HSci2010

7th International Conference Hands-on Science

Bridging the Science and Society gap

July 25 - 31, 2010 - Greece

The University of Crete campus at Rethymno

http://www.clab.edc.uoc.gr/HSci2010/

Edited by:

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The University of Crete

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Front Cover Illustration:

Seal at the upper right corner: The University of Crete logo. Its origin comes from a coin of ancient Gortys (4th century BC) portraying the abducted by Zeus princess Europe from Middle East resting under an olive(?) tree upon their arrival to Crete - south part of the continent named afterwards as Europe.

Top picture stripe: A view of the mountains from the plateau of Omalos at the north entry to the Samaria Gorge.

Middle picture stripe: Using Educational Robotics to teach Science and Technology in the Middle school of Krana.

Base picture stripe: Part of Rethymno seashore as viewed from The University of Crete campus at Rethymno.

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HSci2010 – 7th International Conference
Hands-on Science: Bridging the Science and Society Gap

Knowledge, especially advanced modern knowledge which is not widespread, can be a very effective tool for the welfare and, also, for the power of the groups possessing it – you can easily observe this strong relation between knowledge and power in today's existing states.

Science and Technology is an important constituent of today's knowledge. Consequently in most of the European and other countries there is an ever increasing importance to Science and Technology education. Also, in technology dependent modern societies, an ever increasing number of decisions are based on Science and Technology developments. As a result, the citizens' active conscious participation (which is the foundation of Democracy) to these decisions, requires a sound Science and Technology Literacy. In this sense, practice work in Science teaching acquires new importance for an effective Science and Technology education. Within the above context, globalization as an important aspect of our contemporary times, coupled with the knowledge gap, may easily lead to inequalities in many, even all, aspects of life conditions between different groups. These inequalities are a major actor in promoting the conflicts between different societies.

The Hands-on Science (HSci) network, which was supported initially by the European Commission, organizes, as one of its activities, an annual International Conference focused on Hands-on Science activities - details may be found in http://www.hsci.info. The main objective of these conferences is, in general, the exploration of innovative teaching approaches connecting Science with every day life towards an effective Science and Technology education. The HSci2010, the 7th International Conference is organized July 25 - 31, 2010 in The University of Crete campus at Rethymno - Greece (http://www.clab.edc.uoc.gr/HSci2010) with a focus in **Bridging the Science and Society gap.** Research papers and other scientific works may be presented, sometimes in a better way, through specialized journals. However, conferences like the Hands-on Conference present the real advantage of meeting people from other places, possibly from different cultures, and, in the informal discussions during the breaks and the social events of the Conference, the participants come to know their colleagues in other countries, establish links, understand better their social and cultural values and appreciate the diversity of human behaviours. This is also a way to bridge the gaps between different societies. The conference program includes oral presentations in plenary and in parallel sessions, poster presentations, and other activities useful to Science education. Within the context of this Conference, research is a priority but we also value the school operation and practice. Therefore, the works accepted as Conference activities were selected either because they exhibit a high research calibre or because they exhibit innovative ways for school Science teaching. The mixture resulted is represented in the Conference Program and also in these printed Conference Proceedings while in the web site of the Conference snapshots from the Conference activities may be found.

More than twenty are the countries from which the participants to the Conference and the persons who expressed an interest to participate come from. Although most participants come from the European Union more than ten other countries all over the world are represented to this Conference, an indication of international high calibre.

As president of the Local Organizing Committee, I have the privilege to present the HSci 2010 International Conference proceedings. I have also the pleasure to welcome all the participants to the Conference wishing a fruitful stay.

I want to thank Professor Manuel Filipe Pereira da Cunha Martins Costa of Universidade do Minho for president of the Hands-on Science network for his decision to have the Hands-on Science Conference in Rethymno for a second time.

I sincerely thank also all the members of the Local Organizing Committee for their efforts to have a well organized Conference. Special thanks deserve the vice-chairs, prof. D. Stavrou and M. Kalogiannakis the efforts of whom made this Conference possible.

Rethymno, July 2010, **P. G. Michaelides,** B.Sc., Ph.D., LL.B. Professor at The University of Crete

Hsci 2010: 7th International Conference on
Hands on Science: Bridging the Science and Society Gap

July 25-31 2010 at The University of Crete campus at Rethymno-Crete, GREECE

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HSci2010 – 7th International Conference
Hands-on Science: Bridging the Science and Society Gap

Manuel Filipe Pereira da Cunha Martins Costa
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Foreword

In today' technology driven society science plays a fundamental role. A role that should be understood by all citizens as it affects all aspects of our lives and its fundamental to our development both economical social and human.

The school is and must keep being the main and major vehicle of science learning and of the understanding of its role, thus being crucial to the setting up of a sound and enlarged scientific literacy, at all levels, in our societies. More and more science and technology literacy is needed as citizens in their democratic right are, and will further be, called to make social and governance decisions that do demand that basic understanding.

Efforts must be pursued on approaching science to society. The school and science school education should play the most relevant role in this process.

We expect this conference to point out on the right directions on this process allowing an open friendly sharing of insights and giving participants, and all others that will be able to access the conference proceedings and the outcomes of the conference, tools to better develop their education and pedagogical tasks both at school and further out at different instance in their communities.

On behalf all participants and the members of the Hands-on Science Network I would like to thank and strongly congratulate local organizers for their excellent works in troubled times such as those we are living in today.

Braga, July 2010
Professor Manuel Filipe Pereira da Cunha Martins Costa

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INVITED SPEAKERS

On the role of the experiment in science teaching and learning – Visions and the reality of instructional practice*

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Abstract. *The experiment is of key significance in science instruction – with regard to learning science content, processes and views of the nature of science. The state of research on the role of the experiment in science instruction is reviewed. Based on a brief sketch of the historical development of the role of the experiment in science teaching and learning since the 18th century the aims of experimentation in school and the state of empirical research on teaching and learning science by use of experiments are discussed. It is further analysed, whether the high expectation regarding the value of experimentation are justified. A particular emphasis will be given the fact that self-responsible experimentation is rather demanding for the students. Hence, there seem to be good reasons why this preferable variant of experimentation is so seldom set into practice.*

Keywords. Experiment, Lab Work, Student Self-Responsible Work, Teaching and Learning Science

A preliminary note on the terminology used

As various terms are used in the literature on what is called experiment in the present article some preliminary remarks are necessary. The term *experiment* is used in the meaning of scientific experiments on the one hand. But it is also stands for experiments used in science instruction for various purposes. A number of terms are also in use in the literature such as lab work or practical work. We further use the term *experimentation* throughout the article denoting the process of carrying out experiments.

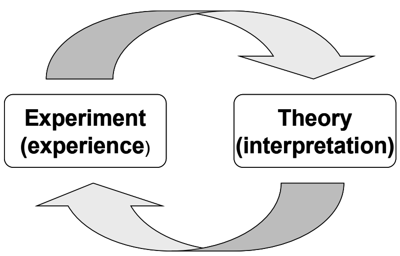

Fig. 1: On the relation of experiment and theory in scientific investigations

Introduction

The experiment plays a key role in teaching science. Science instruction without any experiment is hardly conceivable.[1] Clearly, the experiment is the key feature of science methods of investigating "nature". We deliberately do not use the singular *the* scientific method as it is not possible to identify such a method. There is a wide spectrum of epistemological and ontological views of the nature of science (NOS; [3]), that are linked to rather different strategies and methods of investigations [4].

In science the experiment is used to prove certain hypotheses by deliberate observation. Experimentation is always closely linked with theoretical modelling (Figure 1). Each experiment may only be carried out if it is based on a – maybe preliminary – hypothesis of the relations under inspection. In other words, the inquiry process is always based on an intimate interaction of experiment and theory – it is a *cyclical* process (cf. [5]).

This contemporary view of scientific inquiry is fundamentally different from the inductivist[2] view that formed in the end of the 18th century and that predominated in science and also in science education for a long time. The revolutionary changes of basic views in science (especially physics) that developed in the early 20th century step by step showed that this inductivist view had become obsolete [6,7].

The close interrelation of experiment and theory as outlined in figure 1 also holds for the role of experiments in science instruction. The inductivist view has proven obsolete also for

[1]* This article draws on major ideas presented in [1].
„*Science teaching must take place in the laboratory; about that at least there is no controversy. Science simply belongs there as naturally as cooking belongs in the kitchen and gardening in the garden*" ([2:13].

[2] *Inductivist* denotes the philosophy of science view based on inductivism.

student inquiry processes when learning science. The "theory" (i.e. understanding of concepts and principles) does not develop solely or predominantly from the experiment. The genesis of understanding science is a cyclical process linking experiment and theory as well.

There are many variants of the use of experiments in instruction – ranging from the infamous "chalk & talk" strategy based on demonstrations at best to various forms of open inquiry providing students with opportunities of self-responsible activities. In principle, experiments allow to engage students in unique ways of self-responsible processes of inquiry such as observing, measuring, documenting of results, comparing and ordering, hypothesising and verifying, discussing, arguing and interpreting as well as investigating and communicating. This spectrum of inquiry processes is not only valid in science but also in various other domains. Learning to use these processes in science, however, provides a unique contribution to foster students' general ability to carry out inquiries as the experiment in science allows intensive engagement with and deliberate manipulations of processes in nature and technology and not only mental manipulations.

In the following the role of the experiment in science instruction is investigated. A particular focus will be on the opportunities for student self-responsible work experiments in principle provide. The aims of experimentation will be discussed. But it is also investigated to what extend these aims may be set into practice in the reality of school science teaching. Finally, findings of empirical research on teaching and learning science are reviewed in order to find out whether the ambitious expectations regarding effects of self-resonsible experimentation are justified.

On the role of the experiment in science instruction – a historical account

A brief overview of the role of the experiment in science instruction from the 18th century to the present in German science education is given (for details see [7]). A particular emphasis will be given physics instruction as physics was the leading science until the early 20th century. Of course, the developments in other countries are somewhat or substantially different. The intention is to point out that the present – partly limited – state of the role of experiments in actual instructional practice (see below) may be better understood from a historical perspective.

It seems to be noteworthy, first, that the empiricist view linked with the above mentioned inductivist inquiry methods predominated science instruction in the 19th century and seems to be still – at least implicitly – influencing actual instructional practice. The inductivist method was the method of science inquiry and also the method to teach science.

Without any doubt, the instructional phases affiliated with this method (namely: problem – developing hypotheses – experimentation – analysis of the results – solving the problem – consequences for solving other problems) still plays a significant role in science instruction.

It is interesting to note that this method in the 19th century and in most of the 20th century as well was not explicitly taught in science instruction. It seems that it was taken for granted that instruction following the above phases would implicitly make students familiar with the method of science. It seems that this belief still plays a certain role in the actual practice of science instruction. At least – worldwide – demonstrations predominate and student experiments are integrated into primarily (strictly) teacher controlled instruction.

Without any doubt the past four decades saw significant changes – at least concerning philosophy of science, educational sciences and science education. On the one hand empiricist and positivist positions were questioned; on the other hand the predominating behaviourist view of teaching and learning was replaced by constructivist views [8]. Further, *science processes*, denoting the spectrum of science inquiry methods were established as a self-contained topic of science instruction [9], later also *views of the nature of science* (NOS: [10, 3]).

Investigating the intimate link of experimentation and theoretical modelling as outlined in figure 1 has become an important domain of science education research [11]. In contemporary approaches of scientific literacy [12] self-responsible inquiry is seen as an essential part. A large number of instructional approaches based on ideas of scientific literacy have been developed [13, 14]. In the actual standards for science instruction introduced in many countries worldwide [15] traditional science content (i.e. science concepts and principles) on the one hand and methods of scientific inquiry as well as views of the nature of science on the other hand are seen as equally important topics of instruction.

Briefly summarized, there is a development towards explicitly teaching issues *about* science (i.e., processes of scientific inquiry and views on the nature of science) as topics of science instruction in their own right.

Aims of experimentation in science teaching and learning

Various aims are affiliated with the experiment in science instruction – most of them are rather ambitious. Figure 2 presents key aims discussed in the literature.[3] It becomes apparent that an experiment allows illustrating the abstract science concepts and principles as well as science processes and views of the nature of science. Hodson [22] distinguishes three issues:

(a) learning science
(b) learning about science
(c) doing science.

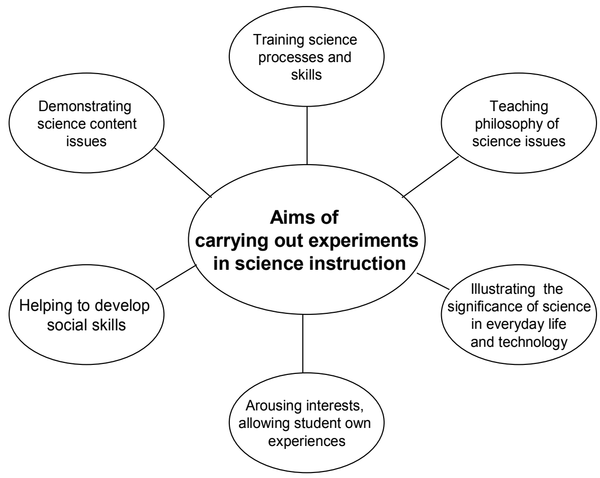

Figure 2: Various aims of experiments in science instruction [19]

Kircher, Girwidz, and Häußler [23:246] provide the following 14 issues:

(1) Illustrating a phenomenon
(2) Illustrating science concepts
(3) Provide basic experiences
(4) Provide experiences of science laws
(5) Prove theoretical predictions
(6) Investigate (find out about) student conceptions
(7) Make familiar with applications of science in technology and everyday contexts
(8) Incite student thinking
(9) Build up science ideas
(10) Prove science laws
(11) Make familiar with science processes
(12) Motivate and raise interests
(13) Provide sustainable impressions
(14) Allow to understand mile stones of human cultural heritage

In the history of science instruction in Germany briefly sketched above training of certain general "virtues" like prudence, accurateness, patience and responsibility also played a significant role. Still, these virtues are given a certain attention in science instruction.

Emphasis given the different aims of experimentation

Within the frame of a European project on the role of the experiment in science teaching and learning [24] a Delphi study on the significance given the various aims mentioned above was carried out. Some 400 science teachers at school and tertiary level from six European countries participated. They were asked to indicate the significance on a five point Likert scale. The following results appeared [25]:

- Linking theory and practice (4.1)
- Achieving skills to carry out experiments (3.7)
- Becoming familiar with methods of scientific inquiry (3.5)
- Motivation, social issues (2.5)
- Proving science knowledge gained (1.3)

It is noteworthy that the differences between the participants from the six countries are only marginal. The contribution to understand science theory is given higher significance than to understand science inquiry methods. It is surprising that achieving skills to carry out experiments is given quite high significance. This may at least partly be due to the fact that teachers at universities put a more significant emphasis of this issue as compared to school teachers who value motivational and social issues much higher than university teachers.

With regard to different kinds of experiments student experiments are quite highly rated by both kinds of teachers. This concerns all domains of science knowledge, i.e. concepts and principles as well as knowledge about science (i.e. on science processes and views about science). Interestingly, student experiments that follow a strict sequence of steps are seen as valuable to achieve experimental skills and to link theory and practice. However, they are viewed as much less valuable to support the

[3] The literature on the various aims of the experiment in teaching and learning science is extensive. We especially draw on the following publications: [16, 17, 18, 19, 20, 21].

development of social competences like fruitful cooperation in a group. Remarkable is also that demonstrations are seen as not useful to support the development of the students' personality. But they are viewed as valuable means to link practice and theory and to motivate students to learn science.

In a nutshell, these results reveal that despite certain differences between the teachers in schools and university there is a general agreement that experiments are significant means to foster learning of traditional science content, experimental skills and methods of science inquiry.

Studies on the practice of experimentation in science instruction

It is interesting that investigating the actual, "normal" practice of science instruction has not been a common research domain in science education. There are some data in the international literature on science instruction in action in various empirical studies with a somewhat different emphasis. In addition a video-study on teaching science in Australia, Czech Republic, Japan, The Netherlands, and the United States was carried out [26]. In Germany, large scale studies on the practice of physics instruction were conducted. Included were also samples from the German speaking part of Switzerland and the Czech Republic. At the moment a large scale video-based study to investigate the practice of physics 9th grade instruction in Finland, Switzerland and Germany is running.[4] Results of the latter study are not available so far.

The experiment in German upper secondary physics instruction

As part of the German TIMSS (Third International Mathematics and Science Study; [27]) Baumert and Köller [28] asked students choosing physics courses in upper secondary level to provide information on the characteristics of their physics instruction. Experiments play a significant role, but it turned out that demonstration experiments predominate. Student experiments are rarely carried out. Further, a teacher dominated instructional style prevails. Usually the teacher carries out the demonstration experiment to develop a physics concept; students copy what the teacher writes on the blackboard. The teacher's instructional script includes the demonstration experiment, explanations by the teacher, and a strictly teacher controlled discussion within the class. This discussion may be characterized as "questioning-developing" strategy. The teacher asks a question, students who show up are invited to give their view. The teacher may respond to this answer or ask another student to provide his or her idea. In principle, this discourse may be fruitful if it is carried out in the spirit of a Galileian dialog. However, in German physics instruction it often seems to be a sort of ritual that is totally controlled by the teacher and does not use the potential for active student engagement.

Baumert and Köller [28: 296] conclude on the basis of the student responses in the TIMSS tests that instruction linking experiments and theory in such a way that students have a chance to be actively engaged in developing the science knowledge intended is particularly efficient.

A videostudy on physics grade 7 and 9 instruction in Germany and Switzerland

As part of a larger program of the German Science Foundation (DFG – Deutsche Forschungsgemeinschaft) a videostudy on the practice of German and Swiss grade 7 to 9 physics instruction was carried out[5] [29, 30, 31]. The pilot phase (2000 to 2002) included 13 teachers (Gymnasium and Middle Level School) from three of the 16 states Germany is composed of. All teachers taught in schools participating in the nation wide quality development program SINUS ([32]. The sample of the second phase included 50 teachers from four German states. In addition a sample of 40 teachers in the German speaking part of Switzerland participated. This part of the study was directed by Peter Labudde [33, 34] and supported by the Swiss Science Foundation.

The focus of the studies was to identify key dominant features of German and Swiss physics instruction. In addition teachers' views about "good" physics instruction were investigated by a questionnaire. It was further intended to investigate relations between certain patterns of instruction and teachers' views on the one side and the development of student physics performance and their interests to learn physics on the other.

[4] http://www.unidue.de/fischer/dox/11.1432.4Njfs.H.De.php (June 2010)

[5] http://www.ipn.uni-kiel.de/projekte/video/videostu.htm (June 2010)

Video-documented physics instruction provide the major data of the studies. The teachers were asked to perform instruction as they normally do. In the first phase three lessons (45 minutes each) for two topics (namely electric circuit and force) were video-taped. In the second phase it was necessary to restrict to two subsequent lessons, either on optical devices or force.

Student questionnaires filled in before and after video-taping the lessons provide information on the development of student performance concerning the topics taught in the video-documented lessons and the development of interests. In addition after each video-documented lesson students were asked to provide their views about instruction documented. Teachers filled in a questionnaire before the video-documented lessons on a set of general views and beliefs. Further, some 40% of the teachers were interviewed after the last lesson video-documented. The intentions of these interviews was to identify teachers' views about good physics instruction on the one hand and their views about their instruction video-documented.

Instruction was documented by two digital cameras. One camera targeted the teacher, the other the whole class. A particularly designed software (Videograph[6] – [35]) allowed to code the videos in sequences of 10 seconds. Major coding systems comprise:

- Basic forms of instructional methods (whole class activities, still work, group work)
- Phases of instruction (repetition, learning of new content, experimentation)
- Support of learning during whole class activities
- Role of experiments

The results concerning the role of the experiment will be briefly summarized in the following (for details see [19, 36]). It is essential to point out first, that instruction in general is rather teacher dominated. Only 17% of instructional time is used for student activities. However, there are substantial differences between the teachers [31]. Time used for whole class activities varies between 19% and 100%. These activities are usually rather strictly teacher controlled. The above mentioned questioning-developing discourse prevails. Usually there is an interaction between the teacher and single students. It rarely happens, for instance, that a teacher asks another student to comment on what the classmate said before.

Experiments play a significant role in the lessons. Some 71% of the lesson time is governed by the experiment. It is particularly remarkable that much time is used to discuss the results.

- Introduction into the experiment (12%)
- Carrying out the experiment (21%)
- Discussion of the results and findings (35%)

For student experiments some 11% for demonstrations some 7% of instructional time is used. There are, however, substantial differences between the teachers. Students only have marginal opportunities to plan experiments, to carry them out and to draw conclusions themselves.

Usually the experiment is employed when a new content issue is developed. In some 70% of the documented cases the experiment is used to illustrate a phenomenon, only in some 20% to illustrate a concept or a law. To prove a hypothesis an experiment is rather rarely used.

The results provided by the video-study very much remind of the above use of the experiment in upper secondary level. The good message is that physics instruction in German and Swiss lower secondary physics instruction may not be indicated by "chalk & talk". On the contrary, the experiment plays a rather significant role as more than 70% of the teaching time is linked to experiments. It is interesting that the actual time the experiments are carried out is not very impressive. The data point out that the discussion of the results of experiments is the essential part of physics instruction. It seems that these findings are in accordance with the view of Baumert, Klieme and Bos [37] drawing on German TIMSS data that it is necessary to "intelligently" integrate the experiment in physics instruction. The introduction phase is essential in order to allow students to understand in which context the experiment to be carried out is embedded. The discussion of the results – which is given much time – is of key significance as well.

Taking into account that the belief is quite common that student experiments result in better learning and better development of interests (see below) it seems to be remarkable that the data of the video-study showed that there is no significant advantage of student experiments

[6] http://www.ipn.uni-kiel.de/aktuell/videograph/htmStart.htm (June 2010)

with regard to better achievement. These results are in accordance with many other studies on the effects of student experiments (see below). Based on the video-data available, often not enough time is spent by the teacher to summarize and analyse the findings of the student experiments. It is quite likely, that this is a major reason for limited development of achievement in student experiments.

Student experiments as observed in the videos are primarily strongly teacher controlled. There are only a few cases where students are given the opportunity to plan an experiment und to carry it out by themselves. In general, students rarely have an opportunity for self-responsible activities.

The data of the first phase of the video-study provide information on the relation between the aims these 13 teachers have with regard to the role of experiments und their actual use of experiments in class ([38, 39]. All teachers claimed that student experiments are rather valuable. In the lessons of two of these teachers, however, no student experiment was carried out. All teachers argued in the interview that they would love to use more student experiments – however they often cannot find the time to do that as student experiments are rather time consuming and the necessary equipment is often missing.

With regard to the above discussed restriction of "traditional" science instruction to concepts and principles, results of the first phase of the video-study seem to be essential. An analysis of the videos from a constructivist perspective [40, 41] revealed that teacher in class almost never mentioned issue regarding science inquiry processes or the nature of science. The teacher interview showed that most teachers were not well familiar with neither of the two issues ([38, 41]; for similar findings see [42].

On the role of the experiment in science instructional practice – a summary

Most results on the role of the experiment in instructional practice are valid for German physics instruction. The results for the German speaking part of Switzerland are basically rather similar. However, the student experiment seems to be more often used in Swiss schools. But also here most of these experiments are teacher controlled.

Fraefel ([43] carried out a small scale video-based study on science instruction in the German speaking part of Switzerland. In this study a basically similar picture occurred as in the above physics video-studies in Germany and Switzerland.

It seems to be remarkable that in the reviews on lab work in the international literature [17, 18, 21, 22, 44] as well as in the TIMSS video-study on science instruction in five countries [25] a similar situation becomes apparent.[7] Hence, it appears that the limited use of the experiment as revealed in the video-studies in Germany and Switzerland is characteristic for the majority of schools also in international perspective.

In a review on the use of contemporary constructivist oriented approaches in science teaching Duit, Treagust and Widodo ([45: 638f] come to the conclusion that major ideas of student oriented conceptual change approaches are rarely to be observed in actual classrooms. In other words, there seem to be limited chances for student self-responsible activities in science classes. Students rarely have the chance to plan an experiment, to develop and prove hypothesis. The wide spectrum of ambitious and challenging self-responsible activities student experiments in principle allow seems to be used insufficiently in instruction practice.[8]

Empirical research on self-responsible experimentation

In the following we will provide a summary of studies on the effects of teaching and learning science with the aid of experiments. A particular emphasis will be given studies on variants of self-responsible student experiments, i.e. on the use of the experiment in settings that allow the students to follow their own ideas in planning, carrying out the experiment and summarizing the results.

The overview is based on the reviews available. Formal meta-analyses are not available so far. The authors of the reviews usually point out that it is rather difficult to come to clear conclusions concerning certain cognitive or affective effects of the many variants of experiments used in

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[7] *„Many of the activities outlined for students in laboratory guides continue to offer „cook-book" lists of tasks for students to follow ritualistically. They do not engage students in thinking about the larger purpose of their investigation and the sequence of tasks they need to pursue to achieve those ends"* ([18:47].

[8] Lyons [46] investigated students' views of their science instruction in Sweden, the United Kingdom and Australia. Surprising similarities occurred. In all countries most students are of the opinion that their teachers would just pass knowledge to them. Students accordingly are of the opinion that instruction is rather closely guided by the teacher and that there are only a few opportunities for self-responsible work.

science instruction as many studies available are somewhat deficient concerning their methodological design ([17:9,18:29]. The following attempts to summarize findings are preliminary due to these deficiencies.

Effects of student experiments

As mentioned already manifold effects are expected from student experiments. These expectations usually are not backed up by empirical research. Student experiments per se do not result in better science performance (i.e, in better understanding of science concepts and principles), they do not incite a more pleasing development of interests in science and learning to understand science, and they do not support understanding science inquiry methods and views of the nature of science. It very much depends on how these experiments are staged. It is essential to provide learning opportunities that sustainably support learning [17, 18, 20, 22].

It is noteworthy that quite a substantial number of studies are available on the three issue listed in the heading of this paragraph. However, only a few studies investigate the development of skills to properly carry out experiments. Even less frequent are studies on the development of the above virtues like prudence, accurateness, patience and responsibility.

Quite frequently, the following proverb is employed to back up the belief that student experiments are superior: "*I hear and I forget, I see and I remember, I do and I understand*". Harlen [17:9] points out that there is no empirical evidence for this belief in studies on teaching and learning science by experiments. Instruction in which student experiments play a significant role does not necessarily lead to better science performance as compared to instruction in which students do not carry out experiments ([17:17, 18:31].

In a study on learning the basic laws of the simple electric circuit, for instance, van den Berg, Katu and Lunetta [47] showed that only "hands on activities" usually did not result in more elaborate student understanding. Carefully designed activities to question student pre-instructional conceptions and hence to incite cognitive conflicts proved to be essential.

White and Gunstone [48] come to the conclusion that meta-cognitive learning experiences play a central role in facilitating understanding. They claim that the manipulation of ideas is more important than manipulation of the materials used in the experiment. In other words, "*hands on"* is less important as compared to "*minds on*".

Hopf [20] embedded student experiments into authentic contexts and allowed problem based student work. Student pre-instructional conceptions were deliberately activated. The basic idea was that students should be given the chance to experience physics as interesting and to further develop their self-concept regarding learning physics. Teachers were of the opinion that this variant of student experiments is a valuable enrichment of the repertoire of instructional methods. It further turned out that embedding into contexts may be result in better cognitive learning outcomes as other research also has shown [49, 50]. However, it also became obvious that a better understanding of science content only occurred if students actually used the potential of the problem-based experiments embedded in authentic contexts. In addition the improvement of affective variables like student interests and self-concepts turned out to be somewhat minor [20: 228].

Hofstein and Lunetta ([18: 31f, 44] point to another important issue. When carrying out experiments often so much time is needed to handle technical and manipulative details that only little time is left for the development of science understanding.[9] Woolnough [51] claims, that for this reason the potential of experiments is often not well used.

As mentioned it is a widely hold view that student experiments lead to better student interests. The manifold results available do not necessarily back up this view [17: 7]. Hodson [52] found that some 50% of his students appreciated student experiments but that this was not at all the case for the other 50%. It further became obvious that many students were not sure what they were actually doing during the experiment and what to do if something went wrong.[10] Labudde [53: 150ff] reports that his female Swiss upper secondary level students preferred demonstration experiments. There are also findings in the above video-study in Germany that point into the same direction. Many female students preferred demonstrations

[9] "*In summary, data gathered in many countries has continued to suggest that teachers spend large portions of laboratory time in managerial functions, not in soliciting and probing ideas or in teaching that challenges students' ideas, encouraging them to consider and test alternative hypotheses and explanations*"([18: 44].

[10] These findings point to an issue more fully discussed below: To carry out student experiments is cognitively rather demanding for students.

– especially when they were carried out by other students. In summarizing, it seems to be justified to state that student experiments may lead to some improvement of affective variables. Hopf ([20], for instance, reports small increases. However, such effects only occur, if the experiments are appropriately staged.

Regarding the development of understanding science inquiry methods (the science processes) and views of the nature of science empirical studies point into two directions. There is clear evidence that the strictly teacher controlled student experiment (including primarily "cook-book activities") is counterproductive ([17:1, 22:95]. Such experiments result in a narrow view *about* science. Again, the development of contemporary epistemological views does not result quasi automatically from the practice of carrying out experiments – even if this practice is deliberately informed by the actual state. It is necessary to carefully initiate and further support such developments. It has to be taken into account that students have serious problems to understand and learn the ambitious science inquiry methods and their interplay [11, 54, 55, 56, 57].

Cooperative work

Student experiments provide powerful opportunities for intense student cooperation – however this needs to be deliberately supported. It also has to be carefully taken into account that the student work is focussed on dealing with the task chosen or given. Alton-Lee, Nuthall and Patrick [58], for instance, observed that most of the discourse in their groups was task related. However, most of the talk dealt with organizational and not with conceptual issues.[11] According to a review provided by Rumann [59], cooperative work seems to be a rather valuable method to support cognitive and affective development. However, the gains are generally somewhat small, i.e. in the same magnitude as the gain achieved by Hopf [20] in his above sketched approach [59: 110].

Students view experiments in their own way

According to constructivist epistemological views of teaching and learning students make their own sense of everything presented to them in science instruction, hence also of the experiments they carry out themselves or presented to them [60]. Lunetta [61: 250f] summarizes a number of studies in stating that students who carry out experiments usually are oriented at other goals than intended by the teacher. Many students, for instance, view "follow the instructions" and "find the right answer" as the major goals of their work.

Tasker [62] asked students who carried out experiments what they were doing and why they were doing that. It turned out that for strictly teacher controlled "cook book" like activities students did not really know what they did and what the purpose of the experiment was. They further had only vague ideas on the aim of the experiment. Champagne, Gunstone and Klopfer [63] as well as Chang and Lederman [64] reported similar findings. An additional problem is due to the fact that students' conceptions of the phenomenon investigated often are not in accordance with the science view [65]. As a result several severe problems occur. Student observations, namely, are substantially influenced by these conceptions. Observations are not objective but at least partly determined by the expectations suggested by the conceptions hold. Hence, students tend to observe something that is different from what the teacher intended [66].

Students' dealing with complexity

Self-guided experimentation is rather demanding for the students – even for strictly teacher controlled experiments. It is necessary to understand the written (or orally given) instruction, to handle the materials properly, to measure, to put down results, to process and interpret the data gained, and to cooperate with others. In addition it has to be taken into account, as outlined previously, that students make their own sense of the experiments. Many students have severe difficulties to deal with this complexity and tend to rather superficial kinds of experimentation. Johnstone and Wham ([67] illustrate how students tend to react to these demands by choosing strategies that have nothing to do with what the teacher intended:

(1) Adopt a recipe approach
(2) Following the steps in the instruction manual mechanically
(3) Focus on one aspect of the experiment in which they are busy getting nowhere
(4) Become helpers or assistants to a group organizing and run by others

Open inquiry

[11] Cf. the findings provided above that during experimentation (in student and demonstration experiments) much time is used for the management and technical details.

Variants of “open” experimentation allowing inquiry are particularly demanding for students. Metz [68] argues that students may loose control of what they are doing and hence are overstrained. In a video-based learning-process study Duit, Roth, Komorek and Wilbers [69], for instance, investigated how students find out the reason for the strange behaviour of a chaotic pendulum themselves. There are a number of cases documented in the data that students constructed a view being not in accordance with the physics explanation. It also becomes obvious how difficult it is to persuade and convince the students that the explanation they constructed, and is hence laden with personal significance is not acceptable from the physics point of view.[12]

Summary and Discussion

The experiment plays a truly significant role in science instruction – in the literature on the role of the experiment and in instructional practice as well. It is rather fortunate that there is no reason at all to blame the practice of experimentation in schools as “talk & chalk”. However, the opportunities provided for an active engagement of students in experimentation is still rather limited. Student self-guided experiments are very seldom to observe in instructional practice – all over the world. Even if the student experiment plays a significant role (as, for instance, in the UK), variants of experiments predominate where the term “cookbook experiment” is well taken. Opportunities for students to plan experiments, carry them out and process the results themselves are not frequent. Hence, opportunities to become familiar with key methods of scientific inquiry are only seldom offered.

It seems, in general, that the practice of science instruction is still significantly focussed on teaching and learning science concepts and principles and neglecting competencies providing insight into science inquiry and views of the nature of science – which are given a major emphasis in more recent standards of science education. As a result science instruction usually seems to provide a somewhat limited scientific literacy.

However, the results on the role of the experiment in teaching and learning science indicate that the certain “resistance” of instructional practice to provide the appropriate learning opportunities to achieve “full” scientific literacy is based on good reasons. As more fully outlined above, the ambitious aims linked with targeting scientific literacy are rather demanding to achieve. Students have serious problems to deal with these ambitious demands. Also teachers usually have severe problems to set the ambitious goals into practice [18: 39].

In a nutshell, there is the following situation. The well founded “visions” on the role and aims of experimentation in science instruction and the reality of teaching-learning-processes in normal practice do not fit well. Self-guided experimentation, for instance, may only be learned in long lasting series of attempts step by step.

Results of research on instructional quality, in general, show that there are no simple recipes for improving achievement and developing affective variables [71]. Student experiments, for instance, per se do not lead to better cognitive learning and a more pleasing development of affective variables. Further, deep understanding of science inquiry and views of the nature of science do not simply result from student self-responsible experiments. The many potential effects of experimentation claimed when the use of experiments is justified may only be set into practice by sustainably supporting the necessary teaching and learning processes.

Taking into account the scripts predominating the practice of science instruction which are based on teachers’ personal views and what research has to offer to improve the situation the following dilemma becomes apparent. On the one hand empirical research on teaching and learning science provides empirical findings on how instruction may be improved. On the other hand, research on teachers’ views and implicit theories of “good” instruction show that most teachers will have severe problems to set the changes suggested by research into practice. In other words, substantial research on professionalization of teachers to enact a more efficient use of experiments is needed.

A final remark concerns the title of the present conference: HANDS-ON SCIENCE. As briefly mentioned, *hands-on* needs to include *minds-on.* That means, diligently and beautifully designed experiments do not necessarily result into the outcomes expected – they need to be staged adequately in such a way that *hands & minds on* actually may occur.

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[12] The learning processes observed often turned out to be “random” when students included a spontaneous idea into the discourse [70].

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A Hands-on "View" of microKosmos

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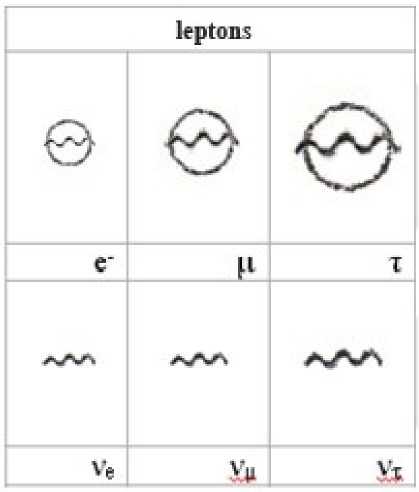
Abstract. *Hands-on "view" of microKosmos, with the structure, the interactions and the movements of microscopic wave-particles are presented. This view is achieved by a simulation / animation hands-on computer program with the use of Monte Carlo methods / techniques since microKosmos is eminently a stochastic system. Furthermore, microKosmos is the part of the world where the wave-particle duality comes up vigorously and such computer simulations / animations may wipe out some students' misconceptions and clarify some quantum "paradox" such as the paradox of wave-particle duality. With this "view" of microKosmos an imaginary journey into the interior of the matter can be attempted offering students (and teachers as well) the opportunity to have a glimpse to the microKosmos processes which can explain to them most of the macroscopic concepts and phenomena.*

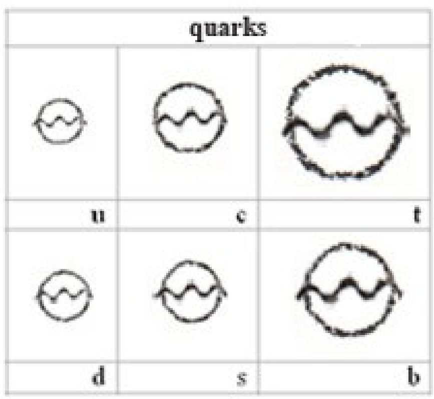
Keywords. Animation, microKosmos, Micro-processes, Monte Carlo methods / Techniques, Simulation, Wave-particles

1. Introduction

The structure, the interactions and the movements of microKosmos –from the "a-toma" / superstrings (;) to molecules– are simulated / animated by a hands-on computer program with the use of Monte Carlo methods / techniques since microKosmos is eminently a stochastic system. Monte Carlo Methods, in general, can be descried as statistical methods involving sequences of random numbers to perform various calculations. Monte Carlo Techniques, in use, employ those methods in order to simulate / animate by the computer certain stochastic processes according to specific distributions. Concerning the modelling and simulation / animation parts of the procedure may offer a view, even a glimpse, to the details of the complex realistic systems operation of microKosmos with a pedagogical virtue. Furthermore, this characteristic of Monte Carlo simulation / animation programs is one of the characteristic which "legitimate" the use of computers to physics education.

On the other hand, microKosmos is the part of the world where the wave-particle duality comes up vigorously and such computer simulations / animations may wipe out the impression / misconception of the students that "quantum mechanics is just incomprehensible" and clarify some quantum "paradox" such as the paradox of wave-particle duality.

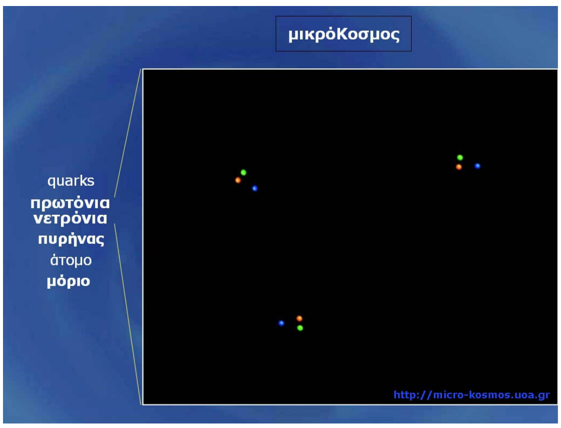


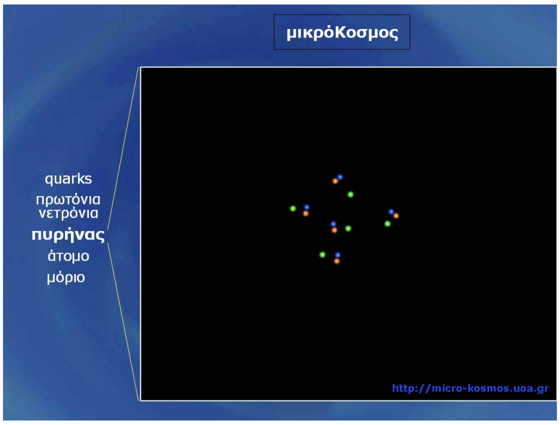


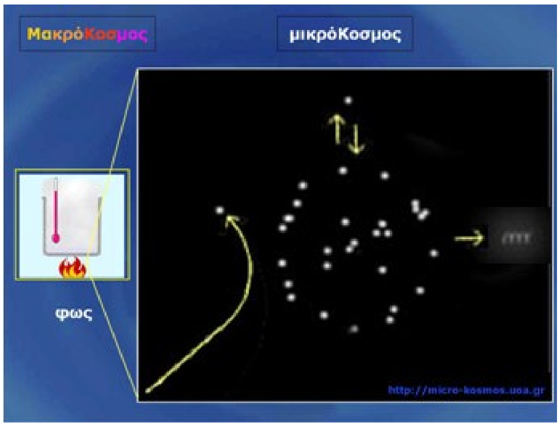
The wave-particles are visualised in the animation program by successive images of a wavepulse (which sometimes is shown and sometimes is not shown) and a particle (according to the model of elastic spheres) without any display of track, whilst they are visualised in static images by overlapped wavepulses and circles.

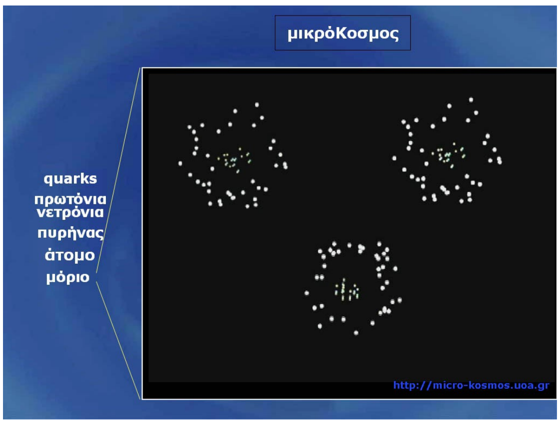
With these "views" of microKosmos an imaginary journey into the interior of the matter can be attempted offering students (and teachers as well) the opportunity to have a glimpse to the microKosmos processes which can explain to them most of the macroscopic concepts and phenomena (e.g. excitation–relaxation of atom's electrons / emission of photons, molecules' interactions / rigidity of solids, molecules' thermal motion / expansion-contraction of matter, molecules' motion / fluidity of liquids and gasses, molecules' movements / static pressure / friction, …). The hands-on operation of an improved version of this computer simulation / animation program may offer the opportunity to the students and teachers as well to change / select the parameters of the desired views of the microscopic processes (number of wave-particles, interactions, motion, …) in order to correspond / fit with certain macroscopic phenomena.

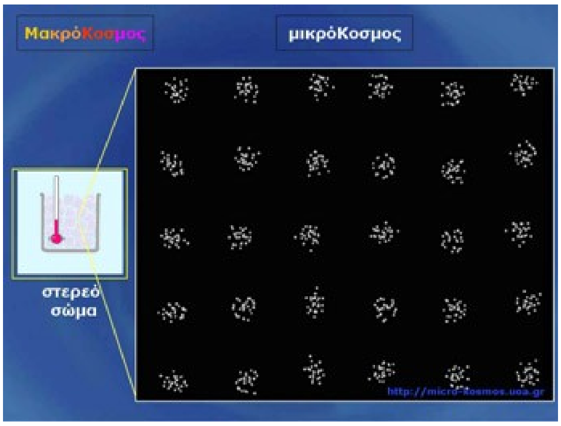
2. Static images of simulated / animated wave-particles

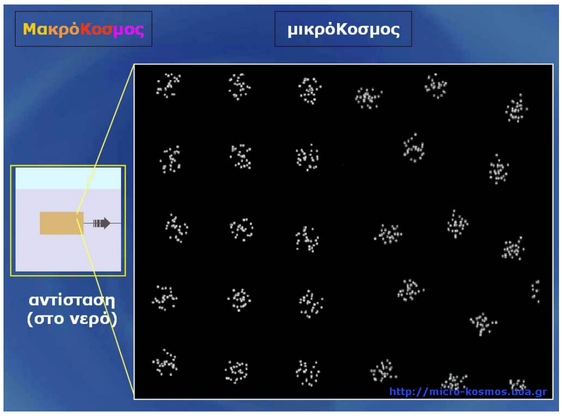


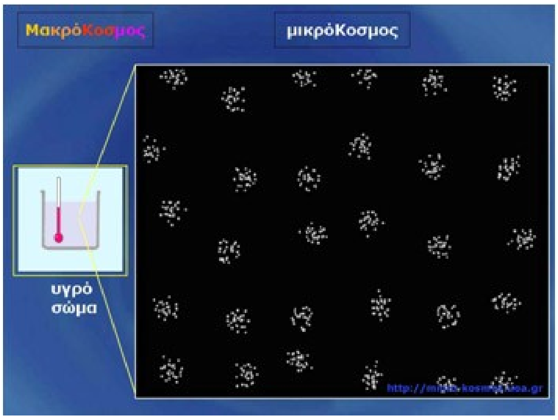


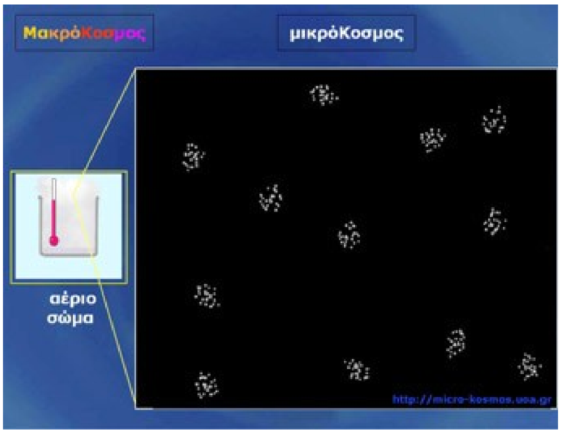


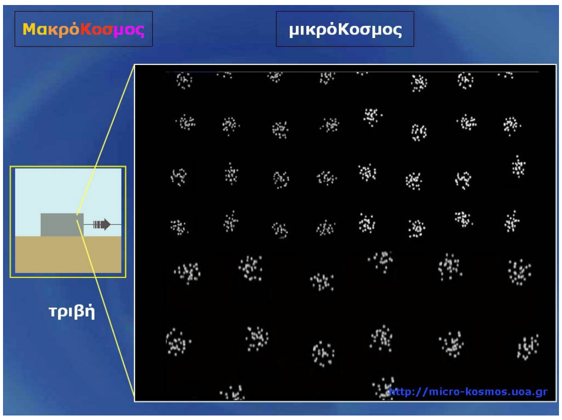












3. Acknowledgements

Acknowledgements to Vasilis Dimopoulos for creating the simulation / animation program, during his doctorate thesis, Ourania Gikopoulou for making the synthesis of static images and all my students for their cooperation.

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Bridging the Gap between Formal Education and Informal Learning: towards Evidence Based Science Education

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Abstract. *The awareness of the public understanding of science is very often linked to the big inventions or crisis in technology. The growth of modern science centres can be traced to the resurgence of interest in the West and in the USA in particular following the launch of Sputnik. Similarly, the growth of science centres since the1990s and 2000s has been clearly been connected to two major developments in society: the crisis of scientific literacy and the visions for the information society. Rapid advances in genetic research and information technology have created new challenges for the public understanding of science. The role of universities, industries and research institutes has been crucial for creating the contents of modern science centres such as Heureka in Finland. The findings of recent research suggest that students' situational motivation can be changed to intrinsic motivation by well organised programmes linking schools to the informal, open learning environments of science centres. A survey taken among university students attests to the fact that informal learning sources such as science centres seem to have a stronger impact on their academic career choices than has hitherto been realised. Also the latest technology like Augmented Reality (AR) can be successfully form a link between formal science education and informal hands-on learning.*

Keywords. Augmented reality, Career choices, Informal learning, Motivation, Open learning environment, Public understanding of science, Science centres, Science education.

Introduction. The role of informal learning is increasing in the modern societies. This phenomenon is closely related to the growing impact of science and technology on our everyday lives. Lifelong learning needs new practical forms.

According to most of the core ideologies of science centres, the essential role of science centres is: to advance public understanding of science. Science centres vary greatly in their nature, size, function and content. However, when starting a new institute, the same reasons are used world-wide: a science centre will advance public understanding of science, create positive attitudes towards science and technology, encourage young people to learn, and maximise their opportunities to try scientific applications. How much evidence do we have to prove that these main goals will be realised in the everyday functions of a science centre? Answering this question is not easy although we know from our everyday experiences that these pragmatic outcomes can be achieved. It is important to answer this question because this same question is asked with increasing frequency by the authorities, sponsors and the people who attend science centres. Because they are fairly new institutes, science centres, in particular, face this question more frequently than some other more traditional cultural institutes. The 'big picture' of the science centre field has become more clear thanks to the publication of carefully collated statistics which are comparable world wide [1]). However, additional data with the focus on educational research and learning results instead of economical and demographic statistics is needed. A science centre is a learning laboratory in two senses. First of all, it is a place where visitors can learn scientific ideas by themselves using interactive exhibit units. Second, it is a place where informal education can be studied in an open learning environment.

History of science –more than mirroring the society

The roots of science museums can be traced to the ideas of such respected scientists as Francis Bacon, Rene Descartes and Benjamin Franklin [2]. Industrialisation gave birth to the Great World Expositions. These presented the latest technical and industrial achievements but were also supported by art. The motivations for the expositions were often simply manifestations of nationalism [3]. The roots of most of the important science museums are to be found in the Great Expositions. Other characteristics of science museums established from 1850 to 1940 were: financial support for private collections which were made publicly accessible; a perceived need for enhanced science education; museum directors with strong and innovative characters and who had personal support at high levels in society [4].

Similarly, national museums and galleries grew up in the 1800s from a need to support the nation state and nationalism with allusions to and rhetoric about heroic wars and history. The era of rapid industrialisation, developing technology and new inventions made it possible to use technology as a tool for nationalism. International reputation was important for the state, and also important for industry and the new manufacturing companies. This dual need for the marketing of science, technology and production, provided the rationale for establishing many science museums and modern science centres. Technology and science played an increasing role in the lives of ordinary people, and came to occupy a place beside religion, the state, art and history in society.

In the USA, the background to the expansion of modern science centres in 1960s was the Sputnik phenomenon. No direct link can be documented, but the crisis in national confidence that resulted from the successful launch of Sputnik had a knock-on effect on all education in the USA. The attitude towards the study and teaching of science dramatically changed. The educational system in the USA was totally reformed [5]. Science education was seen as an element of national security. Federal governments gave resources to local school administrations for the improvement of education. The scholarship system was renewed. Some scientists were enlisted to develop new curricula and learning materials for schools and to re-arrange teacher education [6]. Resources were also directed to pedagogical development projects.

In the 1970s and 1980s there was a period when nearly identical exhibitions were built by science centres just by copying exhibit units and whole exhibitions from other science centres. The main source for this was the ‘Exploratorium Cookbooks’, which were to a large extent published for this purpose. Many new institutes still utilise this concept for their main content. It tells much about the international nature of science and science centres. The scientific principles and laws of nature are universal, and science centres are able to use the same exhibit units in different countries and cultures. However, the staff of science centres adapt their national and local features with their own ideas when choosing the content, design and programme ideas [7].

Innovative methods for creating a new type of interactive (not only hands-on) science exhibitions need a lot of resources. Money is not necessarily the main factor. The content development of these exhibitions has to be carried out in close co-operation with the best available scientific expertise. In this way, the exhibition is reliable and based on the latest knowledge in the subject area. This would not be possible without the input of universities. The value of this expertise cannot be overestimated [1]. The science centres which were initiated by national and local universities were among the most successful and innovative during the 1990s.

The development of science centres and museums must be seen against the background of the wider developments in society. The growth of science centres since the late 1980s has been clearly connected with the major developments in society, namely: the crisis of scientific literacy and the visions for future information societies. The Chernobyl accident clearly showed the inability of the media to put over technical and scientific points to the public. In addition, it highlighted the lack of meaningful and understandable scientific information given by experts themselves. On the other hand, the rapid development of genetic research and information technology of the present time closely resembles the situation in the 1960s with space and nuclear technology [8]. Most recent example of this trend is the climate research, and its role in public understanding of science.

Heureka, the Finnish Science Centre, was opened to the public in April 1989. The Science Centre Foundation behind Heureka was established by the University of Helsinki, the Helsinki University of Technology, the Federation of Finnish Learned Societies and also the Confederation of Finnish Industries and Employers. Heureka immediately became one of the major attractions in Finland. It has usually been number four, in terms of attendance, and usually number one or two among leisure attractions in Finland as measured by independent quality surveys. Heureka is renowned for its interactive science exhibitions, which consist of traditional hands-on experiments, computer and high-tech based audio-visual solutions. Interactive exhibitions related to technology and its solutions in everyday lives have been one clear trend in the content of Heureka's main and temporary exhibitions. The development of the content of these exhibitions is carried out using the best available scientific expertise of universities and relevant companies. In this way, the scientific and technological content of exhibitions is reliable and based on the most up-to-date knowledge in the respective subject areas. The Helsinki University of Technology and more than 60 high-tech companies have played a very significant part in these exhibitions.

New forms for public understanding of science and scientific literacy

The growth of science centres since the 1990s is closely related to the developments of the information society. Communicating science to the public via different media is not only a matter of giving sufficient support for scientific research and academic education in society but also a process of giving citizens their basic democratic rights in relation to scientific information [9]; [10].

The continuing world-wide trend is for a broadening of the subject range of science centres and an increasingly interdisciplinary approach to exhibition themes. One non-trivial problem that has been raised in the discussion of the role of science centres and universities, is related to the meaning of the word 'science'. In English, science generally means the natural and physical sciences and is often limited to physics, chemistry and biology. However, in German, Swedish or Finnish, the words 'Wissenschaft', 'vetenskap' and 'tiede' include the humanities, history, psychology, social science and linguistics. The modern science centre must be able to present phenomena related to all academic research. Accordingly, the content of Heureka has been planned in an interdisciplinary way. The content of Heureka's exhibitions is supported by a broad spectrum of temporary exhibition themes. Also the recent PISA-results [11];[12] are showing the importance of this relation and interaction between science and society.

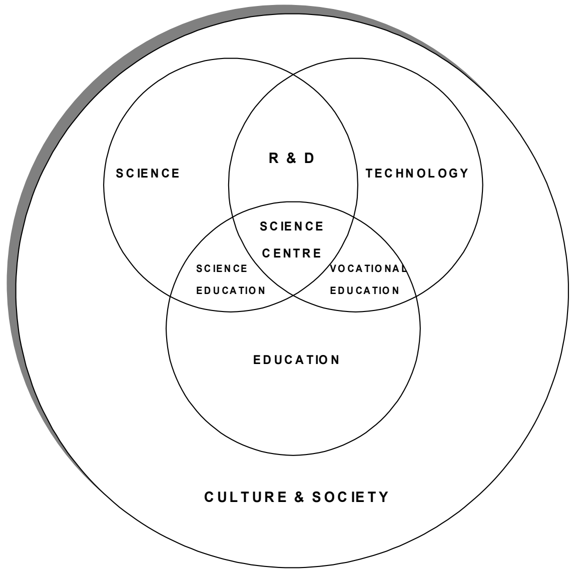

Figure 1: Science, technology, education and a science centre in relation to society and culture

To define the positions of a science centre in its relation to science, technology and education is presented in figure 1 [6]; [13]. Science education occurs at the point where science and education overlap. Science and technology combine in the area of research and development (R&D), where academic research is used to develop industrial methods. Vocational education is located at the intersection of technology and education.

In figure 1, a science centre is located where science, technology and education all meet. According to this description, a science centre features all of these three. Any exhibition, event or audience activity combines these three elements depending on the nature of the exhibition.

Science centres are no longer isolated hands-on workshops created by a couple of 'science freaks', but have become part of a larger movement promoting public understanding of science. They are influenced by not only the scientific community, but also by the other groups of society and vice versa.

Science education is not only a question of advancing technology or of demands for a scientifically qualified workforce, but it is also a question of social goals. As Coombs [14] summarised: 'The aim is not solely to produce more scientists and technologists; it is also to produce a new generation of citizens who are scientifically literate and thus better prepared to function in a world that is increasingly influenced by science and technology'.

The theory of informal learning

To advance public understanding of science, new forms of education are actively being sought. A huge amount of information especially about modern phenomena is obtained in a personal way from family, friends, peer groups. Furthermore, the roles of television, libraries, magazines and newspapers are also essential. Museums and science centres have increased the number of their visitors regularly during the last decade. Most of these forms of education can be classified as informal learning either focused on young people via informal, out-of-school education programmes or as clearly informal learning occurring totally outside of any educational institutions for young people or adults.

Informal education has often been regarded as the opposite of formal education. Even the names of the classic books - *Deschooling Society* by Ivan Illich [15] and *The Unschooled Mind* by Howard Gardner [16] - have been provocative. These books also contained harsh criticism of failures of schooling, which has alienated students from meaningful learning. Moreover, they argued that learning from informal sources was effective and motivating. These books have had a great effect to education and its research.

Since the 1990s informal education has become a widely accepted and integrated part of school systems. However, examples of theoretical or empirical research concerning informal education are rare [19, 20, 21, 22]. Recently informal learning has become a more accepted part of educational science, although there is still very little valid research for example about such a central topic as learning via the Internet [23]. The role of the Internet is a clear example of a learning source that was originally created for other purposes. The Internet is an effective informal learning source, which was first used by individual teachers and then officially by schools and other formal learning institutions. In other words the Internet can be described by the term ‘out-of school education’ meaning schools using informal learning settings and sources as a part of their curriculum.

The educational role of science centres has been regarded as more or less as self-evident. However, some classical educational theories can be detected in the principles underlying science centre education, although few educators in these institutions have been explicit in their approach. They have relied on the practical and common-sense application of loosely formulated pedagogy.

Frank Oppenheimer [17] has been quoted as the creator of the science centre pedagogy. His criticism of the passive pedagogy of science education derives implicitly from Dewey's ideas [18] expressed in his thesis: ‘learning by doing’ . The same approach can be seen in contemporary developments in science centre pedagogy: The famous hands-on principle articulated by Oppenheimer is a corner-stone of the principle of interaction in modern science centres. What Dewey and modern science centre pedagogy share is the accent on motivation, free will and the learner's own activity, stimulated but not forced.

Motivation and meaningful learning

Every-day knowledge tells us that students are eager to learn in informal settings. Field trips, schools camps, visits to industry, to a museum or science centre, or even having an art lesson in the school yard, are positive occasions in students' minds. The roots of this positive attitude are in the freedom of leaving the setting of the classroom. This free feeling arises as much from the wish to avoid school as from positive motivation towards the informal learning goal. Can the motivating effects of freedom and physical context be taken advantage of? This is an aim of science centre education. The recent research about motivation and science education also indicates the central role of intrinsic motivation in explaining many learning processes.

The Rocard-report - Science education now: A renewed pedagogy for the future of Europe [19] is describing the situation mostly in the pre-schools, primary and secondary schools while we also see the trends around the formal education. The role of informal learning is increasing in the modern societies – meaning the countries which are developing their societies by investing and creating opportunities for research, innovations, and education. The phenomenon is closely related to the growing impact of science and technology in our everyday lives. Lifelong learning needs new practical forms and the formal education can learn something from the informal, open learning environments like the science centres.

The Rocard report specifically underlines the term Inquiry-Based Science Education. One of the weaknesses of school’s science teaching has been that the studies and lessons at school are mainly deductive. There are some exceptions in some schools, but, historically the main trend in the European science teaching pedagogy has applied “Deductive approach”. In this approach, the teacher presents the concepts, their logical – deductive – implications and gives examples of applications. This method is also referred to as ‘top-down transmission”.

“Hands-on learning” is the main pedagogical principle of the science centres. On opposite to “Deductive”, it represents the “Inductive method”. This classical “learning by doing” method is something that the science centres have been pioneering in Europe during the last decades. The multidiscipline contents of modern science centre exhibitions form a unique and reliable learning source for inductive, Inquiry-Based Science Education.

