring people closer to Science, what stands out are the new interactive museums [2-3] which emerged at the end of the 20th century with the appearance of a new public with new scientific-technological demands which gave impetus to a conceptual change in traditional museums, they stopped being mere collecting objects, to become one of the fundamental bases of education for people. At present, interactive science museums [4] have opened their doors to a public eager to satisfy their natural curiosity in a world which is highly technical.

However, real specific situations do not always answer to or come near to this new conception of a scientific museum, which is partially explained by insufficient funding, the absence of specialists in many of the tasks related to the sector and the apparent discrepancy between the museum and educational world.

The educational world can set into motion new mechanisms and performance strategies in the learning of Science by using the existing resources in running a museum, by always choosing the use of specialists in the varied areas involved, so that all the potential that this sector should develop increases in value and also by creating the necessary channels so that the school, as a whole, becomes an active element, as a recipient of the value and service of this particular system of communication [5] such as:, scientific value, cultural value, educational value and the social value organized in the heart of the educational community, as occurs in certain concrete cases [6].

In this essay we present the theoretical premises related to the objectives, results and methodology associated to the design, assembly and evaluation of an Indoor Interactive Science Museum (IISM) in the school itself. The practical execution of these ideas has been carried out during the last three years in various teaching centres coordinated by the Universidad de Vigo within the Hands-on-Science network. [7].

2. Objectives

The main objectives of our proposals are centred on promoting a playful and contextualized approximation to Science by creating an interactive museum within the formal learning environment itself [8-11]. To achieve this objective it is necessary for other more specific ones to be achieved, amongst which we could mention:

- The creation of a general information framework for the museum's visitor, so that the visitor has an organized and documented presentation available of the interactive modules which they can use.
- To spread, in the interactive museum, the existence of signifiers linked to the contents of a formal curriculum.
- Create a self guiding interpretive tour organizing the movement of the public so that it is possible for them to make the most out of the experience.

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- Help in the comprehension of concepts, principles and laws demonstrated through the installation of self-explanatory interpretative panels.
- Organize the public's movement within the interior space, allowing for their attention to be called to certain signifiers noticed with difficulty by the visitors.
- Highlight the concepts related to daily reality and the previous experience of the visitors.
- Put into practice the actual techniques of interpretation which contribute to awakening feelings and committed attitudes with the values in question.
- Create other elements of interpretation which are easily available and of personalized use.

Figure 1. UVigo IISM

3. Methodology

In this proposal we attempted to set into motion a process directed to all agents related with it: teachers, pupils and families, covering an important chronological section of the population, based on the presupposition that it is possible to import the interactive museum model into the school environment in which the resources involved are linked to the creation of a communicative system in the school, different to that traditionally used which is defined by the unidirectional mode teacher-pupil.

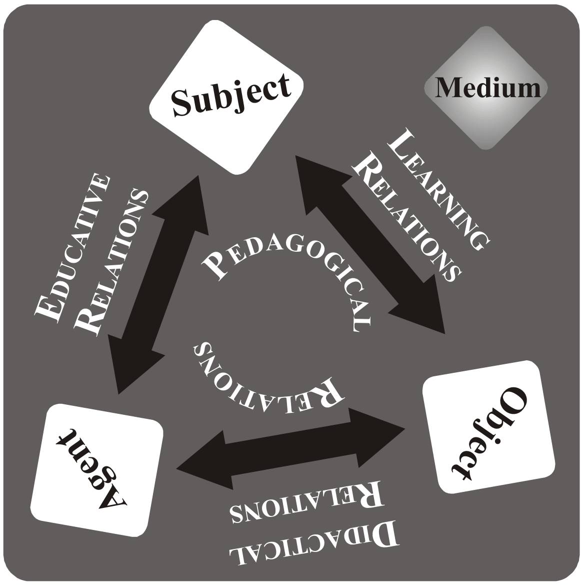

Figure 2. Pedagogical relations in Indoor Interactive Science Museums in School (based on Legendre 1983)

As in all communicative experiments, it is also possible to identify here as the basic elements: the transmitter (the museum space itself in the school), the recipient (represented above all in this case by pupils and their families), the message (numerous and heterogeneous, made up of a set of signifiers previously selected by the teacher amongst many possibilities) and the medium (understood as the techniques and procedures that are used to ensure the success of the communicative system).

The methodology for the organization of an informal learning experiment of this kind needs to be based on pedagogical criteria, which once defined, orientates the construction of the same devising the pedagogical relations of the learning and communication system [12]. Thus, once a group of pupils and teachers (agent) have made the decision to carry out a learning experiment through the implementation of an interactive museum for the school community (subject), the imminent question is to clearly define the fundamental ideas or concepts (object) which are intended to be transmitted in the school itself (medium). Figure 2 shows the relations (pedagogical, didactic, of teaching and learning) which are established according to the discourse or set of messages which are trying to be transmitted and the objectives set out [11]. All the concepts dealt with will necessarily have to be related to the academic curriculum, be coherent with the objectives of the activity, accessible in their presentation and have a hierarchical organization. For its presentation and transmission several mediums will be considered which will consider the possibility of several reading levels and will be orientated towards the stimulation of several capacities: observation, use, mental agility, use of the senses, etc…

Figure 3. Auga da Laxe Secondary School IISM

The agents who act in the setting into action of the experiment should involve, as a minimum, the group of teachers related to the subjects and a group of pupils who voluntarily join the activity. Any other kind of professional contribution will enhance the project, but on the contrary, this will not be possible if it is by unilateral decision or imposition by one of the parts. It will be necessary to define the figure of the coordinator of the teamwork in order to organize, distribute tasks and supervise the phases of coordination and/or creation of the medium in a way and form which we have designed to materialize the experiment. These agents will participate in the carrying out of the whole process: the preparation of the discourse, execution of the medium, transmission agents,… becoming themselves active elements of the medium and of the same evaluation.

In relation to the role that the voluntary pupils (agents) should develop in support of the transmission of the contents, we can say that they must transform themselves into real interpreters of the selected message. Thus, each person will be in charge of an experiment or set of experiments related thematically and far from being limited to waiting for visitor's questions they should show a receptive attitude by being prepared to talk and arouse curiosity with simple explanations, using a language that is accessible and also explain its relation to daily life. They should be prepared to listen and express themselves in a correct manner and tone, using their hands to point and always be situated in front of the visitor. In like manner, the pupils involved in the experiment become protagonists of a rich and motivating experiment due to the novel value it presents.

Figure 4. Escolas Proval Secondary School IISM

The definition of the medium requires theoretical and practice proceedings for the materialization of the setup as a learning situation. This means the definition itself of the necessary physical space, which must be the centre itself in which formal education takes place: a laboratory, a playground, a classroom, an auditorium, an assembly hall, a gym… The interior organization of this space must be coherent with the tour layout and the presentation of the contents, it being usual to organize the direction of the visit, although sometimes on occasion it is possible to setup experiments which allow the visitor to freely choose according to their interests. In the event of a spatial organization of the experiment existing, it must be duly indicated.

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Figure 5. A Xunqueira Secondary School IISM

For the presentation of the contents which are intended to be shown in this communicative system, a selection must be made from an immense wealth of information available at present. In order to do this the interests of the pupils, the time available, their material needs or conceptual level will have to be taken into account. Once the selection phase of the written information is over, the same criteria are used for the graphic information. The use of plans, drawings, sketches, photographs, maps, etc is essential to improve the perception of these realities. In the communicative systems that are trying to be built, the public, helped by the necessary infrastructure, carry out the visit according to their own rhythm and interests.

As a general rule, the contents that we want to transmit should have some point of contact with the reality or daily life of the public and they should be offered in an attractive way. If it were not so, we would run the risk of failure due to the loss of interest during a visit which may have nothing in common with the social, cultural or motivational reality of the public for whom it is directed. The use of everyday materials for the physical production of the interactive modules establishes important relations between scientific learning and personal experience so that pupils easily assimilate the fact that the theoretical contents of a classroom have an immediate reflection in their lives.

The contents of this design can be classified as follows:

1. Informative, of a generic nature, they correspond to a level of reading directed towards all the visitors. They are formed by clearly stated messages about the objects they can visit, the nature of the visit, itineraries, the instructions to follow, points of interest, information area and recommendations on the approach to be taken.
2. Interpretive, more specific and containing messages with significance about concrete aspects of the diverse interactive museums. These contents are thematic; they are organized according to their specificity on several levels. For their presentation sentence-topic titles will be used, continuing with texts made up of a maximum of 100 words with an attractive, understandable message, relevant to the Ego which receives it, with a logical outline and a central idea. Also, this message has to attract attention, have credibility and be short. These messages will be basically installed on panels near the significant elements (the interactive modules) to which they refer to.

Besides the self-explanatory panels it is very useful to have certain publications which contribute to the interpretation of our school museum. This material of personal use, which has the advantage of being taken and read whenever the user wants to, can be used by others; they provide detail and nearly always are a souvenir of the experience.

Figure 6. Poio Secondary School IISM

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To be more precise, we are referring to different kinds of publications which, amongst others, will be suitable for obtaining the structural objective of offering several levels of reading. Accepting the obvious, that the putting up of posters is to all appearances unsatisfactory, the printed media turns out to be more precise and concrete, allowing a thematic deepening, for example a guide book (available for teachers who accompany the pupils during their visit and offers the possibility of deepening the communicative experiment for the sector which is interest in it) or leaflets (which gives all the information of a general and practical nature in order to favour the correct development of the self guided tour by the pupils who can receive the leaflet in the museum itself or beforehand in the classroom).

4. Evaluation

All educational participation projects should consider as the final stage, the creation and setting into motion of some kind of mechanism which allows for the evaluation of the functioning of the same and observes the weak points once it has begun, so that necessary strategies can be designed to eliminate them.

There are several evaluation mechanisms [13] for these kinds of activities directed towards the public and which, in general subject the project to a preliminary test with a reduced group of visitors made up of a similar public to which it is directed, apart from the system of preparing a brief and studied questionnaire that the public can answer in a totally voluntary and anonymous manner, and which would be offered and collected by the voluntary pupils.

In regards to the first of them, there are currently several tests provided by the same theory on interpretation which allows for the evaluation of certain aspects, such as the medium used for the interpretation, the analysis of the interpretative potential of the same, the role of the monitors, etc. Once this phase has been passed, we are now interested in establishing the evaluation mechanism of its effectiveness for the public and the attainment of the proposed objectives.

Finally, a meeting with the voluntary pupils who worked on the experiment, following a pre-established questionnaire, will give important complementary information of the experiment and with it the success of the activity will be measured. The results of the monitoring and evaluation will permit the discussion of the mechanisms of correcting errors and shortcomings pointed out or suggestions that are easily incorporated, as long as they benefit the project.

The results obtained from these kinds of experiments carried out [14-16] show on the one hand, a limited presence of pupils in conventional interactive museums in the context of their extra-school activities but on the other hand a big interest and enthusiasm in participating in the set up of this kind in their own schools. Apparently, they consider it to be a useful source of information and that it shows daily applications of Science and Technology.

5. Conclusions

Interactive museums are important factors devoted to teaching the public. The importation of the model into the world of formal learning can be an additional tool to bringing Science and Technology closer to pupils and it also becomes more relevant for them. In this essay we have theoretically presented the methodological guidelines needed to carry out this process, showing in addition the most common advantages and difficulties. The results obtained over the last three years, with these kinds of experiments in the centres coordinated by the Universidad de Vigo within the Hands-on Science network are highly satisfactory as reflected in the high level of participation and motivation of the pupils. It seems sufficiently proved that the pupils learn better when they explore the phenomena and concepts for themselves. It is the teacher's task to give them the indications and tools they need in order to explore and learn. We believe that interactive museums in schools allow pupils to approach Science as apprentices and discoverers. Possibilities are multiplied if the pupils are given the opportunity a posteriori to carry out similar experiments on their own with real, simple and common materials such as those used during the activity.

6. Acknowledgements

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Interactive Exhibit with Hands-on Experiments as Motivating Elements to Introduce Image and Sound

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Abstract. Images and sounds constitute the main forms of interaction between the majority of human beings and their surroundings since their existence, therefore, they are potentially motivating subjects to promote the public interest in Science, more specifically, Physics. As part of the commemorations of the World Year of Physics, the Institute of Physics of the University of São Paulo presented the exhibit "Image and Sound: Physics in Action", at the Science Museum of the University(Estaçào Ciencia).

The main objective of the exhibit was to introduce, through 14 hands-on experiments and demos (listed below) and two workshops, some properties of light and sound, such as diffraction, refraction, reflection, polarization and interference, some natural phenomena as the rainbow, and some applications as holography, radiography and ultrasonography.

In one of the workshops, the public could learn how to build a simple hologram using only blade and a piece of plastic. The "products" of the other one were a pinhole camera, a

spectroscope (made with a match box and a piece of CD) and a loupe. These workshops were offered only twice a week and participants had to enroll for them.

Nine physics students were trained specifically and acted as monitors in the activities. A guide with basic explanations on the theory involved in each experiment was written for this purpose.

During the three months, about 8000 people visited the exhibit and around 300 participated in the workshops.

The general evaluation was that the approach adopted is feasible and the direct interaction with the public through experiments is vital, in order to promote their interest and some understanding on Science.

EXPERIMENTS
Colored shadows
Mechanical and electromagnetic waves: diffraction, interference (ripple tank and grating)
Measuring hair thickness with ruler
Floating objects: images from parabolic and cylindrical mirrors
Who are you?
Dancing rainbow
Infra-red imaging
Can you see it?
Three dimensional images (Holography and Stereoscopy)
Producing sounds
The image of sound (Chladni plates)
Looking inside the body: radiography and ultrasonography
Where are the images?

Keywords. Exhibit, Science museum, Hands on experiments.

Ocean Phenomena

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Abstract. Science demonstrations can be used to promote the understanding of complex concepts and to help the visitors connect ideas associated to different single exhibits (conceived to explore a single scientific concept or topic). As an example, we propose demonstrations related to (1) the formation of waves in connection with the concepts developed in exhibits such as surface tension, wave propagation, effect of the wind on the oceans surface, (2) demonstration of different types of tectonic plate boundaries to deepen the concepts related with seafloor spreading and continental drift.

Keywords. Science demonstrations, Ocean phenomena

1. Introduction

Creating memorable and rich experiences through the interaction with interactive devices is the main strength of any science centre.

A good hands-on exhibit can serve many purposes: to provide fun and entertainment, to set a mood, to pass along a specific piece of information, to put information in a context, or even to show a process [2].

The best interactive exhibits are phenomenon-based [1], designed to isolate a piece of nature or a concept from the complex world [3]. Exploration and learning of more complex concepts can be reinforced by creating a number of exhibits on similar topics that as a whole may serve to develop a curriculum to reinforce a particular concept or idea [3]. However in small science centres, such as Centro Ciência Viva do Algarve (CCVAlg), with limited area for exhibition, to create clusters of exhibits on the same topic can be a problem. Exhibits are also an expensive medium.

Science programmes such as demonstrations on the floor may be a solution as they can be used to guide visitors through the understanding of complex concepts [2] and to help them to connect ideas associated to different single exhibits. Science demonstrations also add extra value to the visitor experience. Visitors can ask questions and be answered, they can discuss ideas with one another helping them to develop thinking skills. Demonstrations can address specific target groups: schools (which includes teachers and students), families, adults. The combination of demonstrations and exhibits may broaden and deepen the visitor educational experience [1].

After two years closed, at 8th of June, CCVAlg reopened the door to the public with a new permanent exhibition focused on the theme of *The Sea*. The exhibition is organized in six interrelated areas: *Arriving at the Blue Planet*, *From Pantalassa to Today's Ocean*, *The Nature of the Sea/Forces of the Nature*, *Exploring the Unknown Sea*, *Life in the Sea*, *Of the Molecules and Men.* The displayed exhibits explores concepts such as: vortexes, waves and wind, waves motion, surface tension, tides, coriollis effect, pressure, continental drifting and plate tectonics, volcanoes, earthquakes, submarine archaeology, technologies for ocean exploration, biodiversity, evolution and genetics. A team of explainers guide the visitors through the exhibition exploration. The next step will be to assemble an educational programme that will include short demonstrations, of 15 or 20 minutes, adapted to the different target groups, mostly schools.