Similarly, the Rocard-report requests new forms of teacher training, too: “Teachers are the key players in the renewal of science education. Among other methods, being part of the network allows them to improve the quality of their teaching and supports their motivation. – Networks can be used as an effective component of teachers’ professional development, and they are complementary to more traditional forms of in-service teacher training and stimulate morale and motivation.”

The presentation of the “Hot Air Balloon” is a classical science centre exhibit in several institutes around the world. That was one of the reasons why it was chosen as a CONNECT-case for the research and development. The idea was to gain more educational value from the exhibit by using Augmented Reality –technology added to this classical exhibit. The main pedagogical goal was to improve skills for individual observation. This was possible because by the AR-solutions certain invisible phenomenon could be made visible by animations and demonstrations. The combination of traditional hands-on learning and modern technology like Augmented Reality (AR) can create encouraging learning opp0rtunities also for the students having less-than-average success in traditional school grades [13].

Conclusions

Promoting public understanding of science and informal learning are the key elements to attract and retain the interest of greater audiences. Well planned educational programmes are needed, and without reliable and valid educational research the value of the science centres cannot be proven.

The conclusion of the research of informal science learning strongly indicates the following:

(1) The results of knowledge tests showed clear learning effects. However, the time spent in a science centre is rather short, and because of that the focus must be on the quality and not the quantity of learning. This arouses motivation as a key factor. School students having intrinsic motivation gained both better cognitive results and tended to apply deep-learning strategies in the learning process.

(2) The series of visits to a science centre appears to have a positive effect on the motivation of students in all the age groups, but the results were most positive among primary school pupils. Sixth form students’ intrinsic motivation also grew during the project. Motivation decreased among secondary school pupils, but the decrease was smaller among those students who visited the centre compared to the control group with no science centre visits.

(3) Gifted students seemed to get more motivated than others during the visits. However, by using programmes linking the school curriculum and science centre exhibitions, encouraging motivational results were also obtained for the group of students with learning difficulties.

(4) No statistically significant relation between gender and motivation was found in any of the motivation tests given.

(5) Informal learning sources such as science centres have an effect on career choices of university students.

(6) The combination of traditional hands-on learning and modern technology like Augmented Reality (AR) can create encouraging learning opp0rtunities also for the students having less-than-average success in traditional school grades.

Meaningful learning has two components. First, the content should be meaningful for the learner. Second, the learning process should be arranged pedagogically in a meaningful way (according to the age and the former knowledge and skills of the learner and by the logical structure of the topic to be taught.) All the great innovations in education have been based on putting these two principles into practice.

Science centres are firmly planted in the soil of the society that nurtures and continues to support them. The impact of developments in society, science and technology is crucial to the process of starting and developing science centres. If these institutions cannot respond to social change, and renew themselves, they may very easily loose their ideological credibility and financial support. To encourage and report results related to public understanding of science and informal learning is the main element in this process.

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WORKSHOPS

The Model of Educational Reconstruction
A Framework for improving teaching and learning science

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Abstract. *The Model of Educational Reconstruction (MER) provides a frame for research of subject related learning and teaching. By closely linking theory and practice the model aims at the development of learning and teaching sequences. Within the framework of the model three central tasks of science education are investigated: firstly, the clarification and analysis of science subject matter (e.g. in the field of evolution, energy or combustion), secondly, the investigation into students' perspectives with regard to phenomena related to the chosen subject (e.g. conceptions, skills or interests), thirdly, the design of learning environments (e.g. instructional materials, learning activities, lessons or learning sequences). The investigations are carried out empirically and thus are structured by research questions, methods, and findings. But there is no way of solving these three modes of investigation as single tasks one by one. Each of the investigations depends on the findings of the other two; all of the tasks are interrelated and have to be linked closely. The Model of Educational Reconstruction also guides the creative designing process and leads to empirically based proposals for teaching designs and promises for learning about science topics.*
The major features of the MER will be outlined by referring to examples of educational reconstruction of the energy concept, of modelling in science, and of non-linear systems. In addition participants will work on their own examples in small groups. The most recent overview article on the model as well as the Powerpointpresentation used will be available for the participants as data files also.

Keywords. Cconstructivist view, Instructional planning and design; Teaching and learning science, Educational reconstruction

Concept Mapping Activities Using CmapTools

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Abstract. *The technique of conceptual mapping is a tool that facilitates new knowledge construction. It engages the cognitive processes involved in analysis, critical attitude, organization and representation of knowledge, taking into account the social and cultural environment. Concept mapping is involved in various areas of human activities and is used in all levels of education, research, activities, design and programs.*

Keywords. Concept mapping, Concept maps, CmapTools.

1. Introduction

Concept mapping is a 20th century phenomenon. Typically, roots of this technique were created with materials such as paper-and-pencil or sticky notes on a surface, for example a cardboard, blackboard, or a wall. Maps generated with the concept mapping (CM) technique are based on words linked together in a hierarchical structure, like a network. An important feature is cross-links, which are usually propositional links between concepts in different areas and clusters of a concept map, that reveal more complex relations between those concepts.

2. Conceptual Mapping Technique

Current literature suggests that concept maps are used in research, analysis, design, assessment and creative approach. Using learning and teaching tools which focus on the representation of knowledge and the understanding of the trainees contributes to their self-investigation and development. Concept maps are such tools, designed to facilitate meaningful learning [1] as a graphical representation of concepts [3].

3. Concept mapping software

CmapTools [2] is a concept mapping software developed by J. Novak (Novak & Gowin, 1984), based on the meaningful learning theory of Ausubel (Ausubel et al. 1984). It is one of the teaching techniques and learning strategies designed to enhance the constructive and meaningful learning. New knowledge interacts and interrelates with representations, concepts and propositions of the cognitive structure of the trainees in such a way to help them acquire essential meaning.

4. Construction of a Concept Map

A concept map which corresponds to a cognitive field, a problem or a project to be mapped integrates the following stages:

- specify the key question
- brainstorm relative concepts
- main concept selection
- classification
- branching
- cross links between concepts
- redefining relations
- examples
- integration of the map

5. How to use Concept Mapping

Concept maps are a hands-on activity and as such they can uncover students' misconceptions as well as understanding. It may help students follow what comes after and it can be used as a review tool as well. During a session a concept map can be used as (i) an organizer of the course, (ii) a brief presentation of the course-concepts, (iii) an advance organizer, like a bridge to link new concepts with them already have been discussed and (iv) a review tool to have a chance to see what was done, as well.

6. Sample Activity: A concept map about ''water'' with CmapTools

6.1 After a short training exercise with CmapTools, participants in the workshop are kindly requested to create their concept map in the graphical format of the application. There will be an assignment of creating a concept map of their conceptual understanding of the field of Environmental Education about key concept of "water".

6.2 Discussion about what students already know and "how" do they understand the concept. The difficulties students meet in their way to construct their Cmap.

6.3 Which is the 'key question" to construct a map? Pieces of advice that can help discover it.

6.4 The ways to discover relative concepts. Brainstorm but keep in mind the rules. Share ideas and bring them all out for discussion.

6.5 Proposed solutions to single main concepts from others less value in meaning.

6.6 Branch concepts in first taxonomy.

6.7 Place cross-links between concepts to provide understanding words with action.

6.8 Redefine relations between concepts and change if necessary the initial map.

6.9 Add resources in any format of media and examples in the bottom-down concepts to present features abilities.

6.10 Keep in mind the purpose of this map construction.

6.11 Give examples for assessment with Cmaps. What is the critical question? Pre and Post Assessments.

7. Resources

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Inspiring Science Learning

1. Workshop Description

Over the last two decades the design of pedagogical approaches and the development of technological tools for inspiring science learning have had a profound impact on the process of science teaching and learning. The employment of new technologies and applications such as augmented reality, virtual reality, portable devices, wearable computers, simulations and computer modeling of physical phenomena in science classrooms has allowed the enhancement and enrichment of their current curriculum.

However, the introduction of such innovating tools into students' learning experience itself, cannot improve their learning without the active participation of their educators. With the employment of innovative and highly interactive technologies as well as available authoring or data analysis tools, the educators are able to implement sets of demonstrators to enhance the quality and effectiveness of the teaching and learning process.

Furthermore, technology-enhanced learning tools give the opportunity to connect science education with real life & research and motivate learners to engage themselves in exploratory learning.

This workshop aims to introduce educational practices that inspire and support science learning through the usage of innovative technology tools. The application of various leading edge technologies and applications that can transform the educational environment and the teaching and learning processes is further inspected. This workshop embraces the interconnection between science learning and real data collected form daily activities and/or basic research, along with the instructional influence upon learning processes.

Moreover, modern techniques of organizing digital content and metadata are investigated along with educational resources that use these appropriate metadata to form learning objects.

The mapping of pioneering technologies to enhance science education identifies sets of technological tools in which science centres and schools should invest. This will create valuable teaching and learning processes that will effectively capture the needs of modern communities.

2. List of speakers & the title of their talks

Convenor: *Prof. Christine Kourkoumeli*

Dr. Sofoklis Sotiriou
(Ellinogermaniki Agogi)
“Inspiring Science Learning”

Dr. Angelos Lazoudis
(Ellinogermaniki Agogi)
“Associating Sports Activities with Scientific Enquiry and Experimentation”

Dr. Nikitas Kastis
(Lambrakis Foundation)
“Open Science Resources”

Dipl.-Ing. Hagen Buchholz
(Fraunhofer Institute)
“Science Center To Go - A mixed reality learning environment of miniature exhibits”

Prof. Erik Johansson
(University of Stockholm)
"Particle collisions for students and teachers"

The ATLAS Experiment for Schools

1. Workshop Description

Over the last decade it has become more evident that direct interaction with scientists can result in decreasing the gap between research and schools. Such interaction besides demystifying what scientists do and showing how science really works also increases the motivation of teachers and inspires curiosity by addressing big and current questions. The “Learning with ATLAS @ CERN” project introduces a technologically advanced approach for learning by connecting a science institution and frontier research, namely CERN and the ATLAS experiment, with a wide range of learning environments such as schools, universities and science centres. The ATLAS experiment as one of the world’s largest and most complex experiments is having a big impact in inspiring young people to study and appreciate science.

In this framework, scientists working on the ATLAS research project will present innovative educational tools that create 2D and 3D animations and simulations of physical processes and experiments. Moreover, they will show how these developed advanced tools can be used to inspire curiosity, enhance the quality of teaching and give to learners the opportunity to interact directly with real scientific data taken nearly at real time from the CERN laboratory in Geneva. Learning by gaining exposure to the ATLAS experiment in a way that is appropriate to every individual’s level of understanding is also important and will be addressed. In addition, educators will present educational scenarios for science centres and demonstrate how these new educational tools related to the ATLAS experiment can engage science centre visitors in episodes of playful learning.

During this workshop the “Learning with ATLAS @ CERN” consortium will present its methodology for designing, expressing and representing educational practices in a commonly understandable way along with the implementation of the educational activities following the specific educational approach.

2. List of speakers & the title of their talks

Convenor: *Dr. Angelos Lazoudis*

(Part I)
Dr. Crispin Williams and Dr. Despina Hatzifotiadou (University of Bologna)
“The Extreme Energy Events Project (La Scienza nelle Scuole)”

Dr. Despina Hatzifotiadou (University of Bologna)
“An exercise based on visual identification of strange particles - an ALICE experiment proposal for the MasterClasses”

Dr. Michail Koratzinos
“The LHC adventure”

Dr. Kenneth Cecire
“International Masterclasses in Physics”

Prof. Christine Kourkoumeli
(National Kapodistrian University of Athens)
“Learning with ATLAS @ CERN”

(Part II)
Prof. Erik Johansson
(University of Stockholm)
“The ATLAS Outreach Programme”

Prof. Peter Watkins
(University of Birmingham)
“Educational Scenarios for University Students based on the ATLAS experiment”

Prof. Franz Bogner
(University of Bayreuth)
"The users' impact of the ‘Learning with ATLAS@CERN’ portal"

Dr. Christian Reimers
(Austrian Federal Ministry of Education, Arts and Culture)
“Mobile Applications for the ATLAS Outreach Programme”

Dr. Michael Barnett
(Lawrence Berkeley National Laboratory)
“Educational Programs in the US with ATLAS Data”

Hands-On Workshop on the
"Learning with ATLAS@ CERN" Portal

1. Workshop Description

One of the main outcomes of the project "Learning with ATLAS @ CERN" is a portal with a web-based interface that integrates, under a common environment (repository), resources that make use of real scientific data from the ATLAS detector at CERN, scientific data analysis tools and various educational materials. In order to support the different user communities involved in the project (teachers, researchers, university staff, science centre staff etc) the existing content is organized properly.

The employment of the project's developed Metadata Toolkit allows authoring and managing of metadata for all repository contents. Thus, archiving, cataloguing and indexing are specified in a structured manner. Furthermore, an advanced search mechanism system has been developed to increase the usability of the extended digital content. The objective is for users to find easily, through a user friendly interface, what they are looking for. This search mechanism supports the different categories of users of the system.

Our workshop, aims to introduce to teachers the "Learning with ATLAS @ CERN" Portal and train them on using the aforementioned data analysis tools, the Metadata Toolkit and the Search Mechanism in order to:

a) Create educational material enriched with metadata and share them with other members of the portal

b) Search for educational materials relevant to the instructional methodologies they are using in their classes

c) Become members of the "Learning with ATLAS @ CERN" Community and be able to download the most popular educational material/learning activities and have access to the latest data available from the ATLAS Experiment.

2. List of Instructors

Convenor: *Dr. Sofoklis Sotiriou*

(Part I)

Dr. Crispin Williams
(University of Bologna)

Dr. Angelos Lazoudis
(Ellinogermaniki Agogi)

Dr. Sofoklis Sotiriou
(Ellinogermaniki Agogi)

Figure 1. Screenshot of the Repository of the "Learning with ATLAS @ CERN" Outreach and Educational Portal.

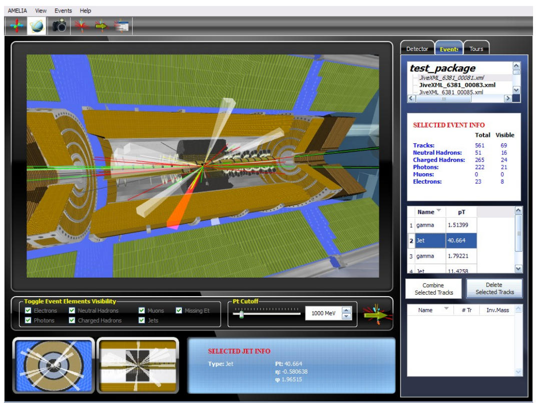

Figure 2. Screenshot of the data analysis tool AMELIA (available at the "Learning with ATLAS @ CERN" Portal's Toolbox section)

(Part II)

Dr. Crispin Williams (University of Bologna)

"A hands-on demonstration of the construction of Multigap Resistive Plate Chambers for the muon telescopes of the EEE project"

The EEE project has a number of muon telescopes installed in ~30 high schools all over Italy. Each telescope consists of three multigap resistive plate chambers, which have been constructed at CERN, in our lab (ALICE TOF), with the participation of pupils and teachers from the schools.

We will demonstrate the chamber construction, showing a small-size prototype: some phases of the construction will be "real" (for example, the stretching of the fishing line spacers between the glass resistive plates and the making of readout planes by sticking copper strips on vetronite); the rest will be explained by projecting video and/or photographs.

Workshop on Organic.Edunet: Challenges in Linking Environmental Education to Sustainable Development and Environmental Protection

1. Workshop Description

The Organic.Edunet project aims to facilitate access, usage and exploitation of digital educational content related to Organic Agriculture (OA) and Agroecology. It has deployed a multilingual online environment (the Organic.Edunet Web Federation portal) that will facilitate end-users' search, retrieval, access and use of the content in the learning repositories (available at: http://portal.organic-edunet.eu). The project studies educational scenarios that introduce the use of the Organic.Edunet portal and content to support teaching of topics related to OA and Agroecology.

The Organic,Edunet project offers to the users a social networking tool, such as "Confolio" (http://confolio.vm.grnet.gr) to support effective collaboration and communication over the web. The users of the Confolio service can store files, links, ideas etc, collaborate with other portfolio owners by sharing information (access control), structure their content using international standardized formats (e.g. IEEE LOM) and publish opinions on contributions by others, in such a way that these opinions are retrievable from the contribution itself.

The workshop's aim is to familiarize the participants with the use of educational portals in order to search, bookmark, retrieve and interact with digital learning resources on their topics of interest as well as to enhance their understanding in learning design processes and strategies by using ICTs. The workshop begins with an introductory presentation to the process of retrieving educational content through search engines over the World Wide Web, and continues with a hands-on session on retrieving learning resources with the use of simple and advanced searching functionalities. Then, a discussion of innovative educational practices implemented in schools that capture associated educational approaches as well as a description of how these approaches are instantiated into actual practice is further examined.

During the workshop teachers will have the opportunity to design their own learning activities as well as to get familiar with new technologies applied in the field of environmental education.

Moreover, teachers will use the Organic.Edunet portal to search for learning scenarios, while they will have the opportunity to use these scenarios in their own educational context.

2. Main research questions addressed at the workshop

1. How ICTs and specifically social networking applications can facilitate the process of searching, retrieving, accessing and using educational content related to Organic Agriculture and Agroecology?
2. How innovative educational practices can enhance environmental education in schools?
3. How can we develop environmental and ecological awareness to students growing up in rural areas?
4. How the design of an educational scenario with the use of ICTs can support teaching and learning related to OA and Agroecology?

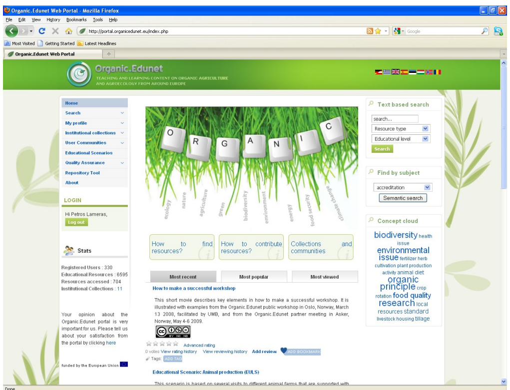

Figure 1. The Organic.Edunet website

4. List of speakers & the title of their talks

Convenors: *Petros Lameras &*
Nikos Palavitsinis

Dr. N. Manouselis and Mr. N. Palavitsinis, (GRNET)
"Retrieving learning resources with the use of simple and advanced searching functionalities"

Mr. N. Tsagliotis,
(Primary Science Laboratory , 9th Primary School of Rethimno)
"An Organic Garden Coming into Being"

Dr. S. Sotiriou
(Ellinogermaniki Agogi)
"Enhancing Social Networking and Teachers' Professional Development in Remote Rural Schools

Dr. P. Lameras
(Ellinogermaniki Agogi)

"Designing and delivering learning scenarios with the use of ICTs to support teaching and learning related to environmental education"

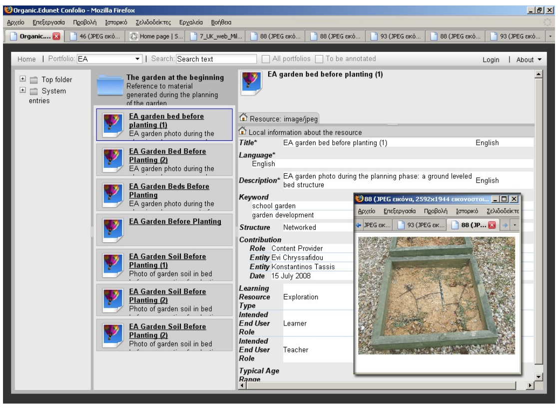

Figure 2. The Organic.Edunet Confolio

Empowering access to and use of environmental culture content related to natural history and nature/environment preservation

1. Workshop Description

In the context that nowadays formal education is facing new challenges and schools can no longer be mere providers of knowledge, non-formal education increasingly appears fundamental to science education. Natural History Museums, Aquariums and science centres can provide supplemental services to formal education beyond the classroom context. Current literature indicates new approaches to learning through inquiry and hands-on experiences which are not usually found in schools, while at the same time museums and science centres have the potential to become more educationally accountable in order to allow students to enhance their learning experience. The development and use of novel graphical interfaces that will facilitate visitors' navigation through a series of learning pathways will contribute on improving and empowering access to and use of environmental culture content related to natural history and nature/environment preservation.

Innovative approaches for teaching and learning through the usage of advanced technological tools and user-generated resources will be presented. A series of scenarios of use will be described and proposed as a means of creating opportunities to interact with science resources in pedagogically-rich ways. To this line, the specific session will interconnect educational activities taking place in school (formal) with informal activities taking place in museums and science centres (informal) through the use of relevant educational approaches that will be highlighted. This will promote knowledge creation, autonomy and self-direction, whilst offering guidance and structure when needed; as well as adding value to the learning process through adaptive, personalised and customised approaches.

The proposed workshop addresses all stakeholders of the educational sector, ranging from trainers, to tutors and teachers, despite the application domain in which they specialize. The subjects of learning theory and its application in schools will be of interest of all practitioners within the broader field of education.

2. Main research questions addressed at the workshop

1. How can we establish a closer and more effective collaboration between museums and/or science centres and schools?

2. How could the visit to a museum/and or science centre be transformed into a creative and innovative experience?

3. How could the visitor of a museum/and or science centre interact in a supportive and meaningful way with relevant content?

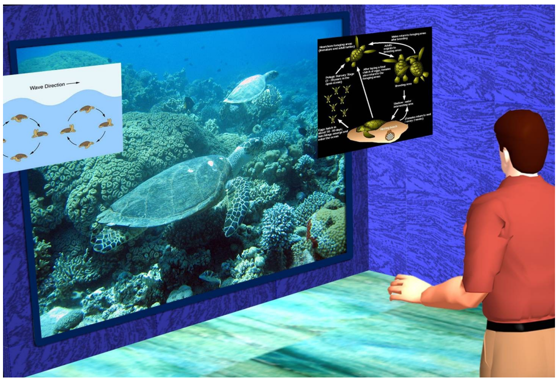

Figure 1. Visit at an aquarium by making use of advanced learning technologies

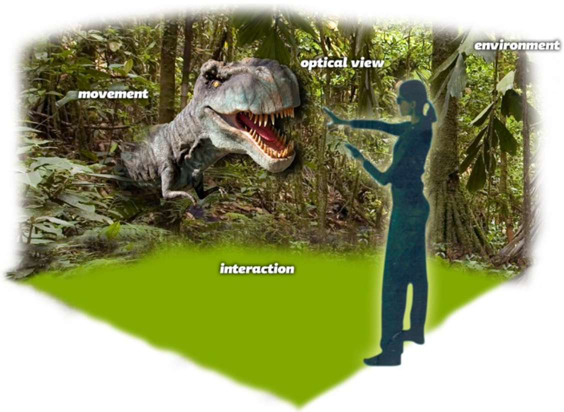

Figure 2. Augmented reality applications in Natural History museums

3. List of speakers & the title of their talks

Convenor: *Sofoklis Sotiriou*

Prof. F. Bogner
(University of Bayreuth)
"Environmental Education and the 2-MEV Model: Interaction with Attitudes and Values in Green Out-of-School Settings."

Dr C. Voreadou
(Natural History Museum of Crete)
"Connecting Formal and Informal Education in the Natural History Museum of Crete"

Dr. M. Papadakis
(CRET@QUARIUM)
"Educational Activities in Cret@quarium"

Dr. N. Manouselis
(GRNET)
"The Natural Europe Initiative"

Dr. S. Sotiriou
(Ellinogermaniki Agogi)

"Transforming the Visit to a Museum/and or Science
Centre into an engaging educational experience"

Dr. P. Lameras
(Ellinogermaniki Agogi)
"Learning Theory and its Application in Schools and Museums"

Interactive Educational Activities in the Natural History Museum of Crete

Location: Natural History Museum of Crete, Heraklion

1. Workshop Description

In the context that nowadays formal education is facing new challenges and schools can no longer be mere providers of knowledge, non-formal education increasingly appears fundamental to science education. Natural History Museums can provide supplemental services to formal education beyond the classroom context.

Current literature indicates new approaches to learning through inquiry and hands-on experiences which are not usually found in schools, while at the same time museums and science centres have the potential to become more educationally accountable in order to allow students to enhance their learning experience.

The development and use of novel graphical interfaces that will facilitate visitors' navigation through a series of learning pathways will contribute on improving and empowering access to and use of environmental culture content related to natural history and nature/environment preservation.

In the framework of the workshop the Natural History Museum educational team will involve to the participants to three interactive and hands-on activities:

- "Live Nature": A Hands on experience in the museum Discovery Centre. An experiential activity.

- "Discover the Nature of the Mediterranean Sea": An Interactive educational program for High School students and teachers into the museum Exhibition Halls. An experiential activity.

- "The Natural History Museum Fairy Tale": An interactive educational program for Pre School children into the museum Exhibition Halls. An experiential activity.

The proposed workshop addresses all stakeholders of the educational sector, ranging from trainers, to tutors and teachers, despite the application domain in which they specialize.
The subjects of learning theory and its application in schools will be of interest of all practitioners within the broader field of education.

2. List of Instructors

Convenors: *C. Voreadou & D. Grammenos*

Dr. C. Voreadou
(Natural History Museum of Crete)

Dr. D. Grammenos
(Foundation of Research and Technology Hellas)

PRESENTATIONS

Broadcasting Science:
a New Bridge between Science and Society

Josep M. Fernández-Novell[1,2] & Carme Zaragoza Domènech[3]
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[2] *IES Isaac Albéniz. Badalona. Spain. jmfernandeznovell@ub.edu*
[3] *IOC. Department of Education. Government of Catalonia. Spain. czaragoz@xtec.cat*

Abstract. *Science has many implications in our everyday lives, from scientific and economic topics to those related to health or the environment. However, society frequently does not appreciate the important role of science in our lives. Furthermore, the problem of science education is how to stimulate students, our future society. To solve this, it is necessary to make science understandable and enjoyable to students and everybody. Science has often been a topic in mass media news, from the printed word to radio and television. We feel that radio could easily be used as a diffusion instrument to give a new and balanced perspective of science to make it more interesting and more participative in the eyes of our pupils and teenagers. The main purpose of this article is to present our radio programs used to communicate and enjoy science to the primary and secondary school students and the whole of society.*

Keywords. Improve science, Radio program, Science communication, Students and society.

1. Introduction

Science and technology are inside and around our lives, science teachers must especially show students that science is also in their lives. Here there are a few examples that relate science and life: nutrients digestion is produced by a lot of chemical reactions; electricity at home and the Moon around the Earth are attempted by physical laws; computers use mathematics; diseases like diabetes or sickle cell anemia (genetic disease) are studied by human biology and, science also comprises environmental and engineering fields. Almost certainly, today during your family lunch or your family dinner, some words about any field of science could be named or asked by children, deoxyribonucleic acid (DNA), genetic modified organisms (GMO), stars, energy, whale, etc., could suddenly appear. Despite of this children science interest, our society frequently does not appreciate the important role of science in our lives. Why?

Probably because for a long time, scientists, science teachers, politicians and media did not give a real importance to science communication. Thus science has only lived in university laboratories and in the mind of researches, science is completely distant out of people's lives. Fortunately, it seems that things are changing and, nowadays is widely accepted the economic and social importance of the science communication to the public [1].

On the other hand, scientists and science teachers use different methods to involve students with scientific knowledge, for example they prepare science experiments (into the laboratory or by internet), visits to museums, industries, etc., and, sometimes with the help of magazines, films or radio programs.

Finally, the purpose of this article is to focus on how to improve science in primary and secondary school students and how to transmit science knowledge to the whole of society. At the end of this venture we will spread the importance of science to young students, families, friends and the public in general. For this reason we want to build bridges between science and society [2].

In this way, we analyzed the question “What should be done to appreciate science between young people and society?” and, we focussed the problem on making science popularization on a radio program, one of the different forms to presenting science to the public [3].

Another point that we have to pay attention for guaranteeing success in science dissemination is that science communication must present science in a pleasant and exciting ways to the public, is not easy to do it but our radio program tries to do it. The promotion of science among young people is crucial if we want to increase their interest in science [4 -6], so we have to educate them from a young age.

2. A radio program

To bridge the gap between primary and secondary school students and the scientific knowledge led us to design a radio program with science news, student's competition, the history of science and everything related to science.

From 1996 we have developed several programs about science and the history of science in an effort to present them with a new perspective to the students and society. These include "*Badaciència* – Bada-science" which began its emission in 1996 and finished in 2007 from the radio station RIA (Ràdio Isaac Albéniz) at the Isaac Albéniz secondary school in Badalona that it emits by 91.6 FM. The radio program "*Juguem amb la Ciència* – Playing Science" which began its emission in 1998 and finished in 2007 from the municipal radio in Sant Andreu de Llavaneres that it emits by 107.8 FM [7] and, finally, a new "Playing with Science" which is been emitting since 2007 in the municipal "Mataró Ràdio" that it emits by 83.9 FM, (all these cities are in the Barcelona area, Spain). The program format was similar in these three different broadcasting companies.

3. A representative program

"Playing with science", is directed to the pupils of primary and secondary school education and it is developed as a space of scientific spreading that tries to involve young students and families into science. The program is on air twice a week, usually on Tuesday from 17.30 h to 18 h and also repeated on Saturday from 10 h to 10.30 h.

FIGURE 1

Program's presentation.
The news.
The quiz.
The History of science.
Taylor's box.
To say goodbye.

Figure 1 includes the program sections that we give explanation in detail. Each section starts with a different and suggestive introductory music.

3.1. The "Program's presentation"

It is the introduction section of the program and it prepares the audience for each part of it. Participants and the main part of the program are introduced by the presenters. Figure 2 shows different student groups. On the left panel you can see primary school students, on the right panel two secondary school students and, in between, the "Matarò radio" trade mark.

Figure 2

3.2. The news

In this section students present and discuss several news reports dealing with science in general.

Figure 3

The news stories are obtained from different mass media sources which the students selected and prepared for the day's program. The news reports cover topics from Physics, Chemistry and Medicine to Biology, Technology or Nuclear energy.

Figure 3 shows a few news paper headlines presented during the last academic year (2009-2010), we always try to work on several science fields. Thus you can observe news from technological and scientific evolution to high cholesterol could course mental problems or from false scientific Myths to Barcelona opens Synchrotron.

3.3. The quiz.

Each student must respond to five questions. Each one of them is accompanied by three possible answers but, only one is the correct one. Frequently additional questions will be asked based upon students' answers. While not officially part of the quiz, these questions help to expand the discussion and review the students' knowledge and understanding of the subject matter.

Figure 4.

1st QUESTION: At what temperature does ice begin to melt in normal conditions?		
A 0ºC	B -10ºC	C 100ºC
2nd QUESTION: The X-Ray was discovered by?		
A Mendeleiev	B Lavoisier	C Roentgen
3rd QUESTION: Which of these animal is a mammal?		
A Penguin	B Dolphin	C Shark
4th QUESTION: How many groups of 2 people are possible with Mary, Laura, Peter and Jim?		
A 8	B 4	C 6
5th QUESTION: What is the name of an atom that has lost one electron?		
A Cation	B Isotope	C Anion

Obviously, the score is different for each question, the easiest (the 1st question) is 1 point, the 2nd is 2 points and consecutively still the most difficult (the 5th question) that is 5 points. Figure 4 shows an example of a secondary school student's questionnaire, the underlined answer is the correct one.

It is important to stand out that the questions never finish when the students guess the correct answer. Thus, all the answers, correct ones and incorrect ones, are analyzed and discussed in detail.

Accordingly, in the 1st question when the participant answered correctly we have to continue with the same question explaining that at -10ºC the water freezes and at 100ºC it boils and we could also ask them "What do you call the passing of solid water to liquid water?" .

In the 2nd question we have to explain who was Mendeleiev and its periodic table of elements and also who was Lavoisier "the father of chemistry" because Röetgen discovered the X-ray and we could also ask them "What is X-Rays used for?".

In the 3rd question when the participant answered correctly we have to ask what kind of group does the penguins (bird) and shark (fish) fall under and we could also ask them "What does mammal mean?".

In the 4th question participant has to count the possibilities of how many groups he can make using only 4 people and we could also ask them "Are there the same number of groups if you have to make them with 4 different letters a, b, c and d?".

And, finally, in the 5th question, the most difficult one, if the participant is wrong we have to help him/her to explain what is an isotope, cation and anion and we could also ask them "What is an atom?".

At the end of this paper there is an attachment with two more examples of questions for primary school (students 10-12 years old) and secondary school (students13-16 years old) in the same format as Figure 4. Furthermore, you can notice the different question levels, primary school are easier than secondary school questions.

3.4. The history of science

The evolution of science is discussed. Students introduce and present an individual scientist, such as Pasteur, Bohr, Einstein, (Santiago Ramón y Cajal and Severo Ochoa, both Spanish Nobel laureates), Fleming, Marie Curie, etc. Students and presenters have a discussion about life, technical findings and discoveries in scientist's living days [8, 9].

3.5. Taylor's box

This section is used to explore together with participants many controversies that have taken place throughout the history of science, such as Phlogiston Theory, Spontaneous generation, Genetically Modified Organisms (GMO) or Heliocentric Theory, for instance.

3.6. To say goodbye

It is the section that finishes the program and thanks the audience, the participants and the radio personal.

Sometimes the program changes its format. Maybe two to four times a year some teachers and scientists are invited to this program and they can talk about things related to science. In this way, science teachers explain the changes in science curricula in schools. Scientists, from the same city or geographical area, try to explain their research in several scientific fields. In addition, this program supports the "Science Week" realized ones a year in Mataró city, with an interview to the organizers where they could explain the publicity of the activities for the event.

4. Impact of the program.

After each years program, the opinions of the students and their teachers were assessed. The students considered that the program is an important experience.

Most of them appreciated the chance to perform on a radio program and the preparation of the dialogues that have increased their language and vocalization. All of this leads the participants to increase their communication ability. Therefore, most of the participants clearly showed a marked tendency to choose studies in which science constitutes a considerable part of the curricula.

Furthermore, primary and secondary school teachers, who have helped to promote our initiative throughout their direct contact with students, have received the program with great enthusiasm.

All of these programs have had a vital impact on science perception around the three cities mentioned before (Badalona, Mataró and Sant Andreu de Llavaneres), because most of the families and friends, from students who participated in this program, listened to it and followed it.

This increase on science interest starts when the parents were listening to their children on the radio program and it continuous with friends and family members joining in to listen to them. At the end, most of the people were transformed into students' supporters and, of course, they also become science supporters.

5. Conclusions

At the end of theses experiences we are able to guarantee that:

1. All secondary schools from Badalona, Mataró and Sant Andreu de Llavaneres have participated in the program and their families have followed them. This implies that science was disseminated to our society.
2. Students are able to better understand science and see the evolution of science.
3. Questions about science and its history during the program increases the knowledge of science in our teenagers and the public in general.
4. Last years, the amount of students who have chosen science curriculum in compulsory and non compulsory secondary school was clearly increased in these schools who participated in the program.

These programs have contributed to:

1. Increasing the reading, writing and oral presentations of students.
2. Showing the history of science to students and society in general.
3. Promoting critical and reflective discussions about the great controversies of our time. Reinforcing the affirmations that each student spills in the program and to know how to refute the opposite ideas.
4. Reinforcing the presence, interest and study of science in and out of the classroom.
5. Spreading the science advances its analysis and estimation.

The final objective is that the young people, our future society, incorporate basic scientific knowledge that in the future allow them to make their own decisions and to influence the resolution of scientific problems in a more technological society.

On basis of our experience, we recommend this initiative as an approach that teachers could apply in their science classes. It is better with a radio transmitter however, this is not essential because students could play the same role in primary or secondary school class that they could play in a radio program.

6. Acknowledgments

We thank primary and secondary school students for their input and science teachers for their fundamental cooperation. We also thank Gideon Coetzee for assistance in preparing the English manuscript.

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Annex.

PLAY SCIENCE (PRIMARY SCHOOL)		
1st QUESTION: Water in normal conditions is liquid. Ice is solid water. What is the name of the process of liquid to solid?		
A Solidification	**B** Melt	**C** Liquefaction
2nd QUESTION: Which of these organs is part of the respiratory system?		
A Liver	**B** Lungs	**C** Heart
3rd QUESTION: What is the unit which scientists measure time with?		
A Seconds	**B** Meters	**C** Kilograms
4th QUESTION: Which material is less dense than water?		
A Petrol	**B** Iron	**C** Crystal
5th QUESTION: The scientist Dr. Severo Ochoa was an important biochemist. Which of these awards did he win?		
A Nobel Prize	**B** BCN City Prize	**C** The Lottery

PLAY SCIENCE (SECONDARY SCHOOL)		
1st QUESTION: What is the chemical symbol for lead?		
A Li	**B** Al	**C** Pb
2nd QUESTION: Who won two Nobel prizes?		
A Pasteur	**B** Marie Curie	**C** Roentgen
3rd QUESTION: What does $(-2)^{-2}$ mean?		
A 4	**B** 0.25 (1/4)	**C** -4
4th QUESTION: Which of these organelles does not have DNA?		
A Nucleus	**B** Golgi system	**C** Mitochondria
5th QUESTION: Rocks are formed by minerals. Which mineral can iron be extracted from?		
A Malachite	**B** Galena	**C** Pyrite

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Teaching Science with Toys.
Toys and Physics

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Abstract. *Physics is frequently rejected by Spanish secondary school students because of the science curriculum difficulty. As a result, secondary school students do not appreciate the importance of physics and technology in many aspects of their lives. Only students that understand the importance that physics has in our society will study sciences or technology. The lack of curiosity and attention to physics (part of chemistry and physics subject) is difficult to tackle and is normally accompanied by a loss of general motivation to learn science. The purpose of this article is to present and discuss the educational experience "teaching physics with toys" a strategy to introduce physical and scientific knowledge to the secondary school physic classrooms. Finally, participant students work as a team in disseminating their knowledge in several presentations: to the classmates, to the Badalona secondary school scientific days and to the parents.*

Keywords: Physic concepts, Scientific toys, Secondary school students, Spreading science.

1. Introduction.

The Spanish policy on education [1] differs in each one of the 17 Spanish Autonomous Communities with their own independent education system.

Our results derive from Catalonia [2, 3] students. In primary school education (children up to the age of 12 with 6 levels) hasn't any mechanisms to promote science. In contrast, the science curriculum established for secondary education includes several subjects such as Biology, Chemistry, Physics, Maths, and Technology.

Secondary education in Spain is divided in two periods. The first, which covers children up to the age of 16 (four levels with a chemistry and physics as a unique subject), is compulsory. While the second, involving 16-18 year old students (two levels with two separated subjects, chemistry and physics), is comparable with high schools in several countries. After completing this stage, students sit a common university entrance exam.

Nowadays, a decrease in science motivation is present when students are learning science in general and physics as well. The heart of the problem lies in their lack of interest in science [4] in physics for us. We have to considerer at least two factors that can explain the lack of interest in physics: the loss of contextualization and the difficulty to realize experiments.

In this way, good teachers start instructing on physics with what is familiar and known by students, and build on what is unknown, "to teach a child, find out first what they know and then build upon it" [5, 6].

In addition, physics' teachers spend less time doing experimental activities and spend more time talking in the class. In some cases, physic experiments show some questions very far to students' lives but end up playing the method of a lecture class, more as a physic experiment. It is known that experimental work and new technologies (developed in the classroom or school laboratories) are valuable resources to increase motivation of students in science as well in physics.

It is essential to promote physics among young people if we want to improve their understanding on this field of science.

Consequently the purpose of this article is to implement a new educational experience with the aim to relate physical knowledge and toys among secondary school students in their last compulsory year. By building a real bridge between physics and these special students is an excellent strategy to introduce scientific knowledge to the secondary school physics classroom.

2. Toys

Discovering things by playing with toys is common in childhood and is the first approach to science "children know that things fall down onto the floor. Why? Because they had proved it by playing at home". We define a toy as an object which presents several characteristics, elasticity, color, movement, etc, which stimulates children activities. The relaxation function of playing with toys are also remarkable, using them like a didactic resource is synonymous of diversion.

Furthermore, several popular toys have had adaptations to the cinema: G.I.Joe, the store of Mr. Magorium, Toy Story, Toy Story 2, Doraemon and the toys' factory, and more. All together leads us to start with this approach on physics and toys.

3. How are scientific explanations built?

"Teaching physics with toys" is a teaching resource that not only introduces scientific knowledge to the secondary school physics classroom, but also it allows students to build a scientific explanation about some daily physical activities [7], events and processes in the world.

It is generally accepted that for building natural physical explanations the next steps are required.

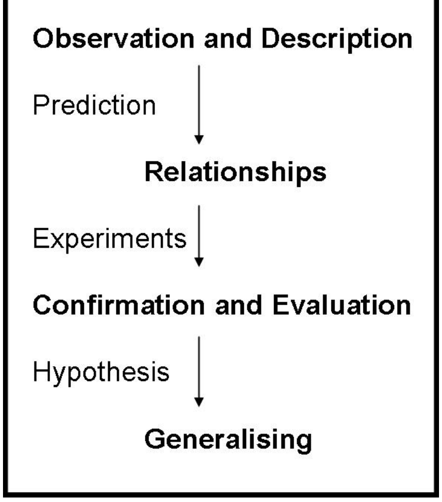


Figure 1

It begins with the event observation followed by its description; students had to answer many questions like "When…where… how does this phenomenon happen?" The observations are psychological phenomena and then they have to be described, written or verbalised in an understandable language and finally in a mathematical way.

Afterwards, it must be distinguish or guess the relationship/s between all the event components by answering "Why… how is A related to B?" Then, the experimental design is arranged, measurements and results analysis from experimental part are used to confirm the relationship predicted. Thus, students prepared their experimental approach by answering "How is A known…how could A law be demonstrated…how can we do it?".

Finally, if results confirm the previous hypothesis (prediction) a generalisation will be made, a model will be proposed to represent this phenomenon [8] and it can be used to solve new situations. Figure 1 shows us the steps from observation to generalization that secondary school students had developed and understood in the whole of their attempt.

4. Students activities.

"Teaching Physics with Toys" switches on the crossing point of physics and education. Students perform a series of key secondary school activities with toys related to physics' laws. The participation of the students, aged 15 to 18, is voluntary; this activity was not evaluated in students' formal curriculum.

Students enrolled in this venture were divided [9] into groups of two; each one studied and presented 4 to 6 toys or common objects. Every student had to prepare, at least, two of them.

4.1 Methodology.

The methodology attempt consisted in a series of toys or common home objects that were given to voluntary students. These toys and objects are supported on the basic laws of physics. Then students tried to explain the physical laws related with each toy or object by answering many questions. Here we present the most important ones such as:

- Question (toys/objects and the physics' laws related with them)
- Can our senses lie to us? (Two equal figures seem one taller than the other).
- Why do you seem different according to the side from the spoon in which

you are looking at yourself? (Spoon and bathroom mirror; light's reflection phenomena).

- How does the thermometer of Galileo work? (Thermometer of Galileo; relationship between density and temperature).
- How is mechanical energy transformed into movement in a tin train with a coil spring? (tin train, tin car both have a coil spring that store energy and then release it to maintaining the train or car movements).
- How do radios and torches work without batteries? (Radios or torches, without batteries; mechanical energy transformed into electromagnetic energy).
- How do we study the waves with springs? (Coloured springs, springs and dynamometer; wave's rules and Hooke's law).
- What happens when two balls contact in an elastic shock? (A basketball, a ping-pong ball and Newton's pendulum; energy conservation and laws of motion demonstration).

4.2 Toys and Physics Demonstrations.

Experiments about physics increase students' interest and generate a positive reaction from students. They understand that physics' laws are discovered by experiments and, by new experiments their could be changed (a little bit).

Students worked on how our event's observation could be erroneous; the reflection laws; temperature and density; mechanical energy changed into movement; torches without batteries, Newton's pendulum and elastic shock; springs, dynamometer and Hooke's law; equilibrium, balance and gravity centre position; a twister into a bottle and so on.

Here we present some of the studies performed by secondary school students last year.

In figure 2 you can see an example how our senses can lie to us. These two figures appear to be one taller than the other one but, in fact, they are the same size. This example showed us how important measurements are in science experiments, or in physical ones for us.

Figure 2

In figure 3 the student face is reflected in the two spoon sides, in Fig 3a in the concave side and in Fig 3b in the convex side. These images are completed with the graph that shows us how the image is obtained in a concave mirror and also in a convex one.

Figure 3a

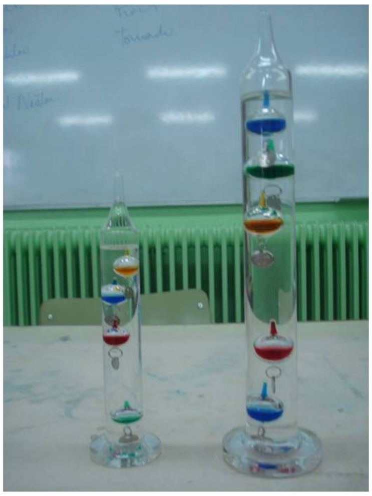
CONCAVE MIRROR

Figure 3b

CONVEX MIRROR

In Figure 4 you can see two Galileo's thermometers, one of the first apparatus that could measure the temperature. It is interesting to explain how it works; temperature is measuring by de difference of density between several liquids inside the Galileo's thermometer. Obviously, it could be used to study the density of liquids and its properties.

Figure 4



In figure 5, several moments in a tin train motion you can observe. The coil spring transform mechanical energy into movement. When the coil spring is winded up and you let go of the tin train the mechanical energy is transform into motion.

Figure 5

In figure 6 a torch without batteries can generate light by transforming mechanical energy into electromagnetic energy. Here you can see the different parts of the torch, A shows us the mechanical elements, B the electromagnetic ones and C the torch in use.

Figure 6

A

B

C

In figure 7, a Newton's pendulum was used to study the energy conservation in an elastic shock and laws of motion. Students moved one ball against the others or two balls together and shocks and movement were analyzed.

Figure 7

4.3. Students as teachers.

These interested students collaborated in how better to understand the physical processes and in the final presentation with the video recording their experiments. Finally, they worked as a team in disseminating their knowledge in several presentations: to the classmates, to the Badalona secondary school scientific days and to the parents.

It has demonstrated the importance of the argument in science teaching [11]. We have also tried to use this methodology for developing students' abilities. Thus making arguments with students opens their minds to present and discuss more questions related with a unique physical event that they have worked with toys.

When working on physics with toys is finished we trained our students the necessity of teaching physics to everybody. It is very important to spread science between society in general with the purpose of creating a scientific culture. For this reason, we persistently wanted to collaborate with students to disseminate their investigation-work in three different ways.

5. So they became physics teachers in their owner class, they explained toys and physical laws to classmates. This activity is a valuable experience because students have to prepare a written work, have to understand the physical event and, the most important thing, have to teach their three-four months work to the classmates in a comprehensible language. It is the first step in reinforcing their knowledge in physics.
6. During the "Badalona secondary school scientific days" [10] students prepared a video showing toys and objects functioning and it was explained at the conference room. At that moment they had to present the video recorded with their own explanations, to other students and science teachers from several secondary schools. Finally, students answered correctly many questions placed by the audience. This experience is the second step in reinforcing their knowledge in physics.
7. Finally, Spanish secondary schools have an "open day". This gives to students the opportunity for a new public presentation. Toys and physics laws were presented and also explained by the students in front of the futures secondary school students and their parents; they were coming from different schools (primary and secondary ones). This meeting was conducted in the school physics laboratory. A good dialogue and discussion about play with toys and learn physics was supported by a relaxed atmosphere and took place among these "new physics teachers", parents and futures secondary school students. There is always a science teacher supervising this event. This meeting is the third step in reinforcing their knowledge in physics.

5. Conclusions.

M. Clara San-Bento wrote [12] "creation, transmission and appropriation of Science require effort, methodical work, persistence,... sometimes sacrifice, always triggered by curiosity or necessity". With our experience we can change these words by "learning and transmitting physics require curiosity, methodical work, effort, persistence and sometimes sacrifice" with this point of view the educational approach was developed.

This educational work has contributed to:

- Using toys and objects commonly found at home, students developed their research without special laboratory material.
- Observing and understanding common physical phenomena were easily created from these toys and objects and wake up students' curiosity.
- Emphasizing the presence, interest and study of physics topics in secondary school classroom.
- Increasing students' implication in their activity, preparing written and oral presentations. Students have to realize a methodical work.
- Reinforcing the interest and general study of science.

As a consequence:

- The use of the toys within the classroom with the purpose of teaching physics is, without a doubt, an excellent didactic procedure and it wakes up the curiosity in students fomenting its creativity and participation.

- This activity leaves the classroom because families and friends are implicated in students' project, it is very important to spread science between the public in general with the purpose of creating a real scientific culture.
- This is an approach that science secondary school teachers could directly apply in their classrooms of physics.

The final objective is that the young people, our future society, incorporate and propagate basic physics knowledge that in the future allow them to make their own decisions on the resolution of scientific problems in our society. "Teaching physics with toys" could help us to achieve our aims.

6. Acknowledgments

We thank our secondary school students for their input and special thanks to Carla Fernández, Desireé Fernández, Raquel Luzón and Irene Sánchez for preparing videos and public presentations. We also thank Gideon Coetzee for assistance in preparing the English manuscript.

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Techniques of delivering science through newspapers

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Abstract. *Like air, water and food; newspaper has also become essential part of everyday life all over the world. Newspapers keeps us updated and make us live smart .It is something almost everybody picks up everyday for some or the other reason. Some for hardcore news, some for their pictures in last nights page three party, some for share prices and some for sports, etc. Not only men even ladies pick it up for kitchen tips, show on idiot-box etc and children for comic strips, puzzles etc. Newspaper is obviously a major tool of mass communication .Now, if we have to communicate science- Newspaper could prove to be of great help. Everyday some space could be allotted to science. For that matter, language and terminology for writing science has to be melted down to be understood by a layman. In this way everybody will automatically take a daily dose of scientific knowledge without even straining his mind. But this has to be done in proper manner to make the column of newspaper readable and catchy to eyes. This paper discusses the techniques of delivering science through newspapers and an analysis of worth of this kind of science communication in society.*

Keywords: Science writing, Headlines, Scientific jargons, Vernacular press.

INTRODUCTION

The status of science education in our country is very pathetic. Need of the hour is to disseminate scientific knowledge. It has to be done on a regular basis to retain the consistency. Newspapers can prove to be of great help for propagation of scientific knowledge. It will help in establishing the public understanding of Science & Technology.

HOW NEWSPAPER IS A BETTER MEDIUM?

People of all age groups grab a newspaper for some or the other reason. Reach of newspaper is vast. Newspaper is a comparatively cheaper medium. Vernacular press breaks all language barriers. Regularity makes newspapers a habit. Newspapers cuttings can be saved for future revision of facts.

EFFECTIVENESS OF SCIENCE COMMUNICATION THROUGH NEWSPAPERS

Regular reading keeps the curiosity to know more on. Along with knowledge, newspapers keep one updated. It inculcates scientific temper among readers. It becomes easy to recall facts in mind once read. Horror of Science in students ends when it comes to daily newspapers from annual syllabus/course books.

Figure 1: Vice president of India Mr. Bheron Singh Shekhawat releasing a special issue of Vaigyanik Drishtikon

HOW TO MAKE A COLUMN CATCHY?

Attractive headlines, colorful pictures and illustrations, use of "Scientoons", easy and understandable words and by use of scientific jargons.

Figure 2: Former President of India Dr. A.P.J Abdul Kalam discussing with editors of Vaigyanik Drishtikon while reading the issue.

MORE THAN JUST NEWS…

In order to make the process of dissemination of scientific knowledge more easy and interesting there are lot many ways which can be adopted by the newspaper organizations. It is a very well known phrase in journalism that a picture speaks more than thousand words. It means that visuals like diagrams, graphs, cartoons, pictures, or scientoons can prove to be an effective tool for explaining facts by occupying lesser space on the page of a newspaper. Other than these there are many other ways also which help in this regard like scientific puzzles and crosswords, amazing facts. E.g. "Do you know??" Etc. Also science jokes, Questions/Answers related to science & technology and stories of discoveries/inventions/research works etc.

VAIGYANIK DRISHTIKON: A Science Newspaper

It is the one and only science newspapers publishing from Rajasthan, India since last decade back. It contains news on current developments in field of Science & Technology, latest discoveries & inventions, achievements of great scientists and a look on all major scientific organizations of India and abroad. Its success is clearly reflected by its sustainability.

R.N.I. No. RAJHIN/2000/2179
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Celebrating Ten Years of Science Communication.

वैज्ञानिक दृष्टिकोण

देश का एकमात्र विज्ञान समाचारपत्र (पाक्षिक)

विज्ञान लोकप्रियकरण के लिए राष्ट्रीय विज्ञान एवं प्रौद्योगिकी संचार परिषद
विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार के तकनीकी एवं आर्थिक सहयोग से प्रकाशित

● वर्ष 10 अंक 24 ● जयपुर 1 जुलाई 2010, गुरूवार ● पृष्ठ 8 ● मूल्य : रु. 4

खाद्यान्न भंडारण क्षेत्र में भारत - चीन सहयोग

भारत और चीन के बीच होने वाले सहयोग में अब खाद्यान्न भंडारण सहयोग भी शामिल हो गया है। कृषि, उपभोक्ता कार्य एवं सार्वजनिक वितरण राज्यमंत्री प्रो. के.वी. थामस के नेतृत्व में एक आधिकारिक शिष्टमंडल ने सात से 11 जून, 2010 तक चीन की यात्रा की। उसी दौरान दोनों देशों के बीच खाद्यान्न भंडारण क्षेत्र में सहयोग पर चर्चा हुई। भारतीय खाद्य निगम और केंद्रीय भंडारण निगम के तकनीकी विशेषज्ञों और निर्माण इंजिनियरों का एक दल चीन जाएगा और वहां आधुनिक भंडार निर्माण तथा संरक्षण तरीकों का अध्ययन करेगा।
प्रो. के.वी. थामस के साथ शिष्टमंडल में भारतीय खाद्य निगम के अध्यक्ष एवं महानिदेशक सिराज हुसैन, खाद्य एवं सार्वजनिक वितरण विभाग के सचिव श्री नवीन प्रकाश, केंद्रीय भंडारण निगम के प्रबंध निदेशक बी.बी. पटनायक और मंत्री महोदय के निजी सचिव बी. अशोक शामिल थे। प्रो. के.वी. थामस ने पत्रकारों को बताया कि चीनी अधिकारियों के साथ हुई चर्चा में तय किया गया कि भारतीय खाद्य निगम, केंद्रीय भंडारण निगम और कुछ राज्य एजेंसियों के तकनीकी विशेषज्ञ तथा निर्माण इंजीनियर चीन का दौरा करेंगे और वहां खाद्यान्न भंडारण के तौर-तरीकों का अध्ययन करेंगे। उन्होंने बताया कि चीन के विशेषज्ञ भी इस वर्ष अक्टूबर नवंबर में भारत आएंगे और देश में उपलब्ध भंडारण सुविधाओं का जायजा लेंगे। चीनी विशेषज्ञ भारतीय खाद्य निगम और केंद्रीय भंडारण निगम के अधिकारियों से भी वार्ता करेंगे।
प्रो. थामस ने बताया कि सात वर्षीय सरकारी योजना के अंतर्गत देश के विभिन्न भागों में 127 लाख टन खाद्यान्न भंडारण की अतिरिक्त क्षमता विकसित की जाएगी। यह नई सुविधा बुखारी और वातावरण नियंत्रित भंडारों के रूप में विकसित की जाएगी।

उत्तरी अमेरिका महाद्वीप में अलास्का क्षेत्र की सबसे ऊंची चोटी पर फतह के बाद विजयी मुद्रा में विंग कमाण्डर आर. सी. त्रिपाठी एवं साथी।

राष्ट्रमंडल खेलों के लिए आधुनिक संचार और सूचना प्रौद्योगिकी व्यवस्था- सचिन पायलट

संचार और सूचना प्रौद्योगिकी मंत्रालय ने राष्ट्रमंडल खेल 2010 के दौरान विश्वसनीय, सुरक्षित और उच्चगति वाले नेटवर्क के जरिए सम्पर्कता सुनिश्चित करने के व्यापक प्रबंध किए हैं। चल रही तैयारियों की विस्तृत जानकारी देते हुए संचार और सूचना प्रौद्योगिकी राज्य मंत्री सचिन पायलट ने कहा कि व्यापक बुनियादी ढांचा निर्माण कार्य के अलावा शान्त और महत्त्वपूर्ण तैयारियां भी जारी हैं ताकि यह सुनिश्चित किया जा सके कि खेलों को सुविधाजनक बनाने की सूचना प्रौद्योगिकी आधुनिक रहे। कार्यान्वयन के सभी कार्य अग्रिम चरण में चल रहे हैं और खेलों के शुरू होने से काफी पहले पूरे कर लिए जाएंगे।
भारत की मेजबानी में आयोजित होने वाले सबसे बड़े खेल समारोह को सुविधाजनक बनाने के लिए उच्च गति वाले इंटरनेट के साथ राष्ट्रमंडल खेलों के सभी आयोजन स्थलों को संचार व्यवस्था से जोड़ने के लिए एमटीएनएल करीब चार सौ करोड़ रुपए खर्च करेगा।
एमटीएनएल तीन अलग-अलग, पर, अन्तर सम्बद्ध नेटवर्क यथा सुरक्षा नेटवर्क, प्रसारण नेटवर्क और आंकड़ा नेटवर्क तैयार किए जा रहे हैं। सभी स्टेडियमों से सीधे खेल प्रसारण का काम प्रसारण नेटवर्क देखेगा और उसे प्रगति मैदान में अन्तर्राष्ट्रीय प्रसारण केन्द्र को रिले करेगा। जहां से इसे प्रसारकों को उपलब्ध कराया जायेगा।
यह सुनिश्चित करने की भी तैयारियां की गई हैं कि खेलों के लिए समूचा सूचना प्रौद्योगिकी बुनियादी ढांचा किसी प्रकार के शरारती तत्वों से पूरी तरह सुरक्षित रहे।

शिक्षा ऋणों के लिए ब्याज सब्सिडी की योजना तय

मानव संसाधन विकास मंत्रालय ने आर्थिक रूप से कमजोर तबकों (सभी साधनों से अभिभावक की आमदनी 4.5 लाख रुपये वार्षिक से कम हो) के छात्रों के लिए शिक्षा ऋणों पर रोक की अवधि के दौरान पूर्ण ब्याज सब्सिडी प्रदान करने के लिए एक नई केन्द्रीय योजना के क्रियान्वयन की रूपरेखा तय कर दी है। ये ऋण भारत में मान्यता प्राप्त संस्थानों से व्यावसायिक तकनीकी क्षेत्रों के अध्ययन में पढ़ाई जारी रखने के लिए भारतीय बैंक संगठन (आईबीए) की शिक्षा ऋण योजना के तहत निर्धारित बैंकों से दिए जाते हैं। इस योजना के क्रियान्वयन की रूपरेखा को भारतीय बैंक संगठन के साथ परामर्श करके तय किया गया है। यह योजना

भारतीय युवाओं का दल नोबेल विजेताओं की वार्षिक बैठक में भाग लेगा

भारत सरकार के विज्ञान एवं प्रौद्योगिकी विभाग द्वारा मनोनीत 20 भारतीय छात्र लिंडाऊ, जर्मनी में करीब 60नोबल पुरस्कार विजेताओं और छात्रों से नोबल पुरस्कार विजेताओं की 60वीं वार्षिक बैठक में मुलाकात करेगा और उनसे बातचीत करेगा। वर्ष 2001 से भारतीय युवा अनुसंधानकर्ताओं का दल वार्षिक नोबल पुरस्कार विजेता बैठक में हिस्सा ले रहा है। इस वार्षिक सम्मेलन में भारतीय भागीदारी को विज्ञान एवं प्रौद्योगिकी विभाग (डीएसटी), लिंडाऊ परिषद और जर्मन अनुसंधान संस्था डीएफजी ने संयुक्त रूप से प्रायोजित किया है। इस वर्ष, शरीर विज्ञान या औषध, भौतिकी और रसायन विज्ञान की बहुविषयी बैठक से दल को विज्ञान सत्रों व चर्चाओं के साथ सामाजिक समारोहों में नोबेल पुरस्कार विजेताओं के साथ बातचीत करने का अनोखा अवसर मिलेगा।
लिंडाऊ बैठक 27 जून से दो जुलाई 2010 तक चलेगी। उसके बाद भारतीय छात्र पांच से नौ जुलाई तक लीपजेम ड्रेसडेन, जेना और वॉन में जर्मन विश्वविद्यालयों और अनुसंधान संस्थानों का दौरा करेंगे। यह यात्रा डीएफजी द्वारा आयोजित और समथित है। डीएफजी इंडिया ऑफिस द्वारा आयोजित सांस्थानिक यात्रा से युवा अनुसंधानकर्ताओं और छात्रों को प्राध्यापकों और छात्रों के साथ चर्चा के जरिए जर्मन अनुसंधान प्रयोगशालाओं में उपलब्ध उत्कृष्ट सुविधाओं के विषय में प्रत्यक्ष जानकारी प्राप्त करने का अनोखा अवसर मिलेगा।
नोबल पुरस्कार विजेता बैठक में जाने से पहले और वापस आने के बाद भारतीय छात्रों के दल को दिल्ली में प्रतिष्ठित विज्ञानियों और प्रतिष्ठित व्यक्तियों द्वारा विवरण दिया जाएगा। लिंडाऊ कार्यक्रम के बारे में विवरण जानने के लिए http://lindau-noble.de/. पर लॉग ऑन करें।

नए विचारों के लिए पांच करोड

विचार 2010 की शक्ति नवीनता की संस्कृति का पोषण

भारत सरकार का विज्ञान व प्रौद्योगिक विभाग (डीएसटी) पावर ऑफ आईडियाज - विचारों की शक्ति, पहल के लिए 5 करोड़ रुपये मूल्य की गारंटीयुक्त निधि प्रस्तुत कर रहा है। इस पहल की शुरूआत 22 जून, 2010 को कर दी गई है जो भारत का सबसे बड़ा उद्यमशील प्लेटफार्म है। यह कारोबारी विचारों को प्रासंगिक परामर्शदाताओं, संरक्षकों और निवेशकों से जोड़कर इन विचारों को प्रोत्साहन देता है, इनका पालन करना है और इनका विकास करना है। इस अनोखी सार्वजनिक-निजी-शैक्षणिक भागीदारी का मतलब है, विचारों की शक्ति 2010 को शक्ति प्रदान करने के लिए वास्तविक धन और वास्तविक विशेषज्ञता की मौजूदगी।
विचारों की शक्ति की शुरूआत सबसे पहले दी इकोनोमिक टाइम्स ने वैश्विक आर्थिक मंदी के बीच, 2009 में मंदी से अलग तरीके से निपटने के लिए उत्साह को बढ़ाने और भारतीय कंपनिओं को प्रोत्साहित करने के लिए किया था। इस वर्ष इस पहल का उद्देश्य है प्रयासों को उद्यमशील पारितंत्र में रूपांतरित करना जो अर्थव्यवस्था को आगे ले जाएगी।

कोई भी कार्य करने से पूर्व वैज्ञानिक दृष्टिकोण अपनाऐं

Figure 3: Vaigyanik Drishtikon is the one and only science newspaper of India that has maintained its consistency of publication. Celebrating 10 years of science communication through newspapers. Tenth year issue.

ACHIEVEMENTS

Vaigyanik Drishtikon has completed ten years of its publication. Former president Dr A.P.J Abdul Kalam has appreciated Vaigyanik Drishtikon and given his wishes to make it a daily newspaper. Vaigyanik Drishtikon has published many special issues time to time like Nobel Laureates of physics, Indian Air force, Child Scientists of India etc. Great Indian scientists like Dr. Kalam, Prof. Yashpal, Dr. R. Chidambaram, Dr. R. A. Mashelkar and others have also appreciated this publication time to time. Ministry of science and technology, Govt. of India is funding for this publication.

SUGGESTIONS

The career in science writing must be made attractive by initiating new professional and job-oriented courses at University level like University of Lucknow in India is successfully running this course of Masters in Mass Communication in Science and Technology since many years. Science writing must be included in school and college syllabus. Government must support such causes. Newspaper organizations must take the lead role in spreading scientific knowledge. People must subscribe to such newspapers for their upliftment.

CONCLUSION

Newspaper is a great medium for Science & Technology communication. It has privilege over other mediums, which fall short in some, or the other way. It can contribute a lot in a country's scientific development. Newspaper organizations are thus advised to come up and unite for the dissemination of scientific knowledge for the growth of society and country at large.

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Analysis on Science Communication Effect of the Exhibition of China Adolescents Science & Technology Innovation Contest

Based on the Assessment on the Theme Exhibition at Beijing Main Venue of 2009 National Science Popularization Day

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Abstract. *The theme exhibition at the Beijing main venue of 2009 China National Science Popularization Day covers the top inventions in the various Chinese adolescents' science & technology innovation activities over the past 30 years. They are reworked to be innovative, attractive and interactive, and aim to arouse the interest in and inspire the idea of innovation. The questionnaire survey of the exhibition among 1525 visitors shows that the exhibition exerts a positive influence on the visitors, in particular the adolescents. The author holds that the exhibition of innovation contest focusing on interactivity is a good idea for science communication.*

Keywords. China National Science Popularization Day, Effect Assessment, Innovation, Theme Exhibition.

1. Introduction

This paper assesses, analyzes and studies the theme exhibition at the Beijing main venue of 2009 China National Science Popularization Day – "Supporting Scientific Development and Leading Future through Innovation: China Adolescents Science & Technology Innovation Exhibition". The paper introduces the National Science Popularization Day activities and the Chinese adolescents' innovation exhibitions over the past few years, describes the features of the content, form and idea of the theme exhibition, gives the purpose, method and index of assessment on the theme exhibition, focuses on analyzing and assessing the shown effect of the theme exhibition, and finally presents some views about the science communication activities among adolescents from the theme exhibition and the assessment.

2. Background of the theme exhibition

The theme exhibition at the Beijing main venue of 2009 China National Science Popularization Day is "Supporting Scientific Development and Leading Future through Innovation: China Adolescents Science & Technology Innovation Exhibition".

2.1 China National Science Popularization Day activities

The China National Science Popularization Day is an annual, large and nationwide science popularization activity initiated by the China Association for Science and Technology in coordination with associations and societies for science and technology at all levels from 2003. Their themes and content keep pace with the development of society and the public's demands of production and living, and their forms include display board, lecture, multimedia show, interactive activity, experimental demonstration, artistic performance, garden party, etc. The 2009 National Science Popularization Day was themed "Saving Energy Resources, Preserving Ecological Environment, Protecting Safety & Health", and held in all provinces and cities nationwide.

The activities at Beijing main venue, having always been the focus of National Science Popularization Day, play a public-opinion guiding and exemplary role [1], and are themed "Supporting Scientific Development and Leading Future through Innovation".

2.2 Adolescents Science & Technology Innovation Contests in China

The Chinese government has emphasized developing adolescents' awareness and ability of innovation since the reform and opening up. China Association for Science and Technology, the Ministry of Education, and the Central Committee of Chinese Communist Youth League, for instance, have organized China Adolescents Science & Technology Innovation Contest, Awarding Program for Future Scientists, China Adolescent Robotics

Competition, "Challenge Cup" National University Students' Extracurricular Academic Science and Technology Work Competition, and other Chinese adolescents' science & technology educational activities playing a guiding and exemplary role since 1978, which the adolescents nationwide can participate in under the organization of their schools or universities for practice and improvement.

3. Feature of theme exhibition

3.1 Idea of the theme exhibition

The theme exhibition gives full play of the scientific thought and innovative approach reflected in the award-winning inventions of adolescents' science & technology innovation, explores the social educational function of the exhibition, and displays the top inventions in the Chinese adolescents' science & technology innovation activities and the reworked science popularization exhibits based on adolescents' creative inspiration. It publicizes the scientific development concept of saving energy resources, preserving ecological environment and protecting safety & health while inspiring innovative thought.

3.2 Content and form of the theme exhibition

The theme exhibition with the content of "Saving Energy Resources, Preserving Ecological Environment and Protecting Safety & Health" highlights the theme of innovation and scientific development, reviews the adolescents' science & technology innovation activities over the past 30 years since the reform and opening up, and tells the adolescents' innovation stories. It consists of eight parts: (1) "Thirty Years of National Students' Extracurricular Academic Innovation Contest" is a display board and multimedia show area which reviews the adolescents' innovation contests over the past 30 years since the reform and opening up; (2) "My Innovation Story" is an area where the young inventors demonstrate their inventions and tell their innovative thoughts and experience; (3) "'Adolescents Invention' Concept Vehicle" centers on the theme of energy saving, where the visitors can participate in the interactive activity of driving simulation; (4) "Stair-climbing Wheelchair" is about the theme of caring, where the visitors can watch the demonstration of the wheelchair and participate in the interaction; (5) "Safety & Risk Avoiding" displays a risk-avoiding device featuring hands-on participation and experimental demonstration; (6) "Sewage Treatment Research" is an experimental demonstration area about the reutilization of treated sewage; (7) "New Energy and New Materials" is an area focusing on experimental demonstration, where the visitors can know the application of new energy and new materials to future life; (8) "Technical Challenge" is a scientific & technological device/model area and displays the adolescents' inventions in the aerospace field; (9) "New Innovative Life" is an activity area focusing on experimental demonstration and model display and introducing new lifestyle in the future society; and (10) "Show Your Creativity" is a workshop where the visitors can give full play of their imagination by making inventions from newspapers and other used articles. (2) to (10) among the above are designed for exhibits based on the adolescents' inventions.

4. Assessment on the theme exhibition

4.1 Purpose of the assessment

The purpose of the assessment is to know to what extent the theme exhibition exerts a positive influence on the visitors in view of inspiring innovative thought and publicizing innovative concept, and to know the visitors' particular evaluation and feeling of the planning, design, organization and conducting of the activities, so as to provide a basis for improving the activities in the future. CRISP conducts the assessment on the theme exhibition with the focus on the effect.

4.2 Index and method of the assessment

The index system of the assessment is comprehensive, aiming at measuring the multiple aspects of the theme exhibition (refer to table 1).

Table 1, Index of the assessment

Order-I Index	Order-II Index
Designation	Content
	Form
	Theme
Implementation	Explanation &consulting
	Exhibit displaying
	On-site organization
Effect	Interest
	Concept & understanding

4.2.1 On-site questionnaire survey

The one-to-one questionnaire survey was conducted among the visitors at the theme exhibition on September 19, 20, 21, 26 and 27, 2009.1,525 effective completed questionnaires are collected, coded, input and then analyzed with SPSS15.0 frequency analysis & cross analysis software.

4.2.2 Observation

15 postgraduate students majoring in science & technology communication from Graduate University of Chinese Academy of Sciences selected and observed 60 groups of the visitors at the theme exhibition on September 20, 2009 to infer the visitors' favorite activities and testify the results of the questionnaire survey from different angles. The specific approach is: the observers secretly follow and observe the visitors and then record information such as visitors' background, staying time, visited areas, on-site spreading information and explanatory information, of which visitors' background includes the visitors' number, age (child, adolescent, the middle-aged, or the elderly), and organization (individual, group or family); the staying time includes the time spent on visiting the entire exhibition and that on each area; on-site spreading information is whether there are publicizing data on the visited sites; and explanatory information refers to the on-site guides, technical service workers, description of the sites, etc.

4.3 Characteristics of respondents

4.3.1 Equal proportion of male and female respondents; high proportion of young respondents

Among the 1525 respondents, men account for 49.7% and women 50.3%.

From the angle of age distribution, young respondents account for the vast majority. The respondents under 18 years old enjoy the highest proportion of 28.7%, followed by those between 19 and 24 years old: 25.3%, ranking second; and those between 35 and 44 years old: 22.8%, ranking third. The respondents above 45 years old take the lower proportion of 8.1%.

4.3.2 Almost half of the respondents with bachelor degree or above; high proportion of students

From the angle of education, the respondents with bachelor degree (35.9%) and with master degree or above (12.4%) account for 48.3%, indicating an overall high education level.

5. Science communication effect of the theme exhibition

5.1 Most respondents take more interest in the topic of "innovation"

The data shows that 74.9% of the respondents take more interest in the topic of "innovation" to one degree or another after visiting the exhibition; and the respondents under13 years old and above 45 years old are obviously under a positive influence

Some questions are designed in the questionnaire to know whether there are any changes of the respondents' interest in the topic of "innovation" after visiting the exhibition. The results show that 68.1% of the respondents become more interested and 6.8% become interested while they weren't previously .

From the angle of age, the respondents under 13 years old and above 45 years old obviously take more interest in "innovation". The statistical data from the two options about the positive changes of interest show that 70.8% of the respondents under 13 years old and 73.8% of the respondents above 45 years old choose "interested before, and now more interested", and 9.7% of the former and 9.8% of the latter choose "not interested before, and now interested to some degree", apparently higher than the average proportion of 68.1% and 6.8% respectively. The proportion of the respondents of the two age groups ranks first and second respectively.

5.2 Most respondents are under a positive influence in view of understanding and thinking of "innovation"

The theme exhibition conveys the core concept of "Innovation Anytime, Innovation Anywhere, and Innovation of Anybody". 4 innovation-related statements are designed in the questionnaire to know to what extent the theme exhibition exerts a positive influence on the respondents in view of the concept of "innovation" and to infer the changes of respondents' understanding of the statements after visiting the exhibition, which are: (1) Everyone has the potential to innovate; (2) Much innovative inspiration originates from observing and thinking about little things in daily life; (3) To ignore innovative inspiration is to give up innovative opportunity; and (4) Innovation is professionals' business and has nothing to do with me.

5.2.1 "Everyone has the potential to innovate"

The survey shows that 14.3% of the respondents change their attitude towards the statement from "against" to "for" after visiting the theme exhibition, and 79.8% of the respondents who were previously for the statement say "it is consolidated after visiting".

From the angle of age, the respondents under 18 years old are most influenced by the theme exhibition. On the one hand, 28.0% of the respondents under 13 years old and 20.1% of those between 13 and 18 years old say they become for the statement after visiting the theme exhibition, the proportion of which ranks first and second respectively ; on the other hand, 87.4% of the respondents under 13 years old and 83.3% of those between 13 and 18 years old who were previously for the statement say "it is consolidated after visiting", the proportion of which ranks first and second respectively.

5.2.2 "Much innovative inspiration originates from observing and thinking about little things in daily life"

The survey shows that 13.7% of the respondents change their attitude towards the statement from "against" to "for" after visiting the theme exhibition, and 79.8% of the respondents who were previously for the statement say "it is consolidated after visiting".

From the angle of age, the respondents under 18 years old are most influenced by the theme exhibition. On the one hand, 26.6% of the respondents under 13 years old and 14.5% of those between 13 and 18 years old say they change their attitude towards the statement from "against" to "for" after visiting the theme exhibition, the proportion of which ranks first and fourth respectively, while 18.4% of the respondents between 45 and 54 years old and 17.2% of those between 55 and 69 years old think so, the proportion of which ranks second and third respectively (however, the figures related to the respondents between 55 and 69 years old are not of statistical significance and can only serve as reference because the number of the age group is less than 30); on the other hand, 88.6% of the respondents under 13 years old and 83.6% of those between 13 and 18 years old who were previously for the statement say "it is consolidated after visiting", the proportion of which ranks first and second respectively .

5.2.3 "To ignore innovative inspiration is to give up innovative opportunity"

The survey shows that 17.9% of the respondents change their attitude towards the statement from "against" to "for" after visiting the theme exhibition, and 80.0% of the respondents who were previously for the statement say "it is consolidated after visiting".

From the angle of age, the respondents under 13 years old are most influenced by the theme exhibition. On the one hand, 35.4% of the respondents under 13 years old and 18.6% of those between 13 and 18 years old say they become for the statement after visiting the theme exhibition, the proportion of which ranks first and fourth respectively (while 20.2% of the respondents between 45 and 54 years old and 20.0% of those between 55 and 69 years old think so, the proportion of which ranks second and third respectively) ; on the other hand, 86.9% of the respondents under 13 years old and 82.9% of those between 13 and 18 years old who were previously for the statement say "it is consolidated after visiting", the proportion of which ranks first and second respectively .

5.2.4 "Innovation is professionals' business and has nothing to do with me"

The survey shows that 12.7% of the respondents change their attitude towards the statement from "for" to "against" after visiting the theme exhibition, and 66.3% of the respondents who were previously against the statement say "it is consolidated after visiting".

From the angle of age, the respondents under 18 years old are most influenced by the theme exhibition. On the one hand, 26.7% of the respondents under 13 years old and 13.3% of those between 13 and 18 years old say they become against the statement after visiting the theme exhibition, the proportion of which ranks first and second respectively ; on the other hand, 75.0% of the respondents under 13 years old and 68.7% of those between 13 and 18 years old who were previously against the statement say “it is consolidated after visiting”, the proportion of which ranks first and third respectively .

6. Discussions

The assessment results show that the theme exhibition helps inspire innovative thought and develop innovative concept – which are the purport and intention of the exhibition – to some degree, and obviously exerts a positive influence on the most visitors of the exhibition – adolescents, and therefore enjoys a good science communication effect. It is evident from the analysis on the reasons for the success of the exhibition based on the assessment that the following factors are the preconditions of the good effect:

6.1 To influence adolescents by adolescents’ innovative inventions and experience is a successful idea

The theme exhibition targets adolescents, to stimulate them with the inventions of adolescents of the same age and to encourage them with the innovative stories of the latter. The assessment on the observation show that in the area of “My Innovation Story”, the young inventors serving as guides effectively help improve the adolescents’ visiting quality. Therefore, it is necessary to emphasize the communication between the disseminator and the people for the purpose of boosting the science communication activities among adolescents.

6.2 Hands-on interactive activities are the soul of the exhibition and the design of them should be in line with the people’s understanding level

The assessment results show that the interactive activities are the visitors’ favorite, and the on-site questionnaire survey indicates that the respondents favor the three activities – hands-on interactive activity (71.9%), experimental demonstration (69.6%) and scientific & technological device (model) display (59.3%) – to those traditional one-way publicizing methods like display board, multimedia show, innovative story telling, etc.

Some questions are designed in the questionnaire to inquire the respondents’ feeling about the difficulty levels of the hands-on activities in the exhibition. The statistics show that 82.2% of the respondents think they are not difficult, 13.8% think somewhat difficult, and only 0.6% think very difficult, which indicate that the hands-on activities are designed in line with the people’s understanding level and for the people’s convenience, therefore are easy to participate in.

Furthermore, it is worth noting that the science popularization activities are conducted and sustained on the basis of mobilizing lots of social resources. To disseminate scientific & technological knowledge and to facilitate the interaction between science & technology and the people via science popularization activities are the wish of the organizers of science popularization activities, however, whether the activities have desired effect and whether they really respond to the people’s demands for scientific & technological knowledge are independent of the intention of the organizers [2]. Therefore, it is necessary to pay more attention to the assessment on the activities. The assessment practice shows that scientific assessment can not only verify the effect of the activities, discover the successful highlights, and also pay a reliable foundation for improving the activities.

Acknowledgements

Acknowledgements to the members of the research group of the large science popularization activity assessment team of CRISP who conduct the assessment on the theme exhibition at Beijing main venue of 2009 National Science Popularization Day.

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Communicating science through puppetry

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Abstract. *Today science has already advanced a lot technologically and now the need of the hour is to connect the hi-tech scientific advancements to a common men. More appropriately, its time to build an abacus to teach rocket science as an example. Because there is no use of such discoveries, inventions and experiments if society is unaware of them.. Science has to be based on term used in civics i.e. 'democratic' that means it has to be made by the people, for the people, to the people. It has to come out of the laboratories and dark rooms into a common man's life so as to make ultimate use of it. For that matter, there are different methods that can be used to explain difficult fundamentals of science to a layman. One such way, which has interested mankind since decades is 'Puppetry'. It's a traditional art which can prove to be of real help in delivering knowledge to people of any age .A puppet has the advantage of taking any shape, size or appearance which makes it more interesting. This paper analyses the effectiveness of using puppetry in dissemination of science to the society and the ways to do it. After all, the true value of scientific technology has never been about chips, space ships, cloning or teleporting etc. Rather it is the ability to help people understand what has happen, is happening and may yet happen.*

Keywords: Puppets, Disseminate, Science communication, Superstition, Teaching-learning experience, Human puppets.

1. Introduction

Science is not only a subject but the basis of life and much more. Every happening or development in the world is related to science in some or the other way. Science is so much into us. It's a part of our daily life. It's as urgent as Oxygen is for breathing to survive. Other than God and Ghost, there is hardly anything left without a scientific background. In simple words, science is the foundation of life on Earth.

Generally people take science only as a subject to study which can get one a nice highly paying job anywhere in the world. People are still unaware of the fact that science is much more than merely engineering and doctory. The need of the hour is to make them understand science, the true meaning of the word and not just the prospects. Science has to be disseminated to the common men for whom the meaning of science lays only in the three words- Physics, Chemistry and Biology. He has to be necessarily told that science is all about living smart and knowing life in and out. It's about seeing the light of wisdom and walking towards it and not just following a mob going in wrong direction based on myths or superstition.

2. "Puppetry" – A tool

Puppetry has been used traditionally in India as a famous and cheap medium to disseminate knowledge about various things like myths, legends, superstitions, dreadly diseases, personal hygiene, cultures, government policies and schemes, etc. Puppetry imbibes elements of all art and science forms such as laws, literature, fundas, painting, sculptures, music, dance, drama, etc. Puppetry has been introduced as an aid of science education. In schools, puppetry can prove to be of great help as teaching-learning experience. Puppetry helps in developing imagination, creativity and observation skills.

Figure 1. Puppetry imbibies elements of all art

3. Puppets are "IN"

Puppets are traditional, deep rooted and **"in"** which means they are very much in fashion these days in India. Everybody ranging from a kiddo to a grandparent – all are interested in watching puppets interacting over serious and meaningful conversations. They are no more limited only to primary students.

We have examples from Indian television and film industry where puppets have been the basic theme and were way too successful. For a start, the Vodafone **"Zoo-Zoo's"** made a history in advertising world by using **"Human Puppets".** The Hindi film **"Paheli"** used puppets and was nominated for **Oscar Film Awards** from India. **"Gustakhi Maaf",** a discussion show of puppets resembling political authorities and famous people of India is also a big hit amongst grown-up lot of generation. Other than these there are many more shows and films which have made a mark in knowledge dissemination in India.

Figure 2: International Puppetry Day celebrated on 21st March every year in memory of Russian puppeteer SERGAI ABRATISOV

Figure 3: During a puppet show

4. Qafila Lok Natya Sansthan – for S&T Communication

The meaning of word **"Qafila"** is a word in **Urdu language** which means a group of people walking all together towards a specific and desired destination. This organization is working towards the field of science communication and has members of all age groups. It understands the urgent need of spreading basic science in society and thus is striving hard to reach as maximum people as possible to enlighten them with true meaning of "science". They perform puppet shows, workshops, seminars, road-shows, etc. to communicate science through puppetry. "Our main motto is to deliver scientific knowledge along with keeping the traditional art form of puppetry alive", says Mr. Meraj Alam, Director of the organization.

14 the pioneer Lucknow Monday | March 22 | 2010

Puppet show enthrals

Pioneer News Service | Lucknow

To mark the International Puppet Day on Sunday, Qafila Loknatya Sansthan organised a puppet show in association with Sangeet Natak Academy, New Delhi, at Urdu Academy in Kaiserbagh.

The puppet shows covered three topics — 'Kakhra', 'Bura na mano Holi hai' and 'Aaj phir ayenge'. The puppeteers used the rod puppet, gloves puppet and shadow puppet to narrate the stories that enthralled the audience.

'Kakhra' was a satire on the education system. In this show, the alphabets had different meanings like A for Atal and Advani not apple. It sent the audience into peels of laughter. The puppeteers included Tanya Meraj, Tanay Meraj, and Alaknanda.

Director of Qafila Loknatya Sansthan, Meraj Alam told 'The Pioneer' that they were trying to revive the art of puppet in the country.

"The death anniversary of great Russian puppeteer Sergai Abratisov is observed as International Puppet Day. Quafila Loknatya Sansthan is continuously making efforts to revive this art form," Alam added.

Figure 4: Newspaper coverage

Figure 5: Celebrations of International puppetry day

5. Conclusion

Though there are several means of science communication present but still puppetry has something different in it. When a puppet is seen in between of hundreds of cartoons, animations, real people or audio aids, it simply gains the attention of everybody. Therefore, it happens to be an excellent medium of science communication. People could easily relate to puppets and also easily understand them and the scientific knowledge they provide. Puppets are very like humans and the voice over given makes them yet more genuine plus interesting medium of teaching and learning science. They can easily convey basic science to the most rural people who had never even known alphabets since birth. Puppets are successful, in and cosmic.

Acknowledgements

I would like to sincerely thank Mr. Meraj Alam, director of the Qafila Lok Natya Sansthan for his supportin making me realize the worth of this traditional art of Puppetry and teaching it to me. Another grand thanks goes to Prof. Sanjay Pandey of University of Lucknow (India) for making this work possible.

Use of Computer-Based Data Acquisition to Teach Physics Laboratories: Case Study- Simple Harmonic Motion

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Abstract. *Several experiments and demonstrations using computer-based data acquisition systems have been developed in our physics laboratory. These computer applications enable students to collect, display and analyse data in real-time. They also enhance the learning process by helping students visualize and understand the relationship between the theory and the observed behaviour in an easy and intuitive way.*

In this paper, we describe the real-time laboratory experiment of Simple harmonic Motion that we have developed which employs computer-based pedagogical tools. In particular, we demonstrate how computers can actively interface with experiments, rather than simply play a passive role in data acquisition and analysis. We also discuss the interaction between students and the instructor.

Keywords. Simple harmonic motion, Computer based laboratory, Amplitude, Displacement, Velocity, Acceleration.

1. Introduction

Laboratory experiments play a fundamental role in teaching and learning physics. Computer-based laboratory, CBL, experiments and demonstrations have been used to collect and analyse data measurements, to provide graphic representations, and to fit data with functions suggested by the adopted model. CBL experiments have been successfully implemented for many years in science and technology colleges, as reported elsewhere in literature [1-3].

Several CBL experiments and demonstrations in physics have been developed and implemented at our institution, École de Technologie Supérieure (ÉTS). Appropriate sensors, interfaces and software have been used to produce an effective data acquisition system for collection, analysis and display of experimental data [4].

Students doing experiments can examine the display of their results and graphs in real-time. Thus the interpretation of data is done in a reasonably short time-frame. The main finding from various aspects of CBL implementation in educational laboratory settings is that students and instructors have a high level of motivation and gain more control over the curriculum. The CBL hands-on experiment enhances students' learning by allowing them to perceive relationships between independent and dependent variable parameters as soon as it is finished.

The exploration with real-time measurements gives students feedback and comprehension of the subject by presenting data graphically. It also enables them to predict relationships between variables and to verify the nature of these relationships [5-6]. By using hardware (sensors, interfaces and accessories) and software students can simultaneously measure and graph physically quantities such as force, temperature, pressure, volume position, velocity, acceleration. These tools are found to be effective in teaching science and technology and can provide a mechanism to deal with conceptual difficulties**.** The proposed lab experiments are closely related to the lecture topics of the physics curriculum**.** The experiments are performed by small groups (three to four-person teams) using the implemented laboratory reservation system to book an experiment session. This schedule system facilitates users' request at different priority levels, such as scheduling laboratory rooms, selection of number of experimental setup in each laboratory, cancellation of any scheduled laboratory session, book any scheduled laboratory experiment. This laboratory scheduling system was integrated in to the department in order to optimise the efficiency of learning sciences.

The CBL experiments and demonstrations were using personal computers, interfaces, hardware and software produced by *PASCO*

Scientific [7]. Hardware consists of sensors for detecting movements, sound waves, pressure, temperature, and electrical signals, as well as signal generating components, including an amplifier that can provide external laboratory equipment with digital or analog signals. The software (*Science workshop Datastudio*) allows the user to collect the data, calculations, and data displays, to analyse results, to compare relationships, and to present conclusions.

To illustrate the importance of computer based laboratory (CBL) in physics education**,** we present below a practical work based on real time experiment of the displacement of vertical mass-spring oscillating in simple harmonic motion. This work was carried out by instructor and students.

2. Simple Harmonic Motion (SHM) practical work

One of the topics in physics laboratory courses which can help students to learn from the use of CBL systems is the simple harmonic motion taught in mechanics and waves course. The oscillatory motion is very important to evaluate time evolution, displacement from the equilibrium position, velocity, acceleration and phase of oscillation of a mass attached to a spring. The system under investigation is the analysis of vertical simple harmonic motion (SHM), as shown in Figure 1. The components of the experimental arrangement are: a rod, a rod base, a mass of 200g, a spring, a motion sensor, a *science Workshop 750* Interface and a laptop. The motion sensor measures the position of the oscillating mass as a function of time.
Students have to analyze a vertical mass-spring oscillating in simple harmonic motion, which is described by

$$x(t)=A\cos(\omega t+\varphi), \quad (1)$$

where $x(t)$ is the displacement position of the mass at time t from the equilibrium position ($-A\leq x\leq A$), A is the amplitude of oscillation, ω is the angular frequency, $\omega = \sqrt{\frac{k}{m}} = \frac{2\pi}{T}$ T is the period of oscillation, and φ is the initial phase ($0\leq \varphi \leq 2\pi$) which corresponds to x and v at $t = 0$.

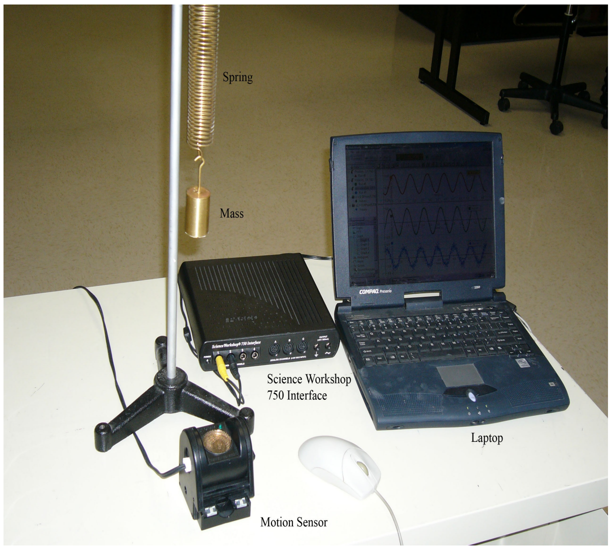

Figure 1. Experimental setup of mass-spring oscillator.

2.1. Analysis of the displacement position in SHM

In order to verify the movement of a vertical mass-spring oscillator, Eq. (1), students carry out the following steps:

1. Measuring the amplitude (A) and the period (T) from the graph displacement as a function of time, Figure 2, and calculate the angular frequency (ω). The obtained results are summarized in Table 1.

Table 1. Results of measurements

Height (m)	0.403 0.243
Period (S)	1.101
Offset	0.323
Position (X)	+0.08 -0.08
Amplitude	0.08
Angular frequency ω (rad/s)	5.70654

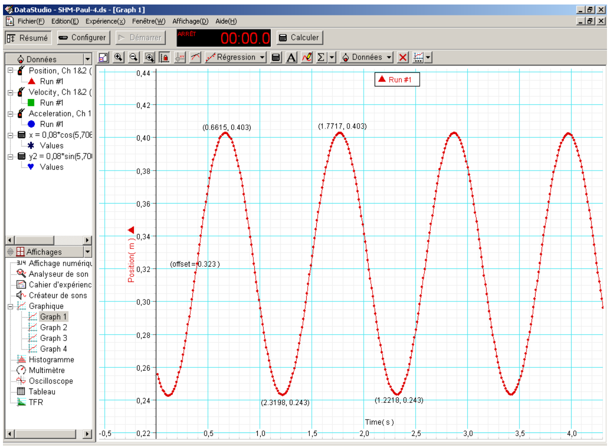

Figure 2. Position as a function of time of mass-spring oscillator.

2. Evaluating mathematically the initial phase (φ) using the position (x) from equilibrium and the velocity (v) at time t > 0. The graph representing the velocity as a function of time is illustrated in Figure 3. The values of position (x) and velocity (v) which were taken from the graphs position and velocity as a function of time were

Graph *x (t)*: at t = 1.0694 s, the position x = -0.053 m

Graph *v (t)*: at t = 1.0694 s, the measured velocity v = -0.34 m/s

Equations *x (t)* and *v (t)* at time t = 1.0694 s are as follows:

$$x(t{=}1.0694s)=A\cos(5.70654*1.0694+\varphi) =-0.053m \qquad (2)$$

$$v(t{=}1.0694s)=-5.70654A\sin(5.70654*1.0694+\varphi) =-0.34m \qquad (3)$$

Dividing Eq. (2) by Eq. (1) we obtain $tg(6.10257+\varphi)=-1.12417$ ή $tg(\alpha)=-1.12417$ (4)

Where, $\alpha = tg^{-1}(1.012417) = -0.843785$ or $\pi - 0.843785 = 2.29781$

The choice of α depends on the sign of cos α or sin α. Since cos α is negative and sin α is positive, then α = 2.29781 and the value φ = 2.47842 is chosen, because it corresponds to the conditions of position and velocity at the chosen instant time t. The equation, $x(t) = 0.08 * \cos(5.70654 * t + 2.47842)$ which describes the displacement from the equilibrium position is entered into the calculator of *Science Workshop* software.

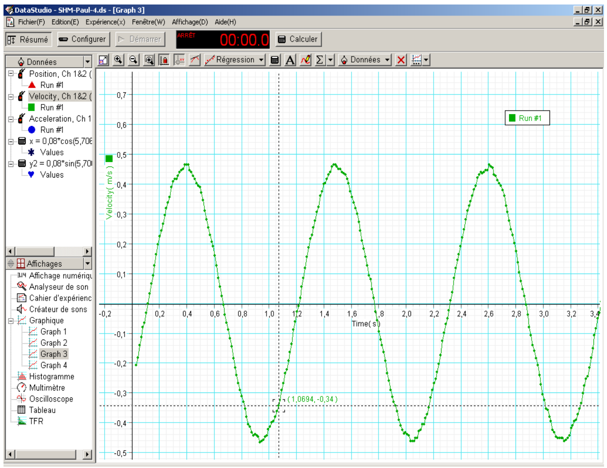

Figure 3. Velocity as a function of time of mass-spring oscillator.

The plot of this equation is displayed in the same window of the graph position as a function of time, as shown in Figure 4. The plot at the top of Figure 4 represents the measured position and the lower one is the graph obtained by calculation. The calculated and measured displacement position equations for vertical mass-spring were compared. One can notice immediately from the results these two periodic shapes of displacement position are in good agreement between them. It was confirmed that the periods and amplitudes are also the same; with relative errors of 0 % and 0.5%, respectively.

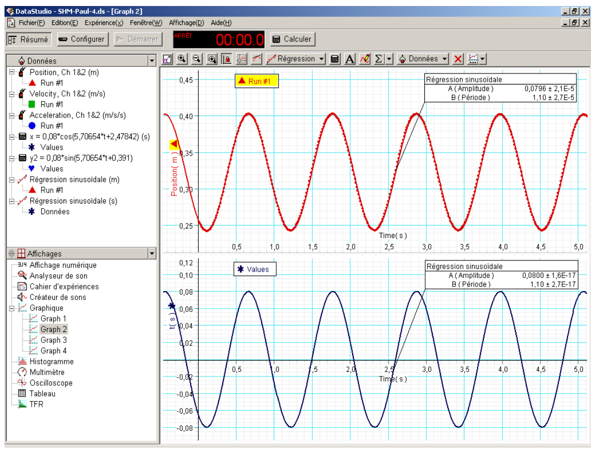

Figure 4. Comparison of calculated and experimental position of mass-spring oscillator.

2.2. Velocity and acceleration of mass-spring in SHM

The two other phenomena which were investigated by students are the velocity and acceleration of mass-spring oscillating in simple harmonic motion. *Science Workshop* software allows the data measurements and graph display of displacement position, velocity and acceleration. First, the position-time data is recorded for some periods of oscillations of vertical mass-spring. Graphs of position, velocity and acceleration as a function of time are displayed in real time in the same window, illustrated in Figure 5. As shown in the top and middle plots the maximum and minimum values of the position occur when the velocity is zero. Likewise the maximum and minimum values of velocity occur when the position is at its equilibrium. It is also observed that both graphs position vs. time and velocity vs. time are periodic waves of the same frequency just shifted by 90° or $\pi/2$.

The conclusion drawn from the analysis of the position and acceleration plots (top and bottom) is that when the displacement is zero, acceleration is zero, because the total force applied on the mass is zero; when displacement is maximum, acceleration is maximum, because the total force is maximum. As a result, we conclude that the total force applied by the spring is in opposite direction from the displacement.

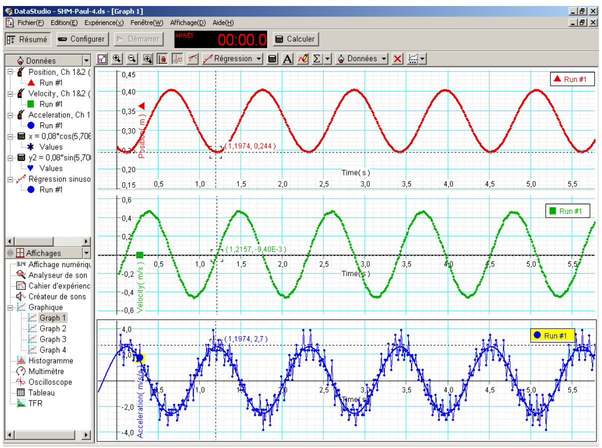

Figure 5. Graphs of position, velocity and acceleration as a function of time of mass spring oscillator.

3. Discussion and conclusion

One effective way of teaching and learning physics is to introduce new pedagogical tools based on the use of CBL experiments in laboratories by providing students with concrete experience of real world phenomena. In our experience students performing experiments using computer-based laboratory have reported improvements in understanding some physical phenomena and their learning appeared equivalent to or better than conventional laboratory instruction [8]. We believe that the implementation of CBL experiments provides students and instructors with several advantages such as data collection and graph display in real time, and interpretation of the data in a reasonably short time frame.

Students manipulating these systems get immediate feedback from the displayed data in graphical form in real-time. The quick display of data allows them to make changes in experimental parameters in a reasonably small time interval. They spend most of their laboratory time observing physical phenomena, interpreting, discussing and analyzing the data [9]. Students performing the CBL experiments scheduled for laboratory courses do not meet any difficulties in handling the variety of probes, interfaces and software. The evaluations by students using CBL experiments are judged positive from the comments written in their lab reports. They appreciate the immediate display of experimental results, the efficient work done by the computer in creating graphs and the use of the function tools available to fit the measured data. The majority confirms a better understanding of the conceptual aspects of the experiments.

Instructors find the use of CBL experiments very attractive and efficient in supervising students for their hands-on experiments. Interaction between groups of students and instructors has led to a greater amount of creative solutions to experimental problems compared to traditional lab. Furthermore, there is a better communication link between instructors and students when discussing theoretical and practical aspect of laboratory experiments.

All our implemented and developed CBL experiments are using *PASCO*-interfaces and sensors and *PASCO Datastudio Science Workshop* software. We believe that similar implemented and developed works can be achieved using software programs, interfaces and sensors which are made by other manufacturers.

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Using a Wireless Accelerometer with Bluetooth Technology to Estimate the Acceleration of Gravity

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Abstract *The introduction and implementation of physics demonstrations and laboratory experiments based on the use of computer with wireless Bluetooth technology are presented and discussed. 3-axis accelerometer - altimeter is employed to investigate the acceleration due to gravity with three different methods. The three performed experiments are free fall, cart on ramp and simple pendulum.*

Keywords. Wireless, Bluetooth technology, 3-axis accelerometer, Altimeter, Pendulum, Inclined plane, Free fall.

1. Introduction

The 3-axis accelerometer - altimeter of PASCO [1] is an instrument for measuring acceleration of moving object or different variable according to desired results in X, Y and Z axis, calculate the resultant and measures the change in altitude. The device can be used in various experiments and demonstrations in science and technology. In this work, we were interested in the measurements of acceleration due to gravity (g) with three different methods. The experiments are the free fall, the inclined plane and the pendulum. 3-axis acceleration and resultant can be displayed on graphs, allowing students to better understand and interpret data measurements.

This wireless 3-axis accelerometer - altimeter can be employed in indoor and outdoor physics experiments and demonstrations. Several example applications using accelerometers can be suggested to physics students, such as Helmholtz resonator to demonstrate the Helmholtz's equation for a resonating cavity, vibration analysis, and impact force of moving object, etc.

Experiment 1

In the experiment of free fall, the 3-axis accelerometer - altimeter was attached to one end of a nylon string and the other end was fixed to a high stand, and then was released freely from a height of 120 cm. the dropped device was held by a wire to prevent from hitting the floor surface. Furthermore, the surface was covered with a layer of foam to protect the accelerometer from damage in case the string breaks down.

For an object released freely is moving with an initial velocity v_o and a constant acceleration a, obeys the following kinematic equation [2].

$$x = v_o t + \frac{1}{2} a t^2 \quad (1)$$

x represents the displacement of the object in time t. For an object at rest falling in gravitational field, equation (1) becomes

$$h = \frac{1}{2} g t^2 \quad (2)$$

Where h is the dropped object. Knowing the height and the time of the free falling body, the acceleration of the gravity can be determined straight forward. In our case, the measurements due to motion were recorded on a wireless interface and the data were analysed through appropriate software on a computer. Accurate acceleration due to gravity is determined on the displayed graph of acceleration as a function of time.

Experiment 2

The second experiment which was performed to determine the acceleration of the gravity was the inclined plane. In this wok, the 3-axis accelerometer – altimeter was attached on frictionless rolling cart on ramp with small angle of inclination, less than 5°, as shown in Figure 1.

Figure 1. Experimental setup of the 3-axis accelerometer - altimeter mounted on cart on inclined ramp.

The gravitational force is present and pulls directly downwards on the object that is positioned on the ramp. The force acting on the object parallel to surface of inclined plane in frictionless movement is given by [3-4].

$$Mg\sin\theta \ , \qquad (3)$$

and the expected value of the acceleration is

$$a = g\sin\theta \Rightarrow g = \frac{a}{\sin\theta} \qquad (4)$$

Where Θ is the angle of inclination, *a* represents the acceleration and *g* is the acceleration of the gravity. The cart was rolled from the top to the bottom of a ramp with an inclined angle of 3°. The X-axis of the accelerometer- altimeter was parallel to the inclined plane. The acceleration on X-axis with the resultant as a function of time were recorded and displayed graphically on a computer using *Datastudio* software analysis of PASCO.

The acceleration due to gravity is calculated from the acceleration of the rolling cart and the inclined angle.

Experiment 3

The experiment is related to the movement of a simple harmonic motion (SHM) of a pendulum, where a 3-axis accelerometer - altimeter was attached to unstretchable thin nylon string and the pivot such that the accelerometer hung few centimeters above the floor, as shown in Figure 2. A hook collar attached to a high bar support worked as the pivot point. The X-axis of the measurement device was pointed in line with the pendulum arm and the Y-axis is directed towards the amplitude motion. The length between the center of the weight and the pivot point was 175 cm. The pendulum was allowed to swing for several oscillations, with small amplitudes, less than 15°, before stopped. The oscillation period of a pendulum is given by the following equation [5-6].

$$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow \qquad g = \frac{l}{\left(\frac{T}{2\pi}\right)^2} \qquad (5)$$

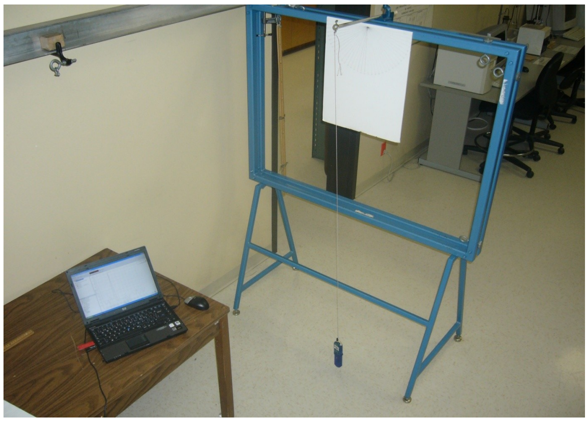

Figure 2. Experimental setup of the 3-axis accelerometer - altimeter as a simple pendulum.

Where *l* is the length of the pendulum between the pivot and the center of gravity, *g* is the gravitational acceleration, and T is the period of one complete swing. The data of oscillation period of Y-axis segment was recorded and analysed by *Datastudio* software application. The Fast Fourier Transform (FFT) was applied to convert the time domain data to frequency domain. The result is plot showing the relative amplitude as a function of frequency, the dominant frequency is used to calculate the period of oscillation (T).

2. Results and discussion

The acceleration due to gravity is determined, by means of three different methods, using a 3-axis accelerometer - altimeter with a Bluetooth wireless technology. Data measurements of free fall, inclined plane and pendulum experiments are plotted in Figures 4, 5 and 6, respectively.

The mean value of acceleration due to gravity, due to free fall, obtained from five trials was 9.75±0.08 ms^{-2}. The measurement of g is obtained directly from the plot of acceleration in X-axis orientation as a function of time, as reported in Figure 3. The experimental result is in good agreement with theoretical value with an error of 0.6 %. The reproducibility of the acceleration of the gravity was dependent on the precision the height drop.

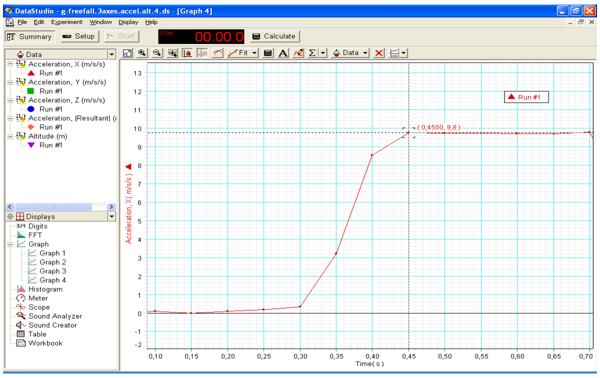

Figure 3. Typical graph of free fall 3-axis accelerometer - altimeter. X-axis direction acceleration as a function of time.

The result of the acceleration in Y-axis direction, parallel to the ramp, was obtained from the plot of acceleration versus time, as shown in Figure 4. The average value of acceleration of five trials was 0.5±0.02 ms^{-2}. The gravitational acceleration was calculated using Eq. (4); with an inclined angle of 3°, the mean experimental value of g was 9.61±0.04 ms^{-2}. The error between the theoretical and experimental value was 2 %.

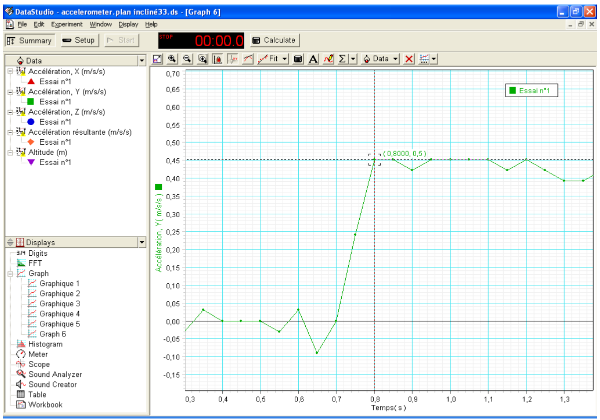

Figure 4. Typical graph of rolling cart on ramp with inclined angle of 3°. The Y-axis accelerometer - altimeter oriented downwards the inclined plane.

Data measurements of periods of accelerometer-altimeter which was used as a simple pendulum were plotted as a function of time. The calculated gravitational acceleration was obtained using The Fast Fourier Transform (FFT), where the time data domain was converted to frequency domain. The Fast Fourier Transform in the *Datastudio* software application was used to plot the relative amplitude versus frequency. A typical graph of FFT is reported in Figure 5.

As can be seen from this plot, the dominant frequency was 0.77 Hz. There are two acceleration peaks per cycle since the pendulum swings past centre twice. Therefore, the frequency of the pendulum is half that of the FFT result, or 0.385 Hz. Since, the period T = 1/frequency. The resulting pendulum period was 2.597 seconds. Using Eq. (5), the mean calculated gravitational acceleration of five trials was 10.23±0.06 ms^{-2}. The error between the theoretical and experimental value of g was 4.2 %.

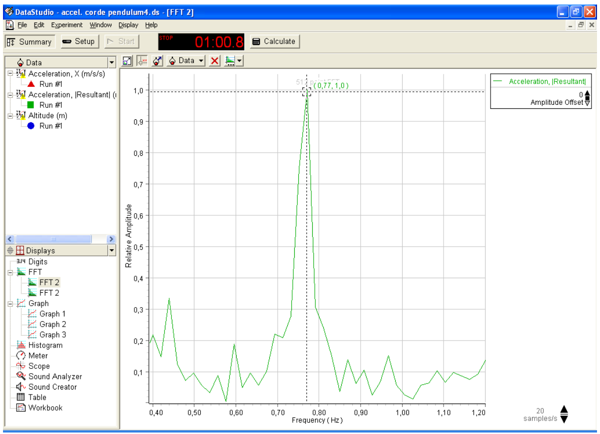

Figure 5. Fast Fourier Transform plot -representing relative amplitude of the pendulum as a function of frequency.

3. Conclusion

We have reported the results of gravitational acceleration of three different methods using a wireless Bluetooth technology with computer. The obtained results are within the accepted theoretical value of g. The experimental value of g of the free fall is more accurate than the inclined plane and the pendulum with 9.75, 9.61 and 10.23 ms^{-2}, respectively. The findings of this work could help science students and teachers to carry out experiments and demonstrations using such advanced wireless technology. Experiments using wireless Bluetooth technology with computer could be performed inside or outside the laboratory.

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e-lab: a valuable tool for teaching

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Abstract. *In recent years the number of students choosing to pursue a scientific career has been decreasing, because they claim to be "difficult" to study these subjects. Having students motivated and interested in learning science is very important for the sake of the scientific culture and of our own future. Studies indicate that to reverse the previous situation, the teaching practices must invest in experimentation and new technologies. The essential goal of this study is to propose ways to achieve this goal. The e-lab is an excellent free resource that has both valences above mentioned, as evidenced by a preliminary study.*

Keywords. e-learning, Laboratory work, Teaching and learning science, Technology, Teaching / learning process.

1. Introduction

In the last years it has been observed a lack of motivation of students towards science subjects like Physics and Chemistry [1,2]. As such, to reverse this situation it is important to promote research that will help to change the mindset of the students in Physics and Chemistry, and Science in general, allowing them to acquire the desirable and necessary scientific literacy to understand the scientific phenomena that surround us. Several studies [1,3-6] indicate that the previous problem is related with the classic teaching approach and with the missing contextualization of scientific concepts.

As part of the solution to the students' lack of motivation and indifference for Physics and Chemistry we suggest a tool called "e-lab", which combines laboratory work and new technologies; valences that seem to be essential to increase students' motivation and interest in scientific subjects like Physics and Chemistry [1,3-6]. The e-lab is a platform to support teaching and learning of Physics and Chemistry that has been tested in the classroom and has proven to be an important tool in stimulating students to scientific subjects, holding their attention and increasing their motivation and interest in science contents. To confirm the encouraging results obtained so far in the teaching/learning of Physics and Chemistry with this platform, we intend to implement a national study in Portugal that will enable the utilization of the e-lab in any public or private school classroom.

2. Objectives

The e-lab platform primary goal is to help in the demystification of the failure causes of the teaching and learning of science, particularly Physics and Chemistry. Specific objectives are intended to: (i) allow students of various levels of education to be able to consolidate their expertise in science and hence develop their scientific skills; (ii) demonstrate that e-lab is a relevant resource for the teaching and learning of Physics and Chemistry; (iii) produce specific materials and scientific contents for students and teachers, as support of the platform; (iv) extend the existing range of experience, particularly in Chemistry; (v) reproduce e-lab experiments in several primary and secondary schools to decrease the time waiting to perform an experiment; (vi) contribute to the training of teachers; (vii) make e-lab an internationally recognized tool for teaching.

3. Description

Our work is focused in the development of an e-learning platform called e-lab. This platform is a real laboratory remotely controlled and thus has a great potential, as it may be used by students and teachers to collect real data from several experiments, anywhere and anytime, using a simple computer with an Internet connection, a player like VLC media player or QuickTime media player and Java Web Start. It is also possible to see the experiment at real time through a webcam, to use a chat room to talk with people connected to e-lab and to see the results of other people that are performing experiments when connected at the same time.

e-lab is a tool which aims to promote e-learning as a normal part of teaching along with time, complementing traditional teaching methods. It intends to support students in science learning, stimulating a scientific culture, and has no intention to replace the traditional lab. By the contrary! e-lab aims to be an ally for the traditional lab. e-lab also intends to allow experiments that for economic or security reasons are not possible to execute in schools.

e-lab motivational effect was already seen in a preliminary study [3] performed with students from primary and secondary education. With the help of e-lab we want to bring up the students' involvement and appreciation of investigation.

In the end of 2009 fifteen teachers of Physics and Chemistry from Portuguese primary and secondary schools in the Lisbon region performed a two months training using e-lab.

The training consisted in nine sessions of four hours each and was developed using the Moodle platform. Moodle is a software packaged for producing Internet-based courses and websites.

Three modules were developed with teachers in this training: (i) introduction of e-lab platform; (ii) tools for data analysis; and (iii) exploration of the e-lab in Physics and Chemistry teaching.

Teachers' continuous training is always important and necessary [7]. In the e-lab platform case it aims to help teachers with the e-lab interface and in the preparation and planning of experimental work.

The experiences currently available in e-lab are being embedded in a new interface (Fig. 1-2).

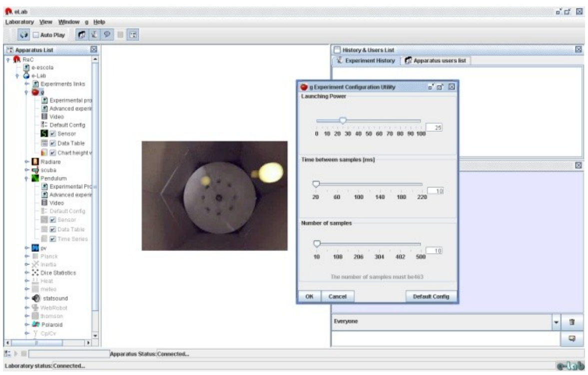

Figure 1. Old e-lab interface

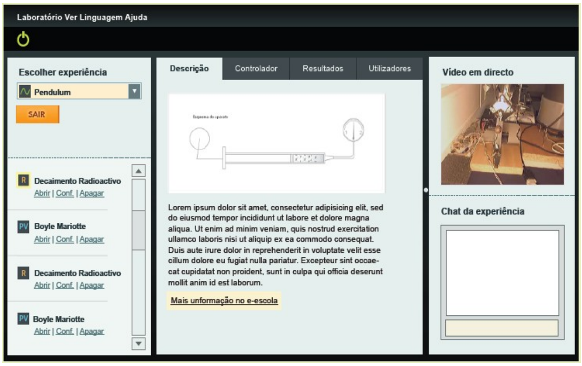

Figure 2. New e-lab interface

The new interface has many improvements compared to the previous. For example, it integrates the video (possibly due to the higher bandwidth available), allows data export to a spreadsheet, and is more intuitive and aesthetically appealing.

The platform has available more than ten experiments, mostly in Physics. For the continuous training four of these experiments were used, namely: (i) determination of earth gravity acceleration (Fig. 3); (ii) Boyle-Mariotte law (pressure change with volume) (Fig. 4); (iii) hydrostatic law (pressure change with depth) (Fig. 5); and (iv) launching data (statistic) (Fig. 6).

(i) Determination of earth gravity acceleration experiment

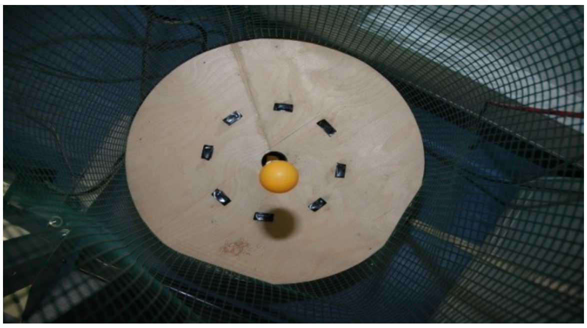

Figure 3. Apparatus for the determination of earth gravity acceleration experiment

The *g* parameter can be obtained by applying the gravity law on the serial results of the vertical temporal coordinate displacement of a ping-pong ball measured by an ultrasonic sensor.

(ii) Boyle-Mariotte law experiment

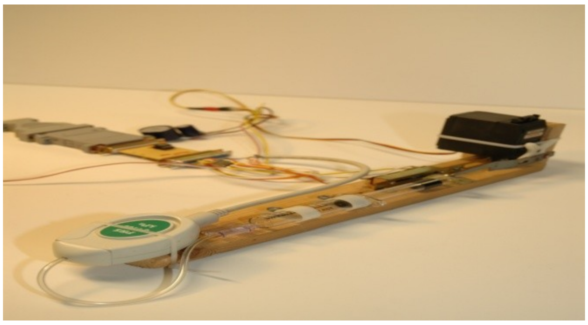

Figure 4. Apparatus of the Boyle-Mariotte law experiment

This laboratorial activity focuses the concept of "constant temperature"; in fact, the speed at which the experiment is conducted reveals that the law is always verified but it can only be considered an adiabatic expansion or compression if performed at a much higher speed.

(iii) *Hydrostatic law experiment*

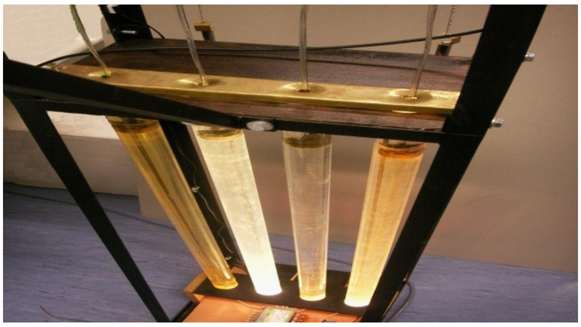

Figure 5. Apparatus of the hydrostatic law experiment

In this experiment you may find this principle for four different liquids: distilled and salt water, glycerine and vegetable oil. The density of each liquid can be calculated through the proportionality between pressure and depth. You will obtain data where depth causes a variation of the pressure given by $P = P_0 + \rho gh$, where P_0 is the pressure at the liquid surface, which is transmitted uniformly throughout the liquid (Pascal's principle) and ρ is its density (mass/volume). g is the acceleration of gravity and h the depth.