In this paper we describe the concepts behind two groups of the exhibits and discuss how demonstrations can be a guiding tool for helping visitors in a deeper and a more significant scientific experience.

Fig. 1 Exhibition view

2. Waves, waves motion and surface tension

2.1. Exhibits concepts

Waves. The "waves" exhibit is a device designed to illustrate how the air, moving rapidly over the water, generates waves. A fan blows air over the water and small ripples are formed. A button allows visitors to generate different wind speeds. Thought the interaction with the device visitors will understand that as they observed, waves are generated at the surface of the sea by the action of prevailing winds, in a process where, through pressure and friction, energy is transferred from the atmosphere to the ocean.

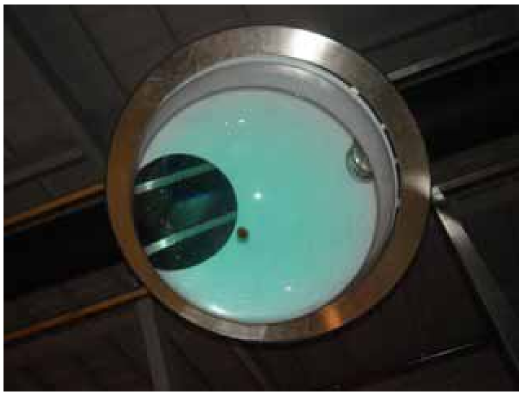

Fig.2 Waves exhibit

Spinning umbrella (waves motion). This exhibit consists in a spinning disc of fabric and shows that a wave is the propagation of a disturbance. The wave transports energy across a medium without moving its particles far from their equilibrium position. In the umbrella, the disturbance is created by friction of the air in the folds of the fabric. Over the ocean, the wind generates waves that move without dragging the water along. The waves in this umbrella rotate around a central point where the disturbance fades.

Fig.3. Spinning umbrella exhibit

Surface tension. Surface tension is a tray filled with a special soap-solution. The visitors raise a bar out of the solution creating a soap film. When visitors read the exhibit label they understand that the effects observed in soap-film are due to the surface tension, a water property important in the wave behaviour. The exhibit label also explains that water, of all the common liquids, has the highest surface tension due to the hydrogen bridges that hold water molecules strongly together. Because of this property, water alone cannot form lasting bubbles. Soap lowers the surface tension and decreases evaporation, allowing the formation of large and lasting soap bubbles.

Fig. 4 Surface tension exhibit

2.2. Demonstrations: connecting ideas

The interaction with the exhibits described in the previous section brings visitors into the knowledge of some physic concepts or ideas that may help them to understand the natural phenomena. Some of those ideas are:

- surface waves are generated due to the friction of the wind with the water;
- a wave is a propagation of a disturbance;
- surface waves move without dragging the water along;
- surface tension is a water property;
- soap lowers the surface tension;

However questions that emerge from the visitor's experiences and that can give them a much better understanding of the displayed physic concepts, such as: what is a wave? Why surface waves move without dragging the water along? What is the surface tension? How is the surface tension related with the process of ocean waves formation? Can not be answered just by the simple interaction with these exhibits.

The connections among the exhibits are promoted with the help of an explainer instead of more complex solutions such as the addition of new exhibits requiring extra financial and space resources.

We think that a 15-20 minutes interactive demonstration is an excellent communication tool to fill these gaps and help visitors to connect the concepts exhibited in the three single devices.

To achieve this purpose we are developing a demonstration prototype, to be tested, which includes the following topics: wave types, wave properties, travel medium, states of matter, water properties (surface tension and water molecular structure), substances that decreases the surface tension of the water and consequently the formation of waves.

The prototype presented was conceived having in mind the school curriculum of 7th to 9th graders.

3. Continental drift

3.1. Exhibit concepts

The stone Rafts (continental drift). In this exhibit visitors are engaged in a 200 million years story-tell. Three of four globes introduce the history of continental drift and show that continents, witch are apart today, were together in the past. Observing the globes in a sequence, from 200 million years to the modern time, visitors may deduce that the movements of the tectonic plates continually build and destroy ocean floor, keeping the continents almost untouched.

In the fourth globe, a solving problem is presented: a plate puzzle where visitors can reconstruct the past and imagine the future of today's continents.

Fig. 5. The Stone Raft Exhibit

Near this exhibit the volcano and the earthquake exhibits are displayed. In the first one, visitors are invited for a sensorial experience: a volcanic eruption. With the help of the exhibit label, visitors realize that the bottom of today's oceans is less than 180 million years old, young in terms of the geological time scale, and that bellow the sediments, there is volcanic rock generated by underwater volcanoes similar to the one displayed on the exhibition floor.

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The earthquake exhibit is a mechanical device, a platform, where visitors are challenged to step on it and feel an "earthquake"

Through the interaction and by the help of the exhibit label visitors will be made aware of:

- the generation of seismic waves in the interior of the earth, occurring when a geological fault moves suddenly and releases the elastic energy accumulated over many years.
- earthquakes and volcanoes as a manifestation of our living planet, most of them occurring at tectonic plate boundaries.

Fig. 6 Volcano exhibit

Fig. 7 Earthquake exhibit

3.2. The challenge: develop props to contribute to the demonstration

Once the connection between the occurrence of earthquakes and volcanoes and the movement of tectonic plates is made, the geochemical phenomena associated need to de explained such as (1) types of plate boundaries and (2) a model of the inner structure of the earth. The demonstration is complemented with a puzzle where the pieces correspond to the different plates, and ocean rifts and subduction zones are identified.

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Image Formation and Hand Drawn Holograms

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Abstract. We describe a Workshop aimed to pupils above 14 years age on images, imaging instruments and hand drawn holograms. It has been performed several times with groups of about 20 pupils. It does no require a fixed script and it is very interesting to develop it driven by questions posed by the pupils themselves.

It consists in a series of easy demonstrations on image formation, starting from pinhole imaging, going through image formation in spherical mirrors and lenses, all these ideas and experiments based on the very simple concepts of pinhole imaging and plane mirror reflection

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and deviation or rays through a prism. The idea of lenses and spherical mirrors as recombinants of elementary pinhole shifted images leads naturally to real image formation, focusing and depth of field.

The idea of the elementary magnifier is then described. The concepts of microscope and telescope are mentioned in this context.

Deformed images and the possibility of correcting the deformations are introduced by using cylindrical anamorphosis examples and a recently developed device that produces very realistic pseudo images. Information on how to construct such device is also given by using mirror foil.

The workshop continues with the elementary description on why depth is perceived and how do stereoscopic devices such as anaglyphs work. Some examples are shown.

A description of waves, Huygens Principle and Fresnel Zone Plates is used to lead to the concept of hologram. Some holograms of different types are shown and questions on them are induced.

Then the participation of the pupils in the construction of simple 3D images is suggested. The very simple theory of Hand drawn holograms is described and the pupils are urged to try to make their own tests using acrylic material and a pairs of compasses. Enthusiastic participation and close interaction with the pupils is the usual outcome.

Keywords. Image formation, Hands drawn holograms.

Start Right from Very Young: Promoting Life Science Awareness in Early Childhood

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Abstract. “De pequenino se torce o pepino” is a project from the Portuguese NGO “Associação Viver a Ciência” aiming at promoting life science awareness in early childhood.

Stories and games will be used as educational resources to support learning of life science concepts related with the Portuguese fauna and flora. Here we present two examples of how telling tales can support science learning.

The tale “The girl of the sea” from the Portuguese writer Sophia de Mello Breyner Andresen illustrates marine habitats and organisms. This story is the basis for a workshop available from the educational program at the “Oceanário de Lisboa”, an aquarium located in Lisbon. During this experience, children observe live examples of the main characters, their behaviour and habitats. Children discover the relationship between external morphology and function and how these relate with habitat and behaviour.

The fairy tale “Fairy Oriana” from the same author, illustrates equilibrium and key species concepts in a terrestrial forest. The workshop based on this story has been carried out at “Moínhos de São Filipe”, and educational farm located at the Arrábida Mediterranean forest. In order to explain these concepts, the children first listen to a narration of this fairy tale and then play a related game in the forest. During this program, children get to experience direct contact with forest fauna and flora, witness many examples of plant and animal ecological relationships, and discover the important role that children play in maintaining our forests.

Keywords. Early childhood, Tales and games, Science learning.

The Role of Science Centers and Museums in Teaching Science

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Abstract. In the current age where technology rules almost every action undertaken by us, knowledge of Science and Technology, and a vibrant populace are assets that the developing countries must focus on. For this purpose, the role of Science Centers and Museums becomes important. Not only for scientific development, but for general benefits also, techniques of

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science are useful. A simple example could be that of building a solar powered generator in a village for rural electrification, or at a more complex level, developing satellites for the purpose of education. Thus, we see how crucial it is to spread scientific awareness.

In this article, we would focus on the role of Science Centers and Museums in development strategies. As a matter of fact; the numbers of science center and science museums, which have been built in India, an upcoming developing country, serve hardly 0.0001 percent of the population. This means that the majority of the population doesn't have access to these forms of scientific education. If we are to assess the consequences of this, we need to find out the relevance of these centers of scientific education. Science centers & Museums have a great role to play in designing developmental strategies to communicate Science to people. We live in a world dominated by Science & Technology and to be ignorant of science is to be ignorant of large part of life.

Keywords. Science Learning, Low Cost Educational Kits, Country wide Public Awareness.

1. Introduction

An important step in the direction of enhancing the role of museums and science centers could be after a natural calamity, or much better before something of the sort occurs, to make people aware of the science behind it, so that people don't link it to superstition.

In India, we find a dichotomy, where on one hand; there is widespread technological awareness in IT hubs like Hyderabad and Bangalore, and on the other, there are beliefs among people that natural calamities occur because of some wrongdoings of theirs in the past life. Thus, there is employment of godmen and others of the kind.

India is today facing global problems like Tsunami, Bird flu, Earthquake, Manmade Disasters (like Bhopal gas tragedy) etc; so the need today is felt all the more for greater scientific spread of understanding among the masses. This calls for the development of participatory exhibits and low cost material. Manthan has made short term programs on these topics which were made very effective by using this material.

For example, after the earthquake in Kutch in 2001, the kits for Vigyan Prasar prepared by us on 'Understanding Earthquakes' became very popular amongst students and the community. This served a dual purpose, firstly, there was better understanding of the phenomenon along scientific lines, and secondly and more importantly, there was spread of science and its importance among the youngsters. The thing to be noted is the that Manthan used low cost toys and other material to explain things like precautions to be taken before, during and after an earthquake, for example, a simple slinky was used to explain seismic waves.

Figure 1

We concluded from this exercise that existing exhibits and programs could be made very effective by using participatory elements in the exhibits. That is because putting an idea in the form of an interactive exhibit is very different from an explanation or experiment in the laboratory. Our exhibition on Solar Eclipse helped communities to understand this phenomenon. It also helped to create awareness against superstitions related to Solar Eclipse and more than a million people used our safe solar viewer to view they eclipse in 1999.

Our experience taught us that getting the community to be a part of the experiment helps to generate and maintain interest in the activities. Manthan has distributed many activity kits related to scientific phenomenon in order to get the children involved, once an interest is generated and curiosity aroused, the student remains interested in the subject. The activity kits would consist of coloring pictures, making cut outs and other things, little information booklets, do-it-yourself little experiments and many such related activities.

Low cost thematic science kits and other carry home materials generate great interest. A

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child or any member of the community takes away mini museum idea to his/her home. It is something like mobile science centers. Manthan also designed some 'Interactive Radio Programs outreach material for National Council for Science & Technology Communication / DST, Govt. of India. Based on science. It collaborated that with the distribution of kits to registered listeners, which could be used according to the instructions on the radio. This was a very popular show and generated a lot of response and enthusiasm from students.

Figure 2

Before the Radio program on Biodiversity, we sent thematic science toys (made from paper) to the registered listeners.

Our kit on Nature designed for the 'National Natural History Museum', New Delhi was very popular amongst students. The material designed in such a way that by displaying, one could create a mini museum on his/her table.

Figure 3

Jathas have been another innovative way employed by Manthan as Low cost travelling exhibition. They act as mobile science centers, and are especially feasible for developing countries. Two reasons can be pointed out for this, firstly, because they are low cost in assembling and secondly, because they are made from locally available resources. This makes them more easy-to-identify-with in a rural set-up. In the north western parts on India, camels and bullock carts are widely used as modes of transportation. Manthan made use of this to display science.

Figure 4

Our Camel cart science center went from village to village with science Exhibition, Participatory toys, Mini library and Puppet Show. These were items that the villagers were familiar with and at the same time were interested in, so it was easier to get them to participate in the activities, than through a typical museum or science center where things are displayed with captions, but which a rural person finds difficult to operate.

It was cost effective, local, and excitable and communicated through the vernacular medium. It is a classic example of where the villagers can't come to the prestigious science centers, so the centers go to them.

Another aspect of science popularization that must go hand in hand to make the science centers more effective is the building up of local & regional networks with common objectives that can help in dissemination of Developmental Ideas faster. These networks can act to communicate common contents, information, ideas, and objectives. This also makes it is easy to implement common programs. This can be facilitated by having a network of NGOs working on grass root levels. Another way is to take the district level administration into confidence which can lead to smooth functioning of any Science Development related project.

Our local network in Kutch is working with Regional and international networks in the field of Science and Technology entrepreneurship program of Anjar Knife manufacturers. This district of Gujarat is famous for its knives, but there were a number of problems in this. One was the lack of innovation in the design of the knives which proved to be hindrance in the sense that the obsolete designs were not very market savvy. Also, the knives were made in the little village of Nanareha and were sold cheaply to middlemen who made huge profits. So, the original craftsperson was not getting the required level of profit. In collaboration with the National Institute of Design, Ahmedabad, new designs were created for these knife manufactures. A German exchange student worked on this project and also paid a visit to Anjar to get an idea of the ground reality.

Manthan in a big way participated in the Jathas also, the mobile exhibition with eye catching posters and games and promoted the culture of Scientific Thinking.

2. Conclusion

Museum and Science centers provide an excellent media to communicate Science for developmental causes. The only area where action needs to be taken is in making them reach out to larger strata of the society and get more people oriented towards it. There is a lot that needs to be done where other than governmental measures; NGOs can play an important role and substantiate the governmental measures with those of their own.

It must also be kept in mind that 'What needs to be communicated?' is clear and well defined.

Developmental programs can be made effective by creating participatory and thematic exhibition. Museums can reach larger segment of the society through that innovative outreach programs. Developmental ideas can be disseminated through local travelling exhibits, low cost material and folk performances with the help of networks, which can disseminate developmental ideas among the masses. Workshops can be conducted, and travelling museums can percolate into remote areas. From exhibitions on camels in Northern India to Science teachers travelling on elephant backs to reach villages not connected by roads, Science Communication should be open to new approaches.

Finally, it is important that the process of science communication doesn't stop at the level of dissemination of information for it to be more effective, it is important that this knowledge is used for implementation of developmental programs. Schemes need to be initiated for this purpose too.

A Low Cost Science Toy Workshop under the Banyan Tree

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Abstract. A banyan Tree is spreading its large masses of green branches and occupies almost 3000 sq. mts. Area with its cool and extremely pleasant atmosphere. Hundred many birds chirp and jump on its beautiful branches. Its gem-like red fruits are a very favourite delicacy for the birds that pirch is this spreading beautiful tree.

Figure 1

Under it there is a group of village children sitting in a carefree way and fashioning same beautiful clay toys.

I went there several times along with my associate volunteer workers. This was a scene and location, which inspired us to take up a simple study on clay toys and science toys.

Science toys occurred in out mind because we saw some of them making toys with some science ideas. These were clay whistles and clay shapes for a classification game initiated by their schoolteacher, and magic pots working on air pressure ideas.

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I built friendship with these children and found out as to how they could make some toys with science ideas.

They promptly told me; 'A kilometre away there is a village where potters make science toys out of clay'.

This led me and my group to go deeper into the problem of clay toys and low cost science toys for science activity.

The village potter also became our friend as we really admired his craft. He told us; "These toys are not made only now, they were made by my father, his father, his father and his father. We do not know the exact date".