(iv) *Launching data experiment*

Figure 6. Apparatus of the launching data experiment

This experience is an automatic launch of a six-sided dice. To count the spots, proceed to the acquisition and automatic image analysis of these data. The values allow the study of the law of averages and the production of a statistical analysis of random phenomena. You can also use the images to develop proprietary algorithms and to the study various tools of computer vision.

3.1. Some results of the preliminary study

After e-lab continuous training (held with the old interface), teachers were invited to answer a few questions about the importance of the e-lab platform for the teaching/learning process. Only eight teachers answered it.

Some results of the inquiry are presented hereinafter.

Table 1. Answers: e-lab utilization

e-lab utilization	Classification 1-5
Relevance to teaching/learning	4.0
Simplicity to be used by students (user interface)	3.1
Simplicity to be used by teachers (user interface)	3.5
Simplicity to install the software interface e-lab, including QuickTime and Java Web Start	3.9

Table 2. Answers: e-lab in the classroom

e-lab in the classroom	Classification 1-5
e-lab experiences relevance to the curriculum of primary education	2.6
e-lab experiences relevance to the curriculum of secondary education	4.8
e-lab experiences feasibility in the classroom	4.0
Solution as a learning tool	3.9
Recommended utilization (upon e-lab availability to all schools)	4.4

Table 4. Answers: how much time did you spend, on average, in the execution of each e-lab experiment with your students (obtention of experimental data in the classroom)?

How much time did you spend, on average, in the execution of each e-lab experiment with your students (obtention of experimental data in the classroom)?	%
Less than 45 minutes	13
Between 45 minutes and 90 minutes	25
More than 90 minutes	62

Table 4. Answers: how much time did students spend in the data processing of each e-lab experiment?

How much time did students spend in the data processing of each e-lab experiment?	%
Less than 1 hour	25
Between 1 hour and 2 hours	25
Between 2 hours and 4 hours	37
More than 4 hours	13

Teachers revealed that the benefits arising from the use of e-lab by students are: (i) A laboratory practical activity that allows self-discovery as well as consolidation of knowledge; (ii) A lab always ready to use that allows the repetition of experiments, enabling more reliable results; (iii) The realization of experiences outside the classroom at anytime; (iv) The opportunity to carry out experiments without the existence of specific equipment in school; (v) The opportunity to use spreadsheets like Microsoft Excel; (vi) To use the Excel Solver tool to maximize solutions; (vii) The possibility to explore experiences that for financial or security reasons cannot be exploited in the school; and (viii) The statistical treatment of data obtained from a real experience (more at secondary level) and the analysis of graphs (where applicable).

The teachers referred to the difficulties they had when using the e-lab platform with students. They appointed: (i) The lack of school resources including computers with Internet connection, and the need to have Java and QuickTime installed in the computers to accomplish the experiments (this can be solved easily); (ii) Lack of time to adapt the experiences available to the school program contents; (iii) The e-lab training should begin before the school year planning in early September, and continue until the end of the third period. The exploitation of resources is fundamental; and (iv) Treatment of experimental results obtained through the remote control of experiments.

Points (ii) and (iii) should not be taken into account, since they relate to the time of completion of training.

4. Conclusion

Nowadays the influence of the Internet in our students is quite evident. In this context, it is essential to implement web contents and e-learning activities to stimulate the study and acquisition of knowledge by the students.

It is also important to use technology and laboratorial work to increase the interest and motivation of students towards scientific subjects such as Physics and Chemistry.

We must never forget that technologies and experimental work are only fantastic resources when well guided by teachers, that should stimulate students' interest in science, and we must never consider them as rescue strategy to motivate students [3].

From the results obtained in preliminary study we conclude that: (i) the enthusiastic results obtained in the preliminary study predicts a great future of e-lab; (ii) the use of technology and laboratorial work in the classroom promotes the students' interest and motivation; (iii) continuous training for constant updating of knowledge for teachers practices is needed; (iv) the e-lab is an intuitive platform that has the resources to explore the various experiences in classrooms at different educational levels; the materials already prepared for the four experiments resulted in a preliminary study and were tested in classroom earlier (Fig. 7).

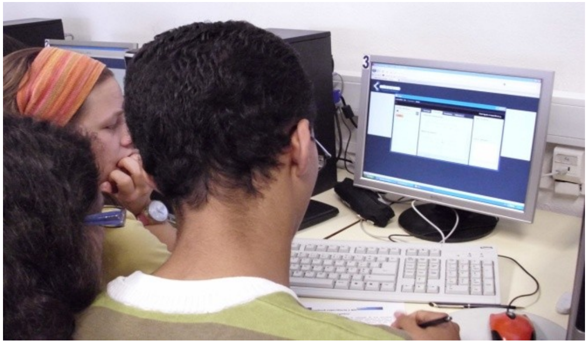

Figure 7. e-lab in the classroom

We believe that e-lab is a proper tool for experiments data collection using a simple, functional, user-friendly platform with all the necessary resources for students and teachers.

The e-lab project is a continuous process which aims to improve the materials that already exist and to create new support materials for teachers and students.

5. Acknowledgements

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The contribution of different types of laboratory work to students´ biological knowledge

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Abstract. *In Science teaching, laboratory work is recognized as one of the cornerstones. In school science laboratory work, computers can be used for computer-supported laboratory work (real) and for virtual laboratory work. Lower secondary school students aged between 11 and 15 years performed three laboratory exercises (Activity of yeast, Gas exchange in breathing, Heart rate) as classic, computer-supported and virtual laboratory. When they were asked which method they liked the most, their first choice was computer-supported laboratory work, followed by classic laboratory, with virtual laboratory at the end. The contribution of these differing methods to the quality of the resulting knowledge is clear: there are no statistically significant differences between these laboratory methods.*

Keywords. Biology, Computer-supported laboratory, Digital competences, Simulations.

Introduction

Laboratory and experimental work is recognised by many experts as a method where students can learn several skills and obtain knowledge of high quality [1, 2, 3, 4, 5 and 6]. It can be performed in many different ways, some of which can include computers and other information and communication technology (ICT) equipment. In recent decades we have witnessed many innovations concerning the use of ICT in our daily routines. The importance of ICT is so great that the EU has recognised working with ICT as one of the key competences that every citizen should possess (Recommendation of the European Parliament and of the Council) for success in life. Computers have become part of our civilization; schools have therefore been unable to avoid this prevalent trend. There are many opportunities for using ICT in Biology instruction and many rationales for the inclusion of virtual and real computer-supported laboratory (CSL) exercises in Biology teaching. In the first case, “virtual” laboratory entails interactive simulations and animations, while “real” laboratories involve bench-top experiments utilizing data acquisition systems. From our previous research we know that our students like active learning [7], experimenting in the laboratory and working with ICT, but the greatest obstacle to including ICT in laboratory work is not the students but the teachers [8], in spite of much research confirming that using ICT increases students’ mental progress and creativity [9, 10 and 11]. We cannot prepare students with old-fashioned methods of learning and technology for their future life but must use up to date equipment and resources.

The focus of the paper was the investigation of three different biology laboratory methods in class: classic laboratory, computer-supported laboratory and computer simulation, each used for at the three biology exercises.

We wanted to establish the contribution to biological knowledge of each laboratory method and which method of laboratory work students preferred.

Results are planned to be used in the development of a new generation of tested experiments to help teachers introduce active and motivational methods of teaching into their daily routine for developing one of the eight key competences - digital competence.

Methods

This paper reports on data that formed part of a study about the contribution to biological knowledge made by three different laboratory methods. We did a pilot test with 170 students and a second test with 455 other students. A group of 625 students of both genders from lower secondary Slovenian school, aged between 11 and 15 (6^{th} to 9^{th} grade) performed three laboratory exercises (Activity of yeast, Gas

exchange in breathing, Heart rate) as classic, computer-supported and virtual experiments. Each student performed all three experiments, but each experiment with a different method. For example: one group of 2-4 students from the same grade performed the exercise «The activity of yeast» as classic laboratory, «Heart rate» as computer supported laboratory and «Gas exchange in breathing» as interactive simulation. In this way, results were collected as 3x3 matrixes, which enabled us to search for differences between groups. Students' opinions and personal data were collected using a pre-test and an equal post-test for each exercise developed for the purpose of the research. The tests were equal for all students. Reliability tests were done after the pilot group with Cronbach α; for the exercise «The activity of yeast», the Cronbach α was 0.84; for the exercise «Gas exchange in breathing» the Cronbach α was 0.74, and for the exercise «Heart rate» the Cronbach α was 0.86. The statistical analyses were done with the Statistical program SPSS 17.0 (ANOVA).
The focus of the paper is the contribution to the stage of knowledge achieved by each exercise according to different laboratory methods.

Description of laboratory exercises

A. Activity of yeast

This exercise is standard because of safety reasons, availability of materials and potential for use at different points and contexts (rising of bread, fermentation, enzymatic activity, etc.) in teaching. The effect of temperature on the activity of yeast is examined. The speed of production of carbon dioxide is measured. In real experiments (both classic and computerized), a suspension of yeast obtained from a local store was prepared. A spoon of table sugar was added to the suspension. The suspension was divided into three bottles and put into water baths at different temperatures (see Fig. 1). Ice cubes were added to the first one, the second one stayed at room temperature, and the third one was warmed to a temperature between 35 and 40°C. In the "classical" variant, the rising of balloons indicates the speed of the reaction; in the computerized laboratory, the rise in gas pressure was measured using gas pressure sensors and in the interactive simulations, results are presented as graphs and flasks with balloons.

Figure 1. The ˝classic˝ variant of the Activity of yeast laboratory exercise

B. Gas exchange in breathing

The main goal of the exercise is to show that the composition of gasses in inhaled air is different from that in exhaled air.

Oxygen is consumed in respiration and carbon dioxide is released. The differences are not constant but are in correlation with the activity.

In the classical variant a volunteer has to exhale air through a straw into a sealed plastic bag with known volume. After that, the exhaled air is poured into distilled water. Carbon dioxide forms a weak acid with the water which results in a change of pH.

Figure 2. The computerized laboratory gas exchange in breathing

The drop in the pH can be registered with a pH meter or as a change in the color of bromthymol blue as an indicator. In the computerized version of the experiment, a volunteer has to exhale air into a plastic bag, and a gas oxygen sensor is used to record changes.

Experiments can be repeated under other conditions (after some kind of activity) with the same or other volunteers (see Fig. 2). In interactive simulations changes are present as a drop in the concentration of oxygen in inhaled air and a rise of exhaled carbon dioxide in exhaled air.

C. Heart rate

The main task of the exercise is to examine differences in heart rate among students, changes caused by some sort of activity and the speed of recovery to an initial state (see Fig. 3).

Figure 3. The classical method Heart rate

Using a stop watch to measure arterial pulse is the classical method; a heart rate monitor was used in the computerized laboratory. In simulations, students can choose between three different persons of either sex (scholars, athletes and on overweight) and examine differences in their heart rates before and after the activity or between persons.

Results

Contribution to students´ knowledge

In the case of the «Gas exchange» exercise, the contribution to student knowledge was greatest with computer-supported laboratory in 6th and 9th grade but in the 7th and 8th grade with the simulations. For the «Activity of yeast» exercise the best contribution to student knowledge occurred with the classic method of work, except in 9th grade, and for the «Heart rate» exercise, the greatest contribution to student knowledge came from computer-supported laboratory, except 7th grade (see Table 1).

Table 1: Overview of results from laboratory exercises showing laboratory methods and students´ grades

Exercise		*«Gas exchange»*								
Method of laboratory work		CL*			CSL*			SIM*		
		∑ results of points in %	$F_{(3. 205)}$	*p*	∑ results of points in %	$F_{(3. 191)}$	*p*	∑ results of points in %	$F_{(3. 179)}$	*p*
grade	6th	46.5	8.07	**< 0.01**	**55.4**	6.49	**< 0.01**	49.8	7.10	**< 0.01**
	7th	55.0			56.8			**58.3**		
	8th	60.3			60.3			**61.0**		
	9th	66.1			**71.4**			68.2		
Exercise		*«Activity of yeast»*								
Method of laboratory work		CL*			CSL*			SIM*		
		∑ results of points in	$F_{(3. 190)}$	*p*	∑ results of points in %	$F_{(3. 203)}$	*p*	∑ results of points in %	$F_{(3. 185)}$	*p*
grade	6th	**73.7**	4.00	**< 0.01**	66.7	7.21	**< 0.01**	67.1	9.05	**< 0.01**
	7th	**70.5**			69.6			68.7		
	8th	**76.5**			70.1			70.2		
	9th	83.0			82.9			**84.2**		
Exercise		*«Heart rate»*								
Method of laboratory work		CL*			CSL*			SIM*		
		∑ results of points in %	$F_{(3. 177)}$	*p*	∑ results of points in %	$F_{(3. 177)}$	*p*	∑ results of points in %	$F_{(3. 208)}$	*p*
grade	6th	62.6	9.12	**< 0.01**	**68.0**	7.82	**< 0.01**	54.2	7.70	**< 0.01**
	7th	**68.1**			63.1			64.0		

	8th	65.2			**71.3**			71.0		
	9th	83.7			**84.3**			83.7		

*CL – classic method of laboratory work, * CSL – computer-supported laboratory, *SIM - simulations

The contribution to students' knowledge of each laboratory method as compared between students in the same class is not statistically significant, but between classes using the same laboratory method there are statistically significant differences (see Table 1).

Students' attitudes toward different methods of laboratory work

Students gave their opinions about the popularity of different laboratory methods (classic, computer-supported laboratory – CSL - and computer simulation).

Table 2: The most popular laboratory method ranked by students in lower secondary school

		laboratory methods		
class		CL*	CSL*	SIM*
6th	number of student opinions	40	**41**	15
7th		61	**84**	31
8ht		52	**62**	34
9th		48	**55**	30
Total		201	**242**	110
	percent %	36.3	**43.8**	19.9

*CL – classic method of laboratory work, * CSL – computer-supported laboratory, *SIM - simulations

From the results presented in Table 2, we can conclude that in all grades their first choice was computer-supported laboratory, followed by classic laboratory, with virtual laboratory in last place. Differences between genders were not statistically significant ($\chi^2_{(6)}$ = 4.42; α = 0.62 in $F_{(3,549)}$ = 0.79 (p = 0.50)).

Conclusions

In Science teaching, laboratory work is recognized because of its active learning methods as one of the cornerstones. With laboratory exercises and experimental work, we can achieve an understanding of many natural processes and empirical goals [12]. Laboratory work can be performed by different methods but according to our study the differences in contributions to students´ knowledge according to different methods of laboratory work are not statically significant, and none of the methods tested in this study can be called the best method of laboratory work. The results of this study confirm the results of other authors [13]. One method is best for one laboratory exercise and another for second activity, it is teachers who select which method is most effective in a particular group of students.

According to our results (see Table 1), older students acquired more knowledge than younger ones, but the older ones had more pre-knowledge than the younger which is the most important factor in the post-test. The authors [14] claim that what and how you learn is controlled by what you already know. The most important single factor influencing learning is what the learner knows. Ascertain this and teach accordingly [15].

When students in our study were asked which method they liked the most, their first choice was computer-supported laboratory, followed by classic laboratory and virtual laboratory at the end (see Table 2). Computer-supported laboratory is preferred because it is a blend of classic laboratory with computer and other ICT equipment. Clicking on the bottom of the computer mouse can quickly become boring, and that is why virtual laboratory ranks last among the preferred methods of laboratory work.

Teachers must incorporate ICT into education because they cannot prepare students for modern life with obsolete methods of teaching.

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Different classroom activities derived from topic minicomposting – a step toward pro-environmental behaviour of students

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Abstract. *Students of different grade classes of primary and other school system should be aware of environmental issues. Beside knowledge students should possess competence for taking action in relation to the environment. In light of this we designed activities that provide students the opportunity to appropriate and internalise the knowledge concerning certain environmental issues. We present different activates for students from 6th to 9th grade classes of nine year primary school regarding wastes; e.g wastes, composting, chemical analysis of waste water samples, and (geno)toxicity tests of waste-water*.

Keywords. Compost, Chemical analyses of waste-water, Environmental education, (Geno)toxicity tests, School activities.

1. Introduction

Topics of Slovenian science curriculum concerning environmental issues are scarce and mainly discussed in the first and the second triad of a nine year primary school. Increasing government and public concern about degradation of the environment and awareness of environmental issues on the other hand lead us to design school activities through which students gain knowledge about a more appropriate waste dumping and become aware that only technology cannot solve environmental problems. As early as 1973 Maloney and Ward [1] believed that ecological crisis is a consequence of a crisis of a maladaptive behaviour. Therefore it is important that students learn to take care for the environment. Fien et al. [2] stated that every teacher is responsible for infusing environmental education into his / her teaching in order to help students to live and work towards a more sustainable environment for all. Knowledge that students gain in school is one among many important preconditions for the development of competence leading to act and behave pro-environmental [3]. However, knowledge *per se* does not lead to environmental action or the development of pro-environmental behaviour [4].

Jensen [3] enlightens such thinking with two factors. He believes that traditional knowledge about the environment as it is thought in the school is not action oriented, and environmental education in his opinion oriented on passing knowledge to pupils. In such way pupils don't get the opportunity to actively appropriate and internalise the knowledge they gain through lessons. In light of this believe we prepared school activities through which students would develop competences by leading action and behaviour adjustments in relation to the environment. We prepared activities that included:

(1) students investigations about how much wastes produces one student per day,
(2) investigations about how student treat wastes,
(3) searching for wastes which could be composted,
(4) chemical analysis of waste-water samples that were a by-product of decomposition of peels and batteries, and
(5) (geno)toxicity test of waste-water samples.

In activates carried out in school years (2008/09 and 2009/10) participated students from 6th to 9th grade classes, altogether 63 students. Activities were part of a science (6th grade class), a biology (9th grade class), and a chemistry (8th and 9th grade classes) lessons.

2. Description of activities

2.1. Wastes

According to data of Slovenian statistical office (Statistični urad Republike Slovenije), Slovenians on average produce 1.24 kilograms of communal wastes per day. Alarming is that 74 % of all wastes are dumped on city dump and only 11% are separated by recyclable items by the users. According to these data we ask students of 6th grade class (N = 47) which (paper, plastic, pells ...) and how many wastes they produce when making one daily ration. In addition to these two questions we asked students how they treat wastes.

Each 6th grade class student prepared and presented a poster. We found out that students produced wastes mainly of a plastic, paper or organic origin (Fig. 1). We calculated that one student on average produces 0.6 kilograms of wastes per day (Fig. 2), which is lower than Slovenian statistical office reported. The result was not surprising. Students explained it with that we daily produce wastes that are not only by products of daily rations. We also found that many 6th grade class students separate wastes by the source. However, those who stated otherwise support the separation of wastes by the source. But from their statements it was evident that for such actions these students don't get support by their parents.

Figure 1. Posters presenting wastes which were obtained from one daily ration

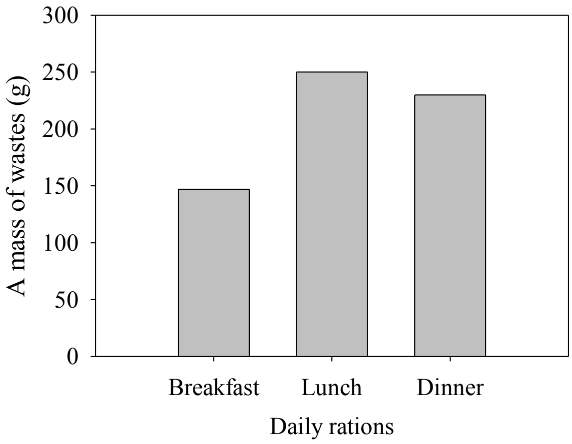

Figure 2. A mass of wastes produced by preparing a daily ration

After poster presentations, 6th grade class students wrote reflections about how to reduce the daily mass of wastes. Students provide answers that we should:

- separate wastes by the source,
- buy products with less package,
- develop recyclable package,
- compost organic wastes,
- make new products from packages,
- use wastes as isolation material for houses,
- extra pay for packages ... etc.

From their answers we can conclude that students are prepared to act in a way to minimize the mass of wastes.

We found that many students act pro-environmental. They separate wastes by the source, compost organic wastes, and use recyclable bags. We also found that family support is an important factor that influences on pro-environmental behaviour of students.

2.2. Waste recycling

Students believe that one step toward minimizing the mass of wastes is the decomposition of organic wastes. According to theirs suggestion we prepared two composts (Fig. 3). In one compost we set peels and in another batteries to decompose. Throughout this activity 6th grade class students observed decomposition of organic wastes. In addition they observed animals in compost and constructed food chains.

Compost where batteries were set to decompose was meant to show students:

(1) that batteries don’t decompose like peels and

(2) dumping them on inappropriate way could have potentially negative impact on the environment.

To examine these, we carried out some tests; chemical analysis of waste water samples, *Daphnia magna* (toxicity test) and *Allium cepa* (genotoxicity) test. Students of 8th and 9th grade classes carried out these tests. Results were presented to students of 6th grade class. It should be noted that students of 7th, 8th and 9th grade classes were aware of what the 6th grade class students were working on. In addition to this, students from 7th and 8th grade classes were in previous school year (2008/09) working on decomposition of different materials (e.g. metal, litter, peels, and batteries).

Figure 3. Students preparing compost

2.3. Analysis of waste-water samples

During decomposition one of the by-products is waste-water. In order to asses if waste-water could have potential negative impact on the environment students carried out chemical analysis of waste-water samples (Fig. 4). Samples of waste water were taken from composts which were prepared in school year 2008 / 09. As negative control water from public supply was used.

Figure 4. Students carried out chemical analysis of waste-water

Students of 8th and 9th grade classes analysed samples of waste-water of peels and batteries decomposition. They measured parameters as NH_4^+, NO_2^-, NO_3^- and pH. Students found that measured parameters were in accordance with Slovenian legislation for all samples except for $NO3^-$ for battery waste-water sample. Permitted limit value (PLV) published in the Official Gazette RS (2000) for NO_3^- for this sample was exceeded 8 times.

The main scope of this activity was to present students that if permitted limit value of certain parameter is not in accordance with Slovenian legislation that parameter could have potentially negative impact on the environment.

In addition to chemical analysis students carried out toxicity test with *Daphnia magna* (Fig. 5) and genotoxicity test with *Allium cepa*. As negative control for (geno)toxicity tests water from public water supply was used.

Figure 5. Student counting *Daphnia magna*

For evaluation of waste-water as pollutant we decided to combine chemical analyses with bioassays. Namely, chemical analyses are limited in their ability to characterize pollutants and their potential effects on living organisms [5]. Bioassays, on the other hand, consider bioavailability and bioaccumulation of chemicals as well as interaction among the pollutants and provide information about the toxic and genotoxic potential of pollutant affecting living organisms. Integration of physico-chemical and biological approaches in ecotoxicological studies is therefore recommended for evaluation of environmental risk [6]. We adopted protocol for *Allium cepa* test according to [7] and for *Daphnia magna* according to *Daphnia magna* acute toxicity test by Department of Environmental Chemistry, ICT Prague.

Results for *Daphnia magna* test indicated that only waste water sample from battery compost was toxic. Genotoxicity tests are still in progress; therefore no results are presented in this paper.

Through activities students could learn that dumping batteries in the nature could have potentially negative effect on the environment and therefore following the regulations of dumping the hazardous wastes is obligatory. In addition, students got experience how to work in a laboratory, which safety recommendations should be aware off and that answers about effects of pollutants on environment require a usage of different tests.

3. Conclusions

Through different activities presented in this paper students gained knowledge about proper and useful waste dumping, which will hopefully be implemented outside the classroom in students` everyday lives. Students learned that careless dumping of hazardous waste has negative impact on the environment.

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Teaching Air Mass Movements to Pre-service Elementary Teachers

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Abstract. *In the present paper a teaching sequence on horizontal and vertical air mass movement is described, which uses hands-on experiments and software simulations and it is aimed at pre-service elementary teachers.*

More specifically, the teaching sequence aims at the wind formation understanding based on air pressure differences, at the weather front formation and the temperature inversion formation understanding based on fluid circulation.

The proposed teaching sequence was practised on pre-service elementary teachers, specifically undergraduate students of the Faculty of Primary Education of the University of Athens, during the winter semester of 2008-09. Research findings appear to be encouraging.

Keywords. Environmental Science, Meteorology, Pre-service Elementary Teachers.

1. Introduction

More and more, requests are being made for teachers to be instructed in Physical Sciences during their initial training [10] [7]. Similar propositions are made by various researchers [25] [22]. In addition, proposals for the introduction of environmental dimension in Physical Science Teaching are also formulated [13] [11]. Environmental Science, as a multidisciplinary subject, aspires to incorporate the Physical Sciences rationalism with the social sensibility and values of Environmental Education [19]. A great effort for training pre-service and in-service elementary teachers in Environmental Science has been made all over the world [3] [4] [23] [2] [5].

Meteorological phenomena, as a part of the Environmental Science, are been didactically approached either by software [15] [26] or by hands-on activities [16] [8]. Additionally, research on students' conceptions about weather [21] [1] [6] [20] [17] [9] [18] has revealed that students of any age find difficult to explain how the wind is created and make use of misconceptions to explain its formation.

Based on research findings and recommendations, we have developed a teaching sequence aimed at pre-service elementary teachers in order to teach meteorological phenomena and especially air mass movements. In this work, we present this teaching sequence and its results on pre-service elementary teachers currently training in the Faculty of Primary Education of the University of Athens.

2. Research aims

The teaching sequence aimed at providing basic knowledge about three important scientific concepts. The first was wind, defined as the horizontal movement of air masses, which is generated by air pressure differences between two locations on the ground. The second was the weather fronts and that they come into being when air masses of different temperature, speed and density run into each other during their horizontal movement. The third and final was temperature inversion formation that is mostly created due to the freezing of the ground and the subsequent freezing of the air near the ground during the night. As a result, the temperature decrease with altitude is altered, vertical air mass movement is blocked and a warm air layer is trapped between two colder layers increasing air pollutants' concentration near the ground. Our research questions are:

a) to what extent pre-service elementary teachers were aware of air mass movements before teaching

b) to what extent the proposed teaching sequence improved their knowledge

3. The teaching sequence

The teaching sequence is based on three hands-on experiments and on two software applications provided via Internet.

The first experiment simulates the creation form of the wind, which is the horizontal air mass movement near the ground [12]. It is implemented by the Density Flow Model apparatus (Sargent-Welsch WL1359J-01) and contributes to wind formation understanding based on air pressure differences. As an additional instructional tool, a software application provided at http://www.phys.ufl.edu/~matchev/MET1010/notes/ ActiveFigures/A_54_files/A_54.swf is used.

The second experiment simulates the horizontal movements of air masses with different temperature and the subsequent weather front formation. It is also implemented by the Density Flow Model apparatus (Sargent-Welsch WL1359J-01) and is accompanied by appropriate slides on the computer screen.

The third experiment is implemented by the Air Mass Generator apparatus (Sargent-Welsch WL6837E) and simulates the vertical air mass movements, which increase or reduce air pollution in relation with temperature differences among air layers. This experiment aims at teaching the temperature inversion formation, in the case that the vertical air mass movement is blocked because of the low temperature of the air near the ground. The experiment is accompanied by a software application provided at http://www.airinfonow.com /html/activities.html.

The didactical methodology used is based in the guided inquiry model [14]. Following the inquiry-based learning students are exerted to make observations, to pose questions, to test hypotheses, to make predictions, to do experiments and to conduct conclusions. Pre-service elementary teachers followed a series of hands-on and written activities, using and recording their results in an appropriate instructional sheet.

4. Research methodology

The teaching sequence was practised on 60 undergraduate students of the Faculty of Primary Education of the University of Athens, during the winter semester of 2008-09, as part of an elective course named "Physical Sciences & Environment – A laboratory approach".

Data came from a) questionnaires submitted a week before and a week after the instruction b) instructional sheets completed during the activities c) recorded discussions among pre-service elementary teachers during the instruction d) recorded interviews given after instruction. Data was processed with the semantic content analysis method [23].

5. Results and discussion

Results show that pre-service elementary teachers, prior to the instruction, possessed a poor command of wind creation mechanisms, of wind naming, direction and velocity assessment and of orientation pattern. They also had no concepts related to weather fronts and temperature inversion. The great majority declared that they had learnt nothing about wind during their prior education. Our teaching sequence seems to have addressed this lack of knowledge.

Table 1. Total answers about wind formation

How is atmospheric wind created?	Before teaching		After teaching	
	Num. of p.t. n=60	Percentage	Num. of p.t. n=60	Percentage
I don't know	39	65%	8	13%
Various erroneous answers	10	16%	5	8%
Through temperature differentials	7	12%	13	22%
Through airstreams	2	3%	5	8%
Through barometric systems	1	2%	7	12%
By air pressure differences	1	2%	22	37%

The same question "How is atmospheric wind created?" has been included in both pre-test and post-test. In the pre-test, 65% of the pre-service elementary teachers answered "I don't know" and only one mentioned air pressure differences as a cause (Table 1). In the post-test, 37% gave the correct answer: "Wind is created by air pressure differences between two areas" (PET22). Furthermore, most of them appoint the precise direction of the movement and discriminate between vertical and horizontal movements. In addition, only 13% declared "I don't know" and "various erroneous answers" reduced from 16% to 8%.

However, there is room for improvement, given that many answers reveal confusion on concepts and various misconceptions. 22% of the pre-service elementary teachers continued to consider temperature differences as the cause of the wind. They confuse surface horizontal air movements, which actually constitute wind, with vertical air movements, which are caused by temperature differences and come before horizontal movements. "The wind is created when warm air masses lay upwards and cold air masses lay downwards creating airstreams" (PET24). Obviously, this answer contains scientifically correct elements, though their correlation cannot explain wind formation in an acceptable way.

It is thus our estimation that there are three kinds of conclusions to be made. At first, some of the pre-service elementary teachers speak with macroscopic terms and usually describe only the observable result of the experiment, because they cannot give a full explanation based on appropriate scientific concepts concerning fluid circulation. Other pre-service elementary teachers fail to discriminate between vertical and horizontal movements, because they cannot discriminate between temperature differences and air pressure differences. Finally, there is confusion between cause and effect, since some of the pre-service elementary teachers believe that the existence of high barometric pressure causes air down-draught movement, while in reality the air down-draught movement creates high barometric pressure on the surface.

Concerning front formation, the pre-test shows that 43% of the pre-service elementary teachers ignored the phenomenon and that only 22% selected the right answer in a closed form question (Table 2). During the interviews this general impression was confirmed.

Table 2. Answers about weather fronts' formation before teaching

When a warm air mass arises over a cold air mass, we observe:	Num. of p.t. n=60	Percentage
A. A cold weather front	12	20%
B. A warm weather front	13	22%
C. Sea breeze	9	15%
D. I don't know	26	43%

In the post-test, 28% of the pre-service elementary teachers accurately answered an open-ended question on cold weather front generation. Most of them focused on the boost of the warm air mass by the cold one: "A cold weather front is created when a cold air mass pushes a warm air mass" (PET27). Some of them tried to explain the phenomenon: "A cold front is created when cold air waves approach land surface due to their heaviness and push warm air waves upwards" (PET30). Furthermore, others mentioned the final physical result: "…the warm air suddenly freezes and shortly precipitates, having as a result rainstorms of short duration" (PET44) (Table 3).

Table 3. Answers about fronts' formation after teaching

How is a cold weather front created?	Num. of p.t. n=60	Percentage
By the boost of the warm air mass by the cold	17	28%
I don't know	15	25%
Various erroneous answers	6	10%
By cold airstreams	6	10%
By barometric systems	4	7%
Due to low ground temperature	4	7%
Due to low temperature	3	5%
By the boost of the cold air mass by the warm	3	5%
Due to air pressure differences	2	3%

However, approximately half of the pre-service elementary teachers denoted wrong causes for fronts' formation. 10% answered that fronts are formed because of cold airstreams, 7% associated fronts with barometric systems, 7% attributed cold front formation to low ground temperature and another 5% made a wider correlation with low temperature. 5% inaccurately described warm front formation, 3% confused front formation with wind formation and 10% gave various erroneous answers. These results proclaim that the pre-service elementary teachers hold wider problems in the use of Physical Science concepts.

During the interviews pre-service teachers recognized that they confuse concepts and phenomena. At first, they declared that "air masses have high or low barometric system", instead of "air masses generate high or low barometric pressure". Then, they didn't simplify the precise "movement which is created" and its causes. They also didn't discriminate if the "removal" is vertical or horizontal.

Finally, 25% of the pre-service elementary teachers could not respond to the question about front formation in the post-test, a fact that confirms the great difficulties that they encountered in this issue.

Concerning the temperature inversion, 73% of the pre-service elementary teachers ignored the concept and only 3% gave the right answer, namely that inversion occurs when a warm air layer is trapped between two colder air layers (Table 4).

Table 4. Answers about temperature inversion before teaching

Temperature inversion is formed when:	Num. of p.t. n=60	Percentage
A. a warm and a cold air layer run across each other	11	18%
B. a cold air layer is trapped between two warmer layers	3	5%
C. a warm air layer is trapped between two colder layers	2	3%
D. I don't know	44	73%

We expected this percentage to be higher, given that temperature inversion is a meteorological phenomenon frequently appearing into closed basins like Athens and often presented in the media as a cause for high concentrations of pollutants.

Table 5. Answers about the cause of temperature inversion after teaching

What is the cause of the meteorological phenomenon presented in the picture?	Num. of p.t. n=60	Percentage
A. the temperature difference between sea and land	23	38%
B. sudden freezing of the ground during nights without clouds	31	52%
C. the increased temperature of the air	5	8%
D. I don't know	1	2%

In the post-test, pre-service elementary teachers were asked to recognize temperature inversion on a picture and to spot its causes. The results show a great improvement. 52% of the sample selected the right answer compared to 3% before teaching (Table 5).

In a following post-test question, 87% of the pre-service elementary teachers substantiate that they know the consequences of temperature inversion and that they could connect it with air pollution increase (Table 6).

Table 6. Answers about the consequences of temperature inversion after teaching

Temperature inversion occurrence over a city:	Num. of p.t. n=60	Percentage
A. increases air pollution	52	87%
B. increases air temperature	4	7%
C. increases ground temperature	3	5%
D. I don't know	1	2%

The differences between the correct answers concerning the causes (52%) and the effects (87%) of temperature inversion could be attributed to the intent visual impact of the third experiment. Pre-service elementary teachers had been asked to carefully observe smoke produced by a struck match, which accumulated near the ground, so that they could associate temperature inversion with air pollution in a visual way. In reverse, there wasn't an analogous visual impact concerning the causes of the inversion but only verbal correspondence of the cold water in the apparatus with the frozen ground reflecting heat. So, a more complex cognitive process was required to label the outcome "sudden freezing of the ground during nights without clouds".

6. Conclusions

The teaching sequence we have developed seems to promote a better understanding of concepts concerning air mass movements. Taking into account that pre-service elementary teachers had difficulties in recognizing the distinction between horizontal and vertical air mass movements, in declaring their different causes and seemed to conflate causes and effects in air pressure existence and air movement, our teaching sequence strongly contributed to understanding wind mechanism.

A lower improvement is to be found in weather front formation's understanding, since difficulties in that case seem to be tied with wider problems concerning Science Teaching Education.

Finally, results show that our sample displayed significantly better understanding of temperature inversion in post-tests.

In conclusion, this research points to the need for greater familiarization of pre-service elementary teachers with hands-on Science Teaching, as a prerequisite step for better understanding Environmental Science.

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Teaching and Learning Energy Transformations in the Context of Environmental Crisis

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Abstract. *In this paper, we present a research aimed at recognizing the teaching and learning procedures of pre-service teachers regarding experimental apparatus that use two exemplary renewable and low impact energy sources, the photovoltaic and the hydrogen cell. In order to collect the data, experimental interviews, the so called "teaching experiment" were used. The interviews lasted three hours and consisted of the serial presentation and discussion of the photovoltaic experiment, the fuel cell experiment and the combinatory experiment. Data was analyzed using qualitative content analysis methods. Results show that most students were able to give adequate answers concerning the energy conversions that take place in the photovoltaic cell and in the fuel cell.*

Keywords. Energy transformation, Energy cell, Photovoltaic, Pre-service teachers

1. Introduction

In recent years, interest about environmental issues in science education has been rising steadily. Arguably the most central of current environmental problems is the energy crisis, which is related with both fossil fuel use and the resulting pollution. One of the many consequences of electrical energy generation through conventional means is the creation of greenhouse gases. For that reason, environmental research has been focused on using renewable and low impact energy sources. In this paper, we present a research aimed at recognizing the teaching and learning procedures of pre-service teachers regarding experimental apparatus that use two exemplary renewable and low impact energy sources, the photovoltaic and the hydrogen cell.

2. The study

The study carried out at the Department of Primary Education, at the University of Athens. In order to collect the data, experimental interviews, the so called "teaching experiment", were used. The teaching experiment was designed for the purpose of eliminating the separation between the practice of research and the practice of teaching [3]. It may be viewed as a Piagetian critical interview that is deliberately employed as a teaching and learning situation. The teaching experiment method setting has proven a powerful means to investigate the development of students' conceptions towards the science points of view [1]. The interviewer assumes the roles of a "classical" interviewer, who tries to understand students' individual conceptions, and a teacher, who must have answers to students' conceptions and make the appropriate intervention at just the right moment [2].

The sample group consisted of 23 pre-service teachers, separated in 7 teams of 3 persons each and 1 team of 2 persons. The interviews lasted three hours and consisted of the serial presentation and discussion of the photovoltaic experiment, the fuel cell experiment and the combinatory experiment. The interviews were videotaped, transcribed and evaluated according to qualitative content analysis methods [4].

3. The experiments

During the interviews three experiments were carried out.

1st Experiment - Photovoltaic Experiment: The arrangement includes a photovoltaic, a voltmeter, a small plastic car with an electric motor installed and an incandescent light bulb which substitutes the sun light for the experimental needs. In Photo 1 the photovoltaic which is placed in front of the light bulb is connected to the voltmeter, giving an evident calibration. Afterwards, in Photo 2, the photovoltaic is connected to the small car.

The photovoltaic transforms solar energy to electrical energy. The electric motor of the plastic car converts electric energy into kinetic. Finally, the kinetic energy degrades to heat due to the work of friction.

The students ascertain the conversion of solar energy into electric, its use in moving a small car and its degradation into heat.

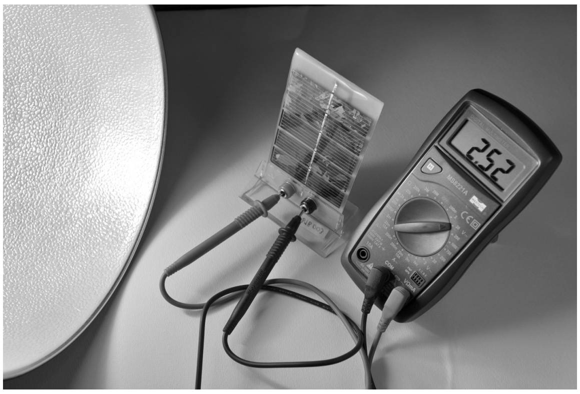

Photo 1: Photovoltaic – Voltmeter

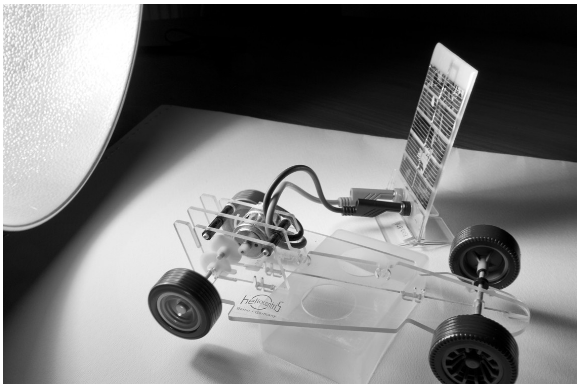

Photo 2: Photovoltaic – Small plastic car

2nd Experiment - Hydrogen cell: The arrangement includes an hydrogen cell, a battery, a voltmeter, and a small plastic car with an electric motor installed. First, electrolysis is carried out in the hydrogen cell, using the battery and afterwards the cell is connected to the small car (Photo 3).

The students ascertain the conversion of stored chemical energy created from electrolysis to electric and subsequently kinetic energy. Finally, friction produces heat.

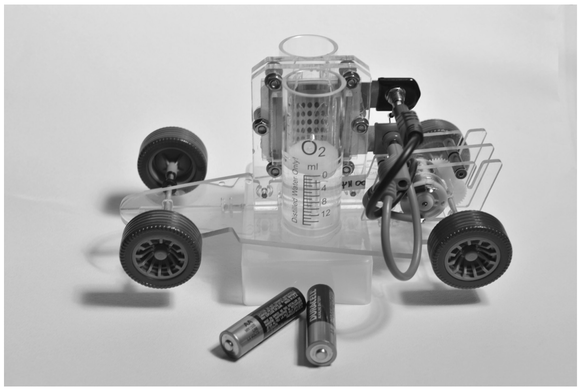

Photo 3: Fuel cell – Battery - Small plastic car

3rd Experiment - Photovoltaic and Hydrogen cell: The arrangement is a combination of the two previous arrangements. In this experiment, the energy source for the electrolysis is the photovoltaic cell, bypassing the need for a conventional energy source (battery) (Photo 4). In this experiment, the fuel cell is used as an energy storage apparatus providing an autonomous system of producing electric energy out of renewable and low impact forms of energy.

Students observe the energy transformations that occur.

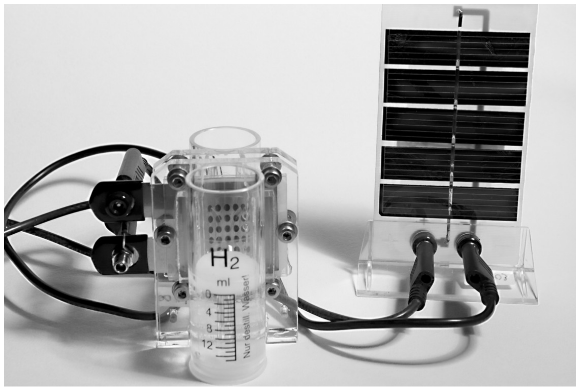

Photo 4: Photovoltaic – Fuel cell

4. Outline of the teaching experiment

The teaching experiment setting aims to investigate the development of students' conceptions towards the science point of view [1]. In this context, we have designed the partially structured interview that follows in order to reveal some of the students' views and learning difficulties as well. A brief outline of the teaching experiment [2] is presented below

1. Introduction to energy crisis – Arising need for renewable and low impact forms of energy
2. Description of the arrangement
3. Expectations and predictions of the outcome of the experiment
4. Run of the experiment
5. First explanation of energy transformations
6. Detailed analysis of the procedure.
7. Emphasis on the role of the arrangement in energy conversion and degradation.
8. Students formulate the experiment conclusion.
9. Students formulate an overall conclusion for energy conversion and degradation.

5. Results

The data analysis demonstrated that the majority of the students at the end of the interview could give satisfactory explanations of energy transformations, conservation and degradation. Some of the students' conceptions very often reported are mentioned below:

1. Confusion between solar water heater and photovoltaic
2. Notion that the photovoltaic stores solar energy somehow
3. Notions concerning the conservation or energy (Energy degradation as opposed to energy conservation – Energy degradation as energy transferred to a different place) [5].
4. Confusion between energy and force

Regarding the confusion between solar water heater and photovoltaic, sometimes it was a matter of apparatus while sometimes it was a matter of the operation mode. The learning difficulty was surpassed by using both the voltmeter and examples from everyday life. The notion that the photovoltaic stores energy was dealt by turning the lump off. When the lump was off the calibration of the voltmeter, which was connected to the photovoltaic, was almost instantly zeroed.

There were several approaches to energy conservation, energy conversions and degradation by the students. Some of the students' notions about energy conservation can be characterised as inconsistent. They know that the energy should be conserved but often doubt it. For example:

P: We know that energy does not disappear. It converts from one form to another. Maybe, the kinetic energy of the wheels was converted into heat.
Teacher: Good. Through which procedure?
P: Frictions?
Teacher: Where does friction appear?
P: in the air… and… while the wheels are moving … perhaps the energy that passes to the environment disappears…

Such a difficulty was treated using examples that students had from their everyday experiences. For example, the produced heat by hands rubbing.

Some of the students associate the degradation of energy with the replacement of energy to another place, often an unknown one. For example:
Teacher: When the light is on, the wheels are moving. What happens when I turn the light off?
I: I believe that something happened within the photovoltaic…
A: In any case, it did not disappear.
I: Was it stored in the photovoltaic?
C: For sure, it has left the wheels and it has gone somewhere…in the atmosphere or it became another form of energy…

There is a remarkable number of students giving right answers yet offering an explanation in the framework of everyday experiences and not in the framework of energy conservation [6]. The everyday way of thinking coexists with the scientific one. Emphasis is given according to the context.

Therefore, we do not aim at replacing an idea with a new one but at the conceptual evolution of the existing idea according to the context. Thus, we do not expect the teacher training materials presented here to be able to replace teachers' everyday language but rather to make teachers aware of the educational risk of using the everyday language in the school context [7].

6. Conclusions

In this paper we have attempted to figure out some of the teaching and learning procedures of pre-service teachers, in the context of environmental crisis. The study illustrates that, at the end of the interview, students could give some satisfactory descriptions and explanations regarding the energy tranformations that happen in the photovoltaic and fuel cell. Moreover, students become more conscious about the development of their conceptions towards the scientific point of view.

It is worth mentioning that some difficulties seem to persist, despite students formulating the proper energy conversions, In any case, students express their gratification for participating in the interview, recognizing its role in their future science teaching:

K: However, these are things that we have been hearing about for years, but never had the chance to see them. At least, we now know something about low impact and renewable energy sources…

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Science Fairs as Learning Tools

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Abstract. *Science fairs are activities well known, in different countries, for their pedagogical relevance. For that reason a 4 years study was developed to evaluate the advantages of this informal teaching method in the context of a basic school in the northwestern Portuguese seaside town of Viana do Castelo. The study included the analysis of the evolution of students that have participated in previous fairs, and also students participating in the present science fair. The motivation of the students was monitored and also the knowledge and skills' gains achieved. This way, the relevance of this teaching modality is once more demonstrated, not only in what concern the short term, right after student participation, but also the students future attitude towards the school and their motivation to the study of science, as well as in long term knowledge and skills acquisition.*

Keywords. Science Fair, Hands-on, Basic schools, Physics, Chemistry

1. Introduction

Science fairs are defined as a cultural and pedagogical activity where students display and discuss scientific projects they developed, being thereafter normally evaluated by adult judges [1, 2]. We think the focus should be at first instance to the pedagogic value of the scientific research developed by the students in an active committed investigative hands-on way.

To participate at a fair, students have first to overcome many problems and past different phases: subject search, project development, experiment design and problem solving, preparation of the presentation, and the science fair final presentation [2,3,4].

This activity has an added advantage of promoting students enthusiasm toward science, while in each phase they develop important skills like research capability, decision making, reasoning and communication skills, while having the opportunity to interact with other science interested students [1, 2, 5, 4].

2. Science Fair Participation

A study about the importance of science fairs on students learning as been developed on a school, in the city of Viana do Castelo, Portugal, during the last four years and is reported elsewhere [3,5,6]. This school, Externato Maria Auxiliadora, is a private catholic school with 135 students from the 5th to the 9th grades (ages between 10 to 15 years old).

We organized a science fair for the 4th consecutive year. Students, with the support of the school and teachers developed, in a voluntary basis, scientific projects extra classroom and presented them at the end of the year to all school community and abroad.

On the first edition 42,9% of school' students have participated (only from 7th to 9th grades); on the second edition 65,6% of the students participated, on the third edition 77,9% and on the fourth edition we reached the 82,6% mark.

With the main objective of knowing students' opinion about science fairs, and the impact it might had on their education, a questionnaire was distributed to 121 students at the beginning of the year of this 4th science fair.

When students were asked about what a science fair is for them, different answers were given as is possible to see on Table 1.

When questioned about their participation of the 4th Science Fair, the reasons why, were varied.

The Figure 1 shows the student answers. The majority of students refer the fact that it was an opportunity to learn something new (31,7%). Others said their participation in this edition happened because they already participated in previous year' editions and enjoyed the experience (25,1%), 9% said it was due to previous visit to the science fair, 23,4% of the students said they wanted to participate as they like science, 6,6% of the students participated due to the fun of the experience and 4,2% because they were required to.

Table 1 – Definition from students of science fairs.

	Nº of answers
Place where you show curiosity about science and / or technology.	35
Place where you have experience and / or projects.	33
Place where are sharing of experiences of learning, fun and live.	18
Place where we see projects developed by children / students.	12
Place where we show what we know and where to get the best experience	8
Others answers	8
Didn't know	7

This answer, the reference of being mandatory, was due to the fact that some school time was available at the subject of "Area de Projecto" for students to develop their projects, and their commitment and participation was evaluated qualitatively. However, it is important to notice that 4 over the 7 that mandatory participated, said that, despite being mandatory, they participate because they already visited and/or participated in previous years and that they were also fan of science.

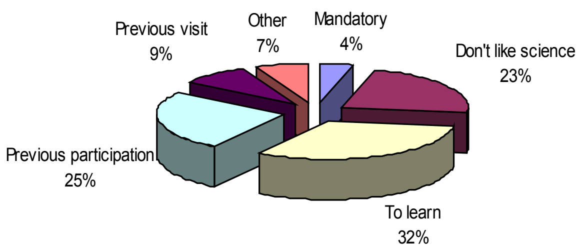

Figure 1 - Reasons for students participated on the 4th science fair.

Concerning the number of participants we would like to stress that all the 17,4% of the students that do not participated at the fair have ages between 12 and 15 years old. This reinforces the tendency, already verified in previous years, fortunately decreasing, that the youngest students are more participative in these activities. The Figure 2 shows the reasons that these students gave for not participating in the fair.

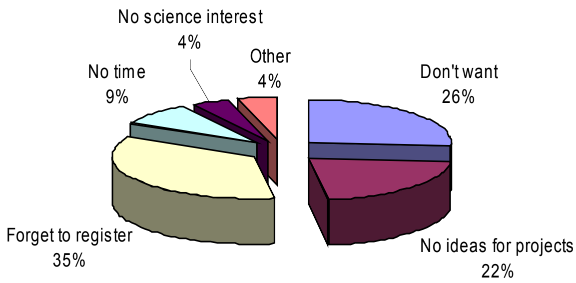

Figure 2 - Reasons pointed for the students to not participated on the 4th science fair.

The fair, as in previous years, was announced at the beginning of the school year. Students had deadlines to select a subject and register themselves at the fair. The majority of these "missing" students (34,8%) forgot to register, 26,1% did not want to participate and 21,7% said that didn't had ideas for their participation. The rest of the answers was that they already have too many activities and cannot conciliate one more (8,7%), they don't like science (4,3%) or 4,3% give other responses.

3. Knowledge Evolution

To evaluate student's knowledge, a theoretical inquest was made at the beginning of the school year and at the end, after the science fair. The question presented was about why boats of 45 ton are capable to float. This question was based on a project developed by 2 girls from the 5th grade (10 years old) on this edition of the science fair.

Figure 3 demonstrates the evolution of the students answers. It is possible to see that the number of students that did not respond decreased from 40,5% to 19,1%. On what concerns the incorrect answers, most of the students did not know why this fact happen and say that it is because of the characteristics of the materials boats are made of, or give illogical answers. Although not dramatic it was possible to notice that the misconception decreased from 42,1% to 34,7% after the science fair process (yet not directly related to the subject it self).

On the other side, the number of answers partially correct increased from 8,3% to 23,1%. Here, students refer essentially the fact that a large part of the boat is hollow, allowing the fluctuation. Finally the number of correct answers increased from 9,1% to 23,1%.

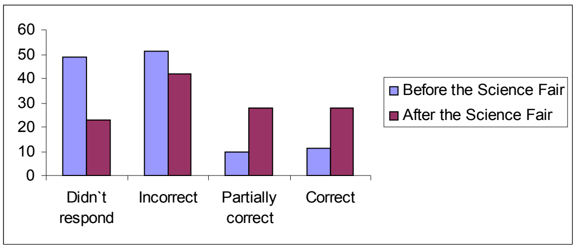

Figure 3 - Answers from students to the theoretical question

4. Conclusions

With this study we can conclude that science fairs are an activity that motivates and approaches students to science. A positive steady evolution on the number of participants along the last four years was noticed as well as in what concerns the reasons given to participate on this activity. Positive results were obtained. A certain tendency of losing interest while growing older was unfortunately also noticed.

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Scientific Research Projects in Vocational Training Schools

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Abstract. *Vocational schools are a resource for many students, with usually low motivation and high learning difficulties. The fact that this type of teaching is of a more practical, experimental, and job oriented type, points to teaching strategies less theoretical and focus on a more practical student involvement.*

Profiting from those characteristics, the study of the use of scientific projects on vocational teaching was initiated. It was proposed to vocational school students, high-school equivalent students, the development of small science projects in the subjects of physics and chemistry with the final objective of being presented.

The difficulty level of the science projects was increased progressively, in a way to be correctly adapted to this type of teaching. Learning gains were evaluated trough questionnaires and tests presented at different stages of the learning process.

Keywords. Science projects, Vocational training.

1. Introduction

Vocational training schools have as primary goal to promote an alternative curriculum to students, giving them the opportunity to acquire a higher level of education and professional qualification. This kind of teaching is in fact oriented to the direct integration of the students on the labour market. The curriculum is prepared according the type of course [1].

There are a wide variety of vocational training courses in Portugal [1,2]. In the official report [1] the courses are divided into:

- Vocational Courses, aimed to insertion of students on the labour market but also allowing the continuation of their studies.
- Learning Courses, strengthening the involvement of companies where students have internship periods in parallel with their studies.
- Education and Formation Courses, aimed preferentially to students older than 15 years and in risk of dropping out from school, that already dropout or, students that already complete high school and want to acquire professional qualifications.
- Courses in Specialized Art Education, based on visual arts and audiovisual programs in domains like dance and music.
- Education and Training of adults, with different school levels oriented to already working students and prepared to certify particular skills.

The technical and vocational teaching in Portugal began on the XVIII century, but only on the XIX century it had a greater development due the necessity of qualified labour workforce upon the Industrial Revolution [3].

For this reason, this different area of teaching was created. It was called the technical-professional teaching aiming to qualify people for the labour market. This teaching promoted the manual dexterity and developed the know-how instead of the theoretical scientific and humanistic knowledge normally taught at regular schools [3].

However, despite these intentions, the fact that these courses do not allow further education at university's level, made them only frequented by students from poor families, from rural zones or by students with learning difficulties [3].

The failure of this approach became soon evident. Since then, several changes were implemented, allowing, for instance, the entry of these students into the university. However, studies reveal that the students attending these vocational schools remain the same [3].

Currently, besides trying to qualify the labour force, these courses seek to minimize the scholar failure an increase the level of literacy of the Portuguese population [1,3], and to promote the articulation between education, training and society, leading to a more significant teaching [1]. For that, the government wants to involve others institutions like universities with the vocational teaching [1,3].

2. The Project Developed

The work herein reported was made on "Education and Formation Courses" and "Learning Courses".

Most of the times, students registered in vocational training schools reveal major difficulties and no motivation to study [4].

The youngest students, from Education and Formation Courses, were in risk of dropping out from school [2] for different reasons, such as learning difficulties and/or problems with classroom behaviour.

The second group, from Learning Courses, consists of students that already completed the mandatory scholarship, i.e., the first nine years of school, but also want follow their studies [2]. Two types of students are found on these classes: those that already have work experience and need specialization in some particular field, and others that have difficulties in achieving regular school objectives and choose a vocational track.

In both cases physics and chemistry subjects are part of the scientific and technological component of the courses. Since many students cannot find any relation between these subjects and the course practical curriculum [4], it is important to remember them that the idea is not only to be specialized on a specific area but also obtaining the basics of a good education [2,4].

Therefore, this type of teaching should be based on practice with only a minimum of theoretical background [4]. The lack of resources like chemistry labs or materials makes this task more difficult.

The Table 1 shows some of the skills that should be developed during the vocational courses and that can be facilitated by the development of scientific projects for the students during classes.

Competencies to Developed	Stages of Development
- Documents Analyses.	- Subject selection
- Research of different information sources.	
- Data collection, selection and organization.	- Project Development
- Formulate hypotheses.	
- Observation of experiences.	
- Confrontation of ideas and argumentation.	
- Propose solutions to solve problems.	
- Present papers and answer questions.	- Presentation
- Capability of presenting ideas, oral and writing.	

Table 1 . Some skills to be developed in vocational courses [5] in different phases of the development of scientific projects [6,7]

The main objective of the development of these skills is to promote the scientific knowledge and, therefore, a better comprehension of the natural world [5].

The contribution of different subjects should be valued because it will allow students to feel the importance of different subjects in their knowledge construction. Furthermore, we expect to promote teaching techniques that develop the willingness to learn.

3. First Case study: Middle school students

The first case that we present here was done with students of Education and Formation Courses. This class had initially 17 students, 10 boys and 7 girls, and the majority of these students were older than 15 years old. During the course 5 students dropped out for different reasons but mainly due to family problems. Three other students were expelled from the course by the teachers' council due to their large amount of faults in classes. Mainly this situation happened due to the inappropriate behaviour of these students. They didn't respect their teacher's rules and none of the strategies applied seems to have worked on them, and on the other hands they also hindered their colleagues learning.

Therefore, at the time of this project, the class only had 9 students.

This project, that will be described, were developed as an interdisciplinary field named "Energy and Environment" that was presented at the "open week"1, were many students from others school visit the training center. Here, students have constructed a small city reusing garbage, like newspapers, milk cartoons… as is possible to see on Figure 1.

Figure 1 - Project developed by the students

Student's committed involvement during the construction of this healthy city, without pollution and using only renewable energies, was evident. They worked during class time but also during breaks, which is quite unusual in this kind of students with major behavioural problems and learning difficulties.
During this work we also asked to students to perform research about the subject and to create posters in English and leaflets including some relevant information.
They worked on the construction of the city and the creation of the leaflets during the classes of Physics and Portuguese. On the English class they create the posters.
The presentation of this project was prepared and practiced. During this phase of the project they presented clearly lower motivation and higher difficulties than during the construction of the project. In fact most students failed on their presentation. This part of the project requires major attention and improvements due to the lack of social skills of these students. However it seams to be an extremely important part of their learning process. One solution could be to involve these students in simpler projects and extend the preparation and presentation' training to the class first and only then they would be more comfortable to present to a larger audience.

4. Second Case study: High School students

This project has been developed with 14 students from the second course. They have already completed the mandatory school years but want to continue the study trough vocational training. About 10 of the 14 students reveal no basic knowledge on physics or chemistry and presented major learning difficulties.

The lack of a suitable laboratory and support materials imposed a different approach: to the students it was proposed to work in groups of 2 or 3 students, choosing a simple topic or experiment that they will study and later on present to the class.

All this work process was given as optional and to be developed at home after class. The student should find the materials by themselves and be responsible for the development of their works. These projects (each student had the possibility of presenting up to 3 per year) were evaluated and had an impact to the student's final evaluation.

All students participated, did research for the chosen subject, proposed it to the teacher and set the date to the presentation. The projects were done out of the classroom with only a minimum amount of time being made available on the classroom to clarify some of students' doubts.

To measure the efficiency of this project on students learning, some inquires related with the projects were made one week before their works' first presentation. The same inquiry was given one week after the last presentation.