Keywords. Science Learning through Low Cost Folk Toys, Radio Serial, Country wide Impact.

1. Storage of science toy making skills opened

The village potter showed us his favourite science toys and ideas used to make them. Some of them were done with amazing imagination and clever material handling like clay.

- Siphon Elephant toy
- Magic Water Pot toy
- Ganges Pot
- Non-Sinkable clay fish
- Clay Bird Calls

They all had a great aesthetic appeal and had certain traditional features. Amazing part of the toys were their science factor and humour.

2. Siphon elephant toy

Figure 2

It has a hidden siphon. It will take water from its trunk and pour water out from the tail. We have used this toy as a base for children to develop some siphon toys ideas.

3. Magic water pottery toy

This lovely little pot will pour out water when a thumb closing its mouth is moved and air pressure occurs.

These types of toys were used by our groups for village children's science entertainment shows. The children were inspired to create toys based on same operational procedures from waste tins, waste small clay pots and similar material.

4. Ganges pot

It is a double walled pot. The double wall contains water. Outwardly the pot is empty, but yet poured out water every few minutes. The trick is the Air Pressure hole

5. Sinkable clay fish toy

Normally baked clay is heavy then water. But in this particular toy special clay with tiny air hole is used. This creates a deception of a heavy object. Really speaking the numerous holes with air make it float on water.

6. Media of olden days

In Olden Times these types of toys and handicrafts travelled with travellers and carried stories related to people and life. They were the media of olden days.

Even today these types of material inspire several activities.

Based on clay toys concept our own group started thinking about low cost toys, which can be created from low cost not cost material. We wanted to use them in small village schools, which had no activity material. They had almost nothing as educational activity support.

7. We started thinking, experimenting and producing

The group members who were involved in R&D for making toys, educational concept support material, production and ultimate evaluation. We remained busy for a year or so. Our first package of paper toys was presented to All India Science Popularization Travelling Group (JATHA) or and they had a sizable demand.

Our mini Science Toys became a part of village children's life wherever the JATHA group presented its science programmes. Media took the note of our little Science toys. They were used in-group presentation, they were shown in Science folk plays and they were discussed on National Radio Network (AIR). The response was very rewarding for all those who had worked on the project just for the love of this noble activity.

8. Media supports. The science toy activity supports the Media

We had been invited by Department of Science & Technology, New Delhi for joining them on a discussion to examine the possibility of low cost Science toys & activities related to their unique Broadcasting Project 'Human Evolution' A Radio Serial'.

Figure 3

(This serial was the longest Science Serial in the broadcasting world, which broadcasted in 17 different languages simultaneously)

All India Radio 'AIR' National Broadcasting System and Department of Science and Technology gave us their problem, which had following major points:

- Design along with scientific experts and broadcasters for outreach material like Science Toys, Science Games and Science Activities.
- They should be created and pre-tested and then mass-produced.
- They should reach all the corners of the country by postal mail or truck roads and related to appropriate topics schedules for broadcast.
- The toys, games, puzzles and other material should be very low cost so that it can reach almost one hundred seventhly five thousand registered member listeners.
- The packaging should be water resistant as India is a land of and heavy rains.
- The material should be so designed that the child gets involved in do-it-yourself activities and produces alternatives, which are creative.
-

9. Basic presentations were convincing enough for all India Radio and Department of Science and Technology government of India

All India Radio is a very mammoth organization having an experience and complex network covering the whole country and operating in various languages and dozens of dialects.

For this Science Radio Serial they collected from our vast country best Science producers and contents people.

Our presentation was based on the points discussed above.

Contents support was provided to us by Department of Science and Technology's NCSTC branch for the preparing the basic presentation to joint group of Radio producers, scientific scriptwriter and educationalist.

10. Flow chart inter-relationship of Media-Broad cast science toy/games and activity kits

The group was explained by MEPS the flow chart of outreach material kits which had certain games, projects, toys, science activity suggestions and a variety of the things.

This was India's largest network for Science education low cost Science toys, games and activities.

While developing the toy-game-activity kits the following salient points were being considered by the design group.

11. Proper involvement of contents people and integrated design group formation

When a group is working on Science toys useful for areas like Health, Sanitation, physical sciences, life sciences and certain socially related aspects, core discussion with contents experts is very helpful. The group must form a unified structure, where the design group understands contents group and vice a Varc.

12. Constantly working with children while project developing the science toys-take children's input

Children have a great creative resource hidden in their brain, when freedom is assured they let loose their imagination and bring forth very impressive outcome. Their ideas can form the core of science toy designs ultimately to be used for low cost mass production of toy ideas.

This mass production is not an industrial mass production to hit the market but to spread idea seeds, which will provide a scope for individual creativity to develop new ideas.

13. How did the science toy game activity triggered of a serious of science toy making activity among a number of science toy, game and activity outreach material kit?

- Mass Communication Media related toy-making activity has a great potential.
- Feed back always provides newer ideas for toy designing activity.

Figure 4

14. What technologies were used in creating science toys, games and activities?

In just 20 cents per kit containing 12 to 15 activities, toy & games mix was to be produced, packaged and were to reach distant corners in a country like India.

- The kits contents were to be worked out along with science experts.
- For an example our space kit received a detailed consultation from a NASA trained space scientist that was trained in space travel.-

At the same it was to satisfy the children's group in a small village in Panch Mahals tribal belt.

It was a great experience for the creative design group.

For making a simple toy like fission happening toy, we had an expert from ISRO to advise us ISRO stands for Indian Space Research Organization. These scientific experts had to come down to the children's level.

Several alternatives were needed.

Concepts of Radio Broadcast on Scientific topics were to be correlated.

Material, which took, complicated electronics devices for public exposition of ideas were reduced skilfully in simple two pieces of paper-engineered toys.

Fission card is a good example.

This idea is presented here to draw the attention to the fact they very good with results can be achieved from low cost materials like paper and card.

There is another example of our successful mass produced science toy, which is simple and has charmed several hundred thousand children. It is 'Heat Absorption Pack'

It is white paper pocket divided into two parts A&B. A is covered with black colour while B is white. The child has two similar metal coins. Each portion A&B contains equal metal coins. The pocket is to be put under the sun for 5 minutes.

Then the child has to touch both the coins and find out which one in warmer. This toy works very well in warm a country like India.

Low cost paper and card are very pliable, yields to modern duplication methodologies, bring fourth needed colour demand. It is simple enough for idea spread.

15. We were convinced that while designing us must keep following in mind

'Toy is any material with which the child plays"

Some of our new volunteers came from a comparative affluent background to them branded expensive plastic toys meant toys, For

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them paper and card, clay or wires were no material to be considered for toy making.

After a passing through a small turmoil the group came to a conclusive agreement.

Some the characteristics for science broadcast outreach kits' material agreed upon were as follows.

- Low cost material
- Simplicity in assembling
- Easy paper engineering
- Contents clarity
- Brief captions
- Multi language captioning or notes system
- Easy and water proof packaging
- Mailing-friendly
- Built in feed back system
- Replicable
- New Idea inspiring
- Real Low cost
  (US 20 cents for a package with 15 toys)
- Auditor worthy documentation

This project was a creative design project but at the same time it had many demands in comparison to signal-person creative project.

At this point professional planning of the project turned out to be very useful.

In final production of work our low cost small experimental workshop helped us. Workshop was an old apartment with a small outdoor work area.

16. Amazing off shoots from the basic science toy making activities

Let us be clear that when we are talking of making toys we certainly do not mean heavily industrialized activities of medium scale business houses.

Modern times for any propagation of good ideas one needs large number production, and also an ever-expanding information network. One has to employ technology but the core expanding information network. One has to employ technology but the core activity will have roots in the individualized group activity.

MEPS toy-activity had several amazing offshoots growths.

All developing countries strongly feel the need of involvement of the child in science and technology. In our country there is a planned approach to the development of science projects for toys and games for the children.

There are annual science conventions fairs and camps for children. Every year hundreds and thousands of children in each region develop ideas for science toys projects and presentation.

Figure 5

17. Largest Media Group gets involved in this mini media games and toy

Our national daily newspaper specially generated for the region felt a great need for toys, games and activities. The newspaper was Time of India.

They located my group and will request us to experiment for two years a weekly page, which should have 'make-it-your-self' science toys games and activity.

The feedback was great. A special mail-receiving box had to be created on the main gate.

It was a great reward for a group, which peacefully developed simple science toys, games and puzzles. They were constantly enriched by children's inputs.

Figure 6

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Science Centres and Science Museums Together Towards a More Valuable Role in the Public Understanding of Science

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Abstract. Science Museums share with Science Centres the wonderful opportunity to bring the general public to science. The collaboration between a traditional Science Museum and a Science Centre has an undeniable interest. Clearly these two types of institutions have a great deal in common with one another, but there are also many differences between them. In contrast to many regular school activities, a visit to an interactive science exhibition is an exciting activity for the students – often it is a unique opportunity to manipulate and explore with freedom of action. At the same time, these activities also have a "minds-on" content, stimulating curiosity and interest for research and promoting observation and intellectual abilities. By contrast, a typical science museum exhibition consists of an historical survey of progress in a particular field of science, offering, in general, few hands-on exhibits. To some extent, Science Museums and Science Centres are complementary and the convergence of efforts in order to promote informal learning should be encouraged: in particular, Science Centres can beneficiate from the ideas underlying the museum collection and, simultaneously, share with the museum the know-how about the hands-on component. The present communication describes a project of collaboration between the Physics Museum of the University of Coimbra (a traditional university museum) and Exploratório of Coimbra (an interactive science centre), with the following general objectives: the design of interactive exhibits inspired in the instruments of the museum collection, including written materials, and research on the comparison between the impact and learning results of the exhibits when shown in both institutions.

Keywords. Science Museums, Science Centres, Interactive exhibits, Hands-on.

The Importance of Personalization in School Visits to a Science Center

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Abstract. Considering their specificity, school groups "demand" from the science center a different approach than the one required by other visitors. Before the actual visit day the science center should clearly understand the desires and ambitions of the group, and during the visit totally match their expectations in order to reach the minds and capture the hearts of students and teachers.

Fábrica Centro Ciência Viva, in Aveiro, offers a wide variety of scientific activities and exhibitions, placed in different areas of a renewed mill.

Taking in consideration the heterogeneity of school groups, each and every one of those spaces have the capacity to be changed in the scientific contents and also in the way scientific communication is performed, through the use of specialized explainers.

So that the teacher can be an active partner in our science center, several mechanisms are placed at his disposal in a way that he can have deep acknowledged of our activities. Therefore, teachers who intend to previously prepare their visit have free admissions and individual meetings with our staff, as well as having access to all of our scientific and pedagogical contents through the internet. Teachers also have an active role in the development of an individual and unique visit program to our center that goes through several steps. This process begins by taking data about the group (age and number of students, activities of interest, availability of time in our center, among others) and will end later, with an agreement from both sides, in that unique visit program.

Having most of the activities an interactive and experimental base, when the number of students is higher than 25, the referred program includes the division of this initial group in

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smaller groups which have their own plan of visit and one designated explainer in each activity. This makes possible for the explainer to have a personalized interaction with each student and teacher, highly increasing the ability to motivate them for science and technology, and therefore reach their minds and capture their hearts.

Keywords. Personalization, Explainer, School groups.

The Joy of Knowledge Sharing: Two Examples of Teachers, Researchers, Students and Science Centers Interaction

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Abstract. The motivation of young students to science is greatly enhanced when their participation is requested for actions that involve, besides the teachers in schools, scientists and science centers. The success is amplified when the science subjects are chosen to represent actual problems that concern the society as a whole and require a strong scientific background for their discussion. The organization of contests and exhibitions at science centers are ways of capturing the youngsters' attention and may result in a great joy of knowledge sharing for all participants. This paper describes two case studies: (1) ionizing radiation; (2) earthquakes.

Keywords. Science Centers, Earthquakes, Case Studies, Radiation.

An Integrated Approach to Attracting and Stimulating Third Level Physics Students

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Abstract. The drop off in the student uptake of physics in third level education has necessitated not only the development of innovative techniques for the promotion of physics based courses but also research into enhancements in pedagogic approaches. The Physics Education Research Group (PERG) and the School of Physics at the Dublin Institute of Technology have been at the forefront of developments in physics promotion and physics education innovation. Our Physics Technology programme was the first in Ireland to be taught in years one and two solely by Problem Based Learning (PBL). This necessitated the development of project based laboratories which enhance student learning by allowing the students to work, self-directed, in groups on real world physics projects. In the classroom the students work in groups on real life physics problems and each problem is accompanied by a set of deliverables. Current developments include the integration of community based learning opportunities for students. The School of Physics also has developed an innovated physics promotion programme in the primary and secondary education sectors which includes visits to schools, interactive physics demonstration lectures, in house laboratory and research programmes for second level transition year students, primary teacher training days and follow up presentations to primary school students, and during National Science Week, lectures, demonstrations and visits to our research laboratories by thousands of secondary school students.

Keywords. Problem Based Learning, Promotion of Science, Community Based Learning.

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Light Project

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Abstract. Because we consider experimentation as the solution to overcome the difficulties in theory learning, Fábrica Centro Ciência Viva de Aveiro are currently elaborating an interactive exhibition which crucial subject is light. However, this project is more than just a scientific exhibition about light; it is a contemporary, dynamic and overall approach of the concept. A visit to the Light exhibit has two main points of interest: to help science learning and at the same time allow adults and children to have a bit of fun, stimulating their curiosity and changing their attitude towards science. This project includes a very important area, in the science centre concept, where the interactivity and the hands-on are key words. With hands-on exhibitions we fight against visitant passivity, to transform apparently complex questions that naturally occur during the exhibition, into simpler and obvious answers promoting the comprehension of the concepts. This experimentation area approaches optics topics taught in school. The purpose of the exhibition is to offer dynamic moments being its main goal to fight preconceived ideas associated to science learning. However, this exhibition concerns not only the experimental component, but also the present times, society and the human being.

Keywords. Light exhibition, Hands-on, Science Centers.

XLAB: The Most Advanced Experimental Laboratory for Young Scientist

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Abstract. The number of students enrolling for university studies in all science disciplines dramatically decreased between 1990 and 2000 in all western countries. This conflicts with the rapid development in Science and Technology during the last decades and the need to impart this knowledge for next generations. There are today many activities in Germany initiated by scientists at universities and research institutions. Germany counts almost two hundred School labs. They focus on elementary, primary and early secondary education. The XLAB focuses primarily on students in their last two years of high school, according to the motto to bridge the gap between high school and university studies. The equipment of our laboratories resembles real research laboratories and the experiments in all science disciplines are very sophisticated. The students mostly stay for several days and reach a deep knowledge of the specific subject. XLAB attracts classes and individual students from all over Germany and from other European countries. Each Summer XLAB organizes an international Science Camps for high school and first year university students from all over the world, who work and live together for three weeks. The schedule can be compared with a scientific workshop and the results of each course are presented in a plenum session. XLAB started in August 2000 and will soon reach a number 43 000 student x days. Many of our participants decided to study science.

Keywords. Hands-on experiments.

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The Access of Women to Science

The communications presented at the 1st International Workshop on "The Access of Women to Science" in Cologne-Germany, June 2004, are also herein published

Socrates Comenius Education and Culture

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Women and Science

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Abstract. The Hands-on Science Network consider of utmost importance to analyze the issue of gender equality and more specifically the problem of the access of Women to Science. In school and to Science education in general but also in what concerns jobs and careers in Science and Technology.

On the report on equality between women and men of February 2004, the European Commission refer as most significant progress achieved by the EU' strategic policy initiative to promote gender equality, the important number of amended treaties and Directives issued. If its true that EU' legislation greatly improved in the direction delineated by the Lisbon agenda, its incorporation on national legislation is far from finalized and its application do not yet generated the practical positive impact that was expected. In Education, over last couple decades, women outnumber men in secondary and higher education and represent the majority of graduates (55% on average). The scenario changes on post-graduations were the percentage of women falls down to the 39%. But, by far, the worst situation happens in the fields of Science and Technologies where the percentage of graduations drop to between 21 and 36%. In what concerns employment the situation is extremely negative. In general women's employment rates increased on last years (yet clearly below the 60% Lisbon target). But it is rather "unusual" to find women employed in Science or Technology business. In industry the situation is even worst in spite the recognized quality of the women graduates and the efforts of some governments, women rights organizations and even some industrial companies. The situation is common all over Europe and it's not a fact that in countries with higher standards of living the situation is better…!