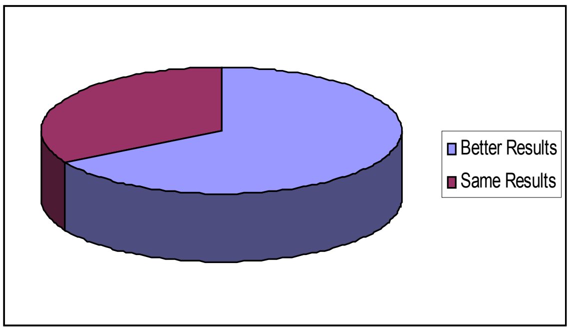

Figure 1 - Results of the inquires

The Figure shows that on 18 of answers, the students improved their results while on 9 presented no significant improvement.

Again a significant feature was that students (4 of the 6 groups) were specially committed on their research and not so much on how to explain/present their specific project.
After this first set of presentations, it was possible to reach to the conclusion that the groups should have only 2 elements per group instead of 3, since one had always a lower participation level on preparation and presentation, and also due to the simplicity of the projects.
In spite the relatively small population involved, positive changes were observed. However, it is possible to conclude on the greater enthusiasm that students showed on preparation and presentation of these little projects. The interest and participation on classroom subject and their performance also increased.

5. Conclusions

In both cases, the project developed by all the class about energies and the small projects developed by the older students, we could conclude that students can be motivated by using the development of simple science project. Unfortunately, the lack of suitable materials and other resources make this kind of activities more difficult to implement. However, this fact has a positive aspect as it is possible to show to these students that science is in everywhere and that it is possible to make science with simple everyday resources.
We can also conclude that in both project' cases the motivation and the acquisition of knowledge on the particular subject researched was improved. On the second case we could clearly conclude that the overall learning of the subjects of physics and chemistry was improved.
With this study, we intended to give a first step on the demonstration of the importance of the development of scientific projects on vocational courses, not only by the knowledge students acquire, but also on developing their interest on science.

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Teacher Training on the Implementation of Science Research Projects In Classroom Context

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Abstract. *The introduction of the use of science projects in the classroom in the context of teacher training is of great relevance, especially since the development of these projects in Portuguese schools is not a regular practice, despite the fact that their pedagogical importance had been widely proved. These advantages include the development of decision making skills and a critical mind, which are essential to the learning and understanding of science.*

In the school year of 2009/2010, a teacher training course on the development of science projects in the classroom was carried out. This course aimed at the creation of strategies for the implementation of the development of science projects, by the students, both in classroom context or as extracurricular activity. In this work, we present the strategies employed at this teachers training course. We also present the discussions and the different contributions received from the group of teachers involved in this activity, along with the proposed in-class/school implementation strategies and different examples.

Keywords. Science fair, Science projects, Teacher training.

1. Introduction

European Union studies [1] revealed that better results on education lead to a higher economic and social development.

For a better education, it is important to improve not only the initial teachers training but also the training that they should attend during their carrier, *lifelong learning* [2]. The need to address teachers' training relies on their unique influence on development of innovation and motivation occurring inside classrooms. Therefore, the training proposed to teachers should give them a permanent update to new techniques and methodologies [3].

On some countries, like in the USA, science teaching has changed due the development of the science fairs. Teachers recognize that the development of scientific projects like activities in the context a science fair preparation process promotes an active learning possibility not commonly available on regular classes [4].

2. The need for the course

The recent Rocard report [5] on science education inside the European Union stresses the declining interest of students on science, pointing the need of a more active, participative and investigative learning.

According to the Lisbon report [1], Portugal had to achieve the following goals until 2010:

- Reduce to 10% the number of young people that abandon their studies prematurely;
- Reach the mark of 85% of the people with ages between 20 and 24 years old with the secondary education complete (12 years);
- Obtain a percentage of 12,5% of adults already working (with ages between 25-60 years old) to increase their qualification.

To fight the students lack of motivation, that teachers have been feeling in their classroom, the use of new methodologies to improve the teaching process is needed [5,6].

The Portuguese curriculum is theoretically geared to a learning where students must relate the acquired knowledge with scientific discoveries, technological processes, and their implications to daily life [7,8].

High school science curriculum is oriented to taking into account previous learning' to lead to a more practical and investigative teaching [8]. So, with the implementation of scientific projects as a different introduction of students to science and technology, we expect to increase the motivation of students to these subjects and to science based careers [6] while cooping with curricula requirements.

To have a fair curriculum is not enough. Teacher's role is fundamental for their development.

3. Objectives of the course

The development of scientific projects is a teaching tool with a great relevance since it involves actively the students in investigative and hands-on learning/discovering activities.
Therefore, the main objective of the training course we developed is to provide to the teachers alternative means, in particular ways of implementing scientific *research* projects to contribute to the effort of motivating students to learn science and technology. This methodology also promotes an improvement on a investigative based education, where students participate voluntarily, actively and committed into their learning. A set of guidelines on how to apply the development of scientific projects at the Physics and Chemistry classes, "Área de Projecto" (a "project" discipline with no a-priori defined subject), in the context of a Science Club or as an extracurricular activity, was presented to teachers.

4. Organization of the Course

The course was planed to allow teachers to lead the student organize a Science Fair by developing science project, with the final aim to expose and present their projects to the school community. The different phases are described on table 1.

Table 1: Phases of the teacher training course.

Phases	Resume
Presentation of the methodology	Importance of this methodology; Analysis of some case studies; Analysis of the Portuguese curriculum.
The Science Fairs	Science Fairs: definitions A way to present scientific projects developed by students.
Organization	How to use in the Portuguese curriculum. Calendar. Objectives. Guidelines and indications to students Rules
Theme choice	What themes can students choose; Advices/strategies to project selection. Research sources.
The development of the theme	Guidelines to help students during the project development. How to present a scientific project.
The preparation of the presentation	Graphical aspects of the presentation. Selection of main ideas and organization.
The evaluation of the activity	Parameters to evaluate. Construction of an evaluation guide in different contexts.
Organization of the science fair	Last details (organization of the space, …)

During the course, activities, projects and moments of reflection were employed for teachers to better promote and apply this methodology.
The course was all trough oriented to implement the scientific projects in the classroom while given to teachers indications on how to organize a science fair (in a way that students could show their work and thus allowing more people to learn from the projects and further recognition of the students work).

5. Results

At the beginning of the course, teachers were a bit apprehensive since they had doubts on the possibility of using this methodology in their classrooms. They all agreed on the advantages of the methodology but express some problems with its implementation (see table 2).

Table 2: Difficulties of implementation felt by teachers and proposed solutions.

Difficulties	Solution
Not enough time at classes	Create partnerships with other teachers that have subjects in common or teachers from "Área de Projecto".
Lack of skills from students: • *Didn't know want kind of project they should and/or could choose.*	6. Give to students some examples of projects; 7. Recommend them to research in the web, on libraries, or talk with family and friends…
• Didn't know where to search for a project.	8. Give them some references of websites or books.
• Didn't know how to conduct a scientific research	9. Discuss the results with the students. 10. Question them, and lead them to think on what they can/should do within their project.

Despite all the problems that these teachers presented, at the end of the course they were more receptive to the idea and managed to implement with success small projects of investigation with their students. It was also proposed to the teachers to plan a larger scale project to use on next year' classes.

6. Conclusions

So far we could conclude that teachers should overlook carefully the evolution of the student's scientific projects. Personal experience is fundamental on this task. With time students will also become familiar with this type of projects, and the sooner they start working on it the sooner they develop the necessary skills.

The difficulties encountered along the course revealed the importance of teacher training in this subject. Since it is impossible to ask students to develop these activities alone, teachers have to know what can be done, or how to plan this activity in a way possible to manage within school schedule or even in extra-curricular activities.

Teachers should take the opportunity to develop this kind of projects extra classes and develop the "scientific spirit" into students.

In-service teacher training in the implementation of investigative hands-on type of activities, like students research of scientific projects in the frame of science fairs, is fundamental to an effective change in the way science teaching occurs in our school.

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Evolving Facets of Cyberchondria: *Primum non nocere* "First, do no harm"

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Abstract. *The phenomenon of cyberchondria continues to be hotly debated in periodicals and other media.*

This paper will continue the discussion of the concept in broad context and present an overview of some of the recent design recommendations developed by search engine architects that are intended to reduce the likelihood that health care information consumers who use the internet as a source of health information become excessively anxious about their health.

Findings from a recent survey, carried out in a population of Ukrainian and International students attending Ternopil National Technical University (TTNU, Ukraine) will be summarized to compare the search habits and health related-anxiety data of the student survey population to data related to the concept of cyberchondria that has been previously reported in other research populations.

Keywords. Consumer health information, The Internet, Information seeking, Cyberchondria, Cyberchondriac.

1. Introduction

The proliferation of consumer oriented health care information on the Internet and the deceptive ease of locating and accessing such resources through search engines have produced what is being considered a new phenomenon, and a new term for this phenomenon and its sequelae has arisen----*cyberchondria* [1]. *Cyberchondria* is still hotly debated in periodicals and other media, and recent studies have outlined a number of issues facing health care information consumers, healthcare providers and IT professionals related to this phenomenon [2].

This paper will continue discussing *cyberchondria* in broad context, present recent survey data, and review recent design recommendations developed by search engine architects to reduce the likelihood that health care information consumers may become excessively anxious about their health.

2. Online health-related information searching; motives, habits, and levels of anxiety

The ongoing amount of health care consumers' Internet search activity is so seemingly stable that the Pew Internet & American Life Project, Harris Interactive, Inc. and other researchers have stopped updating their reports; at least no additional recent data on Internet health information search activity is available on their public web-sites.

Although most health consumers persist in using a general search engine for online health information gathering, the search results now look somewhat different than in previous years, with sponsored links appearing first in combination with a more limited number of information sources that dominate the health information supply [3].

The motives behind healthcare consumers' decisions about whether and how to engage in health information seeking vary, depending on individual needs and circumstances. In order to understand more about online health information seeking activities we carried out a survey to determine health-related search habits and levels of health-related anxiety in Ukrainian and International students at Ternopil National Technical University (TNTU, Ukraine).

The survey form shown in the Appendix includes some similar questions from Table IV and Table X , used by the Microsoft researchers in their recently reported survey research [4].

White and Horvitz distributed their survey within the Microsoft Corporation, to randomly selected employees (350 males and 165 females; average age 36.3 years). They argue that they "have no evidence that the employees' experiences with medical Web search differ significantly from those of the general user population" [5].

At the TNTU, survey forms were completed by 66 students (49 males and 17 females; average age 21.7 years) who study computer science. Their responses to the survey questions are summarized in Table 1. In the discussion section we compare some of the survey data obtained from the student population to data reported by White and Horvitz [6].

Table 1. Responses to the survey questions at TNTU, Ukraine (66 student respondents)

1. Average number of health online searches per month	1.72
2. Average number of health-related online searches (for *professionally undiagnosed medical conditions)*	1.05
3. End-consumer of online search results: • Yourself • Relative • Friend or work colleague • Other	 65.91 % 6.82 % 11.36 % 15.91 %
4. Type of information saught: • Information on symptoms • Information on serious medical conditions • Medical diagnoses • Forums or pages describing others' experiences with similar conditions • Other	 34.09 % 9.09 % 29.55 % 27.27 % 29.55 %
5. Average self-rating of health-related anxiety (1-10 scale)	4.37
6. Being a hypochondriac – self-opinion: • Yes • No	 0 % 100 %
7. Being a hypochondriac – opinion of the people around: • Yes • No	 2.27 % 97.73 %
8. Unjustified self-diagnosis of a serious medical condition: • Yes • No	 29.55 % 70.45 %
9. Escalation of illness anxiety fueled by online search: • Always • Often • Occasionally • Rarely • Never	 2.27 % 13.64 % 27.27 % 29.55 % 27.27 %
10. The ranking of online search results is considered an indicator of the likelihood of diseases: • Always • Often • Occasionally • Rarely • Never	 0 % 0 % 43.18 % 29.55 % 27.27 %
11. The use of online search as a medical expert system: • Yes • No	 29.55 % 70.45 %
12. Scheduling an appointment with a health professional may be urged by the online health care information obtained during searches: • Yes • No	 29.55 % 70.45 %
13. The appointment disproved health concerns: • Yes • No	 34.09 % 65.91 %

3. Discussion of survey results

Of some note is that the student population in our survey performed far fewer online health-related searches per month than the Microsoft employees in the White and Horvitz study– 1.72 versus 10.22 per month, however the students' average health anxiety rating is much higher: 4.37 versus 2.78 in the Microsoft study. (Rating scale 1-10). High morbidity in Ukraine where 10 % of the students suffer from chronic diseases may explain the elevated health anxiety level reported by this student population group. The students in our survey population primarily search for themselves as the end-consumer and target information on general symptoms and possible medical diagnoses, not on the serious medical conditions that were typical search targets of the Microsoft employee survey population.

Nearly three (instead of four in the Microsoft study) in ten respondents reported self-diagnosing a serious medical condition based on their own observations, when no professionally diagnosed condition was present. The students were also far less inclined to review search content on more serious illnesses – 27 % of the student population responded that they never did so versus only 8 % in the Microsoft survey population.

There is an interesting difference in the data related to how respondents interpreted the ranking of online search results between the student survey and the Microsoft study population. While close to one-quarter of Microsoft respondents interpreted the ranking of online search results as indicating the likely presence of disease, all (100%) of the student respondents interpreted search results in this way only occasionally, rarely or never. Perhaps students' knowledge of probability theory and ranking algorithms plays a role in this case, although a significant proportion of them (29.5 %) had used Web search engines as if Web search functioned as a medical expert system.

Comparable proportions of both groups of respondents were persuaded to visit a health professional based on their review of online medical content. However more of the student population (65.9%) reported that they actually had a medical condition that warranted consulting a health care professional (their worries were justified) while only one in four of the Microsoft respondents were reassured that their worries were justified after consulting.

Our findings show that this group of young Internet users could be typified as rather discriminating consumers of online health information.

4. Consensus seems to arise in the doctor-patient-Internet triangle

A recent research study indicates that many patients do not consider the Internet as a substitute for a doctor consultation anymore [7]. They use the Internet as a convenient "first contact" in health-related information access because it is easy to do a search unobtrusively especially if they consider a health concern as too minor to ask a physician or other health care provider. These health-related information consumers then often turn to health care professionals for help in interpreting the confusing nature of online information or to assist in making important health-related decisions regarding diagnosis or treatment. Consumers do need this kind of doctors' support since focused and accurate information retrieval has become an increasing challenge. Even health care professionals who go through special training were found to be only moderately successful at gathering evidence for clinical question-answering with the assistance of literature searching through MEDLINE [8], so it is no surprise that consumers with far lower health literacy might be even less successful in obtaining accurate, relevant and understandable health information online.

The data from the Health Information National Trends Survey (HINTS) [9] agrees with Pew Internet's findings and shows that health consumers' trust in physicians has increased (odds ratio 1,29) with the rise of the Internet, while their trust in Internet information has declined slightly (odds ratio 0.74) over the time from 2002 to 2008.

Thus the Internet seems to take a more proper third party position in the doctor-patient-Internet communication triangle.

5. Conclusion

Since its identification, the main focus of efforts for reducing *cyberchondria* have been devoted to the development of specialized ranking algorithms and techniques for recognizing health-related queries so that they can be specially handled. The Microsoft study authors suggest some opportunities [10]:

- detection of diagnostic intent
- providing expertise
- debiasing search results and searchers
- evaluating search results to flag candidates for escalation
- click-through tuning

Some IT-based solutions would involve:

- displaying additional information above search results, such as the overall incidence rates of relevant search terms
- linking a small set of the most popular queries with focused lists of results, in automated and handcrafted modes, that are less likely to create unjustified concerns about more serious diseases
- describing symptoms and signs in more detail and in terms that are clearer to information searchers
- creating a handcrafted list of queries flagged as candidates for escalation
- providing special ranking of Web pages frequently present in escalatory events; or submitting them for expert review
- adjusting of rank optimization methods based on input click-through and dwell data “to handle medical queries in a special manner, such that the escalatory potential of a page is also considered alongside interaction features such as the click-through frequency and dwell time when ranking search results” [11].

All these relatively sophisticated solutions, which may be expected to be implemented in the future, tend to formalize both health data presentation and diagnosis making. However, this may further complicate health information acquisition due to conceptual and linguistic mismatches between health care consumers and the architects of search engines.

Information system designers and architects of search engines frequently assume that health care consumers desire formal, objective, scientific, biomedical information, “while patients, their families, and their friends often prefer more subjective, informal information about the realities of coping with illness in daily life” [12].

When consumers fail to find materials relevant to their customary reading level, they may rely on “professional help in the process of retrieving credible information and in applying such information to their own health or illness situation by eliciting discussion with their healthcare professionals” [13].

According to the HINTS data [14], it is physicians who most frequently are asked to “translate” medical literature for their less health- and IT-literate patients. Such HINTS findings refer us again to the important subject of health literacy defined by the Institute of Medicine as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” [15].

The survey we completed at the TNTU (Ukraine) illustrates that the student population we surveyed are not only skeptical consumers of online health information, they also are more analytical in interpreting online search results, and more careful in applying the retrieved information to their health problems and seem more balanced in seeking professional medical advice to interpret the information they have retrieved online. In other words, they appear to be less likely to become cyberchondriacs and they do not consider themselves to be hypochondriacal. We assume that any possible explanation of the survey responses should include a consideration of the younger age of the student population. In addition, their IT proficiency and general literacy which could be seen to be at a higher level than in the public in general, once again brings up the question of the impact of heath literacy.

Our findings encourage an alternate view of how the incidence of cyberchondria might be reduced in the future. Strategies of consumer education to develop health information literacy have already been well elaborated in the published literature elsewhere. Such health literacy education would be an effective supplement to the ongoing IT research regarding the improvement of search engine design.

C*yberchondria* is rooted in human behaviour and potentially exascerbated by some of the fundamental properties of Internet-based information systems and as such is not a “foreign body” in a health related Internet search which can be completely eliminated. The concept of *cyberchondria* requires continued examination and research study to be properly managed in the future so that the medical ethics maxim of *Primum non nocere* "First, do no harm" can be upheld.

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Appendix

Health-related search habits and levels of health-related anxiety survey

1. On average, how many health-related Web searches do you perform per month?

2. On average, how many health-related Web searches for *professionally undiagnosed medical conditions* do you perform per month?

3. Who are your health-related Web searches primarily for?

4. When you seek health-related information online you generally search for? (multiple responses permitted)

5. On a scale of 1 to 10, how would you rate your overall anxiety about potential medical conditions that are not present or currently undiagnosed (1 = don't worry about health issues, 10 = severe anxiety)

6. Do you think that you are a hypochondriac?

7. Have you ever been called a "hypochondriac" by friends, family, or a health professional (e.g., a physician)?

8. Have you ever been concerned about having a serious medical condition based on your own observation of symptoms *when no condition was present*?

9. How often do your Web searches for symptoms / basic medical conditions lead to your review of content on serious illnesses?

10. If your queries contain medical symptoms, how often do you consider the ranking of Web search results as indicating the likelihood of the illnesses, with more likely diseases appearing higher up on the result page(s)?

11. Have you ever used Web search as a medical expert system where you input symptoms and expect to review possible diseases ranked by likelihood?

12. Do you believe you have been in the situation where Web content "put you over the threshold" for scheduling an appointment with a health professional, when you would likely have not sought professional medical attention if you had not reviewed Web content?

13. Did the appointment reassure you that your worries were not justified?

Enriching understanding and promoting responsible behaviour to combat climate change: A case study involving the use of Kolb's experiential learning model

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Abstract. *Climate change is possibly one of the central challenge humankind has ever faced. Education is very important in dealing with such a serious global issue. Yet, if education is to deal effectively with such challenges it will have to be education of a particular kind, one that engages people actively in the learning process, which leads to the possibility for behavioural change towards appropriate action for sustainability. After a presentation of the basic characteristics of Kolb's experiential learning model this paper used Kolb's model to design an innovative assignment for undergraduate or graduate students in institutions of higher education. The central aims of this assignment are to increase our understanding of individual inaction with regard to climate change and help people change their daily habits that cause the production of greenhouse gases. However, beyond the issue of climate change, the proposal put forward in this paper may prove useful in other areas of education for sustainability.*

Keywords. Climate change, Experiential learning, Higher education.

1. Introduction

Climate change currently is and will continue to be a matter of great international concern. Global temperature has increased approximately by 0.7°C since the mid-1800s. The last decade is the warmest ever recorded. According to recent IPCC reports, most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations, which are mainly produced from the burning of fossil fuels and from deforestation [31]. If current trends in GHG emissions growth are not altered, global temperatures are expected to rise between 1.4 and 5.8º C (2.5 to 10.4º F) by 2100 [7].

Ackerman and Stanton [1] summarize the likely impacts of climate change by an incremental increase in average global temperature. It should be emphasized that all predictions of emissions scenarios and likely temperature changes are estimates, not exact figures. Some of these impacts include:

0.6°
More frequent extreme weather events, more floods and more droughts, more heat waves.
A slow pole-ward migration of plant and animal species, with less mobile and less adaptable species increasingly at risk of extinction.
2º
More tropical diseases over a wider geographical area.
Decreased crop yields in the developing world and, as a result, widespread hunger.
Many communities facing serious water stress and widespread droughts.
3º
Decreasing crop yields in the developed world and decreasing world food supplies.

Widespread species extinctions and desertification.
4º
Entire regions will have no agricultural production whatsoever and the melting of the West Antarctic ice sheet will gradually increase sea levels by 5 to 6 m.
>4º
There is a 50-50 chance that the ocean's circulation system will shut down, removing the crucial currents that warm and stabilize the climate of Northern Europe.

Using results from surveys in Europe and Germany, Kuckartz [14] points out that we still have a long way to go in order to have truly empowered persons with regard to climate change. Although 80 to 90% of those surveyed are sensitive about climate change, only 20 to 50% are knowledgeable about climate change and a much smaller percentage, 5 to 20%, actually takes action to combat the problem. These statistics show that, while the vast majority of people are concerned about climate change, they are less inclined to take personal actions or to support policies that can counter such change. They also show that, although there is widespread concern, this concern is of secondary importance in guaranteeing that people will adopt the required behaviours for change. Is individual behaviour important for combating climate change? Available evidence shows that it is. If individual behaviour contributes 30 to 40 percent to greenhouse gas emissions [15], [29], then changes in individual life styles, such as modifying transport use, energy use, patterns of settlement, the design of homes, consumption of food and other goods and / or accepting higher prices for some products and services, will not be negligible at all.

Education is very important in dealing with such a serious global issue such as climate change, and this is prioritised by UNESCO (United Nations Educational, Scientific and Cultural Organisation) in the United Nations Decade of Education for Sustainable Development (2005-2014), which seeks to integrate the principles, values, and practices of sustainable development into all aspects of education and learning, in order to address the social, economic, cultural and environmental problems we face in the 21st century [30].

Action competence in environmental education proposes linking knowledge of the environment and positive attitudes to promote behavioural change through appropriate action to support the environment [8], [2], [9]. Action competence has wider implications for education for sustainability, and requires active engagement of the learner in the learning process. Kolb defined experiential learning as a "holistic integrative perspective on learning that combines experience, perception, cognition and behaviour" [12]. Kolb's experiential learning model [12] is commonly regarded as one of the best ways for engaging students in active learning approaches. Kolb's experiential learning model is used and recommended for use in a variety of disciplines [20], [3], [6], [4], [26], [28], [10], [17], [18]. However, there are teachers who are not aware of [6] or do not use or ignore this method of work [4], [26]. The aim of this paper is to apply Kolb's model in designing an innovative assignment in dealing with climate change, one which could be applied to both undergraduate and graduate courses. The central aims of this assignment are to increase our understanding of individual inaction with regard to climate change and help people change their daily habits that cause the production of greenhouse gases.

2. Kolb's Experiential Learning Model

Building upon earlier work by John Dewey and Kurt Levin, American educational theorist David A. Kolb [12] created a theory which consists of four learning stages: concrete experience, reflective observation, abstract conceptualisation and active experimentation.

The first stage, *concrete experience*, is where the learner actively experiences an activity such as a laboratory session or field work. Learning in this stage is based more on open-mindedness and adaptability as a precursor to systematic engagement with the situation or problem. The second stage, *reflective observation*, aims to understand the experience. In this stage, students approach their concrete experiences from a variety of viewpoints and articulate why and how they occurred. The third stage, *abstract conceptualization* links observations and reflections into a theory or concept. In this stage, the aim is to understand the general concept of which the concrete experience was one example. The fourth stage, *active experimentation* tests the theories and leads into new experiences. In this stage, students use the theories they learned or developed in the abstract conceptualization stage in order to attempt predictions about the real world and then act on those predictions. Students' actions are a new concrete experience. The learning cycle begins anew.

The key to planning lessons that take students full cycle is to note that the second word in each of the four stages' names indicates what the learner experiences. The learner begins by having an experience that involves him or her in a situation (experience) and then reflects on the experience from several perspectives (observation). From those reflections, the learner draws concepts or conclusions and formulates them into theories or models (conceptualization) that lead them to experiment or act (experimentation).

Kolb found that learners typically did not use all four learning stages equally, but preferred to focus on one or two of them. He identified four learning preferences, each of which shows learners being most comfortable in a different pair of learning stages. Based on responses to a set of questions called the Learning Style Inventory, Kolb described the four learner preference groups as divergers, assimilators, convergers, and accommodators. Understanding the preferences is fundamental for understanding how students may respond to lessons designed specifically for each stage.

Divergers prefer learning through concrete experience and reflective observation. They may be very good at viewing a situation or problem from many perspectives and developing imaginative solutions. Assimilators prefer abstract conceptualization and reflective observation. These individuals can often pull together very different observations into an explanation or theoretical model. Convergers learn best through abstract conceptualization and active experimentation. Their strength lies in the practical application of ideas. They tend to organize their thinking to use hypothetical-deductive reasoning to focus on specific problems. The dominant learning preferences of accommodators are concrete experience and active experimentation. Accommodators tend to be risk takers who thrive on action and new experiences.

Teaching techniques that provide opportunities for concrete experiences include observations, experiments, simulations, fieldwork, storytelling, films, jokes, cartoons, newspaper articles, examples, taking a survey, role play or reading texts. Techniques that provide opportunities for reflective observation include journals, logs, discussion, brainstorming, thought questions and rhetorical questions. Listening to lectures, seeking out and critiquing models in texts or articles, generating hypotheses, concept maps, building models and construction analogies, papers and projects draw upon abstract conceptualization. Doing case studies, simulations, fieldwork, projects, homework, conducting an experiment in the laboratory or in the field require students to engage in active experimentation [12], [3], [6], [10].

In addition to the points raised above, it must always be kept in mind that learning increases by up to 50 percent if educators set clear and meaningful goals [13].

The assignment which follows is an adaptation of an assignment designed by Sprau [26] while the idea to use the adoption of an environmental behaviour as a concrete experience is inspired by a recent research effort involving teachers and students in voluntarily trying environmental behaviours [24]. The aim is to produce a learning activity that can be easily and widely applied in undergraduate or graduate courses and which can hopefully increase our understanding with regard to combating the problem of individual inaction against climate change and possibly promote environmentally responsible behaviours.

3. An application: An innovative assignment

Objectives

- To create interest in the issue of climate change
- To promote understanding of the problems of actions that contribute to climate change
- To encourage reflection, thought and individual action against climate change

The Assignment

What follows is a description of a semester project, which can be used in environmental education courses for undergraduate or graduate students. The experimentation with environmental behaviours and the writing of the assignment is intended to acquaint students with Kolb's experiential learning model, serve as an alternative to the traditional research / term paper and encourage students to adopt and think about responsible environmental behaviours in their personal lives.

1. Choosing an environmental behaviour

Every student is invited to experiment with environmental behaviour in their own lives, such as, for example, reducing their consumption of electricity, water, paper towels, and over-packaged products, walking more frequently etc. Students may be given a list of responsible environmental behaviours to choose from.

2. Experimenting with the chosen environmental behaviour

Students experiment with the environmental behaviour they chose for a month. Since the duration of a semester is about four months then one month seems like an appropriate time span for the experimenting with the particular behaviour, as this leaves adequate time for creating an outline, as well as writing and submitting the paper. The experimentation with the chosen environmental behaviour is a concrete experience. Following the completion of the one-month experimentation period, students should meet with their tutor so that they can receive guidance with regard to producing an outline of their paper. The tutor encourages students to identify difficulties they encountered while trying the behaviour, factors which helped them persevere in the undertaken change as well as feelings they experienced during their effort. This takes students into Kolb's second stage, reflective observation.

3. The paper outline

Following the meeting with their instructor the students create a detailed outline describing what they plan to do in the final paper they will submit. The paper outline moves students from reflective observation into the abstract conceptualization stage. The outline also helps students organize their thoughts about the structure and contents of their papers early in the thinking process.

4. Research

Initially, students investigate the implications of the selected actions on climate change through reduced greenhouse gas emissions, e.g. reduced burning of fossil fuels through less car use, reduced energy consumption in the home through switching off lights, avoiding use of standby settings etc. or reduced consumption of materials and associated energy use through recycling or reduction in purchasing patterns. The research requirement offers further opportunity for more sophisticated abstract conceptualization. Students are directed to relevant academic literature for use in their paper.

The sources that students should be directed to use in their papers should not be too many or too long (given the amount of time left until submission of papers), should give practical advice to the reader and should raise or inspire important new questions that would need to be answered for adoption of sustainable behaviours, but also for purposes of enriching our understanding of the issue on an academic basis. The work of Kollmus and Agyeman [11], Pruneau *et al.* [24], Moser [21], Lorenzoni, Nicholson-Cole and Whitmarsh [16], Moser [22], Spence and Pidgeon [25] and Swim *et al.* [27] meet the criteria set above.

5. The Writing Process

After completing the outline and following tutor support, students submit a rough draft. Requiring students to organize and develop their ideas in a rough draft encourages further, and more complex, thinking in the abstract conceptualisation stage. Rough drafts are submitted and returned to students at least two weeks before the final draft deadline. Although tutor comments on student drafts will vary from daft to draft, nevertheless, some key questions to be addressed by the tutor may be: Why did you choose to try the environmental behavioural you chose? How may the behaviour influence climate change by reduction of greenhouse gas emissions? Which barrier(s) were the most important? How are the barriers linked to environmental, social or economic issues that may affect you? To what extent did the barriers occur in sequence? What sequence? Which approaches were most effective in overcoming each barrier? On the basis of your experience can you identify new examples to add to the ones used in existing definitions of barriers? On the basis of your experience did you discover any new barriers to add to the lists provided by the academic literature made available to you? On the basis of your experience can you think of new factors aiding or inhibiting the adoption of the environmental behaviour you tried? Will you keep the environmental behaviour you adopted in the future?

The writing process also constitutes Kolb's last experiential learning stage, active experimentation. The issue of how to deal with climate change is context specific, which means that there will be variations from individual to individual and from society to society. And if this the case then the engagement of people in such a project is essential for making progress on addressing the issue of climate change, both with regard to increasing individual action and with regard to filling gaps in the existing literature.

4. Some observations

Of particular importance seems to be the effect of such activities on the view people have about themselves. Although it is not certain whether people will adopt responsible environmental behaviours for life after they have completed such a project [24], nevertheless, such an activity gives people opportunities to experience certain conditions that may have a beneficial effect on them as individuals contributing to globally implicated problems of climate change. Hariz [5] refers to 5 such conditions most of which are relevant to the activity developed in this paper:

> (1) Self – the individual's need for a positive feeling about him/her self as a person.
> (2) Personal meaning – the individual's ability to reach an understanding of him / herself and his / her learning.
> (3) Action – the ability of the individual to develop, apply, and measure the use of his own, and other people's ideas in the learning place; and to learn from the experience.
> (4) Collegiality – the individual's capacity to learn with and from colleagues in both a direct and indirect way.
> (5) Empowerment – the ability of the individual to "feel a sense of ownership, autonomy, self-control and self-direction over their decisions and actions, including over the processes and outcomes of their learning".

The activity discussed in this paper provides opportunities for people to identify and overcome barriers to combat an important environmental problem, while simultaneously turning a class assignment into a life experience. At the same time, everyone gets personally involved, everyone gets the opportunity to critically and constructively review their effort, confirm and expand facilitating and limiting factors and identify areas of personal improvement, e.g. by using better existing competencies or developing new ones.

At the same time it engages students with important academic literature and gives them a chance not only to understand but also to evaluate and enrich these sources. The list of barriers to engagement, as well as the list of facilitating and limiting factors to individual action against climate change is certainly not complete. For purposes of enriching the existing literature the discovery, for instance, of new barriers to engagement or of new examples of a barrier, is something which enriches the particular concepts for the specific phenomenon because it reflects the essence of a larger quantity of instances of the phenomenon [19]. Some have even suggested that such individual experiences may prove more revealing and innovative than the ones we already know [23] and, can, consequently, be invaluable in advancing our knowledge in the specific fields they belong to.

5. Conclusion

Climate change is possibly one of the central challenges humankind has ever faced. Education is very important in dealing with such a serious global issue. Yet, if education is to deal effectively with such challenges it will have to be education of a particular kind, one that engages people actively in the learning process, which leads to the possibility for behavioural change towards appropriate action for sustainability. After a presentation of the basic characteristics of Kolb's experiential learning model this paper used Kolb's model to design an innovative assignment for undergraduate or even graduate students in institutions of higher education. The central aims of this assignment were to increase our understanding of individual inaction with regard to climate change and help people change their daily habits that cause the production of greenhouse gases. However, beyond the issue of climate change, the proposal put forward in this paper may prove useful in other areas of education for sustainability.

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Investigation of the Effect of Inquiry-type vs. Expository Chemistry Labs on Learning and Attitude for Iranian High School Students of 10th.Grade

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Abstract. *The main goal of this research is to investigate the effect of inquiry-based vs. traditional laboratory work on learning and attitude of high school students. The samples of this research were 42 students who had studied in 10th grade and they were divided into two 21 potentially similar member groups.*

The obtained data showed that in the knowledge domain, there was no significant difference between inquiry and expository approaches $(P\langle 0.05)$ *; but inquiry style was very effective in increasing chemistry attitude* $(P\langle 000)$

Therefore, it seems that entering the inquiry-type experiments in high school books, not only can develop the attitude of students, but it can also improve the cognitive levels and critical thinking in them.

Keywords: Attitude, Expository style, Inquiry-type laboratory, Laboratory styles, Learning, traditional lab

1. Introduction

Chemistry is one of the branches of empirical sciences that a main part of its findings come through observing and doing experiments. Laboratory activities have long had a distinctive and central role in the science curriculum, and science educators have suggested that many benefits accrue from engaging students in science laboratory activities (Garnett et al. 1995, Hofstein, Lunetta 2002, Lunetta 1998, Tobin 1990) [1-4].

Hands-on activities are a set of hand and mind purposeful activities that performing them will improve the students' knowledge, attitude and scientific skills. Laboratory activities are not only able to stabilize learning and increase the retention of learnt concepts; they can also lead to attaining skills which will be applied in daily life [5].

Domin (1999) presented four styles to implement laboratory activities. In fact, these styles are the approaches of a laboratory-based curriculum. The best known of them include: expository, discovery, problem-based and inquiry styles [6]. At present, chemistry labs in our high schools are taught in a traditional expository style.

Teachers have recognized the limitations of traditional laboratory work. In traditional laboratory classes, students follow step-by-step instruction to complete an experiment. As students concentrate on the completion of individual steps, they often do not have a deep understanding of the experimental design. For many of them, laboratory work means manipulating equipment but not manipulating ideas [7].

Science educators believe that when properly developed, inquiry-centered laboratories have the potential to enhance students' meaningful learning and conceptual understanding of the nature of science [1, 3].

The benefits of inquiry-based laboratory work are well documented in the literature. It is an effective mode of learning to improve students' content knowledge (Lord and Orkwiszewski, 2006), scientific process skills (Deters, 2005; Hofstein, Shore & Kipnis, 2004), attitudes toward school science (Gibson & Chase, 2002; Gott & Jarman, 2000; Lord& Orkwiszewski, 2006) and communication skills (Deters, 2005) [8]

Tobin (1990) suggested that meaningful learning is possible in the laboratory if the students are given opportunities to manipulate equipment and materials so as to be able to construct their knowledge of phenomena and related scientific concepts. However, he claimed that, in general, research has failed to show evidence that such opportunities really exist [4].

Nevertheless, few chemistry teachers in our country use inquiry-based laboratory work as a teaching aid. Recently, Deters (2005) surveyed 571 high school chemistry teachers in the United States and found that 45.5% of the teachers did not provide students an opportunity to write experimental procedures [9]. In Australia, Hackling, Goodron and Rennie (2001) surveyed 2802 secondary science students. They found that 33% of the students had never planned their own experiments [10].

These findings indicate that even in developed countries such as the United States and Australia, inquiry-based laboratory work is still not popular in schools [8].

Several research studies have been conducted to investigate the reasons why most of chemistry teachers prefer expository lab in contrast with other lab styles (especially inquiry style). Some factors such as: lower price, more safety, waste less time to perform an experimental procedure, easy to control the class and the instruction process and so on were declared to explain the advantages of traditional laboratories.

On the other hand, "lack of time, management problems, material demands, large classes and assessment issues" were the most obstacles they accounted for not to implement inquiry-based laboratories [11].

In this project, we selected the experiments which were about the solutions and the ways to measure the solubility of some familiar species. To do the experiments, we used some kitchen compounds which are cheap, safe and available. We could manage our chemistry laboratory inquiry group by implementing the guided inquiry method.

The guided inquiry is a student-centered method and can be defined as a set of stages in which the learners construct their own knowledge with the aid of experimental data.

The main purpose of this paper is to investigate the effectiveness of inquiry-based laboratory in comparison with expository chemistry lab in learning and attitude of high school Iranian students.

The project was guided by the following two major questions:

1. Does inquiry-based laboratory indicate a meaningful increase in learning of Solution conception in students compared to expository (traditional) laboratory style?

2. Does inquiry-based laboratory indicate a meaningful increase in the attitude of students compared to expository (traditional) laboratory style?

2. Laboratory Instruction Styles

Laboratory instruction is a cornerstone of most science programs because it allows students to be actively involved in their learning [12].

A lab-based curriculum must implement the ways in which the students can experience both of learning and understanding the concepts.

Many researchers have tried to describe a laboratory characteristic and the learning qualifications in it. Hodson (1993) believes that: "Laboratory must be like a puzzle, not a place to review the previous known. The things that students have already understood must not be examined in the laboratories. Furthermore, a laboratory must not be a place to investigate accuracy or inaccuracy of the chemical laws and concepts. If doing an experiment must show something, that thing must be the scientific method. Let's lab be a place where scientific findings and earning experience have priority "[13].

Acquired experiences in a laboratory must include employing logical and creative reflections; meanwhile they must be free from tied manuals existing in traditional way of chemical education.

Domin (1999) by investigating the common ways in laboratory instruction, presented four different styles to perform hands on activities:

"Four distinct styles of laboratory instruction have been utilized throughout the history of chemistry education: expository (traditional), inquiry, discovery and problem-based. Although these instructional styles share many commonalities and oftentimes their labels are used interchangeably, each style is unique and can be distinguished from the others by a set of three descriptors: outcome, approach, and procedure" [6].

Table 1 shows the descriptions of the laboratory styles:

Table1. Description of the laboratory instruction styles

Style	Descriptor		
	Outcome	Approach	Procedure
Expository	Predetermined	Deductive	Given
Discovery	Predetermined	Inductive	Given
Problem-based	Predetermined	Deductive	Student generated
Inquiry	Undetermined	Inductive	Student generated

Although many educators value the laboratory's instructional potential, but laboratory has also been the focus of considerable criticism concerning the lack of student learning in laboratory [13].Therefore, there has been increased interest in alternative laboratory instruction styles, such as inquiry-based or problem-based laboratory experiments.

In current issue, we have selected expository and inquiry type experiments to investigate. So, we explain more about these two styles as follows:

2.1. Expository type experiments

The conventional style of laboratory instruction is the expository one, which is instructor-centered, has a 'cookbook' nature, and has been criticized for placing little emphasis on thinking [14].

In traditional laboratory classes, students follow step-by-step instruction to complete an experiment. The instructor supervises students' work in every step and guides them directly. The outcome is predetermined. In this type of experiments, as students concentrate on the completion of individual steps, they often do not have a deep understanding of the experimental design. For many of them, laboratory work means manipulating equipment but not manipulating ideas.

Meaningful and purposeful learning randomly occurs in this style of laboratory-based activities; and just the lower levels of cognitive skills will improve.

Considering the cognitive levels of Bloom's taxonomy of behavioral objectives, using the expository type laboratory activities can just cover the three initial levels which are knowledge, comprehension and application; and it's unable to develop the higher cognitive levels include analysis, synthesis and evaluation [5].

Experimental planning and management and the procedure is less important in this type of experiments.

However, expository type of laboratory instruction, as was said, is still the most common style of laboratory in high schools and even universities.

Domin suggests that the most popular, though most criticized form of laboratory instruction is the expository or "cookbook" style. It has evolved into its present form from the need to minimize resources such as time, space, equipment, and personnel [6].

2.2. Inquiry type experiments

Inquiry-based laboratories include a set of continued and related activities. These experiments are designed to resolve the issues of scientific phenomena existing in nature or are caused by everyday life and students try to solve them by inquiring [15].

In this style, teacher is a facilitator and does not introduce an explicit procedure to students. In inquiry-type laboratories which are in accordance with scientific methods, students pose hypothesis and try to design experiments and perform them by taking advantage of their own creativity and innovation.

Science educators believe that when properly developed, inquiry-centered laboratories have the potential to enhance students' meaningful learning and conceptual understanding of the nature of science.

In inquiry-based laboratories the students are involved in more open-ended type experiences such as asking relevant questions, hypothesizing, choosing a question for further investigation, planning an experiment, conducting the experiment and finally analysing the findings and arriving at conclusions. It is thought that this type allows the students to learn and experience science with understanding. Moreover, it provides them the opportunity to construct their knowledge by actually doing scientific work [16].

Since the output of this style leads to creativity and innovation, most developed countries stress on applying inquiry style of laboratory instruction in science education, especially chemistry.

3. Methodology
3.1. Research design

This investigation was done in Iran, Tehran with 42 students of 10th grade in 2009_2010 academic year which were randomly selected from one of Tehran's high schools. Students were equated by their first semester's total average and chemistry scores and divided into two 21 member groups. 21 students were determined as the ' inquiry group' and the other group was 21 students that they do the experiments by traditional expository style and were dominated as the 'control group'. The methodology was an equivalent posttest control group design.

We grouped the students to 3-person groups. Students were taken at two intervals to the laboratory. We gave them analogous contents. The selected experiments were about the solutions and solubility.

To assess the students' achievement and progress during the performance, the check lists (for each phase: expository and inquiry) were designed and the teacher marked her observations in them.

After the execution of desired experiments, we took post-test from each group and then we evaluated the dependent variables after exposure to the independent variable.

3.2. Instruments

The purpose of this project was to compare the two laboratory styles: inquiry and expository. In this research, there were dependent variables (learning progress) and (attitude); and independent variable was laboratory style instruction. So, learning test and chemistry attitude questionnaire was used to collect data.

The learning test consisted of different kinds of questions, such as multiple choice questions, restricted questions and fill in the blanks questions aiming to measure all attainments from the given topics. Ten chemistry teachers examined the instrument for content validity. The reliability of the instrument based on Cronbach's alpha was 0.78.

The chemistry attitude questionnaire was a set of 30 standard questions and was designed by Likert-type scale.

3.3. The Laboratory performances

The considered experiments were about:
1.The factors affect on the rate of dissolution 2.Saturated solutions and 3.Determining the solubility of some familiar chemical compounds such as sodium chloride and sugar. (Our chosen experiments were simply performable at a kitchen and that's because we wanted to show the relation between chemistry and daily life and also we tried to use materials which are as safe as possible).

I. At first interval, the students of Inquiry group (experimental group) were taken to the laboratory. They were divided to seven 3-member groups. Our lab process was as follows:

"Good question is the heart of good inquiry" and motivation has a central role in posing good questions.

To motivate the students, we showed them some experiments that were about how to prepare a saturated solution and the effect of temperature on it and they were indirectly guided to the topic. Then, some background information was presented. In this phase, the pre-prepared sheets were provided. In these sheets, the inquiry purposes were defined and the students must hypothesize, plan, design experiment(s), implement experiment(s), collect data or evidences and finally arrive at conclusions. We also asked them to share their group's findings with the members of another groups and discuss about them and develop their inquiry. We can summarize the inquiry sequences by figure 1.

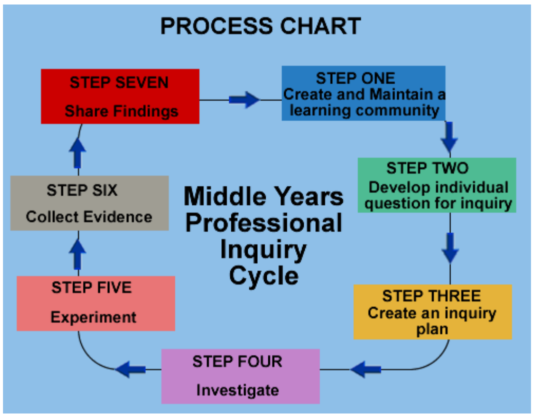

Fig.1. Inquiry cycle

The students must write their laboratory reports include the following parts:
1. Topic 2. Purpose 3. Materials and apparatuses 4. Hypothesizes 5. Procedure (in detail) 6. Data table 7. Results 8. Conclusion 9. The results obtained from sharing the findings and new findings.

The students' achievement and progress during the performance was assessed by the check list that was designed for inquiry phase and the teacher marked her observations in it.

II. Then the students of Expository group (control group) were taken to the laboratory. They were seven 3-person groups, too.

The experimental procedure was given to the control group. The instructions for the experiments were explicit and detailed. The students knew about what materials to use, how to conduct the experiments, how to collect the data and how to analyse the data. This phase which was largely closed, the students were asked to conduct the experiment based on specific instructions given in the laboratory manual.

Their laboratory reports must include the following parts:
1. Title 2. Purpose 3. Materials and apparatuses 4. Procedure (in detail) 5. Data and results 6. Conclusion

In this phase, expository lab check list was designed and we used it to assess the students' achievement and progress during the performance.

The exams as post-tests of learning and attitude were taken from the students of both groups (Inquiry and Expository) after the laboratory activities were finished.

4. The analysis and discussion

The analysis of the results was based on a comparison between the inquiry and the expository groups regarding knowledge and attitude post-tests scores. Both of two groups were equated on the averages and chemistry scores. Descriptive and inferential statistics were applied to analyse the quantitative data. Both data groups were analysed quantitatively by the SPSS (version 17) software.

Table 2 shows the descriptive data of two groups in learning exam.

Table2. Paired samples statistics

Lab style	Mean*	N	Std. Deviation	Std. Error Mean
Exp.	7.2381	21	2.38023	.51941
Inq.	7.3095	21	1.54496	.33714

***Scale Score = 10**

Table 3 shows the results of t-Test for two groups.

Table3. t-Test analysis results of leaning post-tests

Paired Differences					t	df	Sig. 2-tailed
Mean Diff.	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
-.07143	1.04026	.22700	-.54495	.40209	-.315	20	.756

When we compare the results of two groups, we found that although the students of inquiry group had a better performance in the learning exam, but the results from t-Test showed that there is no significant difference ($p=0.756$) between the mean scores of two groups at the significance level of 0.05. In another word, inquiry-based and expository laboratory has the same effect on knowledge domain.

Table 4 and Table 5 indicate the data analysis of attitude posttests of two groups:

Table4. Paired sample statistics for Attitude post-tests

Lab style	Mean*	N	Std. Deviation	Std. Error Mean
Inq.	3.6219	21	.48798	.10649
Exp.	3.0700	21	.59587	.13003

Scale Score=5*

Table 5. t-test analysis results of Attitude posttests

Paired Differences					t	df	Sig. 2-tailed
Mean diff.	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper			
.55190	.20238	.0441	.45978	.64403	12.49	20	.000

As can be seen, the students in Inquiry group had a better sense during lab work and got higher degrees in attitude test than Expository (traditional) group. The grades of students were reported by using a Likert – type scale. According to t-Test results, the difference between two groups was significant (p = 000) and it indicates that Inquiry style laboratory can develop students' positive attitudes toward chemistry.

5. Conclusion

An inquiry-oriented, "hands on" approach to science instruction stimulates the natural curiosity and theory-building inclination of students while providing a solid conceptual framework for supporting the development of accurate concepts. Such experiences provide the raw material from which mature scientific theories are constructed. To increase a "minds-on" factor to a "hands-on" approach, teachers should decrease the "cookbook" nature of whatever labs they conduct and sequence the hand-s on activities before any readings or lectures so that students can explore topics before learning the terms [17].

The purpose of this research was to investigate the effectiveness of inquiry style of chemistry laboratory on high school students. From the findings of this study, we concluded that laboratory activities by implementing inquiry style had positive effects on students. At first the students of inquiry group were anxious; they faced with an unknown situation that was very different from previous sections of chemistry labs. They were confused because they should perform the experiments without any recipe. But, very soon they initiated to consult with their peers, pose hypothesis and plan their practical works. They provided a list of their essential materials and apparatuses and work began. Even, some of hypothesizes were new for instructor and she encouraged the students to test their ideas by performing experiments. The students continued their works with enthusiasm and time was not important for them. We were satisfied with this method, too.

After this project, the students who had participated in the inquiry-type laboratories claimed that the lab experiments, in which they are engaged, were very interesting and challenging; and gave them the opportunities to develop their scientific skills, share ideas and cooperate with their peers in the group and construct their knowledge individually. In addition, they felt that each member in the group had the opportunity to contribute to the discussion in order to achieve a common goal.

It should be noted that, in general, students who were involved in traditional expository lab described this type of laboratory boring and without excitement. Some of them had no desire to continue working, because they claimed that: "We should follow a procedure in recipe-like fashion, all doing the same things. We know the activities are contrived, and we know that we are expected to come up with a particular right answer. There are no surprises for us or for you."

To sum up, based on these quotes, it is seen that the students who were involved in inquiry style, are aware of the meaningful contribution of the inquiry method to their learning of chemistry.

In according to research results in attitude test, there was significant difference between expository and inquiry styles. Inquiry method had benefits for students such as: learning by doing, self-confidence, satisfaction, interest and experience, motivation, being active, curiosity, learning with pleasure, meaningful learning and so on. "Introducing inquiry-type experiments into the chemistry laboratory is a 'breath of fresh air' in the way chemistry is taught and learned, in the way students are assessed, and in our attempt to improve teachers' professional development" [18].

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ICT integration in Education: A Right to Democracy by way of Emancipator Education

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Abstract. *This paper presents a Transformative Polymorphic Model for training, researching and teaching, a learning community of educators, which involves the integration of Information and Communication Technologies (ICTs) into the educational practice. It promotes transformative learning by way of emancipator education that fosters the human rights and equity that manifest in the everyday digital lives of people, from every level of online society. It consists in a learning environment that facilitates development of higher order cognitive abilities and it promotes a critical community of learners, where both reflection and discourse facilitate the construction of personally meaningful and socially valid knowledge and guides decision and action.*

Keywords. Polymorphic Model, ICT, Emancipator Education, Polymorphic Education.

1. Introduction

The revival of democracy calls for the revival of the concept of citizenship; the revival of the concept of citizenship requires the revival of solidarity and responsibility, in other words the development of anthropo-ethics.
(Edgar Morin, UNESCO 1999)

The *Online Distance education* has the potential to adopt cutting-edge technologies in order to bring together learners, e-facilitators/tutors and e-content. Dynamic itself, seems to diminish when it creates a chasm between an arcane, highly specialized techno-science and citizens that leads to a new social antithesis between a "new class" and the citizens. Consequently, the potential of incorporating *Information and Communication Technologies* (*ICTs)* in the educational process, through *Online Distance Education*, should not be restricted to bringing together learners, tutors and e-content, but must contribute to a new ethic, whereby with the aid of people and communities, they are reformed and perhaps new human values will emerge as a collective conscience and solidarity for all mankind.

The present paper aims to present a Transformative *Polymorphic Model* for training, research and teaching, the major objective being the integration of ICTs in the educational practice with an "*emancipatory cognitive interest"* and the promotion of a qualitative education for liberation. Initially, broad definitions and discussions, found in reviewing the bibliography, are formulated with respect to integrating ICT in the educational process, in *Distance Education.* In continuation, epistemological, theoretical and pedagogical issues are presented, concerning the design and development of the model, and an analysis of its various forms and elements follows. Subsequently, the author pose questions and make recommendations in relation to the integration of ICT in the educational practice, within the framework of an *Online Education for Liberation.*

2. Issues, Controversies, Problems

2.1. The integration of ICTs in education

The potential of ICTs, whereas they facilitate access to information and support the communication and cooperation among citizens and societies, it seems that they cannot contribute, to a satisfactory degree, in managing complex social issues. The aforementioned training activities have not centered on the political, ethical, social and critical dimension of integrating ICTs. They have overlooked the need to develop the trainees' skills to constructively build on the mass of information that they can easily access by using technology, as well as the possibility to apply the functions of critical-reflective and creative thinking to manage compounded problems [1], [2], [3], [4]. The majority of educators and students follow curricula that have been designed by "experts", who do possess the know-how to use software, programs, and systems, but do not have the corresponding pedagogical support for this knowledge, on the basis of a "new" pedagogical outlook and especially an outlook with a critical-constructivist theoretical orientation.

2.2. The dimension of Distance Education

In their majority, *Online Learning Communities* apply a mechanistic view that focuses exclusively on educational material and on technologically advanced methods for transmitting information, without acknowledging the pedagogical dimension, and the positions and methods of a constructivist teaching and learning process [5], [6], [7], [8], [9], [10], [11]. According to Dimitracopoulou (2002) , the most critical factor in ensuring the quality of the technological learning environments, is the theoretical support and the necessary analyses that precede their design and determine their characteristics, as well as those of the educational model that applies them.

3. Solution and Recomendations

The above considerations guided us towards the design of a ***Transformative Polymorphic Model*** for training, researching and teaching a learning community of educators, which involves the integration of *Information and Communication Technologies (*ICTs) into the educational practice.

In the following section, we will present the epistemological, theoretical and pedagogical development framework of the model, which supports a democratic form of teaching and learning in Distance Education, a *Polymorphic Education* [12].

3.1. Epistemological – Theoretical-Pedagogical Framework

The very fibre of Distance Education is defined by the cognitive and value content of teaching, by the teaching and learning process, by the teaching framework in which it occurs, and by the means it employs. Once these facts are covered and Distance Education involves not only the means, but also the principles for learning and teaching, then it is differentiated and may be termed as ***"Polymorphic Education"*** Under these conditions it takes on a particular value and it implies qualitative education that functions according to learning and teaching principles, in a distance environment (ibid). And furthermore, if interpretive and reflective-critical epistemological approaches, constructivist and reflective theories, and collaborative learning methods are adopted, these options will assign Distance Education its pedagogical dimension, i.e. its "*polymorphism".*

The matter of incorporating ICT in the educational process, depends a great deal on the theoretical and methodological approaches, the educational framework, the learning profile of the trainers and the trainees, and it is determined by many different factors that relate more to the "*cognitive interests*" [13] of those participating in the process and to the wider, social, political environment, and less to the possibilities ICT offers [14]. The educational and research-teaching action of the *Transformative-Polymorphic Model* is infused by an ***emancipatory cognitive interest.*** Epistemologically, it belongs to the *Critical-Dialectic Paradigm,* and is in contrast to the *technical cognitive interest*, which basically targets "control" and "management". Nevertheless, it extends the notion of "understanding" a situation, to forming a "critical consciousness" and to "action", aiming at social change (ibid). The educational subjects are above all social and the computer is transformed from a *technical* to a *cognitive tool*, and from this, to an *emancipatory tool* [15*].* They use ICT tools with *emancipatory* methods, in *authentic* contexts of problem solving activities (ibid), in order to examine manners and actions, through which they can transform social reality [16], [17], [18], [19]. ***Transformative pedagogy***, guided by an *emancipatory interest* in knowledge, aims at preparing the students to function as vehicles and not as instruments of change and at transforming the educators from facilitators of the learning process to "critical friends" and advisors [14]. The critical-reflective educator redefines his professional self and from an education technocrat, becomes a dialectic partner, a reformer and an intellectual.

4. Forms & Elements of a Transformative Polymorphic Model

The transformative model promotes a *critical community of learners,* where both 'reflection' and 'discourse' facilitate the construction of personally meaningful and socially valid knowledge and guides decision and action. The forms of the model *(figure 1)* are presented, and their basic elements, for which we argue that they define a qualitative, democratic form of learning in Online Education and grant it its *polymorphic* dimension.

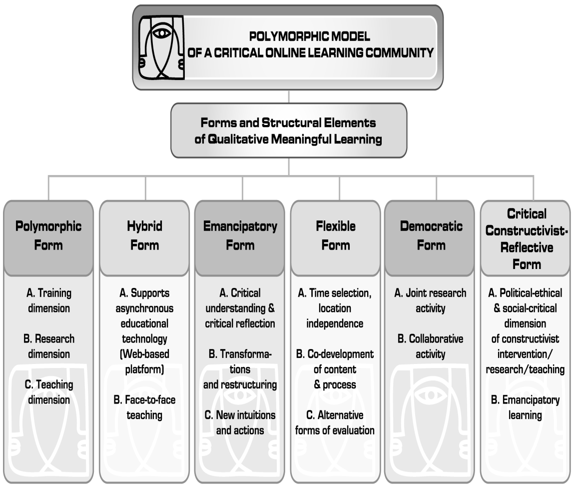

Figure 1: " Polymorphic Model of a Critical Online Learning Community"
(Fragaki, 2008: 184)

4.1.Polymorphic form

A. Training dimension: This concerns a form of in-school training in the use and pedagogical exploitation of ICT, under the social standpoint of teaching and learning. It is carried out in real conditions on school premises, in the wider context of an online learning community, operating from a distance. The training activity is based on the principles of a "*critical-constructivist"* [20], [21], [22], [23], [24], [25], and "*critical-reflective approach"* [26], [27], [28], not only in its design, but also in its training strategy. The teacher trainees acquire knowledge in "*Emancipatory Pedagogy"*; they receive training in contemporary epistemological, theoretical and methodological views and apply this knowledge in practice, through the use of ICT.

B. Research dimension: The members of the online community, teacher trainers and trainees, as "reflective professionals" and "co-researchers in action", conduct an "*emancipatory research action*", exploring (a) the processes of their personal and teaching change, regarding subjects related to teaching and learning and to the pedagogical use of ICT, (b) the possibility of the pedagogical exploitation of ICT in an educational process with an "*emancipatory cognitive interest"*, as well as (c) the possibility of qualitative learning via a *Polymorphic Model* applied on an Online Learning Community (OLC).

C. Teaching dimension: The teacher teams can now apply the "knowledge" they have acquired from their training and the "awareness" they have gained from exploring their own "personal theory" and their work. Thereafter, they are encouraged to design and author *Educational Learning Scenarios* involving the pedagogical application of ICT, focusing not only on knowledge acquisition, nor on knowledge discovery, but on the socio-political and ethical dimension of their pedagogical approach [29]. The issues/problems they will deal with are "authentic", refer to social problems and address the interests and problems of their students. Teachers develop projects and design activities for their students, using digital and other electronic tools and educational software, for each module they are taught. Students confer and conclude on these activities together with their teachers, are involved in the management of complex projects, thus developing their critical thinking and their collaborative skills. The teachers are now ready to activate the educational framework in which they work, as well as in their greater social environment. It is recommended that they introduce educational innovations to their schools, publicize their work, suggest solutions and take measures in relation to the issue or problem they undertake to tackle. In all these actions, they act together with their students, as reflective and active teachers-students-citizens. They creatively integrate into the online community to which they belong, and they succeed in "opening" their schools towards society, with their active integration and participation in common social events.