Since the 1st International Workshop "The Access of Women to Science" we organized in June 2004 in Cologne, Germany, these trends were confirmed and no definitive positive evolution was achieved.

Keywords. Women in Science, Gender.

Gender in Hands-on-Science. Benefits for Schools, Research and Industry

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Abstract. Sir Robert May, Chief Scientific Advisor to the UK Government and Head of the DTI Office of Science and Technology: "Ultimately, nothing in the governance of science engineering and technology is more important than making sure that, women play their full par, at every level. We need this outreach to be in pre-school, and energetically continue through primary, secondary and tertiary education."

Germany is falling behind its European neighbours in terms of the participation of women in science. There is a lack of female students especially in technical disciplines. To increase the number of women in these fields in the long run the only possible solution is to focus on the girls and to keep their interest in technical subjects over the years. This seems o be the best way to strengthen their self-confidence in their own abilities and qualifications. These are skills necessary for women to choose a job where we notice a lack of female role models.

When we talk about gender aspects everybody has an intuitive concept about what it means. But there are different indicators depending on the field of science and the educational situation.

In this work we will present some projects and show experiments which draw special attention to gender issue. We will draw conclusions from experiences in primary schools, secondary schools and finally, universities. The idea is to address girls at a very early age and to keep them occupied with science and technical subjects during their education at school. The aim is to convince girls that they can do a very good job in the field of science and research.

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After the presentation of the best-practice projects we will discuss their approaches and results. There are possibly contributions and experiences from other countries working with the mentioned age groups. We are interested in getting information about their proceedings and previous results.

Last but not least, we would like to set up criteria for improving teaching methods with regards to gender aspects.

Keywords. Gender, Hands-on Science.

Gender Preferences and Science Career Choice

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Abstract. Statistics show that the percentage number of females in science courses at the University of Malta is low when compared to other undergraduate courses. The ratio of males to females varies according to the science undergraduate course. This paper aims to identify reasons for gender differences in science undergraduate courses, lecturing staff and employees in science related professions. A questionnaire was addressed to two hundred and twenty three (223) undergraduate students following science related courses at the University of Malta. They were asked about their experience of science at Primary, Secondary and Post Secondary levels and about their choice of course/career. Personal interest in science was found to be the key factor that determines the decision in whether to pursue a science career or not. No gender difference was found to be statistically significant in this regard. Based on these findings, suggestions are made about how to improve science education with a view of increasing the number of students, both male and female, following a science career.

Keywords. Gender Preferences, Science Career.

1. Introduction

The choice of an occupation or career is an important decision for every school leaver. At the end of compulsory schooling, students decide whether they want to start working or further their education. Vocational choice is the outcome of a synthesis of factors. This study focuses on the role of science education in influencing the choice of a science career.

The total number of students at the University of Malta and the number of undergraduate students following science courses have increased by 34% from 1995 to 2003. According to the Labour Force survey, (March 2001), graduate employees in science related professions make up 12% of the total number of professional employees in Malta. Moreover, compared to other countries, (Science and Engineering Indicators, 2002), Malta ranks among the countries which produce the smallest percentage of science graduates. The faculty with the largest student population at the University of Malta during the academic year 2002/03 was the Faculty of Economics, Management and Accounts (FEMA), with 24.6% of the total student population. During the same academic year, undergraduates in science-related courses made up only 17.6% (1,569 out of 8,920 University students, 57% males and 43% females). This is a low percentage compared to other countries (except for Norway and New Zealand), Table 1, with Malta ranking among those countries producing the least number of science professionals.

Table 1
First university degrees & ratio of first university degrees & Science & Engineering (S&E) degrees to 24-year-old population, in selected regions and locations : 1999 or most recent year

Region/location	All first university degree courses	Total number of S&E degree courses	% total of S&E students of University degrees
Austria	14,365	4,170	29
Belgium	13,107	3,797	29
Czech Republic	18,799	5,416	29
Denmark	11,951	5,006	42
Germany	197,151	90,711	46
Hungary	37,988	9,089	24
Ireland	15,454	4,892	32
Italy	132,968	46,282	35
Malta **	8,920	1,569	18
The Netherlands	75,173	20,448	27
Norway	34,068	5,785	17
Spain	207,898	53,660	26
Sweden	29,787	9,597	32
Switzerland	18,646	5,175	28
Turkey	115,106	43,719	38
United Kingdom	263,671	92,999	35

Data Source: * Science and Engineering Indicators 2002
** University Administration Office (March 2003)

The Labour Force Survey, March 2002 reveals that at the end of September 2001, the

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labour supply totalled 144,692 of which 1969 i.e. 1.4 %, were found to be graduate employees in science related professions. This is also considerably low when compared to the proportion of students for the 12 European Member States in 1992/93 (Key data on Education in the European Union, 1996), *Table 2*. These statistics show that there is need for more science graduates in Malta.

Table 2. Percentage Number of Students in Higher Education by Science–related field & by Member State, 1992/ 93

	DK	D	GR	E	IRL	I	NL	AT	P	FI	SE	UK
Natural Sciences	4	7	5	6	14	6	4	6	4	5	4	7
Mathematics	4	5	4	5	5	3	2	6	4	7	6	5
Medical Sciences, Health	11	10	12	8	4	11	11	8	6	18	13	12
Engineering, Architecture, Transport	16	21	22	16	18	17	13	14	18	23	17	14

Source: Eurostat

The December 2004 labour force figures published by the National Office of Statistics through the labour force survey indicate that the females who are working or willing to work within the economy as a percentage of the total females of working age is still 30.6% compared to the 60% by 2010 target set in the Lisbon Convention of the European Union.

Progress in education depends on government's investment. In 2001, the Maltese government invested 7.3 million of its capital expenditure and 46.6 million of its recurrent expenditure in education. (Consolidated fund account for 2001). With respect to science education, the Prime Minister stated that "unless the country continues to invest heavily in this sector, it will not only lose the momentum it has established in a variety of economic and social fields, but will undergo a systematic process of deterioration, leading to economic dependence", Fenech Adami (1996). The shadow minister, Bartolo (2001), reinforces this initiative by saying that if Maltese citizens leave school without an adequate scientific literacy, Malta runs the risk of falling behind in the 21st century.

Overall, there is a demand for science professionals in Malta. The Employment Barometer Survey 2002, indicates a shortage of mechanical engineers. The statistic is based on the unemployment figures for April 2002 and on the demand of employers during the same period. In addition to graduate professionals, our society also needs employees in the industrial, technical and health related areas which support professionals and who also call for a certain amount of publicity, promotion and exposure to science in order to engage in such a job.

The aim of this paper is to identify gender differences in science-related courses at the University of Malta. It also reports results of a survey conducted among science undergraduates about their interest in a science career. In view of these findings, actions that need to be taken in order to attract more students, particularly females, to science are proposed.

2. Theoretical background.

The under representation of women in science, sex differences in interests and achievements have been the springboard to a wide range of research in gender and science education. Sex differentiation holds its roots to school, the 'hidden' and overt curriculum apart from social interactions in the wider context of society.

Science is perceived as a male domain in schools. Harding (1996) argues that school science becomes masculinised through: the predominance of males working in science; the way science is 'packaged' for teaching and learning; classroom interactions which reinforce stereotyped expectations and the way science itself is conceived and practised. Another disadvantage to females, documented in the AAUW report (1992) states that, in America's schools, girls receive an inferior education to boys in terms of the amount of attention given in the classroom. Thus teachers should be responsible to eradicate any issues which might reserve the association of particular subjects to one sex only. Instead they should provide opportunities for girls "to participate in science as women, rather than substitute men", (Gilbert, 2001).

Vlaeminke et al. (1997) mention the contextual, cooperative and student-centred curriculum as being more compatible with femininity. Females attune more to science in a social context. According to Head (1985) and Harding (1996), they seek humanisation aspects and applications.

The responsibility for the limited number of girls choosing science should not only be attributed to the curriculum. Kelly (1981) proves that boys liked science more than girls. In addition to this, both sexes differ in their preferences within science subjects. In a Maltese study Ventura (1992) reveals that "girls avoid careers in engineering and technology for which mathematics is compulsory, and prefer careers in medicine and related subjects instead."(p.12). These findings, in no way imply that females are inferior to males or are incompetent in science. In fact, Ventura found that at secondary level, girls, perform better than boys in science examinations. As Kelly (1981) claims that despite getting good grades, girls are not accepting the physical and mathematical sciences.

The gender gap due to performance in science and mathematics becomes wider as age increases. Various research works suggest that sex differences in scholastic attainment tend to emerge clearly and consistently after the age of eleven. Gafni and Beller (1996) assessed the performance of 3,300 pupils (aged 9 – 13) from 110 different schools and, found that boys' performance was on average better than girls across all participating countries. In Malta, Gatt (2002) found that although no gender differences were obtained for the overall grade, girls outperformed boys significantly in the coursework aspect of the national certification system.

Boys and girls differ in their interest for science and the confidence and relevance they attribute to the subject. Though a lot of research has been carried out in the attempt to find gender differences in children's performances, researchers like Robertson (1987) express the opinion that "there are more similarities than differences between the performances of girls and boys". In his research, this was particularly so in the case of practical laboratory tasks.

Camilleri (2002) found that in the case of 16 year olds, there are no significant gender differences in the performance of Matriculation Secondary Education (SEC) examinations (held in May 2001) except in Maltese and Physics. Girls perform significantly better in Maltese whereas boys outperform girls in Physics. Camilleri further argues that the effect of gender on school attainment is almost insignificant since out of 4 examinable subjects, one of which was Mathematics, only Maltese and Physics revealed gender differences. A similar foreign study about the performance of 16-year olds by Bell (2001) specifies the cognitive areas in which both sexes differ.

> *"Gender differences exist in question parts that only involve the retrieval of declarative knowledge and not the use of procedural knowledge. These differences are in favour of boys for physics contexts such as mechanics and earth and space, and in favour of females for human biology. A consideration of the processes used would suggest that it is the depth of processing of information that is the critical factor".*
>
> (Bell, 2001, p. 484)

Education and gender do not progress in a vacuum but in the context of society at large and in smaller nuclei such as the family. Bell (2001) considers activities out of school accountable for different performances. He attributes the gender differences mentioned above to the activities in which boys and girls prefer to engage and the environments made available to them by parents and by peers.

Various researchers claim that single-sex schools and classrooms create less gender-related stumbling blocks than in the case of co-education. However, others debate that when elements of good education are present, girls and boys succeed, irrespective of whether they are in single or mixed schooling. The AAUW (2000) comments that "while we can draw lessons from single-sex educational experiments, we must continue to improve co-education so that all students benefit".

Although small in numbers and many drops out from pursuing a career in science, women have shown to be competent in this area of science. Etzkowiz et al. (2000) compare the decreasing number of women in science to a pipeline.

> *"Women pass along a pipe that leaks at every joint along its span, a pipe that begins with a high pressure surge of young women at the source ...and ends at the spigot with a trickle of women prominent enough to be deans or department heads..."*
>
> *Etzkowiz et al. (2000)*

3. Aims and objectives

The main aim of this study was to look at the numbers of female scientists and female students in science-related undergraduate level courses and to identify those factors that share a contribution in the decision to pursue a science career at Tertiary level.

The specific objectives of the study included:

1. Reviewing statistics on number of female students attending science-related courses at the University of Malta;
2. Identifying the factors, among probed influences (personal, family, school) which promote the choice of a science course / career and whether boys and girls are affected differently;
3. Studying the degree of influence of the educational system on the choice of a science career and if there are gender differences with respect to school influence; and
4. Identifying the point at which boys and girls decide to take up a science career.

4. Method of research

The method of research was divided in two parts. The first included an analysis of the statistics of students and staff at the University of Malta. This data was supplied by the University of Malta administration. The second part of the research was based on a questionnaire with university students following an honours science course. A sample size of 223 respondents, stratified to represent the actual ratio of students in the different science courses, was obtained. This made up approximately 17% of the total number of students in each of the following science related honours degree courses: Bachelor in Science, Education, Engineering, Architecture, Nursing, Environmental Health, Dentistry, Pharmacy and Medicine. Ninety-five percent (95%) responded to the questionnaire of which 47% were females and 53% males.

5. Analysis and discussion of results

5.1. Analysis of University Statistics

Table 3: Undergraduate students in science-related courses classified by Course, Gender and Academic year.

COURSE	Year and Gender 2001			2002			2003				
	M	F	T	M	F	T	M	F	T	*MT*	*FT*
B.E.&A.	61	39	**28**	77	23	**26**	64	36	**36**	***67***	***33***
B.Eng.	85	15	**48**	81	19	**64**	81	19	**48**	***83***	***17***
B.Pharm	29	71	**28**	42	58	**36**	29	71	**24**	***33***	***67***
M.D.	59	41	**61**	58	42	**38**	65	35	**37**	***61***	***39***
B.Ch.D.	73	27	**15**	0	0	**0**	54	46	**13**	***64***	***36***
B.Sc	57	43	**30**	52	48	**29**	55	45	**44**	***54***	***46***
IHC	47	53	**36**	39	61	**83**	31	69	**52**	***39***	***61***
Total	**59**	**41**	**246**	**58**	**42**	**112**	**54**	**46**	**254**	**57**	**43**

Note: M= % number of Males; F= % number of Females; T= Total; IHC = Institute of Heath Care
Data Source: Education Statistics 2001

Analysis of student statistics show that, overall, the number of females following science courses at tertiary level has increased by 5% between 2001 and 2003. However, males and females differ in their preferences. From statistics, females predominate in Health Care courses, mainly Pharmacy, Nursing, Environmental Health, Physiotherapy and Radiography courses. Engineering and Architecture courses remain a male domain. With regards to the other science related courses, the presence of females is noticeable, (Table 3).

For the academic year 2002/3, the total student population at the University of Malta had a predominance of males over females in Engineering and Architecture courses. Females predominated in the Pharmacy, Education and Health courses. The number of males and females found Medicine, Science and Dentistry courses was approximately the same.

Females predominate in Pharmacy and Health courses because they are more interested in biological sciences than in the physical sciences (Peltz, 1990). In addition, convenient working hours are perceived to be more appropriate for potential working mothers and thus have an influence on the number of females in the Education course.

The number of female science graduates has increased these last few years, however when compared to other countries, Malta still produces the lowest number of female scientists per capita: Approximately 70 female science graduates / 100,000 persons in the labour force aged between 25 to 34 years, as opposed to 460 male science graduates / 100,000 persons, (OECD, 1996). Thus, the government has the responsibility of providing initiatives aimed at attracting women to science, engineering and technology and providing an environment that retains them.

Table 4. Lecturing staff classified by Faculty and Gender, 1999-2000.

Faculty	% Male	% Female	Total
Architecture	100%	0%	15
Engineering	97%	3%	33
Medicine & Surgery	80%	20%	120
Dental Surgery	90%	10%	10
Science	91%	9%	55
Institute of Health Care	41%	59%	73

Data Source: Education Statistics, Malta 2001

The problem lies with the quantity of graduate women who for some reason do not make it to high academic posts. An under-representation of female scientists at senior level is a proof. In the case of University staff, it was found that at present, there are only two Maltese female professors at the University of Malta, and they are both in science-related faculties. The number of female lecturers is highly inferior to that of males except for the Institute of Health Care where females outweigh males by 18% (Table 4)

5.2. Questionnaire responses

Based on the responses obtained, this part of the study showed that there are no gender differences in the enjoyment of science, the time at which students make their decision to follow a science career and the degree of influence that Primary and Secondary science have on the choice of a career. χ^2 tests of variables conducted across gender were found to be statistically insignificant. Therefore, factors which students consider influential on their science career choice tend to be the same for males as for females. This means that there are no gender differences between those who choose science. This does not rule out the existence of gender differences between the number of boys attracted to science to that of girls. As the statistics in the first part show, significantly fewer females are attracted to particular science courses. The following sections outline those aspects of science that have attracted boys and girls in the same way.

5.3. Type of school attended

Most of the respondents came from church schools at Primary and Secondary levels followed by state education at Sixth form. The schools which produce most science professionals in Malta are church schools. When considering that church schools cater for the education of only 30% of children in Malta, their contribution to promoting science-related career is significant. This may be the result of fewer subject options available in these schools; the effort of guidance teachers to channel clever students to science; or the fact that church schools in Malta are single-sex schools.

Gatt (2003), reveals that 97% of students attending a church postsecondary school come from church secondary schools. This study showed that a relatively greater number of students attended church rather than independent schools. These results suggest that parents tend to perceive church schools as providers of a selective, motivating, social group to their children at an affordable expense when compared to private schools. One should also keep in mind that whereas entry into boys' Church school is through a competitive entrance examination, this is not the case for girls. This shows that it is not only the case of Church schools having better achievers, but for the possibility that these schools tend to promote the science option in both boys' and girls' schools. In addition, Church schools tend to favour females' choice of science as they are single-sex schools. Ormerod (1975) demonstrated that fewer girls opt for science in coeducational schools than in girls' schools.

Post-Secondary state education in Malta known as the Junior College, hosts most of the students because of the limited number of private and church sixth forms available in Malta. Nonetheless, the number of respondents from church sixth forms was quite high. Selectivity in the admission of students to church and state sixth forms plays an important role in the results obtained. Selecting best achievers contributes to have a large percentage furthering their education at tertiary level. Gatt (2004) also reveals that the majority of students from Church Primary and Secondary schools tend to follow general Post-Secondary education rather than the vocational stream.

Considering the limited number of places in church Sixth forms compared to the state Junior college, Higher Secondary and Prevocational school, the number of University students from church sixth forms is quite high. This is not necessarily because Church schools provide better instruction but because the best students are admitted. Places are few whereas the demand is high.

5.4. Science as an enjoyable experience

Respondents, boys and girls, enjoyed science lessons at all levels of schooling. They enjoyed science lessons mostly at primary level. However, for both genders, this decreased as students proceeded from Primary, to Secondary, to Sixth form. The perception of science being a subject to one's liking at Primary level turns out to be less enjoyable as it is studied more formally. Camilleri (1999) reveals that positive attitudes towards science decline from Primary to Secondary. The decline in interest is found to be sharper in science than in other subjects (Gardner 1985). Students who claimed that they enjoyed science less from Primary to Postsecondary are those students who in fact chose a science career and therefore those who are expected to be interested in the subject more than others. This is particularly worrying as one need to look at those students who were turned off science and did not opt for it, particularly in the case of girls.

There is a relationship between the degree of enjoyment of science at Sixth form and the undergraduate course followed. Most students expressed a high level of enjoyment of science at post-secondary level. However, differences did not emerge between the different genders but between the different courses frequented. Science at Sixth form appears to be significantly enjoyed mostly by Education, Science, Engineering, Medicine, Pharmacy and slightly less by Architecture and Health Care students. Dentistry students enjoyed science least at Sixth form level. Education and Science students specialising in science subjects, are the students who showed the greatest degree of enjoyment. On the other hand, Dentistry students might have perceived science as just a stepping stone to the career they aspired for. Therefore students who mostly enjoy science at Post Secondary level tend to choose courses which provide the opportunity to study the pure science (B.Sc. and B.Ed.). With the slight decrease in enjoyment, students opt for applied science University courses such as Engineering, Medicine and Pharmacy, which are vocational courses. Students following Science and Dentistry courses would probably have aimed at a different course such as medicine.

5.5. Decision point to follow a science career

All respondents, that is, for both genders, expressed that they remember their first interest in science mainly at Secondary level. However, they decided which particular science undergraduate course to pursue mainly at the point of entry to University, on receiving their results. Students decide upon the course they would like to follow, by considering those courses they are eligible for, based on their exam results. Most science-related courses for the academic year 2002/2003 required an Advanced level pass at Grade C or better in one or two science subjects, (Special course requirements, 2002). On the other hand, Medicine was the most demanding. To be eligible, students have to obtain passes at Grade B or better in Biology and Chemistry.

A very small number of students decided upon their career before first fostering an interest in science related careers. These were mainly respondents that stated a first interest in science at primary level. Career decisions taken at Primary level are weak and tend to be irrelevant to career decision making. There is consistency in the results obtained, i.e. that first interest in science mainly takes place at secondary school level, while the actual decision, to follow a particular course/career, is made just before admission to University. Ginzberg (1972) shows that realistic career decisions are often made between the age of 18 and 25, when individuals dissociate themselves from their fantasies about careers and make more pragmatic decisions. This depicts subject choice, at Secondary level (age 13/14) as being too early.

5.6. Factors determining science-career choice

When students were asked to identify factors influencing their decision to follow their particular course/career, the predominantly influencing factors mentioned were:

a) personal interest in science (58%);

b) feeling good at science subjects (47%); and

c) examination grades obtained in the order stated (40%).

Personal interest in science was regarded as the most influential factor in career choice. Factors related to science education do not predominate. However science education can act as a secondary factor contributing to the increase of science professions. Fostering interest in the subject, providing experiences of success in science and making students feel they are good at these subjects indirectly influence the choice of a science career.

The second factor considered to be influential was ‘being good at science subjects’. Lau et al. (2002) have found that psychological aspects derive from motivational variables which prove to be the strongest predictors of engagement, choice of science subjects and careers among

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high school students. All the students ticked more than one factor that influenced their decision to follow the science course / career. This confirms Woolnough's (1997) conclusions, that students' career choice in science is the result of "the variety of social, school and personal influences interacting upon the student to form his or her career choice". 'Personal interest in science subjects' is the factor mostly considered when choosing subjects both at Secondary and Post-Secondary levels. Parental influence is considered the least influential of all. 'Status of the future occupation' and 'Requirements for the degree course' are considered to be more influential at Post Secondary than at Secondary level.

6. Discussion

Research in science education (Kelly, 1981; Head, 1985; Whyte, 1986; Darmanin, 1991; AAUW, 1992) shows that there are gender differences, in the performance and achievements of males and females at various levels of education. This was not found to be the case overall in Malta with girls performing as well as boys at school leaving level. However, a disparity in the number of females in particular undergraduate courses was identified. This was accentuated in engineering courses. Whyte (1986) attributes the choice of a career by males and females to the choice of subjects at school. Science subjects are often stereotyped. The label certain subjects are given can narrow the vision of students, who are led into certain paths, to conform to the male/female identity with which they have been brought up from a young age.

> "The 'gender spectrum' of school subjects – arts, languages, domestic subjects for girls, mathematics, physics and technical subjects for boys – not only reflects labour market divisions, it reconstructs them, fitting boys into their future, corresponding positions in the male or female labour market"
>
> (Whyte, 1986, p. 16)

This study shows that those who were attracted to science were influenced by the same factors, irrelevant of their gender. However, the numbers show that the way science is being presented today is pushing away many girls. This means that a percentage of potential scientists, particularly females have been driven away as a result of the way that science and scientific careers are presented.

There are various initiatives that can be taken in order to make science more attractive to a larger number of students. One particular aspect is that girls are more attracted to the social aspect of science. Science is currently often presented as an objective and detached practice which removes any sense of feeling or caring. This has to change if one wants more females to take up science as their career choice. As Harding (1983) argues, we have to take action at all levels of education: national; school; and teacher level.

At national level, Harding (1983) argues the presence of choice options at secondary level limits the students' access to opportunities. However, Ditchfield and Scott (1987) put a counterargument stating that making science compulsory is not the solution. They argue that teachers should cater for all students, giving them the chance to choose whether they would like to study or not certain areas of science. What is important is that students are provided with meaningful experiences. Harding also argues that more attention should be given to those areas such as physical sciences in which girls tend to be weakest. This requires the provision of professionally trained teachers. Teachers should be made aware of gender differences. Spear (1987) recommends that teachers start considering the value of doing science to students, both boys and girls, and to introduce project work on the range of occupations that require or prefer qualifications in science subjects.

Education officers and subject coordinators should be aware of the problem and offer adequate information and effective training schemes for girls to follow at school. Efforts should also be made at primary level such that girls can have the opportunity to overcome the feeling of strangeness that is usually experienced at secondary level. Links should also be set up between schools and women at work at 16+ and 18+ levels.

At school level teachers should be made aware of the different feedback that is generally given to boys and girls and how this may result in setting stereotypes that science is for boys. Within guidance and counselling, girls should be presented with possible employment opportunities, including those involving science. Links with industry should also be kept and personnel at various levels of employment invited to talk to students about their work. Extra help should be made available to girls who experience difficulty with science subjects as it is the case with other subjects. From the GIST (Girls in Science) experience, 'tinkering' activities which were introduced during science lessons or in special girl clubs, were found to give positive results: like enhancing the spatial ability; familiarising girls with topics such as electricity, energy etc.; and building their self-confidence and competence in the subject (Whyte, 1986).

Curricular changes should also change, moving away from more abstract, conceptual, mathematical, less practical and divorced from everyday life approach which tends to put off girls. Instead, science that is more relevant to the environment should be included. Versy (1990) also makes a number of useful additional suggestions in what she calls 'staff development strategies'. These suggestions include: gender issues to be central focus in INSET courses at any level, be it course development, department management, special needs, active learning, school community links etc.; gender issues should be discussed in a friendly atmosphere which can be achieved through small group discussion; development plan concerned with gender should be drawn up and submitted by subject coordinators and education officers; a person in the school should be given the responsibility to keep gender awareness among staff attitudes and teaching material prepared; setting up a monitoring group concerned with gender to foster and suggest teaching approaches better suited to girls and boys; and finally people having responsibility should use their influence on publishers, teachers, examination boards etc..

Many initiatives can be taken at teacher level. The first step is to recognise the existence of the problem and that girls tend to be at a disadvantage due to the low self-esteem that they often have with respect to science. Teachers should push girls to do their best by having similar expectations from girls as from boys. They should give girls more opportunities to handle apparatus and carry out experiments. Examples related to science should also be of interest to girls. This is mainly achieved through considering social issues. Subject specialist teachers seem to oppose possible changes in teaching techniques more than non-subject specialist ones. In addition, to those already mentioned, one finds the need to use non-gender illustrations showing girls and women performing less conventional tasks; experiments to which pupils can relate personally; role-playing exercise; proposing solutions to open-ended problems; and the inclusion of design experiments. Both boys and girls should be considered as equal learners with individual needs, interests and objectives from which benefits are to be derived from the scientific activities.

7. Conclusions

Unless the recruitment of female scientists is promoted, the Maltese economy will be deprived of the talent of a fraction of half the population. Thus it is important to make it easier for women to take a stand in the scientific male-dominated terrain. An effective way of starting to eliminate differentials amongst both sexes is by reforming science education. Instead of trying to make girls fit into the existing science curriculum, the science curriculum must become more inviting for girls.

Students should be encouraged to choose not only on the basis of their liking of the subjects but also to keep in mind their future career. Students should be guided professionally to choose the subjects which will make them fulfil their vocation. In particular, females should have more exposure not only to health sciences. Given the proper career guidance at all levels of education, students would be more prepared to face challenges and make more informed decisions. It is recommended that subject choice at Secondary level is postponed. Students can study Physics, Chemistry and Biology in the form of co-ordinated science. This eliminates studying Physics as the only compulsory science subject at Secondary level. The choice of science subjects can be made at Advanced level, prior to Post-Secondary education. Consequently, all students would have experienced three science subjects and would be more informed when choosing to take up science.

It is hoped that the number of science careers in Malta will increase and match the average number of students in other countries. Increase in the number and proficiency of students, of both sexes, following science courses will help meet the ever changing demands of the Maltese economy.

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Inviting Women to Physics and Engineering

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Abstract. It is a well known fact that women tend to prefer other fields then Physics and Engineering when they choose a career. This is also the case in Portugal.

At our University, female undergraduate students in Engineering are less then twenty percent while in Biology they largely exceed male students. According to research, this gender bias is enforced by an ordinary discourse, shared by secondary school teachers, which tend to ignore female scientists and female engineers accomplishments and adopt a male dominant stance regarding the profile of the profession.

In order to help change in secondary teachers attitudes and discourse, we planned an in-service course, twenty five hours long, focusing in three case studies of high succeeding female in the fields of applied Physics and Engineering. Not only we used biography to highlight the obstacles which confront women when they enter traditionally male dominated fields but we debated the advantage of adopting a feminine shaped style to better solve several kinds of technical or scientific problems. We hope that, after following the course, teachers would be convinced that both, men and women, are equally fitted by nature to succeed in every field of science and technology, regardless particular styles of thought and action associated with gender, and that better performance will be achieved through team work.

Keywords. Women in Science, History.

Women are not just technical operators. It is self-evident that, across the centuries, women have always been in close contact with the technology of everyday home production and, at the least as operators of industrial high-technology devices and tools.

A quick survey of the history of engineering and technology might lead one to believe that technology is the dominion of men. After all, there are few women technologists or scientists whose names resonate like those of men such as Faraday or Edison. This is largely because, historically, women have had limited access to education, especially in fields such as science and engineering. In the first two decades of the 20th century women were excluded from engineering schools, and although many men of the era didn't go to engineering school either, women didn't have the other route of learning the profession—on-the-job training. In addition to the lack of access to schools and workplaces, women were generally assumed to have no mechanical abilities or even interest in technical fields.

Like other marginalized groups, however, women have found ways of making their presence in these fields known. In their roles as workers, consumers, housewives, and later as scientists and engineers, women have always helped shape the direction technology has moved in.

One example of that influence is in the history of communication. Electrical communication is a field that includes technologies ranging from the telegraph and the telephone to satellite communications. Although famous men such as Samuel Morse and Guglielmo Marconi are well known as inventors in this field, women played major, if lesser-known, roles as operators and users of new and developing technologies. That is, women were often central in what is often the key point in the history of a technology—the time when an invention moves from the laboratory into practical use.

What we seek to highlight in this project is not the easily acknowledged technical and industrial role of women in both modern and ancient human societies but the role of women as modern science and technology creators, the special women capability to easily operate and conceive things, ideas and concepts in the front areas of human improvement which are commonly identified as masculine fields. We would not call attention to the typical telegraph and telephone old feminine job but would describe the contribution of some feminine physicist whose work was important in developing telecommunications.

So, when selecting the three personalities whose life and work should provide arguments to enforce and illustrate that thesis, we have chosen three such areas, as pioneering computing, modern physics and aviation.

Gendered skills. Some skills are labelled masculine or feminine because men and women need them specifically to perform their respective gender roles, and they are not generically useful for almost any role (as walking, talking, and seeing are). It takes a particular knowledge of small children to know how to comfort them, a particular knowledge of soldiers to know how to whip up their morale. Although men and women alike may acquire and exercise these skills, they are considered the peculiar responsibility of one or the other gender. Men and women may therefore have differential access to such skill-based knowledge. To the extent that the skill is perceived by the agent as the proper province of the "other" gender, he or she may have a difficult time seeing himself or herself perform it confidently and fluidly, and this inability to self-identify with the task can impair performance. The feedback effects of the phenomenology of gendered embodiment and *de se* knowledge of one's own subjective gender identity can therefore influence the exercise of gendered skills. To the extent that a skill is perceived by others as the proper province of one gender, others may grant or withhold acknowledgment of an agent's expertise. If the successful exercise of the skill requires that others be willing to accept it as a competent performance — as in the cases of comforting children or raising soldiers' morale — others' gender-based readiness or refusal to grant expertise to an agent in exercising that skill can be a self-fulfilling prophecy. These phenomena raise various questions for epistemology. Does the "masculine" symbolism of certain scientific skills, such as of assuming an "objective" stance toward nature, interfere with the integration of women into science? Do actually or symbolically "feminine" skills aid the acquisition of scientific knowledge? (Keller 1983, 1985a; Rose 1987; Smith 1974)

Gendered cognitive styles. Some theorists believe that men and women have different cognitive styles (Belenky et al 1986; Gilligan 1982). Whether or not this is true, cognitive styles are gender symbolized (Rooney 1991). Deductive, analytic, atomistic, acontextual, and quantitative cognitive styles are labelled "masculine," while intuitive, synthetic, holistic, contextual and qualitative cognitive styles are labelled "feminine." Such associations are not

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wholly arbitrary, the way blue is gendered male and pink, female. For example, it is seen as masculine to make one's point by means of argument, feminine to make one's point by means of narrative. Argument is commonly cast as an adversarial mode of discourse, in which one side claims vindication by vanquishing the opposition. Such pursuit of dominance follows the competitive pattern of male gender roles in combat, athletics, and business. Narrative is a seductive mode of discourse, persuading by an enticing invitation to take up the perspective of the narrator, which excites one's imagination and feeling. Its operations are more like love than war, and thereby follows a mode of persuasion thought more suitable for women. These phenomena raise numerous epistemological questions: does the quest for "masculine" prestige by using "masculine" methods distort practices of knowledge acquisition (Addelson 1983)? Are some kinds of sound research unfairly ignored because of their association with "feminine" cognitive styles (Keller 1983, 1985b)? Do "feminine" cognitive styles yield knowledge that is inaccessible or harder to achieve by "masculine" means (Duran 1991, Rose 1987, Smith 1974)?