4.2. Hybrid form

A. Supporting Asynchronous Education Technology: The Model of the present training and research oriented teaching activity belongs to the *Advanced Learning Technologies (ALT)* in Distance Education, since it involves the development of a learning environment on the Internet, it aims to advance interactivity between the trainees-trainers-educational material and educational tools [30], [31], [32], [33]. It is recommended that it be structured as a Virtual Learning Environment 'VLE' that will be incorporated into a wider Management Learning Environment 'MLA' (Higher Education Academy, 2006), [34]. The *Polymorphic Model* stands as a form of asynchronous education, since the teachers themselves can choose the location, time and pace of their own learning. Besides studying the educational material, they are afforded the possibility to communicate, at a predetermined time frame, with their trainer, in a variety of ways *(semi-automatic form of asynchronous education).*

B. Face to Face Teaching: Concurrently with "asynchronous" education, "face to face" personal meetings may be held, whenever and wherever possible, between the trainer and each team separately, before each learning cycle of the Model begins, as well as with all the teams together, during the application of the Model. The participating teachers in the training and research oriented teaching action are actively involved, voluntarily and consciously, in an action where each individual is a separate entity, is released from the shield of anonymity and from the veiled identity/entity that may result in the context of online communication. Each person separately, and together all the individuals of the Community are revealed through the critical-reflective process.

4.3.Emancipatory form

The teachers of the Online Learning Community (OLC), during their training, also explore their work in the framework of an *Emancipatory Action Research"*. They examine the processes of their personal and teaching change, aiming for a long-term educational and social change, in issues concerning teaching and learning, and the pedagogical exploitation of ICT in an educational process. The emancipated reflective researchers accept the principles and conditions of practical interest, with a crucial difference. They are not limited to understanding and personal professional advance, but they reach beyond this, to the analysis of social, cultural and political conditions that shape their educational practices. The goal they set is to understand and transform the present, in order to create a different future. As Grundy reports [35], when "understanding", that is derived from critical reflection on critical social theorems and on the direct social context, is linked to social actions directed towards changing the illiberal and unequal relationships that exist in the social group, then what is applied, is an emancipatory form of action research. *Emancipatory Research* will always be characterised by a critical focus and by its readiness to include the social context within its research field. In this way, emancipatory action research has, in effect, a political dimension. It consists in a dialectic process where the results of reflection are continuously transformed into practice, and practice continuously gives rise to reflection and development.

The findings of *"Emancipatory Action Research"* derive from the examination of case studies of the educators participating in the research and from the evaluative study of the training-research process, through a multi-method approach, based on *Grounded theory.* This constitutes a research method, and at the same time, a method for data analysis, in which a hypothesis is not tested, but discovered, developed and temporarily verified, by the systematic collection and analysis of data that concern the particular phenomenon.

A. Critical understanding and "critical reflection": In a research context, educators declare their *personal theories/praxial knowledge (cognitive cognitions)*, they disclose their educational practices with the aim to assume their measure of responsibility and to change their teaching, and they get to know each other and to interact with the other members of the online Community. The goal is, through critical-reflective processes, to recognize and to understand the social, ethical and political dimension of their teaching alternatives and of the wider framework that affects these. In this theoretical research framework, the educators participating in the research reflect *"during the action" (reflection-in-action)*, i.e. while the action is evolving, as well as "*on the action" (reflection-on-action)*, before the action begins or after it has ended. Trainers, in the framework of the Reflective-Critical Model, function as "critical friends" and their contribution focuses more on enabling the "thought-action" schema.

B. **Transformations & restructuring**: Through critical reflective analysis, the members of the *Online Critical Learning Community* explore contradictions and antitheses in their thoughts and actions that lead to transformations and to restructuring, or "new" intuitions with regard to thoughts for action relating to teaching and learning and to the pedagogical use of ICT.

C. New intuitions & actions: Coupling new intuitions with action, direct educators towards teaching activities that employ electronic tools and educational software with their students, taking into account ethically-politically, socially and culturally "authentic" issues.

4.4. Flexible form

A. Time selection – location independence: The members of the *Polymorphic Community* are not obliged to join in chat-room discussions, at specific times, as is done in a "conventional" educational format. Meetings via a software platform are not predetermined, but it is recommended that they are collectively agreed upon, according to the educational needs of the community members, in the framework of a flexible and anthropocentric teaching approach.

B. Co-development of content & process: Educators have the opportunity to co-develop, together with their trainees, the content of the educational material and the training and research – teaching process. Thus, while initial educational material should exist, corresponding to the Curriculum, at the same time, the opportunity is provided for its transformation and restructuring, in accordance to the educational needs and the specific interests of each educator. Consequently, each team negotiates the teaching subject, selects units of particular interest, electronic tools, enriches the teaching objectives, modifies its tasks and participates in the evaluation of the Model's actions. At the same time, educators reassess their attitude towards "commitment" to the Curriculum and towards the strictly structured and predefined course of teaching and methodology, by restructuring its present, stifling structure. The flexible format of the *Online Polymorphic Model* allows the educators access to the learning content, as well as to the teaching and learning process.

C. Alternative forms of evaluation: "*Alternative evaluation techniques*" are used, which do not specify predefined technical criteria that involve "measurability" and "effectiveness". The evaluation of the effectiveness of the training and research oriented teaching action, by means of experiential-analytical trials has no bearing on the application of a critical-reflective model with an "emancipatory" orientation, but it is based on what is termed "*reasoning feedback"* of the community teams [14]. In this form of qualitative evaluation, evaluation criteria are determined together with the trainees. Educators review their own work, the content, the teaching and learning process, the results and the means used, in accordance to the aims that they have set, transformed and restructured, through the critical-reflective process of examining their personal theory and their work. They take into consideration their students' criticism during the teaching practice, as well as the criticism of the trainers/"friends". Evaluation concerns all the structural elements of the training and research oriented teaching activity and at all its stages (beginning, intermediate, and end), aiming to shape an evolutionary course and to instigate transformations, restructuring and ever newer actions. The role of the trainers is not that of the "expert" who "measures' results. They are collaborators, advisors, tutors, coordinators, who enable educators to create a self-critical and thinking team of educator researchers, a *Critical Online Learning Community* with a *polymorphic* dimension.

4.5. Democratic form

A. **Joint-research activity:** The members of the community examine their own work in cooperation with their trainers/co-researchers. In this manner, the content of the *Polymorphic Model* is not limited solely to a technical dimension, whereby the Community members become familiar with ICT, nor to a technical research action that is concerned with and controls expected results of predetermined criteria for effectiveness and control.

B. **Collaborative activity:** Through "*Computer-Supported Collaborative Learning*" (CSCL), each team works at its own class level (*intra-team activity*), at the overall level of all the classes (*inter-team activity*) and at the broader level, with different classes from different schools (*extended inter-team activity*), and comes into contact with the objects and the situations. Next, the team assumes social roles and acts as a small "society of active citizens". By means of this collaborative activity, democracy permits the rich relationship between citizens and society, where the members of the Community help each other, inter-develop, inter-adjust, and inter-control, with the aim to democratize knowledge, to bridge the gap between the hermetic, super-specialized techno-science and the citizens, and to eliminate the dualism existing between the "knowledgeable", with their out of context splintered knowledge, and the "ignorant", i.e. all the citizens.

4.6. Critical Constructivist-Reflective form

A. Political-ethical & social-critical dimension: The members of the online community reflect upon the socio-political and ethical dimension of their teaching choices. With a critical consciousness, they transform their previous theory and practice. They are guided towards undertaking autonomous -individual and collective action. They develop values and actions that relate to "authentic" teaching activities, as one critical Learning Community.

B. Emancipatory Learning: Throughout the duration of their project, the educators evaluate the result of the training and research oriented teaching action, and redefine themselves. Linking new "intuitions" to "action" includes the attempt to incorporate the members of the greater social environment into the narrower educational environment. Having social interaction as their faithful ally for interfacing with the members of the community and their general environment, they are involved in the practice of problem management, thus developing their critical thinking and their collaboration skills. With respect to the political-ethical dimension of teaching, the acquisition of meaning is not restricted only to the active participation of the students, but it extends to the development of critical consciousness and social sensibility, through exploring the "why" that lies behind the "what" and the "how" of the world's socio-political and ethical issues/problems, hence attributing to the teaching process its social and political dimension.

5. Difficulty in the Application of Innovative Models

The major problem in the application of innovations that depend upon the new technologies, is the negative balance of time and cost, to the results (Ward & Newlands, 1998), the personnel's heavy work load (Wolcot, 1997) and the personnel's wages, which do not correspond to the risk, time and effort demanded. The combination of the training, research and teaching dimension in an online Learning Community render the application of such an innovation a difficult endeavour. Such a process demands the voluntary, as well as the total, conscious and full involvement of the educators. The participants must possess political awareness, be open and democratic citizens, have a positive attitude towards encountering, negotiating and adopting innovative ideas, and must be able to support the principles and positions of the critical-constructivist and critical-reflective approach. Trainers must be "open" and "flexible", accepting of suggestions/transformations to the Curriculum by the trainees, throughout the duration of the application of the model, according to the personal and educational needs, that arise at each point in time, and according to the specific activation and learning pace of each team. On the part of the trainees, they need to communicate regularly with their trainer and with their teams, to follow continuous reflective processes "in action" and "on action", and to systematically observe the reflective tools and to daily incorporate theory into practice.

6. Conclusions – recommendations

The *Transformative Polymorphic Model* was applied in the framework of the "E.P.I.C.T-Esperides" European project, implemented by the "Educational Technology" Laboratory of the Faculty of Primary Education of the National and Kapodistrian University of Athens, in cooperation with international bodies, in the framework of the "*e-Content European Programme*". Primary education educator teams from different areas in Greece took part in the project, who together with their trainer and researcher worked with a high degree of autonomy as, co-researchers and co-developers of the model.

The research results, that derived from the application of the *Transformative Polymorphic Model* show that the reflective-critical educators are now more concerned with the "why" and not only with the "what" of the teaching and learning process, thus abandoning neo-behaviourisms and pseudo-constructivist views and practices in the use of ICT. They have surpassed the methodological speculations of the technocrat educators, without overlooking them, they warily question, they cautiously organize their actions and question the ethical and political impact of teaching, specifically (*micro-level teaching)* and generally (*macro-level teaching*).

Taking into account the examination of the results of the present research, we support that to apply a model with an "emancipatory" orientation is no longer an utopia, but it can be realized within the context of qualitative and meaningful learning. In this way, knowledge is contextual, education acquires a political meaning as an act of socialization and ethos and an *Online Education for Liberation* is promoted.

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eXe (e-learning HTML editor), a Powerful Cognitive Tool for Teaching and Learning

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Abstract. *The eXe project is developing a freely available Open Source authoring application. It is a cognitive tool to assist teachers in the design and development of web based training modules, without the need to be proficient in HTML or XML markup language. The application has the capacity to export content in several formats and so gives the opportunity to be reused and extended depending on the emerging needs of the trainees. The target of eXe software is to provide a user-friendly tool, allowing through developing activities the publication of professional websites for education.*

Keywords. Authoring tools, eXe, Learning object, Teaching and learning

1. Introduction

The Educational Software (ES) in current forms of teaching and learning is associated with Multimedia, Hypermedia, Internet, and is providing management capabilities for multiple channels of communication with the user. These tools provide the advantages of easily accessible environments to users that have not acquired skills to use advanced software tools and so be able to create educational content with acceptable quality and functionality, focusing their interest at the educational part of the project. In this study is presented a user-friendly application the eXe project.

2. Cognitive Tools

When we talk about Computer Supported Learning we primarily mean the enhancements we should offer to students, making them capable to acquire knowledge, develop skills and be able to cope with the ever changing and constantly increasing demands of the modern world [1]. The applications that extend and amplify the cognitive skills of students, hence cognitive tools, are used either in a context of particular courses or crossing between different subject matters of the curriculum. According to Jonassen & Carr [2] "the cognitive tools are the computer-based learning environments that are designed to facilitate critical thinking and learning", while Derry [3] suggests that "cognitive tools are the tools that support, guide, and extent the thinking processes of students". Other researchers [4] suggest that cognitive tools engage and facilitate the cognitive process, and Pea [5] refers to them as intellectual partners that reorganize the way students think.

3. Categories of ICT applications

Applications of ICT in teaching and learning are associated with the prevailing psychological theories of each period, and the corresponding developments in technology [6]. Based on their origin, ICT technologies are divided in: a) Specially designed software for education, in brief 'Educational Software' and b) general purpose software, such as text editors, image editing software, etc.

Especially ES in simple forms of multimedia has a little difference from one electronic book. It presents a book in digital form enriched with sound, pictures and video. However current applications of multimedia are systems that enable the user to interact with them, providing the possibility to intervene with the application while still in progress, which are based on the available options.

An important subcategory of this category of tools is the authorware or courseware tools, which enable the user to create content under of multimedia or hypertext environments. Those tools are based on different work models; depending on their supporting base they are divided into a) page oriented, b) icon oriented, c) time line oriented, d) object oriented and e) free writing tools, while they are still flexible with the way the material is distributed over the internet. The early, specialized authoring tools that required a strong knowledge base and use of programming languages gave their way to less demanding applications, as the evolution of the technology provided new possibilities for tool development by exploiting the internet and the hypertext editors.

Within this framework we refer to specially designed software to support design and development of learning courses and generally of learning material with ready to use structures and easy adaptation with different content, depending on displayed needs. One of the advantages of these tools is that they provide easily accessible applications to users that have acquired poor skills to use advanced software tools. Consequently they will be able to create educational content with acceptable quality and functionality [7], focusing their interest at the educational part of the project.

Furthermore, there have also been developed applications that provide various publishing options for the output material, such as uploading on a website, creating an independent executable application and the creation of a standard package for describing pieces of information and their metadata, such as the *Sharable Content Object Reference Model* (SCORM) or the *Instructional Management Standards* (IMS) [11].

In this way the generated material can be used in the class or published on the internet, or even be put to any Learning Management System (LMS) that supports this standard. This category includes Lectora by Trivantis, Captivate by Adobe, Toolbook by SumTotal, the free CourseLab. The eXe (**e**Learning **X**HTML **e**ditor) [13] software is included in the category of free authoring, publishing, learning content's material and assessment tools.

4. Presentation of eXe software

eXe is a freely available open source application. It is an authoring and publishing tool for digital content on the internet. One of the major design features of the application is the ability to work off-line, thus no internet connectivity is required to create learning content for the web without having to be connected at that time [13].

From 2008 onwards is part of Open Educational Resources (OER), a term adopted by UNESCO's "Forum on the Impact of Open Courseware for Higher Education in Developing Countries" in 2002. Also it was named a finalist in the New Zealand round of the IMS Global Learning Impact Award 2008. Is currently supported by CORE-Education, a not for profit educational research and development organization. Initially, it grew out of the Tertiary Education Commission's eCollaboration Fund and was led by New Zealand's University of Auckland and the Tairawhiti Polytechnic. The application is supported as well by an international user community [13], translated in more than twenty languages, and is accompanied with strong documentation and help.

eXe is available for Windows, Mac and Linux. There is also a handy version of eXe for Windows called **ready2run** which runs entirely from a USB flash disk and does not require to be installed. This could prove very useful if you are away from your normal computer or if you wish to evaluate eXe without installing anything. Home page has full instructions for downloading and installing on all operating systems. It is released under the GPL license which extends certain freedoms to the end user.

Other closed source applications such as MsOffice and PDF have function compatibility with eXe. In addition, many other open source programs such as OpenOffice, Hot Potatoes for creating material of its individual components, Geogebra for mathematics, Audacity for sound recording and editing, CamStudio for video editing etc are compatible too.

Many content management and learning management systems do not provide an intuitive

WYSIWYG environment where authors can see what their content will look like in a browser when published, especially when working offline. eXe's WYSIWYG functionality enables users to see what the content will look like when published online.

Exporting the generated material, in order to cover different educational weight, is possible in various forms such as text files, simple self-contained web pages Menu driven or single page, iPod notes, SCORM 1.2, IMS Common Cartridge or IMS content packages.

5. Learning Objects

The design of Learning Material (LM) is functioned by one or more training tools to operate effectively in terms of content and the anticipated results for the learner. Regarding the created pages in the environment provided by eXe, it is suggested that educational material has the ability to be designed as Learning Objects (LO), defined as “any digital resource that can be reused to support learning” [8]. The application includes "iDevices" for each small chunk of content. Just one click on an iDevice such as **free text** it will immediately create it in the editor window, as well as just one click on the red cross below it is enough to delete it again, if this iDevice was created by accident. Each page may contain one or more components-iDevices that best fit the learning goal/s. To this end it is proposed to take care and fit one page to screen, because scrolling interrupts the evolution of process. eXe is a plain tool to create learning objects that incorporate a range of elements suitable for teaching and learning activities; simple or more complicated tasks depend on how many clicks needed to complete one task. It is worth noting and useful creating a folder to accept all images and/or sound files you wish to use for creating an LO, as just a storage folder for the working files, not the folder that this learning object will be deployed in.

A completed eXe LO has the ability to be exported in a variety of formats such as webpage or website to suit the learner’s needs and utilize of Information Technology. If LO contains some MetaData a fill in on the Properties tab is necessary before exporting the object into a more usable form. Metadata is important in a Virtual Learning Environment (VLE) system which may use the data to allow users to discover your object. Instead, you can export a complete working website in a ZIP package which can be used outside of a VLE in any web browser to allow your object to be shared, perhaps by those using a stand-alone computer with no internet access. To use the zipped website, one must simply unzip the file to its own folder and launch the index.html file.

6. Standardization of Learning Content

When LO creation follows a set of standards the generated material is considered as standardized. Features such as the SCORM or IMS standards are supported by eXe.

Information included in SCORM standard is based on purpose of creation and all those conditions that may be satisfied, so it might give learning results. At the same time, this kind of information provides a conceptual description of data in a manner comprehensible by machines; it is stored in databases, is searchable and may be retrieved with keywords.

The Instructional Management Standards (IMS) describe the learning goals and the activities for achieving them. The assignment of those activities to the learners and the development process flow, regardless of the platform, since the integrated standards provide instructions for encoding in digital form, transfer and reuse.

In recent years the Dublin Core (DC) [12], an internationally widespread standard developed since 1995, is supported by eXe. The DC aims to develop the minimum set of descriptors of digital objects, to facilitate search engines with the best possible organization of their lists, allowing users with most effectively procedure of search services on the internet or elsewhere as well, with a similar way to a library record. Today DC is the simplest and most widespread general metadata standard. It consists of fifteen metadata elements, designed to be quite simple, yet descriptive enough to be useful in the information retrieval process.

7. Material Designing Process

Once the subject matter we are interested in is defined, taking into account all those discussed above, to construct functional material we need to clearly state the general purpose and analyze the specific objectives during the design phase to implement one or more individual activities for each specific goal. Selected activities for implementation, namely **what to**

teach, are related to the way we choose to approach a particular subject. At the same time **how to teach it**, always depends on the targeted audience, meanwhile **whom to teach**, refers to the age of the participants and the prerequisites. Furthermore, the primary concern is adopting the characteristics of one or more theories of learning to orientate more on the exploratory and collaborative learning [1].

Indicative goals are set for everything each activity seeks to achieve in regard with the learners, such as prior knowledge, conceptual change, ways to assess the requested result, so that there may be room for replacement, if intervention is found to be necessary after the implementation. This approach applies also to the economy of the material designed, because it suggests ways to reduce its size and the required time for development [8].

Most of the **R**eusable **L**earning **O**bjects (RLO) created under the requirements of the aforementioned standards. These RLO are not by accident part of a larger scale of material making up a module regulated by an educational scenario. In any case, it is possible to use only a part of the already constructed material and at the same time to design a new RLO to fill a particular gap of the original, which was designed either for this purpose or was reused in a new environment and learning context.

During the design phase eXe may support Metadata development, essential elements of the created material such as its description, title, author/s name/s, subject, and others, useful for those searching for related content in content repositories on the internet.

8. Added value of material construction

If the designing and creating of educational material remains a teacher oriented task, the value of the generated material would be minimum to almost nonexistent. As far as the added value is concerned, the constructed objects worth less when there is no trend to replace simple media with digital media, but instead it lays the foundation for creative and collaborative development.

Besides, there are many benefits when in some cases students create material with the eXe software, including those emanating from the possibilities of the software itself and those that result from the evolution of the learning process. In essence not only content remains current with the review of RLO's created by students, but they also:

- understand better the subject matter
- are encouraged to develop critical thinking
- have better control on the educational process
- are trying new things
- learn from their mistakes
- develop skills beyond those described in the curriculum [9].

In both cases objectives can be approached in different ways to make teaching more exciting and enable learners to discover things for themselves. Especially younger people feel better, if a scenario with open questions might be used. Activities fit well all set of what they will be able to do when they have completed the learning tasks.

9. Interactivity

It is important to recognize that eXe software includes series of components named iDevices for developing effective interactions. It is important keeping focus most on designing the experience and the instruction of learning activities to maintain interest of students, when they are presented with a problem to solve or a scenario and must work to achieve a goal. Some interactions may include team collaboration using a wiki, sharing of information and resources and using RSS readers to receive information that is highly-relevant to the learners. Also they may face some type of challenge, must make decisions, are allowed to explore and to make mistakes without being disciplined [14].

However, it is important to choose the appropriate interactivity level from passive in level I to real-time participation in level IV [15] as described about web based learning. In level I, learners act merely as a receiver of information when they only read text, view graphics and charts or watch a video. The only interaction in this case is simply to move foreword by using buttons. In contrast, in higher levels of interaction there are added components with varied responses to cues and complex simulations where actual data entry is required. This rule can help to select and design interactions based on the type of information it is attempting to teach, required and expected skills and attitudes.

As these levels are related to knowledge's type/s like factual, conceptual or procedural and metacognitive consider a suitable sequence of LO activities to fit all these. It depends on the bit of imagination concluded in those actions which best meet learning goals set at the beginning of the session and the know how to use as teaching or assessment item.These activities may require the participants to :

- gather and summarize the main points of a portion of the material
- identify and analyze new concepts, to analyze data , information, tables
  - compare two or more views, edit references and composition, to locate problems, to resolve, to propose a plan of action to deal with any situation
  - detect errors, incorrect arguments or weaknesses in theories, to prepare studies, expressing personal judgments about how to meet a situation or an issue by proposing better or workarounds for dealing with the troubleshooting
  - make documented thoughts on an issue, to refer to the experience of searching for situations where either considers similar to a given situation, or will managed now differently in the light of knowledge and skills acquired
  - remember something from the previous text e.g. definition, to formulate a text or compile a summary highlighting the main points

10. Affordances

The eXe program integrates all those features that characterize an authoring tool as cognitive tool to make use of such as searching, presentation, investigation, reasoning and assessment skills, if proper use of its structural elements is done [2]. Also, examples may include both teaching and learning. In second case students develop multimedia material when they conclude a particular course of the curriculum with specific goals and predetermined standards. To this end features are given to apply project i.e. on the school's website; assessment and evaluation of trainees through investigation, to solve a problem or explore a case study. According all these, the material created with the eXe project is potential for:

a) *Designing:* to evolve and adapt to weaknesses and interests of each particular student [10]. Educators are provided with opportunities for creative engagement and fruitful teaching, with large margins of freedom to focus in areas where students need help. Explore data on the internet or in the literature which is related with the concepts that are cognitive barriers for students. It is another way to provide more opportunities to design more flexible and reusable teaching material components.

b) *Publishing*: to be exported in many forms and different environments. Furthermore, the provided prospect for initially creating self-assessment tests and later formative and summative assessment in the form of SCORM, is quite interesting.

c) *Standardization*: measures may be taken so metadata is represented according to the supported Dublin Core (DB) standard [12], the simplest and most widespread general standard. The components of DC are not part of the database structure itself; nevertheless they depict the necessary types of data which are required to describe a material, without defining their structure, their correlations or their relevant restrictions. This possibility provides the designers a simple way to create reusable material and a flexible way for users to search for content.

11. Conclusions and future work

In fact eXe provides the teacher with both a range of activities to choose from and present as a sequence to create a learning session. For example start with objectives and pre-knowledge; followed by reading activities, links to external web pages, articles presented inside the tutorial window and create a case study. Also usage of math-symbols or solving problems and math activities with Geogebra software are available. Opportunities for formative assessment include SCORM quiz, multiple choice, multiple-select, Cloze (fill in the gap).

The idevices are perfectly designed and easy to use. It is possible to build a powerful learning package with sequenced activities, where the learner can move easily from one type of activity to another. Obviously, it is an application to create rich, branched learning material standard compliant and sharable, after a little practise.

We carefully observe all those required features under real teaching conditions, as we teach different classes and subjects in high school. Field studies are deemed appropriate to test eXe impacts on the attempts of other subjects design.

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An Innovative Approach to promote Science Education Through Hands-on Activities

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Abstract. *Children are observant as well as curious. They love to explore the world around them. But in the classrooms they are suppressed by the way science is taught, although the science teachers have at their disposal the single most powerful tool in all education – the lecture cum hands-on demonstrations. The scientific skills of the students can be improved by teaching them the concepts of the relevant scientific principle with activity based hands-on experiments. Historically "show and tell" or "seeing is believing" has probably been the best educational technique ever employed. A demo experiment not only gives a better understanding of the scientific ideas, but also makes the study interesting and fun for the students as well as the teachers concerned. This paper presents some demonstration experiments which definitely motivate the students for better understanding of basic physics. The author is one of the senior resource persons of two projects since 2005, a joint venture of Vigyan Prasar(Govt. of India) and IIT- Kanpur for the Teachers' Orientation Programmes and West Bengal District Scheme Interactive Science Workshops for the middle school students.*

Keywords. Hands-on experiments, No-cost, Low-cost

1. Introduction

Science is being taught in our schools since years only through 'chalk and talk'. This certainly affects students' perception of the world and consequently their interest in following scientific careers. In his book "The Art of Teaching", Gilbert Highet [1] discussed "A picture is worth a thousand words and that people learn most quickly by doing something and seeing something done". It is difficult to surpass the learning impact of the combination of 'hearing', 'seeing' and 'doing'. According to the old Chinese proverb ' **I hear and I forget, I see and I remember, I do and I understand',** learning by doing is considered to be the best way of learning science. According to Hans Christian Oersted, the famous discoverer of electromagnetism, "all scientific advances must start from experimentation" [2]. We, the science teachers enjoy finding innovative ways to demonstrate the principles of science, which help the students to develop an intuitive feeling for the real world, for how things work; they also increase the understanding of the basic concepts. Hands-on demonstrations remain the best means of reaching the widest possible audience.

2. Demonstration Experiments:

Out of about seventy five hands-on experiments with no-cost, low-cost materials a few are described here

<u>Experiment No.1</u>: Action and reaction

Theory: According to Newton's third law of motion, to every action there is an equal and opposite reaction and they must act on different bodies.

Method: After placing two ring magnets in the attractive mode on the scale pan, the reading is noted. The magnets are now placed in the repulsive mode, so that the upper magnet floats in air. The reading is same as before. As the lower magnet has to support the upper magnet, an equal and opposite reaction force is applied to the scale pan by the lower magnet. Hence no change in the scale pan reading.

Experiment No.2: Floating of balloon due to difference in air pressure

Theory: An increase in the speed of fluid occurs simultaneously with a decrease in pressure.

Method: An inflated balloon is placed on each of the two thermocole glasses, one having some windows and the other having no window. Also each of them having a hole at the bottom through which a straw is inserted. When air is blown through the straws, the speed of air inside the glass is increased creating low pressure. The air with higher pressure from outside presses the balloon on the mouth of the glass. But in case of the glass having windows, this air of higher pressure rushes inside the glass and makes the balloon to fly away.
With the same principle, a ping-pong ball can be thrown outside a glass tumbler by blowing air horizontally.

Experiment No.3: Burning of candles in a limited supply of air

Theory: Air expands when hot.

Method: The experiment of the rise of water label when a burning candle is covered by an inverted glass tumbler is a very common experiment used by many teachers to verify the compositions of Nitrogen and Oxygen present in air. But using more numbers of candles it can be shown that the rise of water labels are different- more the number of candles, more the rise of water label. This can be explained by using the fact that air expands when hot.

Experiment No.4: Fork-spoon-match system in equilibrium

Theory: Any object whose centre of mass is below its support or pivot point will not topple.

Method: If the fork and spoon are forced together with the match placed between the tines of the fork, the entire apparatus can be balanced on the edge of a glass-tumbler. An interesting situation can be achieved by lighting the end of the matchstick which extends over the edge of the glass tumbler. The wood of the stick will burn until the glass acts as a heat sink and consequently the temperature of the stick drops below the kindling temperature of the matchstick. In this situation the flame will be extinguished leaving the fork and spoon balanced on the tiny portion of the matchstick, which seems to be balanced on practically nothing.

3. Conclusion and Discussion

The author is working with the students of class VIII to class XII standard and their teachers for last six years in different projects and bagged more than seventy five demo-experiments [3]. He has the experience that the hands-on demonstration experiments are very encouraging among the students as well as their teachers. These demo experiments help the students to develop inquisitive temper for learning science. At the end of 3-day workshop, each student is instructed to demonstrate a new experiment which is invented by him. Also they submit a feed–back where they mention the utility of such kinds of hands-on demonstrations and how they help them understanding the basic physics.

According to Prof. M.F.M.Costa, the Hands-on Science Network Coordinator, 'The pursuit of experimental hands-on work by the students on or off the classroom is a powerful way to help science teachers to reach our basic goals'[4]. Any hands-on activity claims that the students are transformed from passive learners to active learners. Learning not only means gathering of information but to use these information in practice.

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Activity Kits on Weather and Biodiversity: An Indian Hands-On Experience

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Abstract: *Vigyan Prasar, the National Institute for Science and Technology Communication, is an autonomous organization under the Department of Science & Technology, Govt. of India. In broad pursuit of its objective, Vigyan Prasar has initiated several large-scale programmes, activities and schemes in the country over the last decade. Vigyan Prasar also has a network of about 12000 Science Clubs, spread throughout India. An important component of majority of Vigyan Prasar's programmes is the development of low cost/no-cost activity kits in the form of Hands-on-activities for nurturing curiosity and excitement among children. As part of the programme of International Year of Planet Earth 2008, two kits, on Biodiversity and 'Weather' were developed for these clubs. The paper highlights and analyzes the feedback received from the science clubs and the other users as a hand- on experience in understanding some basic concepts of science, in general and on Weather and Biodiversity, in particular.*

Key Words: Biodiversity, Vigyan Prasar

1. Introduction.

Vigyan Prasar, under the Ministry of Science and Technology, has flourished into a national resource-cum-facility centre; and is engaged in development of a variety of software utilizing different means, media and modes. Vigyan Prasar has been regularly beaming weekly television programmes aimed at communicating science to the people for over three years now. Vigyan Prasar also has been producing radio programmes on various aspects of science and technology and broadcasting on 117 centers of All India Radio in major 18 Indian languages along with English. Vigyan Prasar has set up a network of satellite interactive terminals spread throughout the country exclusively for S&T communication with two way audio-two way video facility using Edusat, (India's satellite for education). Yet another important activity of Vigyan Prasar is the utilization of the print media and the Internet for S&T popularization. Vigyan Prasar also has a network of about 7500 science clubs spread throughout the country.

An important component of majority of Vigyan Prasar's programmes is the development of low cost/no-cost activity kits and training modules in the form of Hands-on-activities for nurturing curiosity and excitement among children. These modules are more suitable for all developing countries like India, having wide range of socio-economic and cultural diversity. The modules are based on an approach, which is decentralized, activity based, low-cost, participation-intensive and allows local environs to be used as learning and teaching ground. It has also been realized that through these modules (also called parallel or alternative approaches to science education) based on hand-on-activities, what we do or learn is directly and closely connected with real problem(s), situation(s), thing(s) and happening(s) in everyday life. With the help of these modules, children can understand science as a complete process in a simple and enjoyable manner. Till date around 10 kits and 15 such training modules have been standardized by VP. Based on these kits, teacher's training programmes have been organized throughout the country. Some of these kits are 'Understanding Biodiversity', 'Weather', 'Astronomy', 'Emergence of Modren Physics', 'Transit of Venus' and 'Solar Eclipse'. Some of the most popular training modules are "Scientific Explanation of so-called Miracles", "Low cost innovative Physics experiments", "Understan-ding Mathematics through Origami", "Telescope making and Astronomical Activities", "Use of PC for Scientific Experiments", "Exploring Nature" and "Hydroponics-Fun with Plants in Soilless Condition".

2. Kits on Weather and Biodiversity (Special Initiative of International Year of Planet Earth 2008)

On the initiative of two organizations, International union of Geosciences i.e. IUGS and UNESCO, the United Nations general Assembly proclaimed the year 2008 as the International Year of Planet Earth. In addition to research in Earth sciences, the focus was also on outreach activities to create awareness about the extent to which Earth's systems is a part of our daily lives and, in turn, which of our activities interfere with those delicately balanced systems and to focus on the positive aspects of this relationship and to create a sustainable future for humans and this planet.

As part of International Year of Planet Earth 2008, VP planed an ambitious project for various target groups, comprised of production of software (kits, charts, posters, booklets, audio/video films etc.), training programmes and field level activities involving 7500 science clubs.

As result of this initiative, a series of collaborative programmes with like-minded agencies like National Council for S&T communication and S&T Council and S&T Department of States of India were organized to train the master resource persons (MRPs). A 52 episode radio serial "Planet Earth"(*Dharti Meri Dari*) was also broadcast from 117 radio Stations of AIR in 19 Languages. On Doordarshan, a 26 TV Serial "Kahani Dharti Ki" was also shown which was produced by VP. A series of publication (about 20books) in Hindi and English and set of 21 posters on different topics on Planet Earth were also brought out in English & Hindi.

One of the special initiatives of Vigyan Prasar was to developed two activities Kits on "Biodiversity" and "Weather" for the Network of Science Club i.e., VIPNET. Though, majority of these clubs are within the set-up of formal education system, but these kits were developed in the form of material which would be supplementary to formal education. The basic idea for the development of the kits was to develop about 80-50 hand-on activities based on scientific information and physical phenomena to enhance the understanding of `Biodiversity' & `Weather', the sub-themes of Planet Earth 2008 programme. It was expected that the kits would help the target group in the understanding of scientific concept, information, phenomena and the dynamics of natural processes relating to Weather & Biodiversity through hands-on experience.

3. Mechanism for the Development of Kits

As per the earlier experiences of Vigyan Prasar, by using in-house expertise of the organization, a series of in-house brainstorming sessions were organized. As result of these deliberations, a rough sketch and lay-out of the kits were formalized by keeping children and teachers as the main target groups. Initially a list of activities, concepts and information capsules (about 92 for biodiversity and 39 for weather) were finalized for designing the kits. The help of Manthan Education Programme Society (MEPS), Ahmedabad, was taken besides involving a number of students from local University and National School of Design, Ahmedabad. With the help of technical experts from the relevant field, a list of possible hands-on activities was finalized after a series of deliberation followed by presentation before them. Time to time all suggestions & inputs were also included in the prototype of kits. One of the suggestions which came from all experts was that "in both the kits there should be a perfect mix of information with hands-on activities'. "All the activities are to be such that they should be done with the help of locally available resource material at the minimal or no cost". Even after the inclusion of all the inputs & suggestions, the basic premise of both the kits remains same i.e. promoting and encouraging among the children:

a. Curiosity and sense of wonder (meaning how and why) about things and happenings, events and/or phenomena around them;
b. Sprit of inquiry and asking questions and seeking well-reasoned and convincing answers to these questions.
c. Keen and systematic observation of things, facts and oddities around them;
d. Experimentation to check out, verify, disprove or confirm a suspicion or guess;
e. Stress on learning by doing and on low or no-cost activities by using common and easily local material.
f. Involving a large number of people in all programme and activities.
g. To develop kits for training teachers who would be able to innovatively engage

students meaningfully and effectively in low-cost and no-cost activities which would help them use their head and hands to learn things by doing themselves.

Though the basic premise and the philosophy for the development of the kits remained same as per the aims of objectives of the VP, but a contemporary outlook, both in terms of design and content was given to make it more relevant to be used as resource material for the "National Campaign on Planet Earth 2008 "Dharti Meri Dharti" of Vigyan Prasar. These kits were supposed to be distributed as resource material during Master's Resource Person's training programme, which were organized throughout the country along with sending it to about 7500 clubs. The science clubs were also trained to undertake activities based on the kits as part of the campaign during the International Year of Planet Earth 2008. The immediate specific objectives of the development of Kits were:

1. To developed a hands-on resource modules on Biodiversity and Weather in a visually rich format for developing a "Mini Weather Station" and "Repository of Biodiversity" in the clubs.
2. To provide a sustained base of activities to Science Club on theme Planet Earth 2008
3. To help the member of the science clubs to internalize the theory and the abstract concepts taught in the class through hands-on experience relating to Biodiversity & Weather.

4. The other broad objectives were

- To understand the course of nature and the cause effect relationship with nature
- To fill the gap between theory and practice by providing supplementary material
- To develop a responsible behavior towards the environment.
- Develop low-cost or no-cost activity kits on weather and biodiversity as to address the prescribed curricula.

4. Major Challenge: - The major challenge in the development of the kits, beside content was its cost, design and transportability to about 7500 science clubs which are spread throughout the country.

5. Development of Final Prototype:-

I. Content of Biodiversity Kit:- In the final prototype of biodiversity kit, 51 self explanatory activities were included along with two posters to cover five broad aspects on biodiversity i.e. Understanding Biodiversity, Importance of Biodiversity, India as a mega biodiversity Country, Threat to Biodiversity, Conservation efforts (National and International).

II. Content of Weather Kit: - In the prototype of Weather kit, 31 hand-on activities, illustrating scientific principles, physical phenomena to understand the dynamics of weather were included, so as to fulfill the immediate objective of the kit i.e., developing a mini weather station in each club for collecting data relating to weather. In both kits, a series of project idea and activities as open ended experiments to be performed by the students were included. The design of each activity and cover of both the activity kits were finalizes as to ensure their transportability by post to about 7500 science clubs. The cover design was finalized with the help of students from National School of Design after involving the official from Post and Telegraph Office, Govt. of India, Ahmedabad. Before the final production of the kits, once again, the demonstration of the kits was given to a group of students and teachers to get their feedback on the content, language and design. After necessary changes and correction in the language and drawing etc., the prototypes were sent for final production. Both the kits were developed in Hindi and English. Finally, 10000 copies of each kit in two languages (English and Hindi 5000 copies each) were produced.

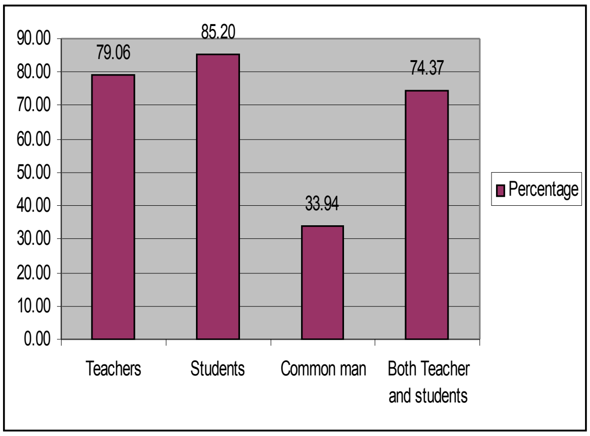
6. Dispatch of the kits to Science Clubs

Both the kits were sent to about 7000 Science Club along with a survey form to get the feedback on content, quality, usability, durability and inviting their comments and suggestions as to what more could be added or deleted from these kits. The feedback form was also distributed during the training programmes of MRPs, organized in different parts of the country to get the feedback. In total about 500 duly filled-up feedbacks were received.

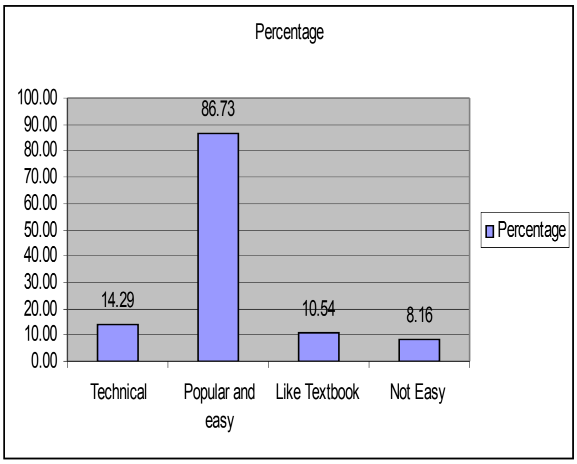
The feedback form was designed in the form of 10 questions. The first five questions were of multiple options on usefulness of the kit, its language and about the activities etc. In all the multiple choice questions, the users were given freedom to tick more than one option, if they feel so. The other five questions were open-ended questions, asking the user about the usefulness of the kits and what kind of activities they are going to plan based on the content and information provided in the kits. It is, however, emphasize that this survey was not an evaluation or assessment per se, but only a qualitative study with an objective to improve the kits.

Question-I : According to you, the Weather and Biodiversity kits are good resource material for Teachers, Students, Common man or For both for teachers and Student.

The majority of user find is good not only for teachers/students but for both (74.37%)

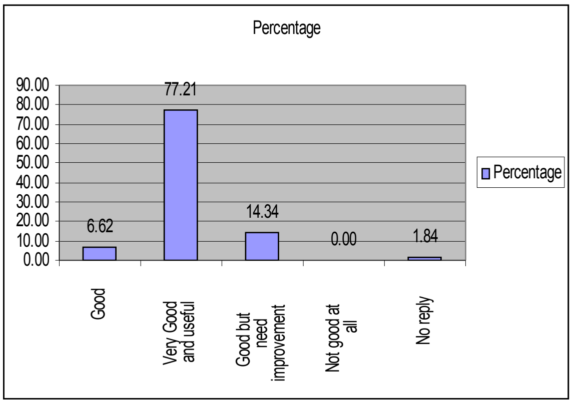


Question-II: Language of Kit……
Majority (86.73%) of them find the language easy and popular

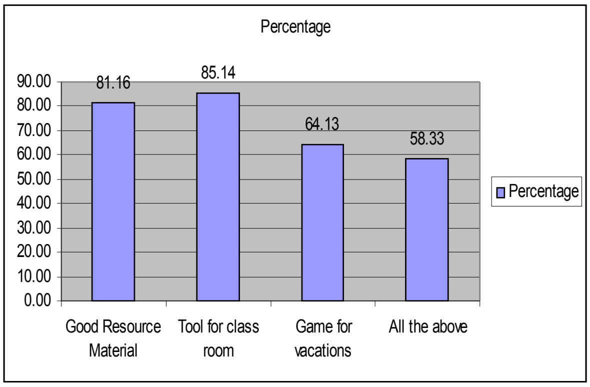


Question-III: - Activities given in Kits are…..?

Majority of the user (77.21) find the activities very good and useful.



Question-IV: - How the kits has been used by coordinators of science clubs and students



Majority of them has used the kits as a resource material in clubs(81.16%), the teachers has used it as a tool to supplement classroom teaching(85.14%) and students have used it as material for games during the vacation(64.13%) and about 58 % used it for all the three purposes.

7. Observations about the Design and Content of the kits.

Majority of the user were satisfied and ranked it between good to excellent as far as the design of both the kits is concerned. Only a few find it bit difficult to arrange the activities sequence wise. Majority of the users suggested to use the plastic as material for the kits instead of paper" to make it more lasting and durable for repetitive use" with "little bigger in size specially the fonts and pictures".

Content wise, majority of the user find it sufficient and interesting, "presented in a beautiful manner". Though, a few were of the opinion that in biodiversity kit "some more information should have been included on the extinct species and pet animals". About the content of weather kit, there were few suggestions to include some information and hand- on activities relating to climatic change, global warming and cyclones/storms.

8. The overall Comments and Suggestions

All the users, those responded, found both the kits very useful for class room and as well as outside class room activity. They found it very good and "a concerted attempt to create awareness about weather and biodiversity in a practical way". According s to some, "these kits provide knowledge in a practical way and should be sent to all schools and colleges to develop the interest of the students in environmental issues". Some typical responses are as follows:-

1. Both kits are really good and can help in clearing the concept of students which otherwise would have been very difficult to clear with regular teaching process.
2. Very nice, we will wait for more such kits in future.
3. Similar hands- on kit can be developed on topics relating to magnetism, heat and some concept of chemistry (Like structure of an atom) so that the topic becomes easy.
4. Content are suitable for classroom teaching.
5. These two kits can truly help in promoting the scientific outlook, and inculcating true scientific temper. Both kits are full of informative material.
6. Both the kits are informative, easy to demonstrate and will surely help children to understand the concept clearly.
7. These kits are very useful for teacher, students and common man. Some activities are directly related with the school curriculums which will be very helpful for students in their studies.
8. It is good resource material for hands- on activities.
9. The kits are activity oriented which is very effective and creates curiosity, enthusiasm and scientific thinking among the students at school level.
10. Immensely useful and language is very easy.
11. Very interesting and useful. Our students have taken great interest.
12. The kits are self explanatory and attractive which motivate learning, thinking and doing among the students. Excellent with lots of information.
13. Good amount of thought has been put up in developing the kits. Congratulation for all of you at Vigyan Prasar
14. Both the kits are like resource pool; help us to expand our knowledge and activities.
15. These two kits are very precious and valuable for the welfare of people.
16. Both Kits are very useful to understand and conserve biodiversity.
17. The kits are systematic and well designed for learning purpose even for upper primary and secondary school students.
18. The set of both kits are new tools and new ideas for the VIPNET students
19. This is sufficient for me to make the project.

8.1 Suggestions

1. If C.D should be provided to make it more interesting
2. Both the kits are really good but need some extra specimen in Biodiversity kit.
3. Both should be available in other regional languages too.
4. It is better to give training to club's members.
5. These kits should be provided to all school.
6. Please publish the book which is based on these kits.
7. Based on the kit an, interactive CD may be developed.
8. Notes to explain the hands- on activities may be added.

8.2 Types of Activities to be added in the kits

Majority of the users were satisfied with the number of activities included in the kits. They were of the view that "activities are sufficient to understand the concepts and there is no need to add any other activity", "in its present form it is enough and sufficient" and "adding more activities will be an overdose" A few suggested that Puzzle, quizzes crosswords, booklets on skits/riddles, 3-D images, some working models, work sheets and games can be added in the kits.

8.3 Future Activities to be taken up by clubs and other users based on kits

Besides establishing a mini weather station and repository of Biodiversity, the users would like to take up following activities based on the kits:-

Activities based on Biodiversity:-

Projects

1. Visit to places of ecological importance like wetland, national park zoo etc.
2. Planning project activities relating to endangered species and their conservation.
3. Selected activities will be converted into permanent display and exhibits to be displayed in school
4. Nature activities will be organized as suggested in the kits.
5. Conference, debates, various competitions to create awareness about the biodiversity conservation/ management will be organized.
6. Setting up of information centers on local biodiversity for farmers.
7. Project on social forestry, medicinal plants, protection of jackal, birds, butterflies, preservation of local biodiversity stock, eco-tourism, Insects-Our Friends, causes of pollution of local rivers etc. Biodiversity in the kitchen and school garden etc would be taken up by the clubs.
8. Demonstration of kits for the students of rural areas.

Projects/Activities based on Weather Kits

9. Project on artificial rain, understanding local Climate condition, weather information Centre, Global warming and Climate change, waste management, Study of rainfall pattern, alternate methods of weather forecasting, storms/cyclones, disaster preparedness .
10. Demonstration based on kit to make everyone in school to understand the science of various physical phenomena effecting weather.
11. Designing and development of equipment for collecting data.
12. Awareness and Training programmes will be organized.
13. Organization of seminars, debates and other competitions based on the information given in the kit.

Conclusion

The above findings, comments and suggestions show that to a great extent the objectives of the development of the kits as hand-on science have been fulfilled. It is not out of context to mention here; no doubt that these kits based on parallel or alternative approach is more suitable for a country which is more diverse like India. But given the rich experience India had had in hands-on science and given the overlapping concern of Afro-Asian-European Nations, the experiences can be shared for cross breeding and cross fertilization of the idea for mutual benefits.

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Educational evaluation of Matlab simulation environment in teaching technological courses: The example of Digital Control Systems

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Abstract. *The computing environment Matlab is widely used internationally, in the modern Engineering Education with constant improvements and potential that reflects recent findings of modern scientific research. This paper presents the educational evaluation of the computer simulation environment Matlab, as it is used in the educational process of Higher Education in the sector of engineers/technologists and in the scientific field of Digital Control Systems. The evaluation methodology involves the learners and studies the following three main features: (a) the usability of the system, (b) the lesson plan and (c) the learners' assessment. The survey was conducted using structured anonymous questionnaires in the department of Automation in TEI of Piraeus during the academic year 2009-10. The first results highlight the importance of the educational use of the Matlab environment in the pedagogical context of teaching technological courses.*

Keywords. Matlab, Simulation, Evaluation, Technological courses.

1. Introduction

The transition to information society and knowledge is a challenge for education more than any other social sector. At the same time, the convergence of computing and communication technologies (ICT) in the educational process creates new opportunities and challenges for both learners and teachers. This convergence is accompanied by an increasing investment in material and human resources. Therefore, the issue of evaluation is of paramount importance [11].

On the other hand, the simulation as a technique of imitating one's system behavior from another system, occupies a prominent position within the framework of educational applications. The training simulation is defined as a model of a phenomenon or an activity, which users use and learn through interaction with simulation [1], [5]. There is a significant number of scientific publications that suggests new strategies for developing educational software, especially in simulation and the multimedia environment [3], [4], [7]. What is observed is that most evaluations focus on the concept of usability, which according to Nielsen, is the ease of learning from new users, high performance work done by experienced users, the sustainability of the capacity to use the system over time by the user, the small number of wrong handling, the easy way of resuscitation and the subjective satisfaction of users from contacting the system [8], [9]. However, it is quite a helpful factor in evaluating an educational system. On the contrary, the learning effectiveness of software is a key assessment factor. How to measure learning effectiveness is an important question that is implicitly connected to the methodological approach to investigate the effectiveness of the educational resources evaluated. For example, when we set as a criterion for educational evaluation the promotion of critical thinking by the software tested, its effectiveness is literally judged by whether it manages to meet this criterion [11]. In conclusion, the educational assessment reflects values attributed by the evaluator to applying information technology in the classroom. Of course a key objective is, if the evaluated educational software improves the educational process, but the factors are difficult to be established clearly and objectively, as it is done in mathematics and applied sciences. From this fact, results the lack of assessment standards.

2. Theoretical Analysis

The educational software that will be assessed in conjunction with educational subject in which it is used (Automatic Control Systems), is a Computer Simulation Environment (of quantitative type), which is applied to the educational process in higher education in the sector of engineers/ technologists, in particular in the scientific field of automatic control. This software is Matlab v.7 and is widely and internationally used in the education of engineers in several sectors (Engineering Education). The evaluation concerns its use at the Digital Control laboratory based on the Educational Objectives (EO) set, and the training methodology used for laboratory teaching of Digital Control Module (5th semester) in the Automation Department of TEI of Piraeus (Table 1) [10], [12].

Table 1. Teaching Approach of Matlab in Digital Control Module

EO	Knowledge	Skills	Training Methodology
EO1-Application/use of mathematical tools of Automatic Control Systems (ACS) EO2-linear systems modelling EO3-simulation of models of digital control systems EO4-use of graphical tool SIMULINK EO5-Design of Digital Controllers (PID) EO6-analysis of the systems in state space	Maths Knowledge (Basic and Applied Mathematics) Design & Analysis Skills CS	Problem-solving -Construction-Analysis Model ACS	-Verifying a model (simulation and interaction with the instructor) -Classical interactive simulation (individual use by students, homework).

The compatibility of EO compared with the description of the course, concern the theoretical foundations of the subject rather than the technical implementation of the ACS (hardware), ie the components, microprocessors, sensors, which constitute the "real" world of an ACS model. Matlab helps the realisation of the "reasonable" world of an ACS model. This relates to the theoretical design and implementation of the ACS model depicted in reality with the design of a software control system for digital automatic control. This implies the following educational activities in the computing environment Matlab: analysis, design and dynamic modelling [10].

3. Research Methodology

The research concerns the educational assessment of Matlab software from the perspective of trainees for use in the laboratory Digital Control Module. It was implemented with the use of a questionnaire, which is divided into two main parts: the training and technical part [10], [13]. In particular, the following issues were examined:

- Assessment of module, teachers and learners themselves,
- Evaluation of technical data of the simulator (using tools, multimedia, textbooks, teaching planning,etc.).

The survey was conducted at the end of the winter semester of the academic year 2009-10 to the students of the Laboratory of Digital Control of the Automation Department of TEI of Piraeus. The number of trainees who participated in the survey was 22 (out of 39 students, who were enrolled in the workshop for this semester). The process of completing a questionnaire (anonymously) was implemented. The processing of research results was made using a computer (MS Excel). In particular, the survey includes the following variables as shown in the following table (Table 2):

Table 2. Methodological Framework (Variable Research)

Independent variable	Dependent variable
1. Year of Study (B-2nd, C-3rd, D-4th, Advanced-Years: concern students who declared the module beyond the formal years of study, mainly because of the	1.Course Assessment(4 sub-variables) 2. Teachers' Evaluation (4 sub-variables) 3. Trainees' Evaluation (three sub-variables) 4. Multimedia use 5. Trainees' tools 6.student User-friendliness (two sub-variables)

requirement to have succeeded in the modules required for attending Digital Control Module).	7. Didactic design (3 sub-variables) 8. Bug fixed in terms of student 9. Evaluation of trainees in simulator 10. Manuals & Help (3 sub-variables) 11.Infrastucture (3 sub-variables)

The dependent variables constitute the criteria relating to the oversight of the use of Matlab simulation environment in this educational process. The tutorial design, presentation, content, structure, dynamics and interactivity are monitored. The evaluation took three main factors into account: Instructional Objectives (tutorial design, course evaluation), the medium used (use of multimedia tools, assessment instrument, friendly user manuals and support, bug fixes, infrastructure) and learning outcomes (assessment of learners, teachers) [3], [4], [7]. The form of the questions included in the evaluation questionnaire to the corresponding scale is as follows (Fig.1):

Question	A lot	Pretty	Moderate	Fairly	Not at all
Analyzes and presents concepts in a simple and interesting way?					

Figure 1. Question Form with the rating scale

The processing and interpretation of responses will be based on the answers, which exceed (numerically and in percentage) for each classification (based on the rating scale) compared with all the answers. The purpose is the clear identification of the sample trend towards a characterization based on the rating scale and its appropriate interpretation. In case of equivalence to more than two classifications (ie a total of six responses there are two “a lot”, two “Pretty” and two “Fairly”) then it is designated as "No Response superiority" because the trend of the sample cannot be determined clearly. The methodology of the survey includes the following steps:
-general information for the purpose of research to trainees;
- completion of the questionnaire (duration 20-25 min) and
- leaving the venue of the survey.

This paper presents the main results of the survey and in particular those related to educational part of the evaluation.

4. Results

After the collection of survey data and their processing, the following information regarding the analysis of the sample to the independent variable is presented:

Independent Variable: Year of Study (B-2nd, C-3rd, D-4th, Advanced Years-AY) for the sample as a whole:
- B-2nd Year: 3 (13.6%)
- C-3rd Year: 7 (32%)
- D-4th Year: 3 (13.6%)
- AY: 9 (41%)

as shown in the following graph (Fig. 2). The normal academic year for the laboratory course is the third year of C-to E’ & F’ semester because it typically belongs to E’ half. The AY concerns the semesters H’ and over (I’, J’, etc.).

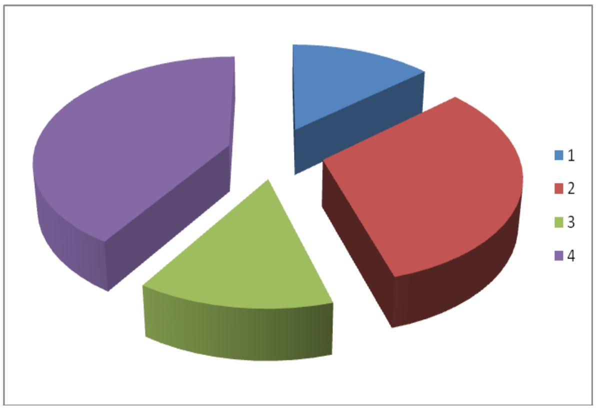

Figure 2. Schematic illustration of the survey sample on the academic year (1:B, 2:C, 3:D, 4:AY)

Below lie the options of the responses in the questionnaire and the corresponding frequencies for the independent variable in relation to the dependent variables and sub-variables of the survey questions regarding the educational part of the questionnaire:

Course Evaluation (Table 3): includes four questions relating to the educational evaluation of the course (content, material, etc.).

Table 3. Most frequent answers in the Assessment of the course (4 sub-variables) in relation to the academic year.

	Year of Study (22)			
Question	*B* *(3)*	C (7)	D *(3)*	*AY* *(9)*
The material covered with Matlab's help met the objectives of the course?	"Pretty" (2)	"Fairly" (4)	"Pretty" (2)	"Fairly" (7)
The educational material given helped to a better understanding of the subject?	"Pretty" (2)	"Fairly" (3)	There is no precedence answer	"Fairly" (4)
Using knowledge from other classes?	"Pretty" (2)	"Fairly" (4)	"Pretty" (3)	"Fairly" (4)
How is the level of difficulty of the course with the help of Matlab for the corresponding academic year?	"Moderate" (3)	"Moderate" (5)	"Moderate" (2)	"Moderate" (7)

Evaluation of Teachers (Table 4): includes 4 questions about the evaluation of teachers in the classroom by the students.

Table 4. Most frequent answers in Educational Evaluation (4 sub-variables) in relation to the academic year.

	Year of Study (22)			
Question	*B* *(3)*	*C* *(7)*	*D* *(3)*	*AY* *(9)*
How do you assess the organization and presentation of the material?	"Very good" *(2)*	"Good" *(5)*	"Good" *(2)*	"Good" *(7)*
Does it succeed in stimulating the interest in the subject?	"Pretty" *(2)*	"Fairly" *(4)*	There is no precedence Response	"Pretty" *(5)*
Analyzes and presents concepts in a simple and interesting way?	"Pretty" *(2)*	"Fairly" *(4)*	"Pretty" (2)	"Fairly" (5)
Encourages students to formulate queries and questions to foster their critical thought?	"Pretty" *(2)*	"Fairly" *(4)*	"Pretty" (2)	"a lot" (4) "Enough" (4)

Student Assessment (Table 5): includes three questions about learners' self-assessment during teaching process.

Table 5. Most frequent answers in Student Assessment (3 sub-variables) depending on the academic year.

	Year of Study (22)			
Question	*B* *(3)*	*C* *(7)*	*D* *(3)*	*AY* *(9)*
Study systematically the subject matter?	There is precedence answer	"Fairly" (4)	There is precedence answer	"Moderate" (5)
Respond systematically to exercises / work?	There is precedence answer	"Fairly" (5)	"Pretty" (2)	"Fairly" (5)
I spend time weekly to study the course with the help of Matlab	*"0-2 hours" (2)*	*"2-4 hours" (5)*	*"0-2 hours" (3)*	*"0-2 hours" (6)*

Didactic Design (Table 6): refers to the instructional design in connection with the help of Matlab provided in the course of Digital Control (educational use, problem solving).

Table 6. Most frequent answers in Educational Planning (3 sub-variables) depending on the academic year.