Purpose of the project. We did not intend to contribute to further the research on those issues. We solely wish to raise awareness of them among secondary school teachers discussing such matters as social, familial and personal preconceptions, education opportunities, life perspectives, natural disposition and personal capacities, academic and social recognition through prize awarding (as the Nobel), public awareness, and historical truth.

Ada Byron, recognized as the first theoretical programmer, before a computer was available, provides an example of effective harmony between "deductive, analytic, atomistic, acontextual, and quantitative cognitive styles, labelled "masculine," and intuitive, synthetic, holistic, contextual and qualitative cognitive styles, labelled "feminine."

Mileva Einstein, whose contribution to the theory of relativity is now well accepted as equal partner of his husband, Albert Einstein, provides an example of the possibility that "to the extent that a skill is perceived by others as the proper province of one gender, others may grant or withhold acknowledgment of an agent's expertise". Sadly, in her case, acknowledgment has been withhold.

Amelia Earhart, one of the most brave and competent aviators of the time of the first long and very long transcontinental flights, broke world records of distance and altitude. Her life, in spite of several difficulties, provides an example of a women whose great skill was not perceived by herself as the proper province of the "other" gender, able to bypass the common inability to self-identify with a "masculine" task - thus impairing performance - but saw herself perform it confidently and fluidly.

The key for success would be to combine "feminine" and "masculine" intellectual styles, step on every profession without preconceptions about their particular demands, to be prepared to ask, or fight, for due credits.

Interest of the project. The presence of women is proportional to the friendliness and openness of the academic and professional community of the particular field. It is likely that these two factors are closely related. Typically, physics and many of the engineering disciplines attract and retain the fewest women, both numerically and proportionally, while the biological sciences seem to attract the most; mathematics has tended to fall somewhere in between (Murray, 2000). Persistence rates for women in science-related fields are significantly lower than those of their male peers. In industrialized countries, the persistence rate of men was about 60 percent at highly selective institutions with an average of 40 percent for global samples, compared to 46 percent and 30 percent, respectively, for women. Early intervention and encouragement can break the gender barrier (Hyde & Newsome, 2000).

Structure of the project. The 24 hours course is organized in eight sessions of three hours each. Each session is divided by a fifteen minutes pause in two periods. The first period of each session will be lectured while the second period will discuss and explore practical aspects of the issues raised in the lecture.

During the first session, other than the presentation of the course, general issues related to gender and profession shall be discussed. Conclusions will be drawn from the discussion and registered for later work.

The next six sessions will be dedicated to the life and work of the three personalities already named. While one session unveils the life, the next one studies the work. Participants will be asked to search the Internet at home and write short essays - from twelve to twenty lines - one for the life, the other for the work of each personality. The texts will be read during the respective session.

Fig 1. Ada Byron – A computer scientist well before the time

Along the final session, general issues related to gender and profession will be discussed as in the first session. The lecturer will comment evolution in the participant's ideas and beliefs.

Ada's life. August Ada Byron was born December 10, 1815 the daughter of the poet, Lord Byron. Five weeks after Ada was born Lady Byron asked for a separation from Lord Byron, and was awarded sole custody of Ada who she brought up to be a mathematician and scientist. Her mother once commented that *Ada was especially fascinated by mechanical things; she loved to figure out what made machines work*. Lady Byron was terrified that Ada might end up being a poet like her father. In her 30's Ada wrote her mother: "If you can't give me poetry, can't you give me poetical science?" *Her understanding of mathematics was laced with imagination, and described in metaphors*.

The one person young Ada most longed to meet was Mary Sommerville, a mathematician who had just published *The Mechanism of the Heavens*, a book on mathematical astronomy. *For Ada, Mrs. Sommerville was a role model* - a woman who was also a mathematician.

At 18, Ada Lovelace met Charles Babbage, who invited her to study his difference engine. By observing what Babbage had designed and by asking him questions, she soon became an expert on the inventor's work. When Babbage changed his plans and began to design his analytical engine, Lovelace saw tremendous potential in the machine. She understood it better than most other people older and more experienced than she.

One of her family's closest friends was Augustus De Morgan , the famous British Logician. Mrs. De Morgan was present at the historic occasion when the young Ada Byron was first shown a working model of the Difference Engine, during a demonstration Babbage held for Lady Byron's friends, in November, 1834. In her memoirs, Mrs. De Morgan remembered the effect on Ada:

While the rest of the party gazed at this beautiful invention with the same sort of expression and feeling that some savages are said to have shown on first seeing a looking glass or hearing a gun, Miss Byron, young as she was, understood its working and saw the great beauty of the invention (Angluin, 1976).

Ada attempted to put mathematics and technology into an appropriate human context. At the dinner party at Mrs. Somerville's, Babbage conjectured: "What if a calculating engine could not only foresee but could act on that foresight." Ada was touched by the "universality of his ideas". Hardly anyone else was.

The Italian mathematician Menabrea had attempted to explain how the analytical engine would work in a presentation at a scientific conference in Vienna. Lovelace was asked to translate his paper into English. While doing so, she added footnotes and explanatory sections which greatly enhanced the original. By the time she was finished, the paper was three times as long as Menabrea's, and much more useful. Babbage was very pleased. He published and distributed Lovelace's work, modestly signed with only her initials "A.A.L." *Although this paper was the summit of her career, she felt it was unbecoming for a woman of her social class to publish anything so "unfeminine."* It was nearly 30 years before the identity of "A.A.L." was commonly known.

After she wrote the description of Babbage's Analytical Engine Ada's life was plagued with illnesses. Her social life, in addition to Charles Babbage, included Sir David Brewster, Charles Wheatstone, Charles Dickens and Michael

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Faraday. *Her interests ranged from music to horses to calculating machines*.

Ada anticipated by more than a century most of what we think is brand-new computing. She wrote about Charles Babbage's "Analytical Engine" with such clarity and insight that her work became the premier text explaining the process now known as computer programming.

Ada died of cancer at the age of thirty-six. Babbage outlived her by decades, but without Ada's advice, support, and sometimes stern guidance, he was not able to complete his long-dreamed-of Analytical Engine.

The Analytical Engine. Ada was one of the few to recognize that the Difference Engine was altogether a different sort of device than the mechanical calculators of the past. Whereas previous devices were analog (performing calculation by means of measurement), Babbage's was digital (performing calculation by means of counting). More importantly, *Babbage's design combined arithmetic and logical functions*. Babbage eventually discovered the new work on the *Algebra of Logic* by De Morgan's friend George Boole. But, by then, it was too late for Ada.

Ada, who had been tutored by De Morgan, the foremost logician of his time, had ideas of her own about the possibilities of what one might do with such devices. Of Ada's gift for this new type of partially mathematical, partially logical exercise, Babbage himself noted: "She seems to understand it better than I do, and is far, far better at explaining it" (Angluin, 1976).

Lady Lovelace's published notes are still understandable today and are particularly meaningful to programmers, who can see how truly far ahead of their contemporaries were the Analytical Engineers. Professor B. H. Newman in the Mathematical Gazette has written that her observations "show her to have fully understood the principles of a programmed computer a century before its time" (Angluin, 1976).

The distinctive characteristic of the Analytical Engine, and that which has rendered it possible to endow a mechanism with such extensive faculties as to make this engine the extensive right hand of algebra, is the introduction into it of the principle which Jacquard devised for regulating, by means of punched cards, the most complicated patters in the fabrication of brocaded stuffs. It is in this the distinction between the Analytical Engine and the Difference Engine, previously invented by Babbage. The bounds of arithmetic were out stepped the moment the idea of applying cards had occurred.

In enabling a mechanism to combine together general symbols, in successions of unlimited variety and extent, a uniting link is established between the operations of matter and the abstract mental processes of the most abstract branch of mathematical science. A new and powerful language is developed for the future use of analysis so that these may become of more speedy and accurate practical application for the purposes of mankind than the means hitherto in our possession have rendered possible. Thus not only the mental and the material, but the theoretical and the practical in the mathematical world, are brought into intimate connexion with each other. We are not aware of its being on record that anything partaking of the nature of what is so well designated the Analytical Engine has been hitherto proposed, or even thought of, as a practical possibility, any more than the idea of a thinking or a reasoning machine (Ada Byron cited by Angluin, 1976).

Because the tool making art of his day was not up to the tolerance demanded by his designs, Babbage pioneered the use of diamond-tipped tools in precision-lathing. In order to systematize the production of components for his Engine, he devised methods to mass-manufacture interchangeable parts and wrote a classic treatise on what has since become known as "mass production."

Fig 2. Mileva Einstein – Under the shadow of a man

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The Einstein's first marriage. It is a truism to state that Albert Einstein was undoubtedly a genius and a breathtakingly original thinker. Nothing will obscure the accomplishments of the most celebrated scientist of all time. But a basic sense of justice and fair play requires that credit must be given where credit is due. It is in that spirit that the world should know the name, and credit should be given, to an equally brilliant scientist, Mileva Maric, the first wife of Albert Einstein.

Albert Einstein met Mileva Maric when he entered the elite Swiss Polytechnic School in Zurich. Albert did not initially gain admittance to this elite school and much has been made by Einstein's critics that Einstein was only admitted on his second attempt. While it is true that Einstein did not initially pass the admittance test, this had nothing to do with his mathematical or scientific understanding. In fact, Einstein scored very well in math and science on the admission test (Albert Einstein, 1990). Where he failed was in the French test. Further, Einstein was trying to gain admission to the Swiss Polytechnic at the tender age of 16, without even having first completed high school. The Swiss Polytechnic advised the young Einstein that they were impressed by his math and science scores but he should really finish high school first and then try to gain admission the next year. Einstein went back to high school in Germany, got his high school diploma, and was easily admitted on his second attempt to enter the Swiss Polytechnic (Pais, 1982). On entering the Swiss Polytechnic School in Zurich, the young 17 year old noticed the only woman in the class, Mileva Maric, a brilliant Serbian student. *Maric remained the only woman studying physics at the Swiss Polytechnic the entire time Einstein was there*. Maric was four years older than Einstein. She was a Serb, an Eastern Orthodox Christian, short of stature and extremely bookish. In addition to taking the exact same course-work in college that Einstein took, Maric studied on her own for one semester in Germany under Phillipe Lenard, the Nobel Prize winning physicist who discovered the photo-electric effect (which was explained in one of the 1905 papers attributed to Einstein).

Soon the two physics students began living together, sharing love and textbooks. Maric is finally beginning to be noticed among scholars. Her achievements were first chronicled by Desanka Trbuhovic-Gjuric in her book *In the Shadow of Albert Einstein*, which, unfortunately, has been published only in German. Because Trbuhovic-Gjuric relied on oral reports of friends of the Einsteins her documentation is not considered rigorous enough. Trbuhovic-Gjuric writes that Maric always considered herself as partner of Einstein, and when asked why she did not insist on more of the credit for their joint work, she replied, "We are one stone - *Einstein*" (Bjerkes, 2002).

No two physicists ever had a closer relationship: Mileva and Albert ate together, went to school together, shared ideas together, shared textbooks together, slept together, raised children together and discussed physics together. They discussed in great detail the work of physicists and mathematicians like Lenard, Helmholtz, Hertz, Drude, Boltzmann, Kirchhoff, and Planck. In their leisure hours, Mileva often would play the piano accompanying Einstein's violin while they entertained friends, including Einstein's inner circle: Besso, Ehrenfest, Habicht, Grossmann, Slovine. This group eventually became known as "The Olympia Academy."

Einstein was extremely secretive about his first marriage. It was only in 1987, with the publication of the Love Letters between Albert and Mileva that we find out Einstein fathered a daughter, named Lieserl, the first child of Albert Einstein and Mileva Maric. Nobody really knows what happened to this child; there is a mention in one of the letters to her having scarlet fever and it is believed that the child was put up for adoption in Serbia. Albert never breathed a word about her publicly during his lifetime. Mileva Maric was absolutely hated by Einstein's mother, Pauline, who protested to her son that Mileva was, "a book like you." Still, despite his mother's fierce objections, Einstein stubbornly went ahead and married her. It was during this marriage that Einstein is credited with producing the 1905 papers which made him famous.

After they married, Mileva bore Albert two more children, sons Hans Albert and Eduard. Eduard suffered psychological troubles throughout his life.

Einstein's marriage to Maric ended in acrimony. He began treating Maric, for whom he had originally professed such great love, cruelly toward the end of the marriage, even calling her "uncommonly ugly". He admitted in a deposition during divorce proceedings that he had carried on an adulterous relationship with one of his cousins, whom he later married (Einstein, 1990).

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Mileva contribution to Einstein success. The Serbian scholar Dord Krstic has written about Maric's close working relationship in an Appendix to the book, *Hans Albert Einstein: Reminiscences of his Life and our Life Together* (Elizabeth Einstein, 1990). He literally has turned the Einstein image around, crediting Maric with having formulated the Special Theory of Relativity as well as other ideas now commonly attributed to Einstein. Other writers have adopted these insights pushing the idea of an Einstein/Maric close collaboration. The *Collected Papers of Albert Einstein* (Einstein, 1990) show that Maric did indeed participate on the authorship of Einstein's famous papers in 1905. Einstein uses the word "collaboration". In a quote from Albert to Mileva from their love letters:

How happy and proud I will be when the two of us together will have brought our work on the relative motion to a victorious conclusion! (Einstein, 1990)

This is just one isolated quotation. One should read the entire *Love Letters* to find that Albert shares all his physics ideas with her and is extremely interested in her opinion. There are literally dozens of examples. Einstein tells his friends that his wife did his math for him. When one realizes the highly mathematical aspect of the 1905 Special Relativity paper, which relies heavily on derivations of the Lorentz transformations, then one can see the importance of having a first-rate mathematician's help. The Collected Papers of Albert Einstein include a photo-static copy of one of Albert's college notebooks, in which Mileva has gone through and corrected Albert's math!

Yet *the myth of the isolated Einstein working alone, who all by himself, without help from anyone, wrote four brilliant papers on physics in 1905, endures*. These papers included the work on Special Relativity; the photo-electric effect; an explanation of Brownian motion; and the famed formula, $E=mc^2$.

Mileva Maric may have actually put her name on the original manuscript of the Special Relativity. However, the original manuscript for the Special Relativity paper is missing. It was lost during Einstein's lifetime. Yet, Abram Joffe, a Russian physics is quoted as having seen the original 1905 manuscript and said it was signed, "Einstein-Marity" (Marity being the Hungarianized version of Maric). It is interesting that Joffe would remember the name as "Einstein-Marity" since "Marity" since Mileva Maric rarely wrote her name as "Marity" except on important formal documents, such as her wedding certificate.

Moreover, when Albert divorced Mileva in 1919, he promised that in the event he should win the Nobel Prize all the money would go to Mileva, which he did when he received the Nobel Prize of Physics. Why all the money?

Maric seems never quite willing to take complete credit for the work she did. One can argue that Maric never graduate from the Swiss Polytechnic, implying that she could not have been the intellectual equal of Albert Einstein. This is not accurate. Mileva faced the obvious invidious prejudice of being a woman. To be allowed admittance as a woman to the elite Swiss Polytechnic, she had to have been brilliant. Although her grades were comparable to Einstein's grades, Mileva ultimately did not pass her final examinations. It must be noted, however, that at the time she was taking these exams she was late in her pregnancy with Albert's second child and also faced the prejudice of her teachers for being both a Slav and a woman. She was, indeed, the only student in Albert's class not to graduate, although she did receive a research position with Professor Weber, which later fell through. Of the students who did actually graduate, Einstein had the lowest grade point average (see The Collected Papers of Albert Einstein, Volume 1, which lists the grades of all those who graduated).

Einstein rarely mentioned those who assisted him. Indeed, in all the famous 1905 papers that he published, only Michele Besso, his friend, is mentioned. There is simply no other source material cited in any other of his 1905 papers.

We know from the Love Letters that he had a very close collaboration with Maric. Unfortunately, these letters are heavily edited, the omissions being mainly from Maric's letters.

Why are Maric's letters so heavily edited? Why are there so many omissions? Will the editors of the Collected Papers of Albert Einstein publish or make available Maric's letters in their entirety? Some have felt that Maric's senior thesis at the Swiss Polytechnic might actually have dealt with Relativity theory. Unfortunately, her thesis cannot be located in the Polytechnic's archives (Bjerkes, 2002).

The full truth of Mileva Maric's role in the work now commonly attributed exclusively to Einstein will only become known when the

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complete, unedited letters of Mileva Maric are made available to scholars. It is also a fervent hope that the senior thesis of Maric might be found - or at least its subject might become known - because that thesis might actually have been about Relativity theory. Clearly, further research on her life and her physics work needs to be done.

Did Albert Einstein---the same man his teachers thought lazy, the same man who after graduating from the ETH could not find a job in physics and was ultimately forced to work for ten years as a lowly patent clerk --- really formulate all by himself the great works in 1905 for which he is credited? *Or did his wife, who struggled against the obvious prejudice of being a woman studying science during a highly "male chauvanistic" era, and the added prejudice of being a Slav in Switzerland, collaborate with Einstein?*

Amelia Earhart life. The world's most celebrated aviators, Amelia Earhart was born on July 24, 1897 in Atchison, Kansas, the daughter of a lawyer who worked for a railroad company. Until the age of 12 she lived with her sister and grandparents in Atchison, and then she moved with her parents to various cities where her father was working until he was dismissed from the railroad company for alcoholism. The family moved often and she completed high school in Chicago, Illinois in 1916. In 1918, at the age of 20, she went to visit her sister in Toronto, Canada. This was during World War I and after seeing wounded servicemen on the streets of Toronto, she volunteered to work as a nurse's aide at a local military hospital. She also visited a local airfield and decided then that she wanted to learn how to fly.

For a short time after the war, Earhart took a medical course at Columbia University in New York. She then joined her family in Los Angeles *and persuaded her father to spend $10 to send her up on a joyride at an airshow. After she landed, she decided that she was going to take flying lessons immediately*. She hired Neta Snook, the first woman instructor to graduate from the Curtiss School of Aviation, to teach her. She paid for the first lessons by driving a sand and gravel truck. So, against her family's wishes, she learned to fly at the age of 24 and made her first solo flight in 1921. After only two hours of instruction, she decided that she wanted to buy her own plane. A few months later she purchased her first airplane, a Kinner Canary, a small experimental plane that cost $2,000 with money advanced by her mother and took a job at a local telephone company sorting mail to help pay for it.

Fig. 3. Amélia Earhart – Women win

In 1924, Earhart's parents divorced, and she bought a yellow roadster to drive her mother back to the east coast. In order to pay for the car, she sold her plane to a young man who took off while she watched and promptly crashed it and killed himself. In Boston, Earhart resumed her medical studies for a short while and then went to work in 1926 as a social worker in a settlement house in Boston.

Ms. Earhart achieved a number of aviation firsts and became known as the "First Lady of the Air". *For years aviation had been dominated by men, but Earhart challenged gender barriers and influenced women's position in the aviation industry.* Her flying career lasted for 16 years.

Amelia Earhart achievements. Shortly afterward she sold its plane she bought a new one and set a new altitude record of 14,000 feet. This record was shortly broken by someone else, and Earhart immediately set out to remake it. She ran into dense fog at 12,000 feet, in a plane with no instruments, and almost crashed but was finally able to land safely.

Flying became a hobby although she tried to fly as often as she had time for and could afford on her small salary. In April 1928, she received an unexpected invitation to travel to New York to be interviewed by a committee headed by the publisher and publicist George Palmer Putnam to

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select the first woman to travel, as a passenger, on a plane across the Atlantic. Earhart was selected and left with a male pilot and navigator on June 3, 1928 in the Friendship, the same plane that Richard Evelyn Byrd had flown across the North Pole. Putnam released the news to the press, and the Christian Science Monitor headlined "Boston Woman Flies Into Dawn on Surprise Atlantic Trip." This news was not exactly accurate since fog forced them to land in Newfoundland and wait there until June 17. They took off that morning with the pilot drunk and landed in a bay in Wales 20 hours and 40 minutes later. They were greeted with great enthusiasm, and Earhart became the centre of international attention because *she was the first woman to have flown over the ocean even though she had only been a passenger*.

On her return to the United States, Earhart was suddenly looked upon as a spokesperson for women aviators, and with George Putnam as her manager undertook an extensive series of lecture tours and was hired to write a column on aviation for Cosmopolitan magazine. She also was hired to endorse several commercial products.

In September 1928, she flew across the country to visit her father in Los Angeles and then flew back to New York. This made her the first woman to fly both ways solo across the country.

In 1929 the Lockheed Company presented Earhart with a brand-new Vega, a new type of single-wing plane. She flew the Vega in the first Women's Air Derby across the United States and came in third. In July 1930 she set a new speed record for women and in 1931 she made a tour of the United States in an autogiro, a forerunner of the helicopter*, in which she set an altitude record*.

In February 1931 Earhart married George Putnam, who had recently divorced. They both pursued their careers, but he used his great abilities as a publicist to make her one of the best-known personalities in America. In 1932 Earhart decided to fly solo across the Atlantic in order to earn the fame that she had been unjustly given in 1928. She took off from Harbour Grace, Newfoundland on the evening of May 20, 1932.

For the first few hours everything went well. Then she began to run into difficulties. She ran into a violent electrical storm, the altimeter failed, the wings iced up and sent the plane into a tailspin for 3,000 feet. Finally, the exhaust manifold caught on fire. In the face of the problems, Earhart decided to land in Ireland rather than continuing on to Paris as she had originally planned. She landed in a pasture outside of Londonderry in Northern Ireland 14 hours and 56 minutes after she had left Newfoundland. Once again she became the centre of public adulation, and this time she felt she had earned it. She was feted throughout Europe and then returned to New York to a giant ticker-tape parade (Earhart, 1932).

In the following years, Earhart was able to profit from her fame by expanding her circle of friends, including flying over Washington with Eleanor Roosevelt and joyriding with her around the White House grounds in a race car. She also undertook interesting professional assignments, including becoming a visiting faculty member at Purdue University. She endorsed numerous products, including her own design for travelling clothes and Amelia Earhart luggage, still being sold today. She loved daredevil stunts such as jumping off a metal tower with a parachute and piloting a one-person submarine.

Then in 1935 she flew solo from Hawaii to California -- a feat that had ended in disaster for other pilots. The distance, incidentally, is greater than from the United States to Europe. But during these years Earhart also continued to set flying records. In April 1935 she set a speed record on a solo flight from Los Angeles to Mexico City and then set another record from Mexico City to New York.

Writing about her flight from Hawaii, she said:

After midnight the moon set and I was alone with the stars. I have often said that the lure of flying is the lure of beauty, and I need no other flights to convince me that the reason flyers fly, whether they know it or not, is the aesthetic appeal of flying.

The flight to Hawaii set a new record of just under 16 hours. However, as she was leaving Hawaii, the heavily laden plane crashed on take-off. It took $50,000 and five weeks of work to repair the plane and to reschedule the flight. The cost was donated by a number of private individuals.

Stimulated by her Hawaii flight, Earhart set herself a new goal, to fly around the world at (or near) the Equator, something never before attempted. Purdue University purchased a new twin-engine Lockheed Electra that was specially modified for the flight. She left from San Francisco in the early morning of March 17.

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Earhart decided to reverse the original course of her flight by flying from west to east to take advantage of changed weather patterns and air currents. She also replaced the original navigator with Fred Noonan. They took off on June 1, 1937 from Miami, Florida and headed for Brazil. They flew across the Atlantic to Africa and then across the Red Sea to Arabia and on to Karachi, Pakistan, Calcutta and Burma. They reached Lae in New Guinea on June 30. This was to be the most dangerous leg, to land on Howland Island, a tiny speck only 2 miles long in the middle of the Pacific Ocean.

But it soon became evident that Earhart and Noonan had little practical knowledge of the use of radio navigation. The frequencies Earhart was using were not well suited to direction finding (in fact, she had left behind the lower-frequency reception and transmission equipment which might have enabled to locate her), and the reception quality of her transmissions was poor. After six hours of frustrating attempts at two-way communications, contact was lost (Knaggs, 1983).

Earhart never reached Howland Island, and to this day no one knows what happened to their plane. There was much speculation then and now that part of Earhart's mission was to spy on the Japanese-mandated Pacific islands. According to this theory, the Japanese knew this, and intercepted her plane and took her captive. There has never been any substantiation for this theory. In 1992, an expedition found certain objects (a shoe and a metal plate) on the small atoll of Nikumaroro south of Howland, which could have been left by Earhart and Noonan. Their disappearance remains one of the great mysteries of aviation.

Amelia Mary Earhart died doing what she most loved -- and was only a few days from celebrating her 40th birthday.

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The Access of Women to Science

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Abstract. Women play vital roles in every facet of modern society. In numerous areas of scientific and technological development, women have historically been responsible for crucial advances, yet they remain severely under-represented in all major scientific areas.

There have been improvements in access for women to science over the last two decades, but many female students at School and University still find access to a career in Science extremely difficult and the prospect profoundly unappealing. It is essential that the barriers that discourage women from studying Science and choosing it as a career are identified and overcome.

In this communication a brief overview of the current situation of the access of Women to Science and Technology in Europe and in the world, will be made. The potential benefits of the use of hands-on experiment's based teaching of Science will be pointed out.

Keywords. Women in Science.

Robots - Girls´ Hidden Passion?

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Abstract. In Germany we notice a decreasing interest from students in technical professions followed by a considerable lack of junior scientists, especially female junior scientists. To increase the number of women in these fields in the long run we must first address girls.

Education must inspire girls to take up technical subjects. Our experience shows that learning by doing is a promising way of raising the appeal of technical subjects, especially to girls and women. While designing, constructing, programming and testing autonomous, mobile robots the girls are learning a lot about technical systems. In addition, they acquire knowledge and capabilities in the field of engineering and information science.

In our project "Roberta - girls discover robots" teaching and study materials introducing in information science, technology and robotics are developed and made accessible. Regional centres are being established to support the distribution of the results now and beyond the end of the project. Teachers are invited to join these centres and to exchange their experiences. The aim is to run a national network, which will ensure the further progress of the development of gender criteria.

The presentation will include the main topics of the project, the course of action and the intermediate results. The German Federal Ministry of Education and Research is funding Roberta for three years. Partners are universities, a technical museum, a school board, a grammar school, the Centre for Women in Information Society and Technology, the initiative SaN (schools to the net) and the LEGO Educational Division. The 'Roberta' team is interested in cooperations with similar initiatives in other European countries and would like to exchange experiences and define joint activities in the field of education based on robots with a particular look at the interest of girls.

Keywords. Robotics, Woman in Science.

Searching for Socio-Economic Patterns in the Role of Woman in World Society

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Abstract. It is well known that a variety of socio-economic aspects (education, culture,…) have directly accounted for the issue of woman

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and decision-making in general, and science in particular. Indeed, the under-representation of women in science prevents its full realization.
In the present work it is intended to find the degree of woman science development in each country using multivariate analysis techniques. Assessing the position of women is made difficult by the absence of reliable, accessible, harmonized data broken down by gender. But, it has also to be borne in mind that the situation of women in science is linked to more general obstacles encountered by women, so a great amount of general socio-economic variables are taken. Ideal Indicators are commented, but only variables of the WDI 2002 CD-ROM Query database of the World Bank Group are used.
Countries with similar and dissimilar characteristics are identified achieving a classification of most countries indifferent groups. Each group will correspond with a different pattern where women presence and/or importance will be in a different evolutionary step. Five different patterns have been found.

Keywords. Woman, Science, Decision-making, Factorial Analysis, Cluster Analysis.

1. Introduction

It is well known that woman has been relegated to domestic or handicraft work, it has been infravaluated and it has been considered intellectually inferior. Therefore women presence in science world has followed the same pattern [1].

Difficulties in acceding to education and work have been, without any doubt, the most important causes of the rare presence of women in scientific questions. Before 1900 well known scientist women can be counted with our fingers:

-Hipatia, considered for centuries the only woman "in science" born in IV dC, worked in Algebra, Geometry, Maths, Astronomy and some others.

-Anna Comnena, from Bizancio was known due to her studies on military technology.

-Trotula was known in the medieval Europe in Medicine and Chirurgy.

-Carolina Herschel discovered in 17000 eight comets.

-Anna Morando Manzolini teached Anatomy in Bolonia University.

-Sonia Kowalevsky was in XIX century the first woman who studied Maths in her country. But she has to do it disguised as a man till she could prove her value. She was well known in the field of Differential Equations.

Woman, in the best case, could only help the scientist man. She was not considered able to propose theories. Therefore, through most mankind history it has been retained and closed in a cave of great darkness.

Nevertheless, from 1900 things began to change. The woman responsible for it was Marie Curie, one of the first recognized women in science in XIX century. She received, together with her husband the Nobel Prize in 1903 and 1911. Her daughter followed her research and received, also together with her husband, the Nobel Price in 1935. But it has no be noted that altogether only ten women have ever received the Nobel Price in any science. It is not before the second part of XIX century that women start to have free access to every stage of national education systems. From that moment and due to the complexity of knowledge, nobody works alone, increased opportunities for women. Nowadays, at least in official speeches, continuous references are made to gender equality in the different levels of education as well as in different decision-making organs. Even so, there is still a long way to achieve complete integration of women. It is also evident that the presence of women in science or others matters are not equally distributed all over the world, not only because of gender circumstances, but also because of ethnic, regional or social class circumstances.

There are different states of development and the main objective of the present work consists on establishing a world map where the real situation of women could be reflected, looking for the desirable characteristics on the achieving of a real and complete gender equality. Due to the fact that there are very few data on that aspects, at least a formal procedure will be presented and used with an initial set of variables poorer that the desired. Therefore, final results do not completely reflect reality.

In the following sections, the desirable data will be commented and some remarks will be made on the used data due to the inaccessibility or inexistence of that ideal data. Later on the methodology will be explained and finally the results and the achieved conclusions will be presented.

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2. Data

In order to achieve the main objective, a gender and Science and Technology indexes will be desirable. In that sense, Zubieta [16] says that each discipline has its own specificities so that gender indexes should give information on the differences that its own specificities impose. A proposal of indexes able to evaluate female presence in science and technology system should be able to identify not only the factors that acted as stimulus but also those that inhibited women entering or permanence on the system. Just as the case of education, these two factors should be analysed taking into account the socio-political, economical and cultural context besides the own characteristic of each discipline.

In this sense, the following indexes would be desirable:

1. Number of pupils, divided by gender, in every educational level.
2. Pupil distribution by discipline, divided bay gender.
3. Economical support to follow/finish studies by discipline, educational level and gender.
4. Students' absence by educational level, discipline and gender.
5. Academic results by educational level, discipline and gender.
6. Teachers' distribution by educational level, discipline and gender.

It would be also desirable to have a time series long enough to study the advance of women presence in the educational system, previous stage for their presence in scientific or others matters. In that sense some indexes as the following would also desirable.

1. Institutional support trough programs and plans, that is to say, degree of existence of public politics designed to increase women access to science and Technology.
2. Economic support to follow/finish studies (distributed by level and gender)
3. Student distribution in post graduated studies by knowledge area, gender and age.
4. Degree of female participation in evaluating committees in charge of recruiting, qualifying and selecting candidates.
5. Academic position by gender, discipline and marital status.
6. Academic production in relation with publications, patents, etc. by first author, gender and discipline.
7. Publishing tendencies alone or in group, by discipline.
8. Mean age in academic career by gender and marital status.
9. Mean age of Ph.D. by gender and civil state.
10. Wages differences by academic rank or position.
11. Academic rank distribution by gender and area.