	Year of Study ***(22)***			
Question	*B* *(3)*	*C* *(7)*	*D* *(3)*	*AY* *(9)*
Rate Matlab in promoting problem solving (on the technical potential)	"Very good" (3)	"Good" (3) "Very good" (3)	"Very good" (2)	"Very good" (5)
educational activity at Matlab helps in understanding the subject (numerical control)	"a lot" (2)	*"a lot" (3)*	"a lot" (2)	"Fairly" (5)
How do you judge as a whole the educational process of Matalb use?	*"Very good" (3)*	"Good" *(4)*	"Very good" *(2)*	*"Very good" (7)*

Respectively, follow the answers to options on the major dependent variable and sub-variables of the survey questions regarding the technical part of the questionnaire:

Use of Multimedia (Table 7): concerns the evaluation of the educational use of multimedia environment Matlab (where available).

Table 7. Most frequent answers concerning the use of multimedia depending on the academic year.

	Year of Study ***(22)***			
Question	*B* (3)	*C* (7)	*D* (3)	*AY* (9)
How do you judge the overall use of multimedia (text, image, sound, animation). Does it help you understand the lesson?	There is no precedence Response to	"Moderate" (4)	There is no precedence Response to	"Moderate" (4)

Trainees' tools (Table 8): Refers to the evaluation of the use of auxiliary tools simulator.

Table 8. Most frequent answers on the Trainees' tools about sex, year of study Knowledge of PC

	Year of Study ***(22)***			
Question	*B* (3)	*C* (7)	*D* (3)	*AY* (9)
How do you assess the overall use of auxiliary tools (graphics, computers, a.) by the software. It helps you understand the lesson?	"Good" (2)	"Good" (6)	There is no precedence answer	"Good" (7)

Trainees' User-Friendliness: Refers to the evaluation of the interface (interface) & navigation provided by the simulator.

Table 9: Most frequent answers in the trainees' User-Friendliness (two sub-variables) depending on the academic year.

Year of Study ***(22)***				
Question	*B* (3)	*C* (7)	*D* (3)	*AY* (9)
How do you assess the overall illustration of the software interface. Is it easy to use?	"a lot" (2)	"Fairly" (5)	There is no precedence answer	"Fairly" (6)
How do you value the navigation aids?	"Very good" (2)	"Good" (4)	"Moderate" (2)	"Good" (6)

5. Discussion

The educational evaluation of a simulation environment has some special features (it does not have separate scenarios, assessment tools) in relation to an "independent" educational software. What should be noted is that Matlab is an integrated environment with significant technical capabilities and important educational opportunities, as long as teachers use them effectively through the correct teaching design. The purpose of the survey is to evaluate the software Matlab in teaching a technological course, regarding features such as digital control, a course that requires a range of prerequisite knowledge (mathematics, physics, control systems, etc.) and at the same time constitutes a specialized field of synthesis of many areas. From the presentation of the survey results as outlined, we draw the following conclusions:

- Trainees (regardless their academic year) are fully satisfied regarding the evaluation of educational material, the combined use of further knowledge and generally the course overall.
- Teachers' evaluation is in general satisfactory with one objection (by the students of the year attending the lesson and also older students) regarding the organization and presentation of the taught material, which means that a better design of the course is needed with the help of Matlab (examples, applications, etc.).
- The trainees' self-evaluation on average (regardless of the year of study) shows that students respond to the demands of the course. But there is a contradiction because regarding the last question on studying hours, except for the trainees who belong to the year of study (3rd Year of Studies – E', F' Semester), all the others respond with 0-2 hours suggesting that they don't prepare well.
- Those who have the responsibility of the course should, with an appropriate design (use of

incentives, assignments etc.), increase students' study time and also, by increasing the hours of training in the form of free workshop, aiming to adequate training in this subject area, which constitutes a key training subject and helps students, especially the older ones, who may abstain (for different reasons: labor, lack of knowledge) from the Faculty, to meet the requirements.

- The Teaching Design is valued by all learners positively and particularly the assistance provided by Matlab in problem solving, thus resulting in better understanding of complex modules of digital control. There is a distinct gap rising only among students who belong to the current year of study regarding the teaching design (lower overall assessment), which would help teachers further explore the causes and improve the educational use.
- Finally, the evaluation reflected the demands of teachers and manufacturers to improve the design of the use of multimedia tools and navigation means (by all students regardless their year of study) that helps learners to familiarize with the capabilities of Matlab, so as to be able to respond in a better way to the educational process.

6. Conclusions

In conclusion, Matlab can help a learner to develop:

- Synthetic thinking. That means creativity and building concepts and acquisition of skills (problem solving, modelling), which promote the design of appropriate educational activities by the instructor.
- Analytical thinking. The available tools help each student to analyze phenomena, complex or simple concepts offering a significant growth in the respective dimension of student thinking.
- Critical capacity. It can be achieved through all the properties of teaching design (discovery, integration, problem solving, modelling) that the Matlab environment can provide to the teacher and student. Also it trains the critical capability for the determination of what is to blame for the mistake (through suggestions from Matlab), through the facilitation process in cases of error.

What should finally be noted is that the computer simulation environments (Matlab) can be used effectively in the educational process, as long as the teacher designs the educational activities in an educational way, giving priority to the knowledge acquisition phase, to the maximum advantage of the opportunities provided by the environment simulation and manufacturers to enhance their product in order to optimize usability.

8. Acknowledgements

We would like to acknowledge the help, support, and feedback from the Emeritus professor K. Tsiantis.

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Science, Scientists and superstition: Perspectives in Indian context

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Abstract. *Over the past few decades, there has been an appreciable increase in efforts at science popularization by media persons, as well as professional scientists. This principally involves efforts in two directions: the first is to make scientific know how accessible to a layman,*
and the second is to develop scientific temper. Any idea or theory that cannot be tested using the Scientific method may be termed as superstition. Many rationalist organizations have put in great amounts of time and effort, to fight superstition.
The plethora of books and articles in newspapers and magazines, and the unprecedented impact of television, has made it possible today for one to
talk about the Pathfinder mission to Mars, "Chandrayaan" or the cloning without committing a faux pas. In the second aim, there has been only a limited success. This article tries to identify some of the failures of the science popularization in developing a scientific attitude among laypersons, and the reasons behind them. Another important point about science for the
people movements: In the absence of regular schools which can teach elementary science in a non-religious idiom, all the many campaigns to
"bring science to the people" are mere band-aids.
In the scientific framework, there is no fundamental difference. In science, no belief exists that is absolute, except of course the implicit belief in the universal validity of the scientific method. Superstition baiters should
take a more pragmatic approach to realising their goals. Scientists try to propagate the greatness of their beliefs, when all they should be propagating, is the greatness of their method. All they end up transmitting, is the greatness of their persona. Is this distortion of the message occurring due to the limitations of the scientist or her audience?
The old held notion that a great popularizer could overcome these barriers to communication successfully, and transmit the idea of the scientific method, to a layperson. Nehru's words, written in stone at the entrance to the Jawaharlal Nehru Institute for Advanced Research in Bangalore: "I too have worshipped at the shrine of science" are an irony to this context. The notion of "worship" and "shrine of science" do not get along with the modern science and the
scientific temper.

Keywords. Science Communication, Science, Superstitions, Society, Development

Importance of the Study

Science is about finding truth. But science in India is largely seen as an instrument that enhances productive capabilities, and not as a transformational tool for creating an educated, informed and rational society.So far the communication has tended to be one way – scientists informing the public about their findings. The current thinking is for science to engage more in dialogue with the public, asking for feedback and views, and taking those views into consideration.

Methodology

The present study is based on the survey of scientists who are working for the cause of bridging the gap between science and society as no society can flourish and develop unless the shackles of superstition are broken and there would be no better than scientist himself as communicator who works for this cause.

Special Relativity: A field where "minds-on" (thought) experiments could be proved valuable didactic tools

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Abstract. *In the first part of this study we investigate how the TSR is introduced in physics textbooks and in books popularizing physics theories. Our findings show that physics textbooks use mathematical formalism and complicated terms. On the other hand, popular science books use more comprehensible examples but they are often limited to the descriptive and peculiar character of these experiments. Thus, a careful design is needed to make the proper didactic transformation and to design educational material, drawing ideas and material from both of them.*

In the second part, we describe a teaching sequence, which has been developed in order to teach the TSR to upper secondary education.

Keywords. Books popularizing physics, Physics textbooks, Theory of Special Relativity, Thought experiments, Upper Secondary Education.

1. Introduction

Nowadays, the members of the science education community seem to agree that there is a need for updating the content of current physics curricula. In upper secondary education, this includes twentieth century physics theories. In that direction, a major problem emerged is how the mentally demanding theories can be introduced in science classrooms. This work attempts to explore ways of teaching the theory of Special Relativity (TSR) to upper secondary school students. This theory is recognized as a major constituent of "modern physics" (physics of the 20th century) and also displays advantages in its teaching, namely that Einstein himself used thought experiments to clarify its meaning and consequences.

2. Methodology

In the first part of this study we investigate how the Theory of Special Relativity (TSR) is introduced in physics textbooks and in books that popularize physics theories. The purpose of this study is to trace the conceptual course and the examples that are used when dealing with the TSR. In that context, we have focused specifically on the two axioms of the theory and on the consequences relevant to the relativity of space and time (relativity of simultaneity, time dilation, length contraction). Based on the findings of this research, a teaching sequence has been designed and educational material has been developed in order to introduce the TSR in upper secondary education and to investigate the students' learning processes.

The books that were analyzed are presented in Table 1.

These physics textbooks were selected due to their extensive use in upper secondary education and in introductory university courses. The fact that some of them are considered as reference books was also taken into consideration.

As far as popularizing science books are concerned, the large number that deal with the TSR led to adopting as a criterion of selection whether the writer was/is famous physicist and/or famous as a popular science book writer.

Table 1: The books that were analyzed

A. **Physics textbooks**
1. Allonso M., Finn E.: *Fundamental University Physics (volume 1).*
2. Berkeley Physics Course: *Mechanics, (volume 1).*
3. Ford K.: *Classical and Modern Physics (volume 3)*
4. Halliday D. & Resnick R.: *Physics.*
5. Hewitt P.: *Conceptual Physics (volume 2).*
6. Ioannou A., Ntanou G., Pittas A., Raptis S.: *Physics (for 12th grade*

Greek Students selecting Science and Technology Orientation).

7. Ohanian H.: *Physics (Second edition, expanded) (volume 2).*
8. Serway R.: *Physics for Scientists & Engineers (volume 1).*
9. Taylor E. & Wheeler J.: *Spacetime Physics.*
10. Young H.: *University Physics Extended Version with Modern Physics (volume 2).*

B. Books Popularizing Physics

1. Einstein A.: *The theory of Relativity*
2. Epstein L.: *Relativity Visualized.*
3. Feymann R.: *Six not-so-easy Pieces.*
4. Gamow G.: *Mr Tompkins in Paperback.*
5. Landau L. & Rumer Y.: *What is Relativity*
6. Stannard R.: *The time and Space of Uncle Albert.*

3. Results

In the analyzed textbooks, we trace two main approaches. The first one is based on the qualitative approach of the theory, with the mathematical formalism coming afterwards. In the second approach, the theory's mathematical formalism is presented first, through which the basic ideas of the TSR arise.

To be specific, the most characteristic approach (A3, A7, A8, A10) is the following: The Einstein's principle of Relativity (1st axiom) is introduced and analyzed using simple paradigms. Based on this, the invariance of the speed of light (2nd axiom) arises. At this point, Galilean transformations are used in order to specify the problems that arise with the invariance of the speed of light, with historical information being given. The usual topic used is Michelson-Morley experiment and the rejection of the ether at the beginning of the 20th century. Einstein's "train paradox" thought experiment is described afterwards, and the relativity of simultaneity is introduced. Using the same set-up and a light-clock, the relativity of time (time dilation) follows and with the use of simple mathematics the mathematical formula is proven. At the end, the relativity of length (length contraction) is introduced as a consequence, through the use of a thought experiment (observers who measure a length) and the relative mathematical formula is also derived. In A9 we find something slightly different: at the beginning a "parable of the Surveyors" is described and the unity of spacetime is discussed. Afterwards, the same course is followed, but length contraction comes before time dilation.

In textbooks A5 and A6, the theory's historical development and the Michelson-Morley experiment are given at the beginning. Afterwards, the theory's axioms are introduced and time dilation and length contraction arise, using the light-clock without referring to the relativity of simultaneity.

In all of the above textbooks, the chapter of Special Relativity continues with the introduction and the elaboration of Lorentz transformation.

On the contrary, in the textbooks A1, A2 & A4, the elaboration of the TSR begins with the mathematical formalism. In the textbooks A1 and A4 there is no chapter dealing exclusively with the TSR. We find the basic points of the theory in various chapters. In textbook A2, the axioms are introduced in two different chapters, whereas in the chapter titled "Theory of Special Relativity: Lorentz transformation" the theory's consequences are derived from the Lorentz transformation.

A common theme we meet, though, in all textbooks dealing with the TSR in a qualitative way, is the use of one or more thought experiments. The most common one is "Einstein's train paradox", which is used for the elaboration of the relativity of simultaneity as originally introduced (A8, A9, A10), or with small changes not in the procedure but in the set-up –e.g. spaceship (A7) or jet-aircraft (A3) instead of train-. This shows that thought experiments can become important educational tools in order to familiarize secondary school students with physics theories of the 20th century [1]. This becomes crucial especially in relation to secondary students, who are not familiar with complicated mathematics –even when they can apply them, they don't know the idea behind them [2]

The popular science books writers approach the TSR in several ways, considering their time and their public.

Specifically, Feymann's approach (B3) is meant for special readers because he uses instruments which are not familiar to everyone (coordinate systems, mathematical formalism) while also making a number of historical reports.

In B1, Einstein himself approaches the two axioms developing philosophical arguments and giving historical evidence. Afterwards, however, he uses a thought experiment to introduce the relativity of simultaneity where he bases the relativity of time. Using the same example he arrives at the relativity of space.

A similar approach is traced in Landau's & Rumer's (B5) book. The examples they use are much simpler and they deal with the first axiom in a more comprehensible way. They use a thought experiment to show the difficulty that arises with the speed of light. In this way they introduce the 2nd axiom and through the use of the same set-up (train that runs in a relativistic speed), they derive the theory's consequences.

In "Relativity visualized", Epstein follows the historical development of the TSR in order to derive the axioms, including a lot of pictures and simple examples. Afterwards, he presents the consequences using thought experiments which take place in spaceships and which are explained at the end.

This point has been traced also in B4 & B6 where emphasis is laid on the consequences of the theory. Through tales of imagination, written in a very attractive way, the protagonists are transported in places where relativistic effects become obvious. The explanations are given indirectly, but the main point is "what happens" and not "why it happens". This poses the risk of these stories being read as fairy-tales or science fiction and not as scientific texts.

As it is obvious, thought experiments are widely used in science popularizing books as well. They are often limited to a descriptive approach and they do not venture towards scientific explanations, which are important for the introduction of the theory in the typical education.

Taken into consideration the above, the related bibliography [3], [4], [5] and a pilot study for the difficulties students face in basic concepts of the TSR [6], a teaching sequence has been designed for the introduction of the TSR. For this purpose, didactical material was designed, combining and drawing ideas and material from all the above approaches.

The conceptual course we followed was the one we found in most textbooks and which we described in page 2 (qualitative approach of the first axiom – reference to the difficulty that arises with the speed of light and subsequent introduction of the second axiom – combining the two axioms, introduction and elaboration of the theory's consequences: relativity of simultaneity, time dilation, length contraction). At the same time, we put aside the mathematical formalism and the complicated terms used by most of the textbooks. Instead, we utilized the examples and the thought experiments that are introduced in the science popularizing books, retaining the set-up (train which moves in relativistic speed) in order to make the picture simpler to the students. In addition, taking into consideration that the concept of the ether is not familiar to the students, the Michelson-Morley experiment was not included. The same subject (the problem that came up historically when the scientists had to combine the principle of Relativity and Galileo's transformation with the speed of light) was developed using the thought experiment we met in B5.

Another crucial point was to avoid presenting the consequences as odd and strange phenomena, and rather to come up with simple examples and justify them using the two theory's axioms. In this way we tried to overcome the difficulty of students classifying them as distortions of perception [2], [7]. More specifically, the steps we followed in order to deal with the consequences were the following:

- Presenting the thought experiment which takes place in a train of vast size moving with a relativistic speed.
- Students had to explain the thought experiment and its results, using the 2nd axiom.
- They were expected to elaborate the thought experiment by comparing and reversing the role of the observers (the one moves with a uniform speed and the other one is stationary) in order to apply the 1st axiom, and finally,
- they were asked to come to the conclusion.

The teaching sequence we designed consisted of 5 meetings. The research method used for the empirical study was that of *teaching experiment*, through which teaching and learning processes are investigated [8]. The sample was

40 students in the tenth grade, from three schools of Athens, working in groups of 4.
At this point, we analyze the data we gathered

- from the questionnaires students answered individually before and after the procedure (pre- and post-test and follow-up test) and
- from the discourses / interviews which were recorded during the meetings.

4. Conclusions

The results of the study, up to this point, are positive since students seem to be able to grasp the basic ideas of the TSR. They work with the TSR's axioms and they can deal with its consequences. This proves that Special Relativity is a field where thought experiments are valuable didactic tools.

Appendix

Books that were studied

A. Textbooks

1. Alonso M, Finn E. Fundamental University Physics, Volume 1, Mechanics and Thermodynamics. Addison-Wesley Publishing Company, 2nd edition; 1980.
2. Berkeley Physics Course, Mechanics, Volume 1, 2nd edition; 1977.
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B. Books Popularizing Physics

1. Einstein A. The theory of Relativity.
2. Epstein L. Relativity Visualized. Insight Press; 1985.
3. Feymann, R. Six not-so-easy Pieces. Addison-Wesley; 1995.
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Education of Nanotechnology with Problem Based Learning (PBL)

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Abstract. *Problem based learning in Nano education increase thinking skills and clear uncertain point of mind and established connection between scientific concepts and consequently, we could move in upper border between scientific education for learners and given scientific learning. The physical and chemical properties of matter can often give us insight into chemical reactivity and behavior. We will implement the PBL pedagogy to learn about "Matter" unit through the real-world application of Nanotechnology in the real life. This research survey way of PBL, and using of it for Nanotechnology, so that students could understand given clues perfectly and, so study how assesses learners correctly.*

Key word. Problem solving train, Nano particles Nanotechnology

Introduction

The year is 1959. Caltech physics professor and Nobel Laureate (1965), Richard P. Feynman delivers a stunning lecture on the possibility of science research from the bottom up. The lecture, cleverly titled, "There is plenty of room at the bottom", suggests that there are no limits on producing things from the atomic level up. He is quoted as saying, "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom." The questions that arose from these lectures were many. But did Feynman really set the spark towards nanotechnology. In 1808, John Dalton, a British Chemist claimed that every single atom of a certain element, is identical. This idea will become Very important later in this perspective. In 1868, Gregor Mendel, A Czech Monk, characterized the structures and functions of heredity. Surely, both of these scientists could not have foreseen what we would do with their work. Probably the most daunting task was to build devices that would allow us to see things that are on the atomic size. The term, "Nano-" itself means a billionth of a meter.This is 100,000 times smaller than a human hair. Feynman suggested in his lecture that we build better microscopes to accomplish the task of seeing things on the atomic level. It wasn't until 26 years later (1981) that we invented the Scanning Tunneling Electron Microscope. This device is widely used in industrial and fundamental research to obtain images of metal surfaces at the atomic scale. It allows us to produce a 3-D profile of the surface, which we can use to characterize roughness, defects, size, and conformation of molecules. The device basically works by placing an atom at the bottom of a very sharp tip of a needle. This needle is brought within close proximity of the surface being tested. Electrical voltage is then applied to the tip. The tip then interacts with the electron clouds on the metal surface. As the distance changes so does the current flowing between the tip and the surface. These changes can then be converted into an image. And thus the ability to work at the atomic scale exploded. It is pretty amazing to think that a lump of coal and a diamond are made of exactly the same chemical: carbon. The only difference is how the atoms are arranged. What would happen if we could manipulate the carbon atoms and manufacture diamonds as easily as M&M's? This certainly raises some questions about how our economic system might change in the near future. One interesting discovery on maneuvering carbon atoms around was in 1985. Scientist Richard Smalley and fellow researchers were able to construct a cage of 60 carbon atoms. It certainly appears that Dalton's basic theory has opened a door for us to fabricate endless things with basic raw elements.

On November 9, 1989 at IBM's Almaden Research Center in San Jose, California, scientists Don Eigler and Erhard Schweizer began a little atomic manipulation project of their own. With company pride they manipulated 35 Xenon atoms to form the logo, "IBM". And thus the era of Nanotechnology began.

Nanotechnology and the National Science Teaching Standards

Below are the National Standards:

✓ Science Content Standards 9-12

- Structure of Atoms
- Structure and properties of matter
- Chemical Reactions
- Motion and Forces
- Conservation of Energy and increase in disorder (entropy)
- Interactions of energy and matter

✓ Science and Technology Standards

- Abilities of technological design
- Understanding about science and technology

✓ Science in Personal and Social Perspectives

- Personal and Community Health
- Population Growth
- Natural Resources
- Environmental Quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

✓ History and nature of science standards

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspective

The physical and chemical properties of matter can often give us insight into chemical reactivity and behavior. This unit focuses on the properties and classification scheme used in science to distinguish between different types of matter. We will implement the problem-based learning (PBL) pedagogy to learn about "Matter" unit through the real-world application of Nano technology.

Lesson Scopes

Below is a brief outline of the scope and sequence of lessons in this unit:

i) Real world science and engineering applications
ii) Educational technologies to build content knowledge
iii) Information technologies for communication, community-building and dissemination
iv) Cognitively-rich pedagogical strategies
v) STEM education and careers investigations.

The lessons can be tailored to include your own common successful instructional strategies.

✓ Lesson 1: Introduction to PBL
✓ Lesson 2: What is "Matter"?
✓ Lesson 3: States of Matter / Phases Changes between States
✓ Lesson 4: Pressure Volume & Temperature / Boyle's Law
✓ Lesson 5: Physical vs. Chemical Changes
✓ Lesson 6: Physical and Chemical Properties
✓ Lesson 7: Nanotechnology Applications
✓ Lesson 8: Experiment
✓ Lesson 9: Assessment

Lesson Plan:
Lesson 1: Introduction to Problem-based Learning (PBL)

What is PBL?

With problem-based-learning (PBL), your teacher presents you with an "ill-structured" problem that has many factors that need to be considered and several possible ways of solving the problem. Since you are not handed the solution, your learning becomes active in the sense that you discover and work with the ideas that are presented in class combined with the research that you conduct individually and in collaboration with peers. Then, you and your peers make important decisions regarding what aspects of the available information are critical for you to solve the problem and craft a solution.

Essential characteristics of PBL:

1. Students must have the responsibility for their own learning (self-directed learning).
2. The problem scenario used in PBL must be ill-structured and allow for free inquiry.
3. Learning should be integrated from a wide range of disciplines or subjects.
4. Collaboration is essential.
5. What students learn during their self-directed learning must be applied back to the problem with reanalysis and resolution.
6. A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned are essential.

7. Self and peer assessment should be carried out at the completion of each problem and at the end of every curricular unit.
8. The activities carried out in problem-based learning must be those valued in the real world.
9. Student assessments must measure student progress towards the goals of problem-based learning.

PBL will provide you with opportunities to:

1. Use technology to examine and try out what you know.
2. Discover what you need to learn.
3. Develop ethical decision-making skills.
4. Improve your communications and social network skills.
5. State and defend positions with evidence and sound argument.
6. Present collaborative solution.
7. Practice skills that you will need after your education.

You may ask your student to work in group and to have some group discussion on problem by PBL.

Presenting an "Ill-structured" Problem:

"The Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars has just put up a new Web site with a searchable list of 212 commercially available nano-products. Thirty-one of those products are cosmetics, which contains tiny nano-capsules full of chemicals. These products claim to be effective in protecting skins from sunshine and aging. But some experts wonder about the safety of highly engineered nanostructures like these. That's because when particles get small, they tend to develop new chemical properties. That might mean unexpected risks. Now your group is contacted by the center to help with their investigation on determining whether the nano cosmetics should be on market".

4.1 Lesson 2: What is "Matter?"

Guiding questions to make connections between matter and nano scale science:

1. What is "Matter?" Give two examples of matter and two examples of non-matter.

"Matter is everything that takes up space and has mass. Matter has different forms / phases: Solid, liquid, gas, plasma, and Bose-Einstein condensates. All matter is made up of small particles (atoms)".

2. What is nanotechnology?

"Nanotechnology is an anticipated manufacturing technology giving thorough, inexpensive control of the structure of matter on a nanometer scale".

3. How small is a nanometer, compared with a hair, a blood cell, a virus, or an atom?

"Nano particle: Particle with one or more dimensions of the order of 100 nm or less"

4. How nano technologies affect the properties of matter?

"Because nano particles exist at a scale smaller than that of human cells, nano particles exhibit different chemical and biological properties than the same materials in larger size".

In tandem with surface-area effects, quantum effects can begin to dominate the properties of matter as size is reduced to the nano scale. These can affect the optical, electrical and magnetic behavior of materials, particularly as the structure or particle size approaches the smaller end of the nano scale. Materials that exploit these effects include quantum dots, and quantum well lasers for optoelectronics. For other materials such as crystalline solids, as the size of their structural components decreases, there is much greater interface area within the material; this can greatly affect both mechanical and electrical properties. For example, most metals are made up of small crystalline grains; the boundaries between the grain slow down or arrest the propagation of defects when the material is stressed, thus giving it strength. If these grains can be made very small, or even nano scale in size, the interface area within the material greatly increases, which enhances its strength. For example, nano crystalline nickel is as strong as hardened steel.

5. What is Nano science? (Ask students to think about "nano" concept)

"Nano science is the name given to the wide range of interdisciplinary science that is exploring the special phenomena that occur when objects are of a size between 1 and 100 nanometers (10^{-9}m) in at least one dimension".

4.2 Lesson 3 & 4: States of Matter / Phases Changes between States

You may ask your students to read the content below:

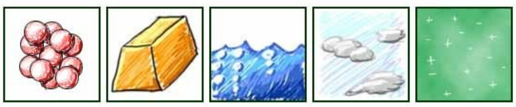

Figure1. Five main states of matter

There are five main states of matter. Solids, liquids, gases, plasmas, and Bose-Einstein condensates are all different states of matter (1).

Each of these states is also known as a phase. Elements and compounds can move from one phase to another phase when special physical forces are present. One example of those forces is temperature. The phase or state of matter can change when the temperature changes. Generally, as the temperature rises, matter moves to a more active state. Phase describes a physical state of matter. The key word to notice is physical. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature or increasing pressure) or if energy is taken away (like freezing something or decreasing pressure) you have created a physical change.

One compound or element can move from phase to phase, but still be the same substance. You can see water vapor over a boiling pot of water. That vapor (or gas) can condense and become a drop of water. If you put that drop in the freezer, it would become a solid. No matter what phase it was in, it was always water. It always had the same chemical properties. All matter can move from one state to another. It may require very low temperatures or very high pressures, but it can be done. Phase changes happen when certain points are reached. Sometimes a liquid wants to become a solid. Scientists use something called a freezing point to measure when that liquid turns into a solid. There are physical effects that can change the freezing point. Pressure is one of those effects. When the pressure surrounding a substance goes up, the freezing point also goes up. That means it's easier to freeze the substance at higher pressures. When it gets colder, most solids shrink in size. There is a few which expand but most shrink.

Now you're a cube of ice sitting on a counter. You dream of becoming liquid water. You need some energy. Atoms in a liquid have more energy than the atoms in a solid. The easiest energy around is probably heat. There is a magic temperature for every substance called the melting point. When a solid reaches the temperature of its melting point it can become a liquid. For water the temperature has to be a little over zero degrees Celsius. If you were salt, sugar, or wood your melting point would be higher than water. The reverse is true if you are a gas. You need to lose some energy from your very excited gas atoms. The easy answer is to lower the surrounding temperature. When the temperature drops, energy will be sucked out of your gas atoms. When you reach the temperature of the condensation point, you become a liquid. Finally, you're a gas. You say, "Hamm. I'd like to become plasma. They are too cool!" You're already halfway there being a gas. You still need to tear off a bunch of electrons from your atoms. Eventually you'll have bunches of positively and negatively charged particles in almost equal concentrations. When the ions are in equal amounts, the charge of the entire plasma is close to neutral. (A whole bunch of positive particles will cancel out the charge of an equal bunch of negatively charged particles) Plasma can be made from a gas if a lot of energy is pushed inside. All of this extra energy makes the neutral atoms break apart into positively and negatively charged ions and free electrons. They wind up in a big gaseous ball.

Lesson 5: Physical and Chemical Changes

During this session, you will have an opportunity to build understanding to help you:

- Refine and extend the particle model to develop an atomic model of matter, and become familiar with some of the history of the evolution of this model.
- Recognize that chemical changes alter particles by rearranging their component atoms into different combinations.
- Recognize that matter is not created or destroyed during chemical changes.
- Recognize that the total number of atoms of each element is conserved during chemical changes.

It is important to understand the difference between chemical and physical changes. The two types are based on studying chemical reactions and states of matter. We admit that some changes are obvious, but there are some basic ideas you can use. Physical changes are about energy and states of matter. Chemical changes happen on a molecular level.

Lesson 6: Physical and Chemical Properties (Nano particles)

The properties of nano particles depend on their shape, size, surface characteristics and inner structure. They can change in the presence of certain chemicals. The transition from micro particles to nano particles can lead to a number of changes in physical properties. Two of the major factors in this are the increase in the ratio of surface area to volume, and the size of the particle moving into the realm where quantum effects predominate.

Ask students what are the chemical and physical properties of the Nano Sunscreen.

Lesson 7: Nano Applications - Sunscreen

Sunscreens are designed to protect against sunburn (UVB rays) and generally provide little protection against UVA rays. They come in two forms:

Chemical Sunscreens contain chemicals such as benzophenone or oxybenzone as the active ingredient. They prevent sunburn by absorbing the ultraviolet (UVB) rays.

Physical Sunscreens contain inert minerals such as titanium dioxide, zinc oxide, or talc and work by reflecting the ultraviolet (UVA and UVB) rays away from the skin.

A sunscreen with a SPF of 15 filters out approximately 94% of the UVB rays. One with a SPF of 30 filters out 97%. The SPF applies for UVB rays only. The protection provided against UVA rays in chemical sunscreens is about 10% of the UVB rating.

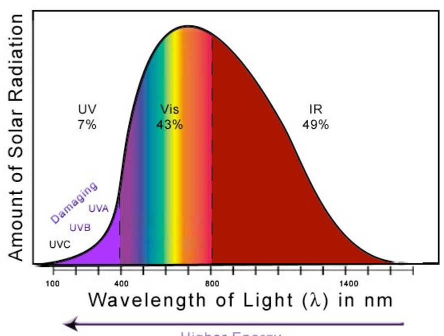

Figure2. The Sun's Radiation Spectrum

Essential Questions (EQ): What essential questions will guide this unit and focus teaching and learning?

1. What are the most important factors to consider in choosing a sunscreen?
2. How do you know if a sunscreen has "nano" ingredients?
3. How do "nano" sunscreen ingredients differ from most other ingredients currently used in sunscreens?

Lesson 8: Experiment

Titanium Dioxide is a fantastic example to use to teach chemistry and nanotechnology at the same time. One of the most interesting features of this incredible photo catalyst is that it can break down almost any organic compound (mold, bacteria) it touches in the presence of UV light. Hence, it can clean itself. Here are some examples of reactions, which focus on Titanium.

Reaction of titanium with air: Titanium metal is coated with an oxide layer that usually renders it inactive. However once titanium starts to burn in air it burns with a spectacular white flame to form titanium dioxide,TiO_2(1) and titanium nitride, TiN(2). Titanium metal even burns in pure nitrogen to form titanium nitride.

1) $Ti(s) + O_2 (g) \longrightarrow TiO_2(s)$
2) $2Ti(s) + N_2 (g) \longrightarrow 2TiN(s)$

Reaction of titanium with water: Titanium metal is coated with an oxide layer that usually renders it inactive. However, titanium will react with steam form the dioxide, titanium (IV) oxide, TiO2, and hydrogen, H_2 (3).

3) $Ti(s) + 2H_2O (g) \longrightarrow TiO_2(s) + 2H_2 (g)$

Reaction of titanium with the halogens: Titanium does react with the halogens upon warming to form titanium (IV) halides. The reaction with fluorine requires heating to 200°C.

The actual process and reactions for making nano particles of titanium dioxide is a bit complicated, but learning the general process is more important. The great thing about the nano titanium is its high surface area. It is this high surface area that allows the chemical to react faster. This, of course, is very important if you are creating a nano sensor to detect a chemical agent. In the event of a disaster, you want to be able to detect and identify the toxin quickly.

1) How many different active ingredients did most of the sunscreens have?
2) What were the most common active sunscreen ingredients you saw? Are these organic or inorganic ingredients?
3) Did any of the sunscreens you looked at have active ingredients that were very different from the rest? If so, what were they?
4) Were you able to find a sunscreen with inorganic ingredients in it? If so, which one(s) contained them?

5) How many of your sunscreens claimed to have UVA protection? UVB protection? Broadband protection?

6) Why do you think that many sunscreens have more than one active ingredient? Why can't they just put in more of the "best" one?

7) You have just looked at a sample of the different chemicals you are putting on your skin when you use sunscreen. Does this raise any health concerns for you? If so, what are some of the things you might be concerned about and why?

8) Where could you go to find out more information about possible health concerns?

4.3 Lesson 9: Assessment

National Assessment Program Science Literacy (2006):

The five elements of scientific literacy, including concepts and processes include:

1. Demonstrating understanding of scientific concepts,
2. Recognizing scientifically investigable questions,
3. Identifying evidence needed in a scientific investigation
4. Drawing or evaluating conclusions, and
5. Communicating valid conclusions.

The following criteria may be included to assess students' PBL learning process:

5.1. Formulating or identifying investigable questions and hypotheses, planning, investigations and collecting evidence: This process domain includes: posing questions or hypotheses for investigation or recognizing scientifically investigable questions; planning investigations by identifying variables and devising procedures where variables are controlled; gathering evidence through measurement and observation; and making records of data in the form of descriptions, drawings, tables and graphs using a range of information and communication technologies.

5.2. Interpreting evidence and drawing conclusions, critiquing the trustworthiness of evidence and claims made by others, and communicating findings: This process domain includes: identifying, describing and explaining the patterns and relationships between variables in scientific data; drawing conclusions that are evidence-based and related to the questions or hypotheses posed; critiquing the trustworthiness of evidence and claims made by others; and, communicating findings using a range of scientific genres and information and communication technologies.

5.3. Using science understandings for describing and explaining natural phenomena, making sense of reports about phenomena, and for decision making. This process includes demonstrating conceptual understandings by being able to: describe, explain and make sense of natural phenomena; understand and interpret reports related to scientific matters; and, make decisions about scientific matters in students' own lives which may involve some consideration of social, environmental and economic costs and benefits.

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F files. A different book of physics.

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Abstract. *To revitalize interest of students for sciences and especially for physics, I wrote this "mini-book" in the hope that we help our students who love Physics. For helping students to get a good knowledge we have suggested them to achieve his own book. How? At the beginning of a chapter or at the end, we formulate a series of questions which entailing the answers that students give us, in order to set the necessary knowledge.*

Keywords. Mechanical, Thermal phenomena (thermodynamics and molecular physics), Electricity and magnetism, Optics, Atomic and nuclear physics, Book, Students.

Enhancing creativity and activism in teaching – important task in the club "Inquisitive Mind"

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Abstract. Stimulation of activism and creativity in school involves fostering an environment of interactive learning, exciting and dynamic. Cooperative learning ensures optimal development of field relations and active creative manifestation of the student in class. This is an important aspect in the functioning of "Inquisitive Mind" club of "Eugen Lovinescu" theoretical high school.

Keywords. "Inquisitive Mind" club, "Eugen Lovinescu" Theoretical High School.

1. Introduction

The active and creative attitude of students is the consequence of both the learning style of the teacher and the student's habit of reporting to duty.

The learning of learning – desiteratum of the post-modernist education style – requires interactivity and creativity in adopting strategies requesting task involvement and a metacognitive attitude of learning and knowing, but also interest in continuous perfectioning.

Stimulating school activism and creativity requires the bulding of an interactive, exciting and dinamic learning environment. Cooperation learning ensures the development of an optimal relations field needed for the creative and active actions of the student. Typical situations and conditions leading to the development of the investigative spirit, divergent thinking, creative and active attitude at school can be:

- Encouraging constraints and frustration-producing factors
- Communication stimulating by organizing open discussions and debates between students, or students and teachers
- Activating students by requesting them to operate with ideas, notions and objects in order to reconsider them and to advance new variants
- Cultivation of cognitive independence, spontaneity and learning authonomy
- Stimulating the growing of constructive critical spirit, argumentation capacity and alternative searching capabilities
- Enabling access to knowledge by the student's own strengths, thus stimulating the reflexive attitude needed for their own learning steps
- Enabling the student's possibility of challenging the "known" and the "unknown" in things and facts.

The teacher is the one who needs to find the most effective ways of stimulating each student's creative potential.

All the activities proposed to students in order to increase their degree of active implication at school need to ensure:

- Stimulation of productive, critical, divergent and lateral thinking
- Freedom of expressing knowledge, thoughts and facts (in this case, activities requiring spontaneity and contributing to the development of independence in thinking and taking actions are recommended)
- Using talents and capacities specifical to each individual
- Inciting interest to the new, to the unknown, and offering the satisfaction of finding the solution after the student's efforts
- Practising investigation capacities, ideas, information, meaning trasfer and classification criteria searching
- Development of the material and idea organization capacity, by elaborating portfolios about own activity, organizing discussions on certain themes or initiating games and trips
- Educating the capability of seeing things *in another way*, of asking unusual questions about usual things. Quoting the "Psychological Dictionary": *Under the incidence of requesting as many as*

possible original unusual answers, a mobilization of potential creativity takes place.This can be recognized by the growing number and diversity of answers at creative indiduals, and also by the differences of originality, flexibility and fluidity in their answers.

In projecting *active and creative learning* , we suggest anticipating certain managerial schemes, applicable in time and space through:

- Classifying the purpose of creative learning at the level of existent interaction between: intelectual operativity – school performance – permanent restructuration of the teaching-learning activity – evaluation
- Stating the teacher's duties in the given conditions of creative learning
- Creating an optimum affective atmosphere, needed for the gradual canceling of lock-up factors (fear, tension, imitation, conformism, criticism)
- Psychological turning to good account of the teacher-student correlation at every level contained by the intelectual-moral-technical-estetical-phisical education.

The learning activation does not mean overstressing the student with activities; it must be thought of as an intensification of the teacher's work of offering students learning opportunities. This way, teaching becomes the activity through which the teacher creates favourable conditions to the student's learning process.

In order to stimulate the student's activism and creativity, the teacher himself has to be the active and creative type and to adopt a positive behaviour and attitude in this regard.

A good teacher gives the student the opportunity of assuming intelectual risks, speculating, making unusual connections, but also offers him comfort in situations of frustration, failure, uncertainty. The teacher should provide students with learning materials and information sources. Students collect information from many and very varied sources. So, the school needs to keep the pace with the technology, renewing the database and the learning methods.

One of the most certain ways of generating, stimulating and developing new ideas in order to solve different situations, is the organizing of microgroups and promoting interactions between their members. Group creativity has established itself because it manages to welcome the needs of solving problems unsolvable by the individual, in time.

The school of the future will surely be cibernetized, a living computer laboratory, that will prepare students, from an early development stage, to become problem solvers, creators of new and persons capable of taking optimal decisions against the more and more unusual and unprecedented situations of the present-day and following social life.

The fundamental objective of superindustrial teaching (Alvin Toffler) has to be the development of the individual's adaptive capacity, for them to be able to easily and quickly adapt to permanent novelty. And the quicker the changing rhytm is, the more attention is required to distinguish the type of events to happen.

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Bernoulli Law

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Abstract. *We will present important laws in Physics verified trough simple experiments (Bernoulli's Law). The movement of a fluid is completely described only if the speed and pressure of the fluid is known in its every point. This means that we need to know the speed field ($\vec{v}$) and also the pressure field.*

If the fluid's speed is constant in different points of its movement path, we say that the fluid has a stationary at a permanent regime movement. A fluid moving due to the action of the Earth's gravitational field behaves similarly to an object thrown horizontally. The fluid's speed can also be considered as the speed of an object freely falling. The Bernoulli's Law is verified by obtaining identical results for the flowing speed of a fluid, considered as the speed of an object freely falling from a defined height (h), or as the speed of an object thrown horizontally.

Keywords. Bernoulli, Torricelli, Fluid, Vessel, Height, Pressure, Verification, Experiment.

1. Introduction

The idea to approach this issue started from two problems that we encountered in the book of Professors David Halladaz and Robert Resnick (Physics vol. I).

A liquid percolating through a hole in a large bowl, the hole being located at a distance below the water level by applying Bernoulli's equation of power lines joining points 1, 2 and 3 show that the flow velocity is $v = \sqrt{2gh}$. This relationship is known as the Torricelli's law (Figure 1).

Upper surface of the water from a reservoir is at a height above the horizontal period. What depth have been a vent than for shoot water out horizontally to hit the ground at a distance of the tank (Figure 2)?

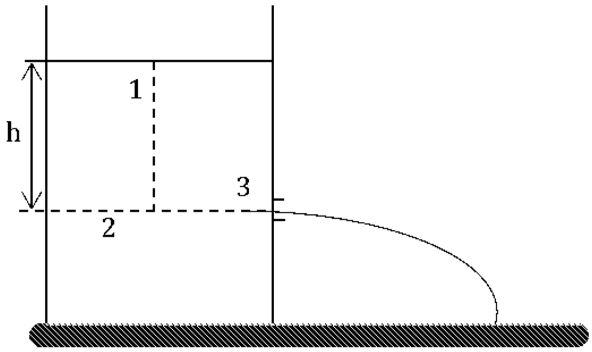


Figure 1. Torricelli's law

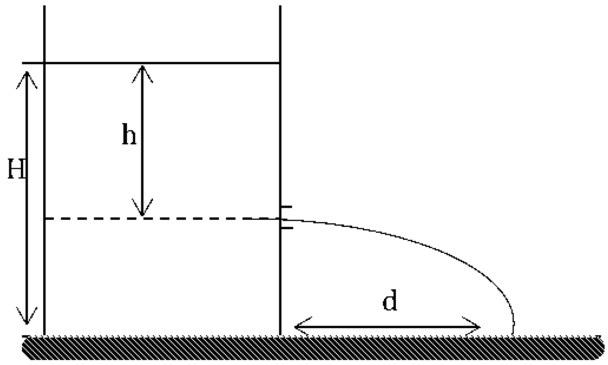


Figure 2. Interpretation of Torricelli's law

2. Necessary materials:

- a 2 liter plastic bottle in which we practice a unique opening at height *H/h* towards the bottom;
- graph paper glued on length glass;
- rule;
- horizontal tray to drain water.

3. Theory of experimental work:

The liquid flowing out through the inlet section is considered to be in steady flow. Applying Bernoulli's law for the tube current between sections *S* and *s* we get:

$$p_a + \frac{\rho v_0^2}{2} + \rho g h = p_a + \frac{\rho v^2}{2} \quad (1)$$

where v_0 is the speed with which the liquid down in the vessel.

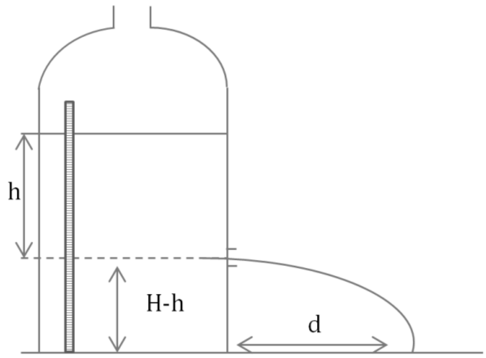


Figure 3. Theory of experimental work

If S sectional area is much larger than the section through which fluid flows ($S >> s$), based on the continuity equation can neglect the term $\frac{\rho v_0^2}{2}$ in equation (1) ($v_0^2 \longrightarrow 0$).

Bernoulli's law gets the following form:

$$p_a + \rho g h = p_a + \frac{\rho v^2}{2}$$

$$\rho g h = \frac{\rho v^2}{2} \quad \text{and} \quad v = \sqrt{2gh} \quad (2)$$

This law is called Torricelli's law and shows that the fluid flow velocity in this case coincides with the speed of a body falling freely from height.

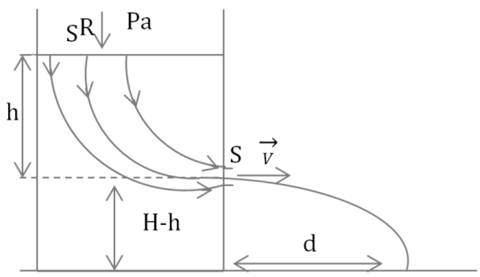


Figure 4. Bernoulli *vs.* Torricelli laws

Evaluation of fluid flow rate through the section can be made by measuring the distance that a jet crosses the horizontal stroke (*d*).

Fluid motion in gravitational field is similar to throwing horizontally so that the speed is given by:

$$v = d\sqrt{\frac{g}{2(H-h)}} \quad (3).$$

Verification of Torricelli's relationship just comparing flow velocity values obtained with relations (2) and (3).

As a work do the following:

- for determining speed of fluid flow and to chech Torricelli's law , is measured at different moments of time (close together) height using graph paper, using the rule that beating located near vessel;
- the data and the results are recorded in a table and compare the results.

$$\sqrt{2gh} = d\sqrt{\frac{g}{2(H-h)}}$$

$$d = 2\sqrt{H-h}\sqrt{h} \quad (4)$$

where $H-h$ is constant. Verification of relationship (4) can be done graphically representing $d = f(h)$. The slope of the line is $tg\alpha = 2\sqrt{(H-h)}$. Determine the height ($H-h$) of slope chart ($H - h = \frac{tg^2\alpha}{4}$) and compared with experimentally determined value.

4. Calculation errors:

$$\Delta v = \Delta g + \Delta h$$

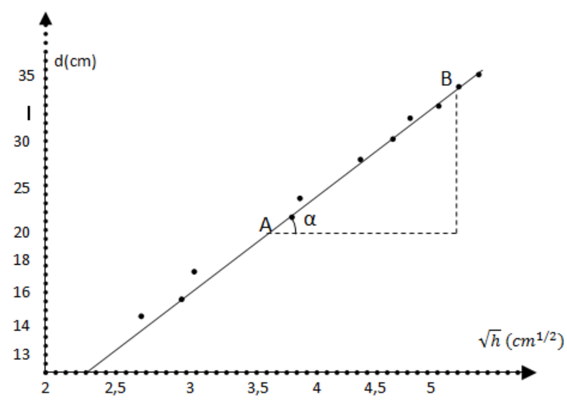
$$\Delta v' = \Delta d + \frac{1}{2}\Delta(H-h) + \frac{1}{2}\Delta g$$

if $g = 9{,}81\frac{m}{s^2}$, $\Delta g = 0{,}5 \cdot 10^{-2}\frac{m}{s^2}$

$$\Delta(H-h) = \Delta d = \Delta h = 1mm$$

5. Experimental data. Interpretation:

We present, for a number of determinations, the graphical representation of relationship $d = f(\sqrt{h})$.



$$tg\alpha = 6{,}387\ cm^{1/2}$$

Obtain $H_{calculat} = \frac{tg^2\alpha}{4} = 10{,}2\ cm$ in comparison with

$$H_{experimental} = 10\ cm$$

which means a relative error:

$$\Delta_h = \frac{H_{calculat} - H_{experimental}}{H_{calculat}} = 1{,}9\%$$

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Hands-on amphibians: teachers comparing traditional with hands-on instruction

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Abstract. *In the present paper I report the teachers' views about implementation and evaluation of two types of instruction. One included students working with (experiencing) live amphibian species and the other was in a form of traditional instruction.*
Results from written interview with teachers show that teachers generally approve and are fond of working with live animals in life science instruction. They see the beneficial effects on students developing competences beyond factual understanding of the topic of instruction. At the same time, they perceive many obstacles that are preventing them to effectively introduce students to live animals.
Implications for life science instruction are discussed.

Keywords. Amphibians, Instruction, Live animals, Teachers' views.

1. Introduction

Past decades have seen an extensive research on effectiveness of different teaching approaches with the purpose of improving children's knowledge, attitude and behaviour in life science instruction. Some authors argue, that biology without living organisms in instruction is for students dull and disconnected with nature [1]. If students meet nature in nature or nature is "brought" into the biology classrooms, the quality of instruction increases [2]. Despite that, there are reports about decrease of practical work, experimental work and fieldwork in life science instruction [3]. Although, there are reports that practical work by itself doesn't always have the strongest effect on long-term decisions about pro-science engagements of students in future life, it most certainly has short time effect on students' interest in practical work and motivation to learn [4].

Students are generally fond of working with live organisms. They like to learn about animals over plants [5]. Much too often, we are looking at the effects of instruction solely on the amount of information students can recall or the level of conceptual understanding they poses about given topics. Other dimensions of students' competences are in most cases neglected. In the year 2006, the European Parliament published a framework of eight key competences for lifelong learning [6]. Each competence is presented as a set of knowledge, skills and attitudes appropriate to the context. Morgan found that only the balanced amount of information and level of involvement leads to forming "appropriate" attitudes [7]. It is therefore necessary to design such instruction that would build on all three components of competences.

Although, amphibians are one of the most endangered animal groups and are facing worldwide extinction [8], there is few empirical data present on how people perceive these organisms. There are several classroom and field activities published about amphibians that teachers can use for their instruction [9, 10]. But there is almost no data how different types of instruction help children to learn about and appreciate amphibian diversity [11, 12]. Children perceive some amphibian species especially toads as disgusting, slimy, non attractive species that are spitting poison onto people and give them warts. In a study conducted by Tomažič, seventh graders rated toad as the most disgusting among 20 animals listed [13]. Direct experience in that study turned out to be the most important factor in forming students' attitude and acquisition of knowledge.

2. Methods

This work is the follow-up study that was conducted in a year 2004/2005, where I investigated the effect of different types of instruction on seventh grade students' knowledge about and attitude toward amphibians [12]. In that research I was also carrying out both instruction types myself.

The present study took place in the end of the year 2009. The study was conducted as a part of the project entitled "*Development of Natural Science Competences*" performed at the Faculty of Natural Sciences of University of Maribor.

2.1. Design of the study

2.1.1. Participants

Teachers who participated in this study, were all biology (science) teachers with at least five years of teaching experiences. They were chosen as evaluators of the provided teaching materials (unit).

Students involved in the study were from sixth and eighth grades of primary school and second grade of secondary school (Gymnasium). On account that research is still in progress, final sample of students is not yet known.

The reasons for choosing students of those grades was, because according to our science-biology curricula, students of sixth grade could met/have learned about amphibians on elementary level, students of eighth grade met/have learned about amphibians in lower sixth and seventh grades and high school students did not learn about amphibians in first year of high school.

All teachers taught both teaching methods to students with the same education level. This way we will be able to compare different instructional types and at the same time assess the level of knowledge and attitude of students before any of our methodology has been incorporated into instruction.

2.2. Teaching unit

This part explains both types of instruction that were used in our research. After invitation, teachers were informed about the topic of our research, but not of our research questions. Teachers were first asked about their most frequently used instruction types. Then they were instructed to prepare teacher-centred instruction by themselves. They were given only detailed instructions, which concepts must they cover during their two school hour unit and one page reminder about the steps of teacher-centred instruction [15].

After they have completed this part of instruction, they met with the researcher (each teacher met with the researcher separately). On that meetings (4 school hours) every teacher was given information on how to carry out hands-on instruction using live animals [14], learned how to work with individual amphibian species and was informed about the most frequent difficulties that could emerge within such instruction (e.g. expressed fear or disgust and avoidance in students).

Topics of both instructions were:

- amphibian species of Slovenia (the common toad (*Bufo bufo*), the green frog (*Pelophylax sp.*), the European tree frog (*Hyla arborea*), yellow-bellied toad (*Bombina variegata*), the European fire salamander (*Salamandra salamandra*), the alpine salamander (*Salamandra atra*), the alpine newt (*Triturus alpestris*), the Italian crested newt (*Triturus carnifex*) and the cave salamander or olm (*Proteus anguinus*),
- biology of amphibian species of Slovenia,
- understanding the concept 'amphibians',
- conservation biology and worldwide decline of amphibian species.

2.2.1. Teacher-centred instruction

All teachers decided to use overhead transparencies as their main teaching material. In the first school hour they presented several amphibian species of Slovenia and their biology to the students. Second school hour was reserved for generalizing the concept of amphibians, learning about conservation of amphibian species and drawing general conclusions on the learned material. The main focus of that instruction was the teacher, who presented this topic to the students. Students were in the course of instruction allowed to pose questions to the teacher and discuss their experiences with the teacher.

2.2.2. Hands-on (experiential) instruction

In this type of instruction, for the first school hour, teachers' main activity was to give students instructions on what they will be doing and instructed them on how to work with animals. Every teacher included at least four species of live amphibians in the course of instruction. In the first part, students had the opportunity to observe animals in closed containers (each animal for approximately five minutes) and try to find out as much as possible about them. For the purpose of not harming the animals in the next 20 minutes of the first school hour, the students had the opportunity to come with teacher's guidance in direct contact with individual amphibian species. Detailed description on how to work with amphibians can be found in Schneider et al. [10]. The second school hour has been reserved for the same topics as in teacher-centred instruction. In addition teacher skimmed through species that were used in the first school hour. The rest of the material was the same as in the second school hour of teacher centred instruction.

Figure 1. Observing animals; photo by Romana Čuješ

Figure 2. Handling of an animal (toad); photo by Petra Kavčič

Figure 3. Observing an animal; photo by Petra Kavčič

Figure 4. Observing eating; photo by Petra Kavčič

Figure 5. Sample MSPowerPoint slide

2.3. Students knowledge and attitude assessment

Students were given questionnaires that assessed their knowledge about amphibians and attitude toward toads prior to the instruction and two times after instruction. As mentioned before, analysis of this data is still in progress.

2.4. Teachers evaluations

This part presents the main focus of this paper. Teacher's role was to evaluate provided teaching materials in their classrooms and suggest possible improvements for instruction. A questionnaire was constructed that could help teachers with evaluation. There were 16 open-ended questions included. The questionnaire focused on four main topics:

(1) comparison of traditional with hands-on instruction.

(2) advantages and disadvantages of introducing live animals into instruction.

(3) suitability of the topic for individual grade

(4) suitability of the questionnaires for the students

Teachers were also offered the following instructions: "As evaluators, you have gained immediate insight into children's acceptance of teaching unit and changing attitudes toward organisms. Now, I would like you to answer the following questions.

Five teachers evaluated their work. For each, the codes were assigned (U1, U2, U3, U4 and U5).

3. Results with discussion

3.1. Comparison of traditional with hands-on instruction

Below is the excerpt from two teacher's answers when comparing traditional with hands-on instruction.

Teacher 1: "*In traditional teaching approach, instruction was focused mainly on my explaining, clarifying and stating facts. For this type of instruction, I have prepared PowerPoint presentation. In that presentation I have included a lot of pictorial material and several movie clips which were displaying feeding and reproductive behaviours of some amphibian species. Some students displayed interest about the topic while other students were not so interested. In hands-on type of instruction I placed students in a circle. All were actively involved in experiencing animals. They had the opportunity to observe each other, their reactions to live animals. After experiencing animals, they listened very carefully to my explanations.*"

Next question was asking teachers about motivation/interest of students according to different instruction types.

Teacher 2: "*In hands-on type of instruction students motivation was higher. Some students were expressing fear and revulsion toward amphibians. They didn't want to have any direct contact with them. In contrast to those students, some students didn't want to stay without direct experience with live animals. According to their explanations, the instruction was interesting and the time passed quickly. In traditional type of instruction students were motivated when I showed them movie clips, otherwise it was just an ordinary school hour.*"

Also, all teachers were experiencing hands-on instruction more demanding as teacher centred instruction. There was more effort needed to prepare teaching materials and animals for instruction. In their opinion, hands-on instruction itself is more demanding, because it requires greater organizational skills and greater skills of working with students from teachers.

While classical hands-on instruction is not the same as inquiry, teachers still had to first let students experience animals by themselves, posing questions on the basis of gained experiences and communicating their questions with teachers. One such example is observing feeding ("*What does this animal eat? - What do you think? - Insects.- Let us try and feed it.*"; Figure 4).

This is in accordance with Crawford, where she stated that teacher in such instruction is confronted with a set of quite different teaching strategies. Instruction like this situates inquiry in a context, this way teachers embrace inquiry as a content and pedagogy, collaboration between teacher and students enhances inquiry, teacher and student roles become more complex and this type of instruction is demanding greater levels of involvement by teachers than in traditional teaching. In that kind of instruction teachers' roles are versatile, they are motivators, diagnosticians, guides, innovators, experimenters, researchers, modelers, mentors, collaborators and learners [16].

One teacher in our study mentioned that some students were frightened at the beginning and they were avoiding being close to the animals. But when they met live animals and when they saw their peers working with animals, they come closer to the animals and even tried to come in contact with them. According to Bandura, modelling represents one of the main sources of information for self-efficacy appraisal. Students who observe peers who successfully perform a task can be more certain that they too are capable of accomplishing that task. As a consequence, the achievement of those students is higher. Self-efficacy therefore refers to beliefs about one's capabilities to learn or act in a certain way [17]. In our hands-on instruction fearful students were encouraged to come in direct contact with animals by peers (peer - modelling) and teachers (expert-modelling) what in consequence influenced students' behaviour.

Students who participated in teacher centred instruction had to be additionally motivated with different stories and teacher told experiences with animals. One teacher stated that pictorial material alone didn't suffice to enhance students' communication, while the other teacher reported that short movies about animals heightened students' interest. Furthermore, students were expressing the wish to see live animals. All teachers stated that motivation of students was higher in hands-on instruction.

Observation skill is in teachers' opinion one of the most important skills that students were developing. This skill is vital for any naturalist and we should develop it in schoolchildren [18]. Beside that children were to higher extent developing skills of handling animals and building more on the concerns for animal wellbeing thus forming positive attitudes toward animals.

3.2. Advantages and disadvantages of introducing live animals into instruction

Teachers mentioned several drawbacks that limit including live animals in to instruction. The main problems mentioned were: (1) unsuitably equipped facilities. One teacher doesn't have a room for keeping animals and other teaching materials and is keeping them in the classroom. In this classroom, a several teachers teach different subjects, not only science. (2) Teachers mentioned legislation that is very strict and limits the use of live animals from local environments as well as keeping animals bought in pet stores. (3) Teachers mentioned students negative emotions and attitudes that children have toward some animals. This I do not see as limiting factor because that is also the reason why it is so important that children beside gaining knowledge are at the same time building on their attitude. With only teacher-centred instruction, their attitude would not be affected as much as it would be in student centred instruction [12].

Teachers acquire live animals mainly from local environments, pet stores or institutions such as universities.

They also believe that they are well prepared for working with live animals. They all agreed that researcher's advice on how to handle animals and methodology of presenting them to the children was useful for them. Amphibians are organisms that require special care. Their skin is generally very sensitive and can be easily damaged.

One teacher clearly stated that science and biology curricula are demanding much greater knowledge from students that can be gained through hands-on instruction alone. Practical work is in teachers' opinion therefore not quite compatible with curricular demands.