Some other strategic indexes that could give a real vision of gender equality in science and Technology could be:

1. Female contribution in more that one author publications, by discipline.
2. Research projects by discipline and gender of the main researcher.
3. Researchers with teaching activities by gender, discipline and teaching educational level.
4. National and international participation by gender and discipline.
5. Female presence in teaching, research, technological development and decision making positions in Science and Technology institutions.
6. Research investment by gender and discipline.
7. Mean investment by post graduated student by gender and discipline.
8. Stage curses by sex, discipline and seniority.
9. Publication level by gender and discipline.
10. Research distinctions, prizes, etc. by gender and age.

As it has been already said, with these indexes a clear image of the actual access of women to science can be obtained. Nevertheless, most of them have not been observed, determined or measured.

To do the present study most of the variables from the following sections of the WDI 2002CD-ROM Query database of the World Bank Group have been initially considered: Woman development, Employment, Education inputs, Poverty, Output, Economy size and Population dynamics. But, as many of the variables were not complete, that is to say, there were no data for

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some countries and Multivariate Analysis does not allow missing data, only 27 of the initial variables could be finally considered.

Total population year 1980
Total population year 2001
Total population year 2015
Annual average population growth rate, years 2001-2015
Annual average population growth rate, years 1980-2001
Population between 0 and 14 years, in 2001
Population between 15 and 64 years, in 2001
Population with more than 65 years, in 2001
Young dependency ratio (dependants as proportion of working rate population), year 2001
Old dependency ratio (dependants as proportion of working rate population), year 2001
Crude death rate (per 1000 people), year 2001
Crude birth rate (per 1000 people), year 2001
Female population, % of total, year 2001
Male life expectancy at birth, year 2001
Female life expectancy at birth, year 2001
Labour gender index, year 1990
Force parity, year 2001
Under-five mortality rate (%) 1990
Under-five mortality rate (%) 2001
Maternal mortality ratio per 100000 live births (modelled estimates), year 1995
Population density (people per sq km), year 2001
Gross national income per capita ($), year 2001
Gross national income per capita rank, year 2001
PPP gross national income converted to international dollars rank, using purchasing power parity rates. An international dollar has the same purchasing power over GNI as a U.S. dollar has in the United States, year 2001
Gross domestic product growth (%), year 2000-01
Gross domestic product growth (%) per capita, year 2000-01.
Woman in decision-making positions, % of total at ministerial level, year 1994 or 1998.

The number of countries conjointly considered in the multivariate analysis has been 134 from the existent 207.

3. Methodology

In order to produce complementary insights into the main objective of the paper different statistical techniques have been applied: Factorial Analysis (AF) and Multivariate Analysis Cluster Analysis (CA).

3.1. Factor Analysis and cluster Analysis

In order to shed light on the underlying causes of the differences, FA is applied [14],[11]. This technique objective is double [9], [15].

1) Reducing the original set of data dimension in a way that the set may be substitute by a smaller number of variables, called factors, that will explain the main part of the data, that is, FA leads to transform a set of dependent variables into a smaller set of independent latent variables (factors).
2) Detecting the latent structure in the set of data.

The second approach is intended to establish groups with different school achievement that emerge naturally. So, cluster analysis is the most appropriated multivariate technique to conduct [8], [3], [5], [6], [4]. The objective of cluster analysis is the partition of a set of individuals (in this case, countries of the world) into groups or clusters, so that countries belonging to a group are very similar among them, but very different from countries belonging to other groups (homogeneity inside the group, heterogeneity among groups).

Finally, the purpose of the third approach consists on testing the association between clusters obtained (second approach) and belonging program (first approach) and contingence analysis will be applied [3], [5], [6]. Then, with this third approach a triangulated study is intended, in the sense that we explore the association between groups emerge naturally (*a posteriori*) and groups previously fixed according to the recruiting program (*a priori)*.

4. Analysis and Results

4.1. Factor Analysis

A FA has been carried out in order to find out the initial set of 27 variables hidden structure. Both the Bartlett sphericity test and the KMO contrast, as reflected in table I, show the

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convenience of FA that will explain nearly 90% of the total variance trough only six independent factors.

Kaiser-Meyer-Olkin sample adequation measurement.		.854
Bartlett Sphericity test	Chi-square approximate	8997.205
	Gl	351
	Sig.	.000

Table I. KMO and Bartlett test

In table II the corresponding communalities can be seen. They give a measurement of the explanation degree trough the six retained factors. Most of the communalities are bigger than 0.8, so each variable explanation degree trough the six factors is good. Therefore, the existence of six factors justifying the initially considered interdependent variables is accepted.
Variables are presented in table III ordered according to the total variance explanation degree of each factor: variables with bigger factor scores in absolute values in the first factor appear first, later variables with bigger factor scores in absolute values in the second factor, and so on. There are only included those cases whose correlation in absolute value are bigger than 0.4. Factors appear decreasingly ordered according to their respective explained variance, whose values are at the end of the table.

	Extraction
total population 80	.993
total population 01	.999
total population 15	.995
annual average population growth rate (2001-2015)	.901
annual average population growth rate (1980-2001)	.886
population between 0 and 14 years	.973
population between 15 and 64 years	.928
population with more than 65 years	.918
young dependency ratio	.955
old dependency ratio	.726
crude death rate	.852
crude birth rate	.974
female population, % of total	.791
male life expectancy at birth	.931
female life expectancy at birth	.932
labour gender index	.831
force parity	.801
under-five mortality rate (%)1990	.885
under-five mortality rate (%)2001	.917
maternal mortality ratio	.800
population density	.900
gross national income per capita	.750
gross national income per capita rank	.895
PPP gross national income converted to international dollars rank	.887
gross domestic product growth (%),	.992
gross domestic product growth (%) per capita	.990
woman in decision-making positions	.672

Table II. Communalities

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	Factor					
	1	2	3	4	5	6
crude birth rate	.975					
young dependency ratio	.960					
population between 15 and 64 years	-.951					
population between 0 and 14 years	.948					
female life expectancy at birth	-.933					
under-five mortality rate (%)2001	.933					
under-five mortality rate (%)1990	.927					
male life expectancy at birth	-.902					
maternal mortality ratio	.873					
PPP gross national income converted to international dollars rank	.833				-.403	
annual average population growth rate (1980-2001)	.812	-.453				
population with more than 65 years	-.808					
annual average population growth rate (2001-2015)	.805	-.496				
gross national income per capita rank	.791				-.445	
old dependency ratio	-.699					
crude death rate	.649	.633				
labour gender index		.889				
force parity		.881				
female population, % of total		.785				
total population 01			.997			
total population 15			.995			
total population 80			.994			
gross domestic product growth (%)				.975		
gross domestic product growth (%) per capita				.951		
woman in decision-making positions					.764	
gross national income per capita					.684	
population density						.938
% explain variance	45.7	13.9	11.2	7.5	6.5	4.3

Table III. Rotated factor matrix

A short description of each factor most significative characteristics is given below.

FACTOR 1. It is interpreted as **Demographic Factor** (F1) as the most correlated variables are, in most cases, variables giving different demographic aspects information: crude birth rate, young dependency ratio, population between 15 and 64 years, population between 0 and 14 years, female life, expectancy at birth, under-five mortality rate (%)2001, under-five mortality rate (%)1990, male life expectancy at birth, annual average population growth rate (1980-2001), population with more than 65 years, annual average population growth rate (2001-2015), gross national income per capita rank, old dependency ratio, crude death rate.
All correlations are positive except for population between 15 and 64 years, female life expectancy at birth, annual average population growth rate (2001-2015) and old dependency ratio.

Therefore countries with high values have a young population, high life expectancy, low dependency degree and are countries where generational stand is guaranteed and vice verse.

FACTOR 2. The most correlated variables are labour gender index, force parity and female population (% of total), therefore the factor is interpreted as **Labour Gender Factor** (F2). All correlations are positive so a high factor value implies a high percentage of female presence in labour market and vice verse.

FACTOR 3. It is interpreted as **Total Population Change Factor** (F3) due to the fact that the most correlated variables are: total population 01, total population 15 and total population 80. All correlations are positive implying that a high value of the factor identifies countries with high population and vice verse.

FACTOR 4. It is interpreted as **Gross Domestic Product Growth Factor** (F4) because the most correlated variables are: gross domestic product growth (%) and gross domestic product growth (%) per capita. Like the previous factors, all variables have positive correlations then a high factor value identifies countries with high GDP growth and vice verse.

FACTOR 5. It is interpreted as **Woman in Decision-Making Positions Factor** (F5) as the most correlated variables are: woman in decision-making positions and gross national income per capita. Their correlations are both positive implying there is a great relation between female presence in decision making positions and high gross national income and vice verse.

FACTOR 6. It is interpreted as **Population Density Factor** (F6) because the only correlated variable is precisely population density. It has to be noted also that its correlation with the factor is positive. It can be seen that the initial set of variables has a six factor hidden structure, where only two of them, Labour Gender and Woman in Decision-Making Positions factors, are directly related with aspects of women in socio-economic life and society.

4.2.Cluster Analysis

In order to obtain more objective and significant socio-economic behaviour patterns taking into account every factor, it is necessary to use multidimensional statistical methods and the best option is to proceed with a Cluster Analysis.

The main objective of Cluster Analysis is to classify the different elements from a sample into groups (called clusters), so each cluster elements are as similar as possible among them but very different to other cluster elements (homogeneity inside clusters and heterogeneity among them).

In the present work non hierarchical cluster analysis has been used, particularly, k-average algorithm has been put into practice, considering as variables the factor scores obtained in the Factor Analysis of the previous section. To use the k-average method it is necessary, firstly, to decide the number of clusters (k). k is a value previously fixed, so it will be advisable to try different values for it. The selection of the most appropriated one should be based on mathematical criteria as well as interpretability criteria. Later on, clusters can be obtained. As said before, dispersion between elements in the same group should be as small as possible and among groups as big as possible. That condition is call variance criterion and consists on obtaining the gravity centre (average of the data elements in the same group) and then achieving the sum of the quadratic deviations of every element relative to the centre. Total residual variance is the sum of every group residual variance.

5. Multidimensional typology

To obtain a socio-economic behavioural pattern in a more objective and significant way, applying a statistical multidimensional analysis is necessary. So a conjoint cluster analysis using as variables the factors previously defined is going to be applied on the countries. However, as the aimed results are related with woman position only two of the six previously obtained factors are to be considered, in concrete only Labour Gender and Woman in Decision-Making Positions factors are to be used. In that case, the number of clusters considered to give an optimal pattern explanation is 7.

There are 3 small clusters (C1, C2 and C5), formed by 9, 3 and 4 countries respectively, while the other four clusters (C3, C4, C6 and C7) are bigger, with similar cardinality. In figure 1 the map of the 7 clusters appears and in figure 2 final centres for each cluster are represented.

Taking into account factor interpretation together with each cluster values, the following description of each of the 7 groups or clusters finally considered. Figure 1 shows each country belonging cluster.

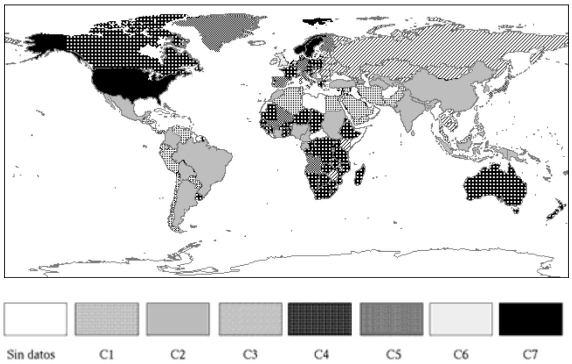


Fig. 1. Clusters

According to the factor interpretation and values reached in each cluster, the following characterization in seven groups has been established:

CLUSTER 1. It is formed by 9 countries, and considering both factors it is almost the best situated. Both factor values are over the mean, therefore woman position both in labour market and in decisionmaking positions is quite good. Geographically, most cluster countries are in Europe.

CLUSTER 2. The 3 forming countries (USA, Norway and Finland) are the best for women. Labour gender factor is slightly smaller than in the previous cluster, but Decision-making position factor value is the bigger one.

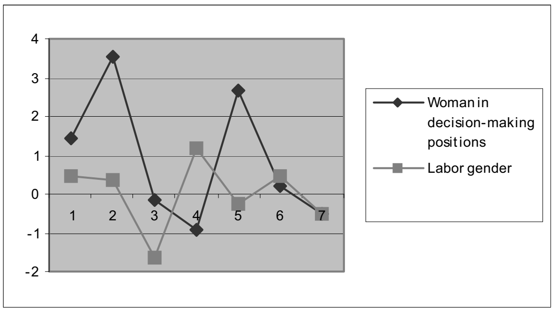
CLUSTER 3. Both factor values in these cluster countries are under the mean, especially labour gender factor, whose value is the worst. These are countries where special measures to help women to access to labour market, as a first step, should be taken as soon as possible, because their situation is really worrying.

CLUSTER 4. In this cluster Labour gender factor values is the best one, but Woman in decisionmaking position factor value is the worst one. Therefore women are well introduced in labour market, but they representation is not reflected in high positions.

CLUSTER 5. This is a symmetric case of the previous cluster and it is quite strange because Woman in decision-making position factor value is almost the best one, but on the contrary, Labour gender factor value is under the mean.

CLUSTER 6. Both factor values are over the mean and quite similar, therefore there is almost no difference between women in labour market and in decision making positions. These countries present a quite balanced profile.

CLUSTER 7. This is, together with cluster 3 the worst situated. Here both Woman in decision-making positions and Labour gender factor values are very similar, but below the mean. As cluster 3 countries, these are countries where special measures to help women to access to labour market should also be taken.



7. Conclusions

The previous methodology has been applied to determine patterns of woman position in society in the different countries of the world. A number of 27 variables have been finally taken. FA had shown it was possible to reduce data dimension and a number of 6 factors have been obtained explaining almost a 90% of the total variance. The most important factors have been named Demographic, Labour Gender, Total Population Change, Gross Domestic Product Growth, Woman in Decision-Making Positions and Population Density.

A CA on only 2 of the found factors has been applied in order to multidimensional classify World countries in 7 groups, each of them representing a different woman position pattern.

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Women in Science: How to Improve Their Presence in Hard Sciences

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Abstract. A case study on the presence of women in sciences for the State University of Campinas with focus in its Institute of Physic is here presented. Unicamp is a research university predominantly targeted to hardsciences. The option for careers which are typically “male” is based on pre-existent social and cultural settings. Therefore, it is important to promote the interest on hard sciences among young students,so that we can probably double the number of scientists available to deal with the problems of development in the countries. Women scientists serve as role models for girls.In addition, they bring in their teaching a different perspective proper to their gender.

Data collected for 1994 for the Institute of Physics of Unicamp reveal that the male percentage of faculties is higher at the full professor level as compared to the associate professor level, since only full professors are eligible for higher positions such as Institute´s Directors and President (Rector). Yet, for women faculties, the number of full professors is even lower than the number of associate professors, since they do not usually get to higher posts in the University.

In 2004 the percentage of women full professors at Unicamp more than doubled as compared to 1994, going from 10% to 22%. In the Institute of Physics, there are no women full professors, even though the title level of its faculties is higher than the University´s average.

Just 20% of all bachelor graduates of the Institute of Physics are women, and this figure is declining. Yet, the percentage for master degrees is increasing faster for women than for men, while the reverse is true for Ph. D. degrees granted to students. Women Ph. Ds. decreased from 30% to 20% between 1994 and 2004. This work is now being extended to other hard science majors in the University.

Keywords. Case study, Women in science, Physics, Hard sciences.

Girls and Science Teaching

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Abstract. The paper will address our experience concerning the involvement of young female students in science teaching in Romanian schools in the frame of the Comenius 3 Network “Hands-on Science”. Various means to achieve this goal will be presented: science club activities, science related contests and presentations, the use of arts in science teaching. A discussion on the new means to attract girls’ participation in studying sciences will be included as a starting point for further debates.

Keywords. Science education, Girls, Alternative teaching methods.

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