Other teachers believe that sixth and seventh grade Science curricula are suitable for such instruction. They perceive grater difficulties in eighth grades, where they believe that biology curricula is overloaded. That is also the reason why teachers are including taxonomy topics in sixth and seventh grades although it is not obligatory.

In high school there is one additional problem for hands-on instruction. Namely, there are as much as 32 students in each classroom. In this way teacher feels very constrained about practical work and recommend dividing classes to at least two groups in order to achieve quality instruction.

3.3. Suitability of the topic for individual grade

Teachers pointed out two main problems about hands-on instruction with the use of live animals. This type of instruction is more time consuming than it is teacher-centred instruction.

Also, work of a biology (life science) teacher is in their opinion more demanding than any other science subject. Namely, if life science teacher likes to offer students direct experiences with organisms and nature, he or she would need to take students outdoors or "bring nature" to the classroom. For this, much time to find and prepare teaching materials is needed. In case of using animals, teachers also need more time to take care of the animals. Not all teachers especially primary school teachers didn't have assistant. Biology teachers would need assistants who are well prepared to work with and are able to take care of living organisms.

Teachers are convinced that the main goal of science should not be remembering concepts only, but students should be able to explain different phenomena.

3.4. Suitability of the questionnaires for the students

Students generally didn't have much difficulties understanding methodology of the questionnaires. Teachers mentioned the lack of students' knowledge about the topic of the survey and sometimes lack of broader knowledge (e.g. not knowing the names of the Earth's continents from which students had to figure out where is the highest diversity of amphibian species) that prevented students to answer questions correctly. Some students didn't see the reason, why they must answer questionnaires again after instruction, and majority of students were glad that they were not graded on the topic of instruction.

4. Conclusion

Teachers believe that hands-on instruction contributed to higher motivation and higher interest of students than teacher-centred instruction. In first type of instruction, students' attitude changed more than in later type of instruction. Two teachers had to prolong hands-on instruction into third school hour because students showed great interest in experiencing live animals. Teachers reported that students were much more active in that type of instruction and were posing a lot of questions. Teachers believe that students in hands-on instruction learned more than their counterparts in teacher centred instruction. Teacher generally favour hands-on approach when students are learning about animal diversity. But they are pointing on several limitations of that type of instruction that must be addressed in the future: (1) lack of facilities for keeping live organisms, (2) restrictive legislation, (3) science and biology curricula are overloaded and (4) the need for well educated assistants.

5. Acknowledgements

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Optical elements applied in simply building of toy realised by students in Fun Club Science

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Abstract. *Optical elements were applied in simply building of toy realised by students in Fun Club Science, which is a club from „Emil Racoviţă"High School Baia Mare.*

The toys are using mirrors for studing the reflexion phenomenon.

Students were organised in groups of three members. Each working group developed experiments. Students have taken photos and videos that accompany the explanations of experiments. Students have prepared files (PowerPoint presentations / video that accompany the explanations of experiments) with the proper software. I will organise an exhibition in the school with results of the project. The result is "Fun and learn!" thematic posters.

Keywords. Mirror, Racovita High School Days, Physics Club.

1. The beginnings of the club

It all took place as a "relay race" between the students in the classes I was a headmistress to and the students who participated in the activities of the "Saturday School Project" and Physics Club.

Working in projects has been an organized way of spending leisure time. It was also been pleasant and useful and it was accompanied by formative and stimulative appreciations. These activities in fact lay the foundations of life long education and learning. [1]

To show students that SCIENCE is a very interesting and thus to encourage them to learn it I made this club. Preparing exhibition about students projects in our school.

Now we have a virtual space for students projects .It is the online project is name "Fun Club Science -Open doors to the world" .It is a virtual Fun Club Science.

The Subjects is: Astronomy, Chemistry, Informatics / ICT, Natural Sciences, Physics

Languages used is português - english - română

We used tools: e-mail, MP3, other software (Powerpoint, video, pictures and drawings), virtual learning environment (communities, virtual classes, ...), web publishing

The result is "Fun and learn!", thematic posters, pupils create an information-rich photo gallery of their partners entertaining physics class, probably „The entertaining science ",CD, www .

About one activity view link MAGIC number 05.05- 5th anniversary: MAGIC DAY from site project eTwinning [2].

2. The projects

The toys are using mirrors for studing the reflexion phenomenon.

2.1. The number of images in mirrors

Bianca & Ionut were determinated which is the connection between an dihedral angle and a number of images in mirrors.

Figure 1. Bianca, Ionut and mirrors

When the dihedral angle is 90˚ result 4 images, when the dihedral angle is 60˚ result 6 images.

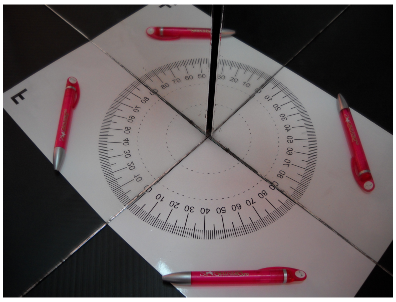


Figure 2. When the dihedral angle is 90˚ result 4 images

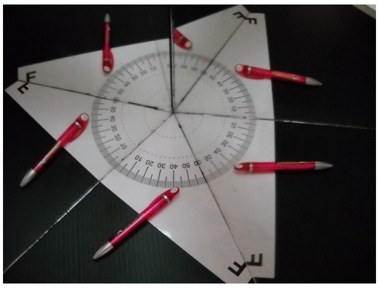


Figure 3. When the dihedral angle is 60˚ result 6 images

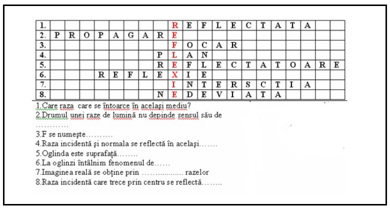
2.2. “How to make a caleidoscope?”

The project "How to make an caleidoscope?” was made by Noemi, Ramona and Carmen. Their project are related to etymology of the word "kaleidoscope",history of kaleidoscope, reflection symmetry, fractal and their made a worksheet.In theres objects several mirrors (3,4,5 or 6) are attached together.

Figure 4. At work ...

Their project is finised with an Crossword Puzzle

Or “Another REVISION “ Learn and FUN !



1.									R	E	F	L	E	C	T	A	T	A		
2.	P	R	O	P	A	G	A	R	E											
3.									F	O	C	A	R							
4.								P	L	A	N									
5.								R	E	F	L	E	C	T	A	T	O	A	R	E
6.				R	E	F	L	E	X	I	E									
7.									I	N	T	E	R	S	C	T	I	A		
8.								N	E	D	E	V	I	A	T	A				

1.Care raza care se întoarce în acelaşi mediu?
2.Drumul unei raze de lumină nu depinde sensul său de …………
3.F se numeşte……….
4.Raza incidentă şi normala se reflectă în acelaşi…….
5.Oglinda este suprafaţă……..
6.La oglinzi întâlnim fenomenul de……
7.Imaginea reală se obţine prin ……............ razelor
8.Raza incidentă care trece prin centru se reflectă……..

Figure 5. Crossword Puzzle about reflection

3. Fun an learn about: laser, light and transmits data

We have built a laser transmitter that transmits data by laser light on and off, intermittently, by a bulb that will light up.

I have removed optic fibres and transmitted the light through the air only, which is called free space transmission of laser data.

For the laser data transmitter you need the following components:
package laser, a bulb, a circuit board ,a 9 volt battery, a screw or nail about 2 inches long with a flat head, a small wooden block for a basis, tape and some glue to hold them together.

The basic idea of this project was the wireless transmission, a technology increasingly more and more requested and used, technology that transmit signals from one place to another without wires, which can light a bulb located at a distance just by sending laser signals.

4. Virtual Fun Science Club

Now we have a virtual space for students projects .It is the online project is name “Fun Club Science -Open doors to the world”. It is a virtual Fun Club Science [3].

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[2] site project ETwinning: http://www.etwinning.net/en/pub/anniversary/index.htm http://www.friendsandflags.org/

[3] site project Fun Club Science -Open doors to the world: http://new- twinspace.etwinning.net /web/p29527/welcome

“Distance dependence” or “Angle of sun rays Incidence dependence”? The Design of an Experimental Device for teaching about Seasonal Change

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Abstract. *The present study focuses on the presentation of an experimental device which was designed for serving the purpose of teaching about Seasonal Change.*
Late bibliography illustrates that students adopt mainly "Alteration in the distance between the Sun and the Earth" as a Scheme of explanation for the concerned phenomenon, no matter whether they have been taught its scientific model or not.
Bearing in mind that "dissatisfaction with existing conceptions" is a basic presupposition for conceptual change; students' initial Scheme of explanation about Seasonal Change must be confronted with the scientific one.
Therefore we designed an experimental device, using a model of the Earth, an illuminated model of the Sun and a photometer in order to check i) distance between the Sun and the Earth and ii) angle of the sun rays incidence on the Earth, as independent variables, concerning the prostrated radiation of light on the Earth.

Keywords. Conceptual Change, Photometer, Seasonal Change

1. Introduction

In the past three decades many researchers have examined children's and adults' ideas of basic astronomical events [1]. Some of these studies concerned Seasonal Change [2, 3, 4, 5, 6, 7, 8, 9]. The most common notion found, is the one which attributes the phenomenon to the variations in the distance between the Sun and the Earth. The basic root of this notion seems to be the everyday experience, according to which, the closer we come to a source of heat the warmer we feel [10].

According to bibliography "distance dependence" notion seems to be resistant to change, since students appear to hold it, no matter whether they have been taught the scientific model of the phenomenon or not.

Hsy [11] used a Technologically Enhanced Environment to promote second-year senior high school students' conceptual change about Seasons. Data analysis revealed that the "distance dependence" responses were doubled after the instructional approach.

Tsai and Chang [12] used the framework of cognitive "conflict map" to facilitate ninth grade student's conceptual learning about Seasonal Change and found that many of them, even after instruction, had a common alternative conception that Seasons were determined by the Earth's distance to the Sun. Moreover, according to the researchers, the target scientific concept was that Seasons are mainly caused by the Earth's 23,5degree inclination of its spinning axis. However, this tilt can explain Seasons either in the context of the scientific explanation or in the context of the "distance dependence" notion.

Starakis and Halkia [13] compared Seasonal Changes' conceptions of students who have never been taught the phenomenon before (k-5) with those of students who have been taught it twice (pre-service elementary teachers). They found a considerable increase of the corresponding percentages, from k-5 students to pre-service teachers as regards the "distance dependence" notion. Further analysis of the data revealed that as time passes after having been taught at school, students "embody" in this notion all parts of scientific knowledge *(Earth's elliptic orbit around Sun* and *Tilt of the Earth's rotational axis)* that can be assimilated, while they "reject" that part which cannot assimilated *(Angle of Sun rays incidence).*

The previously mentioned cases illustrate that "distance dependence" notion is resistant to change because teaching about Seasons does not step on the *'dissatisfaction with existing conceptions'* which is considered as a basic condition for conceptual change [14]. Therefore students have no reason to change their alternative view and incorporate into it declarative aspects of scientific knowledge. That is consistent with previous studies on how students embody the culturally accepted views to their initial models [15].

2. Seasons (the scientific model)

The Earth's spinning axis is not vertical to its revolution level around the Sun, but it forms a 23,5° inclination, pointing always to the Polar Star. The combination of the Earth's inclination and revolution around the Sun, results in Seasonal Change. Specifically, during the Earth's revolution around the Sun, the hemisphere leaning towards the Sun is exposed to solar radiation more than the other since solar radiation prostrates more vertically to this hemisphere.

3. The present study

3.1. Theoretical framework

The present study is part of a broader research concerning the Sun-Earth-Moon system's relative movements from an educational point of view and is based on the "Model of Educational Reconstruction". In this model the understanding of students' perspectives and the interpretation of the scientific content, are closely linked, aiming at designing new teaching and learning sequences [16, 17].

Following the process of Educational Reconstruction, a preliminary analysis of the scientific content took place, followed by studies on students' conceptions about the Sun-Earth-Moon system's relative movements. These steps merged into the construction of a teaching and learning sequence which aims at investigating k-5 students' learning processes into the scientific model using the "Teaching Experiment" method. The basic idea of this method is to design an interview situation deliberately as a teaching situation [18]. Hence, the researcher acts either as an interviewer who tries to analyze students' notions, or as a teacher, who must make the appropriate teaching interventions when they are needed.

The concerned teaching and learning sequence consists of three sections: i) *Apparent Movement of the Sun* ii) *Apparent Movement of the Moon* and iii) *Seasonal Change*. For the purposes of this manuscript we focus on that part of the third section of the sequence which is seen through the eyes of the aforementioned '*dissatisfaction'* with the "distance dependence" notion.

3.2 The teaching and learning sequence

The third section of the teaching and learning sequence deals with Seasonal Change and it is mostly based on an experiment which was designed in order to simulate the prostration of solar radiation on different places of the Earth.

At the beginning of the sequence students are asked to answer the following question:
"*Why is it hotter in Summer than in Winter? How do you explain Seasonal Change on Earth?*"
(At this point it has to be stressed that k-5 students in Greece are not yet taught either of Earth's 23,5 degree inclination of its spinning axis or of Earth's rotating around the Sun)

The most popular reply according to previous pilot studies is that "*Seasons are determined by the Earth's distance to the Sun*".

Moreover students have to study a table (see Table 1) which displays the 24hour average temperatures in July of two (2) cities of the north hemisphere (Kiev and Khartoum) which are almost of the same longitude. They also observe these cities on a not inclined Earth globe (see Fig. 1) and then they are asked to interpret these data in the light of their "distance dependence" notion. Most of the students are expected to attribute the considerable difference in the average temperatures of Kiev and Khartoum to the fact that Khartoum, compared to Kiev, is situated closer to the Sun.

Table 1. Kiev's and Khartoum's temperatures

24hour Average Temperature	
CITY	*JULY*
KIEV *(UCRAINE)*	**19,4**
KHARTOUM *(SUDAN)*	**31,4**

Figure 1. Earth globe. The upper flag represents Kiev and the lower, Khartoum

Figure 2. An illuminated model of the Sun and an Earth globe (not inclined)

Figure 3. The photometer

Afterwards students operate an experimental device which is comprised of an illuminated model of the Sun, a not inclined Earth globe, set one (1) meter away from the Sun (see Fig.2), and a photometer (see Fig.3). The photometer is used as a means of measuring the difference between the prostrated "solar" radiation a) on Khartoum (see Fig. 4) and b) on Kiev (see Fig. 5).

Figure 4. Measurement of the prostrated "solar" radiation on Khartoum

Figure 5. Measurement of the prostrated "solar" radiation on Kiev

Right after these two (2) measurements: *i) the horizontal distance between the Sun and the chosen cities* (see Fig. 6 & 7) and *ii) the angle of the sun rays incidence on each city* (see Fig. 8 &9) are recognized and checked as independent variables, concerning the prostrated radiation of light on the Earth.

Figure 6. Checking distance as independent variable (a)

Figure 7. Checking distance as independent variable (b)

Through this procedure students are expected to become dissatisfied with their existing "distance dependence" notion and finally to reach the conclusion that the difference in the amount of the prostrated solar radiation on different places of the Earth is strongly connected with the difference in the angle of sun rays incidence.

Figure 8. Checking angle of sun rays incidence as independent variable (a)

Figure 9. Checking angle of sun rays incidence as independent variable (b)

To connect the previously mentioned conclusion with Seasons, students must study two (2) more tables (see Table 2 and Table 3) which display the 24hour average temperatures, both in January and July, of three (3) cities of the north and three (3) cities of the south hemisphere, respectively. These cities, by twos, are almost of the same latitude and longitude, (Norfolk and Concepcion, Tokyo and Adelaide, Cairo and Maseru). Students can also observe these cities on the same, not inclined, globe of the Earth (see Fig. 10) and then they are posed the following question:

"How would you set the Earth globe when it is Summer in the north and Winter in the south hemisphere, and vice versa?"

Students are expected to incline each hemisphere of the globe towards the Sun when it has Summer, on the basis of changing the angle of sun rays incidence on the Earth's surface.

Table 2. 24hour average temperatures in North hemisphere

24hour Average Temperature of 3 cities of the North Hemisphere		
CITY	*JANUARY*	*JULY*
NORFOLK *(USA)*	**3,9**	**25,6**
TOKYO *(JAPAN)*	**3,6**	**24,6**
CAIRO *(EGUPT)*	**13,8**	**27,9**

Table 3. 24hour average temperatures in South hemisphere

24hour Average Temperature of 3 cities of the South Hemisphere		
CITY	*JANUARY*	*JULY*
CONCEPCION *(CHILE)*	**16,6**	**8,8**
ADELAIDE *(AUSTRALIA)*	**22,6**	**11,1**
MASERU *(LESOTHO)*	**23,5**	**8,5**

Figure 10. A not inclined Earth globe. Each flag represent one city of the North or South hemisphere

4. Conclusions

In this paper we described the design and the content of a teaching and learning sequence concerning Seasonal Change. The sequence is focused on the confrontation of students' main alternative view (periodic alterations in the distance between the Sun and the Earth cause

Seasons) with the scientific model through the use of an experimental device. The research is in full progress since pilot implementations of the sequence have already been completed and provided us with all the encouraging information needed in order to proceed with the central core of the "teaching experiments".

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An Effective Strategy on Knowledge packaging and Delivery dynamics towards S&T literacy to transform common mass into science oriented society (SOS) through learning - participating - understanding mechanism

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Abstract. *Presently knowledge packaging & delivery of science communication is formal and inefficient, as a result in S&T literacy, situation is shaky and unsustainable. More effective enhancing communication packages between researchers, education institutions and general public are needed; exchange of experiences with various technologies, and analys is of their respective benefits; dissemination of knowledge to sustainable development is also needed The time needs highly accurate and nano-level analysis and re-synthesis of communication strategies to disseminate science. We have to create Information based science communication technology, in terms of technical and human capacity with interactive knowledge networks to improve understanding and enhance exchange of ideas to transform information into knowledge and knowledge into adequate government policies and packages on techniques, methodologies, dissemination methods, advocacy approaches and regulations in science communication. It may be used as background for the eventual determination of a strategy for establishing a delivery dynamics which can permit organizations within in the region to become familiar with one another, learn from one another and collaborate when appropriate. Hence, there is an urgent need today, in science communication to conduct integrated, innovative and collaborative research to obtain the required information and solve the constraints and problems in everyday life; and need to seek people's participation at the grassroots level, thereby making them full partners in the research and development work to develop science oriented society (SOS).*

Keywords. Advocacy, Delivery-Dynamics, Knowledge-Packaging, Knowledge-Network, Science Oriented Society (SOS), S&T literacy.

Study of doing simple practical work by inquiry method on attitude of one grade high school students in chemistry course

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Abstract. *Chemistry is one of the sciences which students feel it hard because they should image reactions and molecular behaviour in them. In fact doing chemistry in labs cause better learning and promote student's abilities such as questioning, investigating, discussing and so on because it makes their attitude enhance and they like learning. For this purpose, inquiry approach is selected in 4 levels. This study is focuses on attitude of high school students who learn chemistry through inquiry approach. For this study, 120 students were chosen who were in first year of high school and divided into 2 main groups (traditional and inquiry groups). Our results show every level of inquiry had different effect on student's attitude. Highest score in attitude was for highest level of inquiry teaching method where the students had more freedom in their experiments and lowest one was lowest level which had no difference with traditional approach.*

Keywords. Chemistry education, High school, Attitude, Inquiry method.

1. Introduction

In recent years, science inquiry has been the focus of researchers and K–12 practitioners. According to the National Science Education Standards [1], an inquiry-based learning environment encourages opportunities for children to learn science, learn to do science, and learn about science. Science inquiry encourages the development of problem solving, communication, and thinking skills as students pose questions about the natural world and then seek evidence to answer their questions. Particularly, efforts have been focused on improving inquiry skills for students from non mainstream backgrounds who have traditionally been underserved in the education system [2-4]. The ability to question, hypothesize, design investigations, and develop conclusions based on evidence gives all students the problem-solving, communication, and thinking skills that they will need to take their place in the 21st century world [1].

Teachers of science at all levels have come to the conclusion that students need much more experience in "doing" science. Most agree that exercises based in inquiry, where students use their laboratory skills to answer a pertinent question, are the most valuable. Unfortunately, many older laboratory manuals and books are limited in their ability to give students this experience; rather, students follow a cookbook-type procedure, taking measurements prescribed by the instructions for the procedure and answering a number of questions at the end. The reason that they need each data point or measurement may not always be clear. The decisions regarding what to measure and when to measure are already made for them [5].

2. Inquiry definition

The idea of inquiry in science education is not new. Researchers have argued its importance since the middle of the last decade when science education was found to have a serious flaw. From the nineteenth century until today's reform movement, several people, including Dewey, Schwab, and Rutherford, emphasized the role of inquiry in science teaching and education [6].

Dewey is frequently cited by science educators as a pioneer in education who emphasized the role of inquiry in science education. Dewey stated that science teaching overemphasized the "accumulation of ready-made material with which students are to be made familiar, not enough as a method of thinking, an attitude of mind, after the pattern of which mental habits are to be transformed" [7].

During the 1960s, Joseph Schwab suggested that science should be presented as inquiry and students should carry out inquiry activities [8]. As an alternative to the teaching of science as a presentation of facts already known, Schwab (1960) put forward enquiry (his choice of spelling) as a way of teaching classroom science. He emphasized, "We need to imbue our courses and exposition with the colour of science as enquiry. We need to give the student an effective glimpse of the vicissitudes of research [9].

Numerous definitions can be found in the education literature. Flick (2002) provided a three part definition that includes the process of how modern science is conducted, an approach for teaching science, and knowledge about the nature of science [10]. Other definitions encompass processes, such as using investigative skills; actively seeking answers to questions about specific science concepts; and developing students' ability to engage, explore, consolidate, and assess information [11]. Inquiry is agreed upon as student centred or open when students generate a question and carry out an investigation, teacher guided when the teacher selects the question and both students and teacher decide how to design and carry out an investigation, and teacher centred or explicit when the teacher selects the question and carries out an investigation through direct instruction or modelling [1].

Additionally, students engaged in simple inquiry engage in processes such as observing, comparing, contrasting, and hypothesizing. Students engaged in full inquiry use these skills in the context of well-structured, science-subject-matter knowledge and the ability to reason and apply scientific understanding to a variety of problems [1]. Settlage (2003) suggested that the commonly held framework of science inquiry has remained essentially the same from the middle of the previous century until today: Inquiry begins with a question based on observation, which ultimately leads to a conclusion based on evidence. However, Keys and Bryan (2001) challenged the notion that there is a simple, preconceived framework of inquiry waiting to be discovered by students. Based on a constructivist view of inquiry, Keys and Bryan proposed that inquiry is individually constructed by each student based on his or her interaction with the physical world and abstract ideas. Rather than a lock-step trip through the various components of the inquiry process, Keys and Bryan assumed that students construct their own knowledge about science, about how scientists work, and about the inquiry process as they interact with their peers, their teacher, and the classroom context [12].

A critical challenge in the study of science inquiry is the lack of a clear or agreed upon conception of what science inquiry involves. The National Science Education Standards provide a definition modelled after the work of scientists:

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world [1].

3. Inquiry models

The NSES uses inquiry in three different ways: scientific inquiry, inquiry learning, and inquiry teaching [13].

The use of "scientific inquiry" in the NSES reflects an understanding of "'science as process,' in which students learn such skills as observing, inferring, and experimenting" and is independent of instructional strategy.

"Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" [1].

When inquiry is used in the manner of "inquiry learning," it refers to a learning process wherein students are engaged. This active learning process reflects the nature of scientific inquiry [13]. The NSES rest on the premise that learning science requires students' involvement both in "Hands-on" and "Minds-on" activities.

Some of the descriptions of inquiry as teaching as depicted by NSES include: (a) Inquiry as the activities in which students develop knowledge and understandings of scientific ideas, as well as an understanding of how scientists study the natural world; (b) Inquiry as activities that involve students in generating authentic questions from their experiences; (c) Inquiry as activities that provide a basis for observation, data collection, reflection, and analysis of firsthand events and phenomena; (d) Inquiry as activities that encourage the critical analysis of secondary sources--including media, books, and journals in a library.

A classification scheme developed by Herron (1971) based on the work of Schwab [8] is useful in assessing the levels of inquiry, or degree to which laboratory activities promote student inquiry.

Characterized by four distinct levels of inquiry, or openness, the classification scheme differentiates each level of inquiry by the information and support provided to the students as part of the laboratory activity [14]. In other words, an activity's level of inquiry is determined by whether the problem, procedure, and solution are text directed or open for the student to establish. We use this classification for our survey (table 1).

Table 1. Levels of Inquiry

Level	problem	procedure	solution
0	given	given	given
1	open	given	given
2	open	open	given
3	open	open	open

Perhaps the best example of inductive inquiry is the Inquiry Development Program developed a number of years ago by J. Richard Schumann (fig.1). Schumann produced a number of inquiry programs designed to help students find out about science phenomena through inquiry:

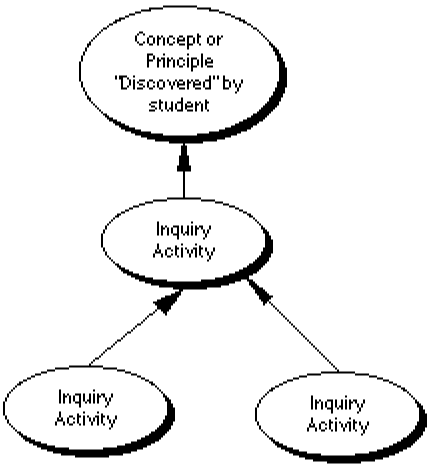

Fig.1. Inductive inquiry diagram

Another form of inquiry teaching is deductive inquiry, which we can contrast with inductive inquiry (fig.2). In this approach to inquiry, the teacher presents a generalization, principle or concept, and then engages students in one or more inquiry activities to help understand the concept.

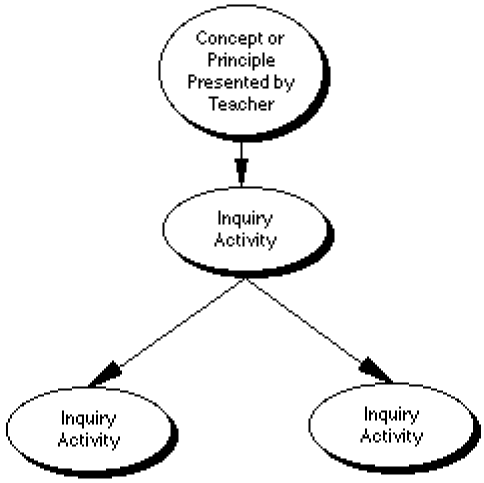

Fig. 2. Deductive inquiry diagram

4. Methodology

For this survey, 120 students was selected, who were in first year of high school. They divided into 2 groups, inquiry group and traditional group. In every class they put in small groups. Each one should had a representative who allowed to stand up and speak with other groups even to teacher when they should answered.

At first we had a section which we learned safety notations to students and became them familiar with lab tools. In every class students should sat with their groups members so that they can do works with each other and can look class board (fig.3.).

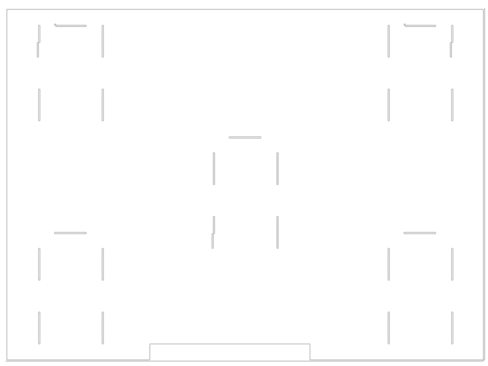

Fig. 3. Arrangement of students in class

Before starting, all of students took attitude test. It had 34 questions with 5 answers for every one that were from absolutely agree to absolutely disagree.

The traditional group teaching method was lecture, and every thing was demonstrated for students with teacher. At the end of period they took an attitude test again and their scores were gathered.

For inquiry group we had 4 sections and took this test at the end of each one. As you see above for this method we have 4 levels, so we teach each level in each section. At level 0, teacher says problem, clear it and at the end solve some questions and illustrate them. For level 1, we asked students that each group choose one subject and one picture which they took was important, so we state them and said their notations. In level 2, they should choose a subject from their chemistry book and with any thing they like explained it to class, it was wonderful they made some pictures, tools, even graphs to explain their subject. Because it had a competition sense between them we set times to do it and each group that could done work they get a stars and each one that had less stars should buy ice-cream for others.

In level 3, we wanted they choose a subject and with an experiment show it to class. But before starting they should write their experiment if we confirmed they can come to school lab, otherwise they should go to school library for more studies.

In designing experiment they allowed use every thing that was safe, and write their purpose, tools were needed, steps of doing work and predict what happen? And why?.

At first some of them were confused and said it is boring.

"What is this? We never have chemistry like this"

"Sorry; I think it is your work not students, if we knew these why we come in school?"

"It is so boring and hard you wanted we write lab book"

Yes! These are their chiding when we said design your experiment. But it's not from all of them. In forth section they came to class with papers many of them were allowed to go to lab and start work. A few of them had safety problems so groups members should correct, they allowed to come into lab and if they know what is wrong and correct it can do their experiment in extra time.

Working in groups let students to learn from each other, correct their plans and think. Our more problems with student was in level 3, somebody did not know how look for a experiment, someone did not write and some students could not conclusion. But being in groups gave them a fortune to learn these.

"I ever know answers but did not know how to explain it; I learned it with my friends when we were taking about our work".

"At first it was terrible for me to think alone, but now I fill it is necessary".

"It was a bit hard but wonderful"

5. Data analysis

The analysis of the results in this study was done in 2 aspects.

1: comparing attitude scores of students in 2 main groups, traditional and inquiry.

2: comparing attitude scores between inquiry levels.

As you see in table 2, the students who were in inquiry group have better senses in learning chemistry than traditional method. Our attitude test had 34 questions which it's answered were arranged by likert scale.

According our results in table. 2, using inquiry method in doing made simple practical works intend to increase chemistry attitude sense between students. As shown in table 3, the difference attitude test results between inquiry and traditional groups are meaningful. As a result, by using inquiry method, the attitude of learners increases by doing some simple activities in chemistry.

6. Conclusion

The purpose of this study was establishing inquiry method on high school class and surveying what is the sense of students when they learn chemistry in this manner? For subject that we selected we spent just one section more than traditional classes, but at the end of survey students liked to resumed it for more class times.

It is important that we do not forget in every class you my have some willing students, somebody who do not learn or participate in class arguments; but we think with hands- on teaching strategies like inquiry method in class you know them and how many they are? But in traditional classes can you say how many students do you have that are willing in your class?

However we should know that there are times when it is more appropriate to give students a procedure; for example when a particular technique is being taught. There are also benefits to students learning how to read and perform a given set of steps. Students can still experience in-depth analysis and understanding

Table 2. t test results of pre and post attitude test in inquiry group

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pre and post attitude test (inquiry group)	Equal variances assumed	20.138	.000	-13.1	118	.000	-30.567	2.31195	-35.144	-25.988
	Equal variances not assumed	.00000		-13.1	99.83	.000	-30.567	2.31195	-35.151	-25.973

Table 3. Comparing attitude scores of students in 2 main groups, traditional and inquiry (level 3) by using t test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attitude post test (Inquiry method (after level 3) and traditional method)	Equal variances assumed	44.516	.000	24.250	118	.000	54.6333	2.25292	50.1719	59.0947
	Equal variances not assumed			24.250	78.031	.000	54.6333	2.25292	50.1481	59.1185

with good questioning and discussion after a non-inquiry lab.

Therefore, inquiry-based approaches should be used as often as is practical. If students perform even a few inquiry-based labs each year throughout their middle school and high school careers, by graduation they will be more self-confident, critical-thinking people who are unafraid of "doing science" [15].

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Microscope studies in Primary Science: following the footsteps of R. Hooke in *Micrographia*

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Abstract. *This is an inquiry conducted with 40 children of the 6th grade of a Greek primary school, divided in two classes. Initially, each child constructed a simple reflective microscope using modern materials like a plastic tube and two plastic lenses (objective and eye piece), which were extracted out of single-use disposable cameras. It is actually a modified (re)construction of a microscope (approximate magnification 20x), which has been proposed by researchers of the Istituto e Museo di Storia Della Scienza of Florence. At a later phase, an extra middle lens was added to the microscope to minimize distortion, create sharper images and enhance magnification by 3-5 times.*

The children have been briefly introduced to the historical development of the microscope, with a focus on the life and discoveries of Robert Hooke (1635-1703), from the early years at the Isle of White till the achievements of Micrographia (1665), having him portrayed as a natural philosopher and polymath who played an important role in the scientific revolution, through both experimental and theoretical work. After that, microscope studies were conducted with each child recording their observations with the constructed microscope on a notebook with text and sketches, in an approach inspired by Hooke's Micrographia. Before putting down their notes on paper, they studied a relevant extract from the classic text of Hooke, adequately transformed and adjusted for the instance. Thus, following similar steps to those of Hooke, the children initially studied the point of a needle and a small printed dot, which have also worked as focus exercises for the use of the microscope. Then they studied plant seeds (thyme and petunias) as well as parts of plants during their development in the greenhouse and the school garden. Later, they studied garden insects, conducting "insectigations" as they called them, examining ants and isopods. They concluded with a free study, on either plants or insects, since they had developed interests in various and diverse specimens they wanted to examine further. The children discussed and exchanged in class their notes and observations, within a framework of investigations about the development and functions of plants and insects. The analysis of children's notebooks is expected to reveal aspects of "doing science" in an authentic environment (inquiry-based teaching and learning approach), within a framework of learners' scientific community dealing with an intentional task and/or investigative activity.

Keywords. Simple microscope, Study of plants, Study of insects, Observation notebooks, Primary science.

1. On the early history of the microscope & microscopical studies

In the museum of *Middelburg* a very old microscope is preserved, which is reputed to be an instrument constructed by *Zacharias Janssen* himself, probably with the aid of his father *Hans,* circa 1590-1595 (Bradbury, 1967).

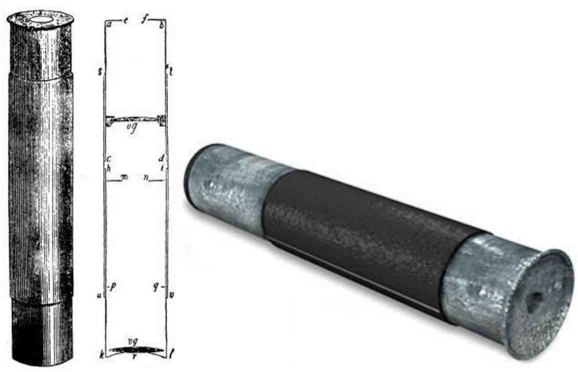

Figure 1: The Middelburg compound microscope

Despite the fact that there is no direct evidence to link this particular microscope to the *Janssens* and their craftsmanship on lenses at the time, it is still a remarkable instrument, which includes two draw tubes that could slide out of another outer casing tube, acting as a supporting sleeve. The lenses were in the ends of the draw tubes; the eyepiece lens was bi-convex and the objective lens was plano-convex. There was no stand provided for this instrument, which was apparently held in hand whilst in use. It is estimated that it was capable of magnifying images approximately three times when fully closed and up to ten times when extended to the maximum.

Galileo Galilei (1564-1642) mentioned in *Il Saggiatore* [The Assayer] (Rome, 1623) that he had probably achieved to have a *"telescope modified to see objects very close"*. It appears that in 1625 a member of the *Accademia dei Lincei* and friend of Galileo, *Johannes Faber* (1574-1629) conferred on the instrument, until then called "occhialino", "cannoncino", "perspicillo", and "occhiale", the name of "microscope". In the second half of the 17th century, remarkable results were achieved by the Italian instrument makers *Eustachio Divini* (1610-1685) and *Giuseppe Campani* (1635-1715), while in England levels of excellence were reached by *Robert Hooke* (1635-1703) or opticians and instrument makers like *Christopher Cock* (circa 1665).

Figure 2: Divini's vase-shaped microscope (left), Campani's ivory turned monocular microscope (centre) & Cock's compound microscope, manufactured in London for R. Hooke (right).

Microscope studies began during the course of the 17th century with *Federico Cesi* (1585-1630) and *Francesco Stelluti* (1577-1651) in the *Apiarium* (Rome, 1625). *Melissographia* (also appearing in Greek as "*ΜΕΛΙΣΣΟΓΡΑΦΙΑ*") is a work of *Stelluti*, covering a single folio of extraordinary size, containing detailed descriptions on bees, seen as a free inquiry into nature from the bondage of scholastics *"who have presumed to dogmatize on Nature"*, as *Bacon* criticized. Later, *Giovanni Battista Hodierna* (1597-1660) published, in *L'occhio della mosca* (Palermo, 1644), a text dedicated to the anatomy of insects, a masterly example of naturalist research conducted with the aid of the microscope.

Figure 3: The cover page of *Melissographia*, by *Francesco Stelluti*, 1625.

Robert Hooke has been undoubtedly one of the greatest personalities of English science of the 17th century. He was one of the first to realize the potentialities of the new invention of the microscope, which had been recently brought to England from the Continent. He was born in 1635 in Freshwater, Isle of White, and upon the death of his father he was apprenticed to a portrait painter in London. He soon abandoned this, however, and went to Westminster School and subsequently to Oxford. It appears that the originator of the superb microscopical illustrations later to be drawn in *Micrographia* (1665) had not only artistic talent, but also some formal training in a branch of art, which required accurate delineation and observation of detail (Bradbury, 1967).

Hooke was a scientist with a curious mind. From a very early age he worked in many scientific fields such as physics, chemistry, geology, biology, meteorology and astronomy, thus he has often been called the *Leonardo* of England (Inwood, 2003). He also knew and worked with some of the greatest scientists of the 17th century, like *John Wilkins*, *Robert Boyle*, *Christopher Wren*. He also discussed his ideas with *Isaac Newton*, *Christiaan Huygens* and *Johann Hevelius,* although he had strong disagreements and finally became rival with all three of them on different scientific issues (Burgan, 2008).

Hooke became associated with the newly formed *"Royal Society of London for Improving Natural Knowledge"*, which was initially a small group of scientists, called *fellows*, who met once a week to discuss their latest experiments and scientific ideas (Jardine, 2004). In 1662 the group decided to hire someone to do experiments and then report the results. Hooke was the first choice for the job, so he became the "Curator of Experiments". It was this time that he carried out microscopical studies, and the Royal Society recognizing the importance of this new branch of study, encouraged this endeavor. In 1663 he was solicited by the Society to prosecute his microscopical observations in order to publish them eventually and he was also instructed to *"bring in at every meeting one microscopical observation, at least"* (Bradbury, 1967). Hooke faithfully complied with this directive and showed the Society fellows the appearance under the microscope of common moss, the view of the edge of a sharp razor and of a point of a needle etc. He demonstrated various insects such as the flea, the louse, the gnat, the spider, the ant and various types of hairs. All these observations and many others besides were published in 1665 under the long title *"Micrographia: or some physiological description of minute bodies made by magnifying glasses with observations and inquiries thereon"*.

Micrographia was a huge book and was filled with descriptions of what Hooke saw under the microscope. He claimed that his goal was to use *"a sincere hand, and a faithful eye, to examine, and record the things themselves as they appear"*. Along with texts of lucid descriptions, Hooke included stunning, detailed drawings of what he saw under the microscope's lens, which often folded out of the book. For the first time ever, natural scientists as well as common people could see a new world around them which they barely knew it existed (Burgan, 2008). His lively drawings of insects made them seem *"as if they were lions or elephants seen with the naked eye"*, he commented. The book was a great success and still ranks high today as one of the great masterpieces of microscopical literature (Inwood, 2003).

Figure 4: A detailed drawing of an ant by R. Hooke with the description on page 203 of *Micrographia*.

No original painted portrait of Hooke is known to exist. It is said that any existing portrait disappeared when Newton was elected president of the Royal Society. Despite the claim that a recently discovered portrait is considered to be the one of Hooke's (Jardine, 2004), it is still not fully accredited and/or mutually accepted as such. Nevertheless, for the educational purposes of this inquiry, for the children to have a more immediate link to the scientist and his work, a visual image of Hooke has been drawn out of the paintings of the history artist *Rita Greer*. Her paintings, based on two detailed written descriptions, aim *"to put him back into history"*, in an attempt to recreate his face and appearance.

Figure 5: 'Robert Hooke, Engineer'. A memorial portrait by the history painter *Rita Greer*, 2009.

2. (Re)constructing a simple microscope

The construction of a microscope with common and readily available materials has been the first part of the twofold objective of this inquiry. The second part has been its implementation into practice, within the framework of children's laboratory work linking it with Hooke's *Micrographia* (*see section 3*).

The initial idea for the microscope construction was one that resembled to the first *Middelburg* compound microscope, in a simplified version with one tube, two lenses and a diaphragm (Vannoni *et al.*, 2006; 2007). Thus initially the children used a PVC tube (16,5 cm length and 16 cm inner diameter) and two plastic lenses (objective and eyepiece), which had been extracted out of single-use disposable cameras. A piece of black carton was rolled and inserted inside the plastic tube, to avoid light reflections. The lenses were put inside adequate metal washers and affixed with sticky tack. To reduce colour and spherical aberration, the aperture of the objective lens needed to be reduced, thus a black rubber washer was used as a diaphragm and stuck on top of the washer of the objective lens. At the other end of the microscope tube, a black film can was cut and fixed accordingly at the eye piece, providing a smooth dark base for the observer's eye. The microscope was finally fixed inside the niche of a 2-tube base glued on a third bigger supporting tube. This base was glued with a glue-gun on a piece of cardboard and the microscope was ready for observations.

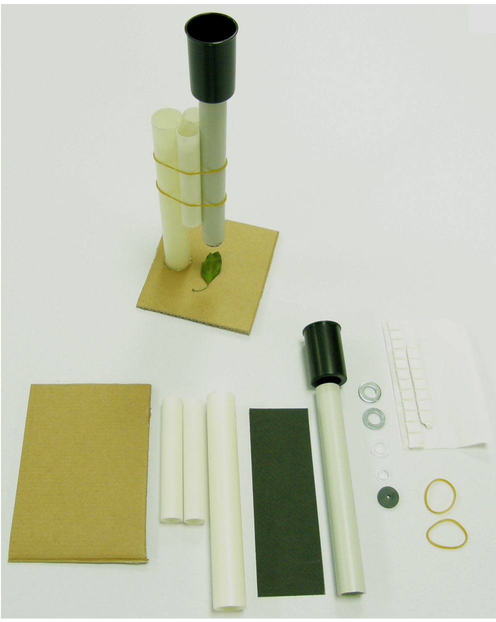

Figure 6: The materials used & the first version of the constructed microscope with 2 lenses.

The microscope tube was held onto the base with two or three elastic bands and it moved up and down to focus. The children made some initial observations on small objects, like sand, salt, but also feathers, pieces of cloth etc. A small and cheap reading spotlight was used to shed light to the objects under inspection.

Rather soon, we realized that we could make an improvement to the microscope, in order to have more precise and crisp images, with less distortion. The idea was to use an extra *field lens* to achieve this. So, by extending the microscope tube with a conjunction piece we added a third lens. Thus, an extra field lens was fixed in between the end of the initial microscope tube and the new location of the eye piece, placed at the end of the attached conjunction piece (*see fig. 7*). The microscope tube was stabilized to the supporting base with a plastic cable tie fastener, which enabled the children to focus on images and remain stable for longer observation time. The friction created by the cable tie fastener, forcing the microscope tube and its base in contact, kept it firm and steady. In order to focus on the specimen, the children now had to turn the microscope gently and simultaneously move it up and down. To reach upon this cost effective, simple solution, we had spent quite some time trying out alternative ideas, always in search for the better one, dealing with a particular problem with an intentional added value in the result.

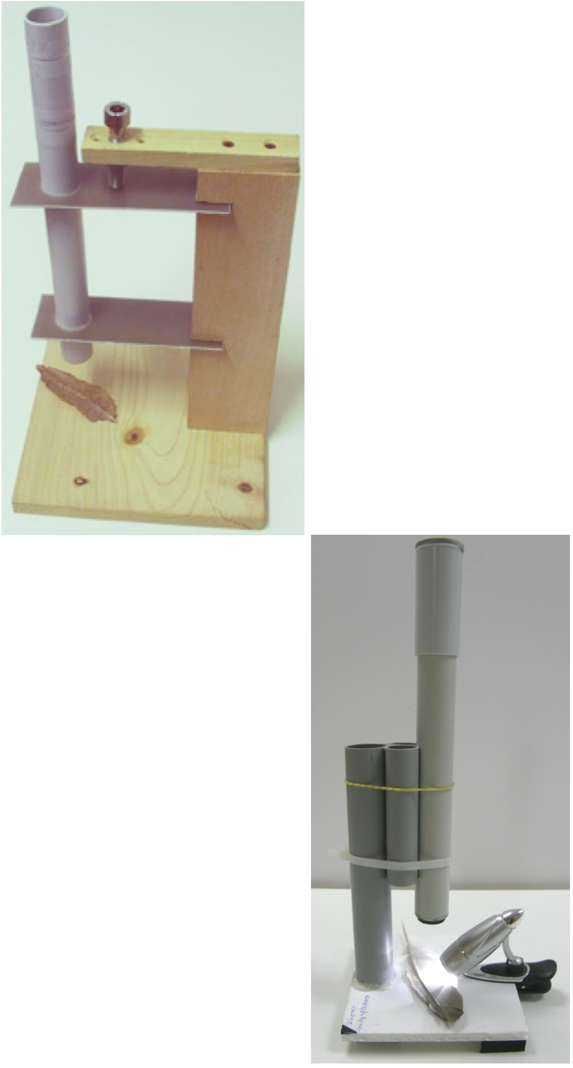

Figure 7: The improved microscope proposed by Vannoni *et al.*, 2007 (left) and the one constructed by the Primary Science Laboratory, 2009-10 (right).

These improvements have completed the construction of a simple compound microscope. In fact, we made more than 45 of them, ready to be used for microscope studies.

3. Following the footsteps of Hooke in microscope studies

The children were very curious to put their microscopes into action and investigate various specimens. In classroom discussions, after some arbitrary microscope observations, we agreed that we needed some sort of guidance to lead us along the way of microscope investigations. It was exactly at this point that the idea of linking our observations with those of a distinguished scientist came into context. Thus, Robert Hooke, in fact the first scientist to conduct systematic microscope studies in his *Micrographia*, was introduced to the children, in order to act as a scientist from the past to assist us with our studies. For this to be a successful endeavor, children had to know more about who Hooke was, starting from his early age on the Isle of White, till the writing of *Micrographia* and further on. Thus, Hooke had to be placed into a historical context, didactically transposed in an adequate manner, familiar and suitable for the children of this age. A presentation has been developed for this purpose, using many paintings of *Rita Greer*[**], the history artist, which helped a lot to visualize aspects of Hooke's life.

Figure 8: 'The Fossil Hunter'. Robert Hooke as a ten year old child on the Isle of Wight at Freshwater Bay. Oil on board by *Rita Greer*, 2005.

Robert Hooke was often sick as a child and his parents thought that he would not survive his childhood, but eventually his health improved as a teenager. His parents decided to teach him at home rather than send him to school. He developed a natural intelligence and curiosity about the world around him. Surrounded by the sea, he seams to have taken an early interest in ships and he had constructed a very detailed model toy ship (Burgan, 2008). He would have seen tall chalk cliffs on the Isle of White and worn seaside rocks. He had probably discovered fossils, remains of ancient plants and small animals preserved in the soil and rock of the island (*see fig. 8*). The young Robert also showed his artistic skills by copying paintings he saw in his family's house with impressive detail. Soon after the death of his father in 1648, Robert, at the age of 13, moved to London to begin his education as a scientist in the Westminster School, one of the oldest and best schools in England. As a teenager, he studied Euclidian

[**] These paintings are available in the following URL: http://commons.wikimedia.org/wiki/Category:Paintings_by_Rita_Greer.

geometry and learned Greek and Latin. He also developed practical skills by learning how to use the lathe, a machine used to shape wood or metal. In 1653, Hooke left Westminster and moved to Oxford University to study "natural philosophy", which included many branches of science such as physics, biology and chemistry. By the time he published *Micrographia*, in 1665, he was in his thirties, a distinguished member of the Royal Society, a polymath, a very skilful scientist and probably the first systematic microscopist.

The children were impressed by the presentation of the life story of a scientist such as Hooke and were very curious to see more closely what he had actually written and drawn in *Micrographia*. They mentioned that it would be interesting to have him alongside as a "teacher", to guide us through our own microscope studies.

Hence, for the purposes of this inquiry, seven worksheets have been designed, starting from adequately translated pieces of Hooke's text and drawings, which turned into hands-on classroom investigations and observations with similar specimens (i.e. point of needle, a printed dot, seeds of thyme, the ant). These investigations were extended to the study of other resembling specimens, which have been discussed in class and the children were curious to observe (i.e. the seeds and parts of the petunia plant, other insects like the isopods etc.). In the end, they had developed the skills and the interests to study lots of various different specimens, which were waiting for them, just outside the Science Laboratory, at the school garden. Thus, they concluded their observations with a "free study" to investigate *"something particularly of our own"*, as they insisted. A brief discussion of all these studies follows in the subsequent sections.

3.1. Microscope studies on the point of a needle and a printed dot

The first two study worksheets were linked to the beginning of Hooke's studies in *Micrographia*. The worksheet on the study of *the point of the needle* is directly linked with page 1 of *Micrographia*, where Hooke comments that "we will begin these our Inquiries therefore with the Observations of Bodies of the most *simple nature* first, and so gradually proceed to those of a more *compounded* one" [emphasis in the original]. This appears to be an interesting scientific, but also didactical proposition, which we adopted with the study of the point of the needle and later with the printed dot. Both symbolise something extremely small and rather dimensionless, similar to the Euclidian "point" in geometry or the "physical point" according to Hooke, which might in fact look rather different and huge under the microscope.

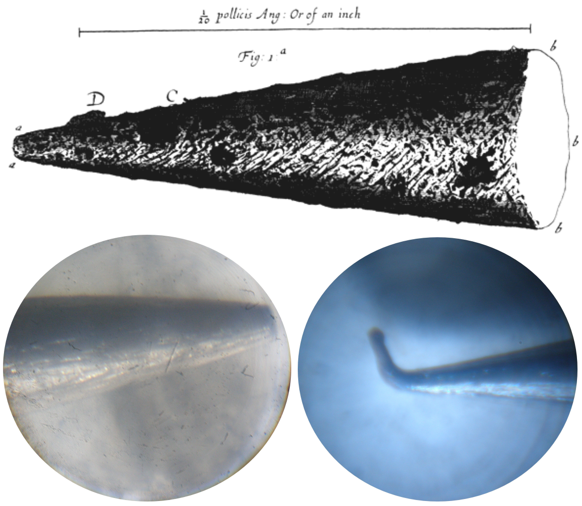

Figure 9: Hooke's drawing of the point of the needle (top) and two digital photos of needles the children observed under their microscopes.

The children read in class Hooke's description of the point of the needle, which referred to the relevant detailed drawing (*see fig. 9, top*). Then, they were invited to observe the point of a needle with their microscopes, record their own description and make their own drawings. In the beginning, they had some difficulties in finding the point of the needle and then focus on it, but rather quickly they developed skills and their own techniques, which they shared with each other. Each worksheet was kept in a plastic pocket inside a binder folder. So, at the end of children's microscope studies all of the worksheets together constituted an *observation notebook* (Klentschy, 2008; Martin, 2009).

Hooke noted that the point of the needle looked rather sharp and smooth to the naked eye, but under the microscope it *"could not hide a multitude of holes and scratches"*. A child wrote in his description that the point of a needle *"although in reality it is very straight and very sharp, under the microscope it is a bit curved and not sharp at all. It has a slight bump, probably from its bad use. At the rest part of the needle there are cracks and small bumps"*.

Another child noted that *"the needle has an edge, which looks as if it is cut. It is as if it has a lot of damages on it, like long narrow bumps. It has a dark colour and a small cut. Anyhow, it is not as flat and sharp as we could imagine. At the centre the needle is more flat than at its point. Under the microscope it reminds me more of the point of a pencil"*. Although the photos of fig. 9 are not very clear, because of the inappropriate contact of the digital camera lens on the eye piece part of the microscope, it appears that the children could observe the point of the needle in a similar magnification to that of Hooke's. But, they reported a greater variety of cases, since they even found a couple of "imperfect", rather curved, needle points in each class.

Observing the printed dot, or *"a mark of full stop or period"*, Hooke mentioned that it had various irregularities and in fact it reminded him *"a great splatch (splash) of London dirt"*. One of the children wrote that *"the dots appear totally different under the microscope than with the naked eye. This one has a gray-black colour and it looks like a hairy fur ball or like a splash. It has a strange and uneven shape, which looks like the surface of the sun. At some points it appears that small sticky points are edging out of the dot"*. Another child compares a printed dot with a handwritten one and claims that the first *"has a lot of "peaks" and it appears like a big black hole"*, whereas the latter *"looks like a big cloud of smoke"* and also *"some curly pieces of hair are formed, all around the dot"*.

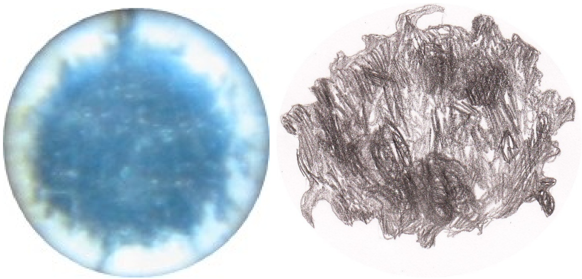

Figure 10: A digital photo of a printed dot under the microscope (left) and a child's drawing (right).

3.2. Microscope studies on the seeds of thyme and petunias

Moving on with the microscope studies, we examined *the seeds of thyme* as Hooke had also described in *Micrographia*. He noted that the seeds had a variety of shapes, whereas *"each of them exactly resembled a Lemmon or Orange dried; and this both in shape and colour"* and they were different from common seeds like beans and peas. The children used the needle, they had examined earlier, as a tool to put the small thyme seeds in place under the objective lens of the microscope and again they had to deal with some problems regarding the focus and the lighting of the specimens under inspection. Soon these were resolved with persistence and patience; virtues which children started to develop, improving their technical and methodological skills. One child wrote that some of the seeds of thyme *"have bumps and others have peaks and they look like lemons, oranges, olives and some look like "choco pop" cereals. Most of them have some small "bumps" than others which have "scratches". Most with the scratches look like nuts, whereas those with bumps look like the skin of a rotten orange and their colours are black brown or brown with black"*. Another child noted down in her worksheet that the seeds of thyme reminded her of lemons or oranges and *"they are all in a different position. There is a great variety in the volume and shape of the seeds. The seeds under the microscope have a black or a brown colour. The seeds are nosey or common like lemons. Every time we observe things they are not as we see them. The seeds look bigger and different than we see them with the naked eye. Thus, we should never say we see something unless we observe it with other methods like the microscope etc."* The latter statement appears to be an interesting epistemological note.

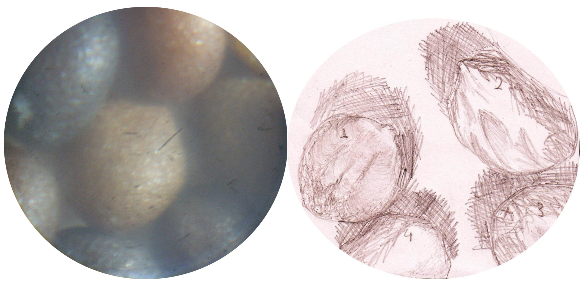

Figure 11: A digital photo of seeds of thyme under the microscope (left) and a child's drawing (right). Notice the shadows she has observed and drawn, created by the small reading spotlight lamp, which illuminated the seeds from an angle.

When the children were preparing their seed plants to be raised in the greenhouse of the organic school garden, they were impressed about the small size of some seeds. The smallest seeds they had planted were the petunia seeds. Hence, they were very interested to observe them under the microscope and this is exactly what happened as an extended investigation, following the one on the seeds of thyme. A child commented that *"the colour of the petunia seeds is dark brown. Their shape is round and they have holes and bumps. They look like small insects. In front they have something like a piece of string hanging out, whereas the back side is a bit round"*. Another child wrote that the petunia seeds *"are very small and different to those of thyme, but under the microscope they look rather big. They remind me of raisins, rotten fruits, cereals, small olives etc. They look like small bumpy marbles with brown colour"*.

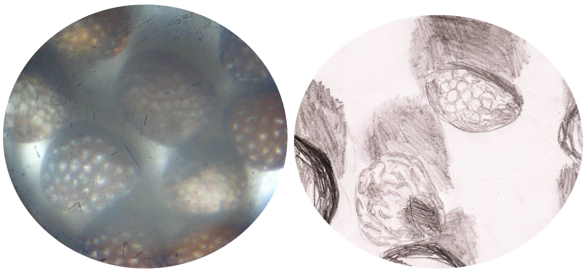

Figure 12: A digital photo of seeds of petunia (left) and a child's drawing (right).

The children went on to observe parts of the petunia plants they brought out of the greenhouse at the time of the microscope studies. One child inspecting a petunia leaf recorded that it was very strange, since *"petunias are beautiful plants, but you never know what they are hiding. Their leaves have very small white hair on their surface and they glitter as they stick out of the leaf, but they also look a bit transparent"*. Another child noted that *"the roots of petunias look like hands with fingers sticking out, with some soil on them and short hair. The roots are very small and thin, but I can see them clearly."*

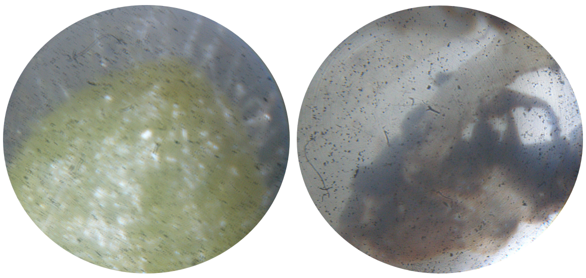

Figure 13: A digital photo of the tip of a "hairy" petunia leaf (left) and petunia roots with some soil (right).

3.3. Microscope studies on insects like ants and isopods

The next study was an investigation on insects, an *"insectigation"* in a creative term (Blobaum, 2005). Hooke had conducted several studies of insects in *Micrographia*, but one of his most descriptive and at the same time more familiar to primary school children is the one on the ant. He mentions that he had a hard time trying to keep the ant steady under the microscope for observation. Having selected some ants he *"made choice of the tallest grown among them, and separating it from the rest, gave it a Gill of Brandy, or Spirit of Wine, which after a while knocked him down dead drunk, so that he became moveless, though at first putting in he struggled for a pretty while very much, till at last, certain bubbles issuing out of its mouth, it ceased to move"*. Then he was able to take the ant under the microscope and study it (*see fig. 4*), although after an hour or so *"upon a sudden, as if it had been awaken out of a drunken sleep, it suddenly revived and ran away"*. He records that this could happen a few more times, so he could inspect the insect without killing it.

The children found this whole process rather strange at first, but fascinating later on, since they had to deal with the exactly same problem in their study of the ant. So, they went out in the school garden "hunting for ants" to be kept in small plastic pots filled with alcohol lotion. They observed that the ants were "unconscious" after 10 minutes in the alcohol lotion, ready to be put under the microscope for inspection. All of a sudden, most of them revived and started moving after 20 to 30 minutes or so. In this way most of the children managed to observe the ants in a steady position, but also in motion and they were very thrilled to be able to do so.

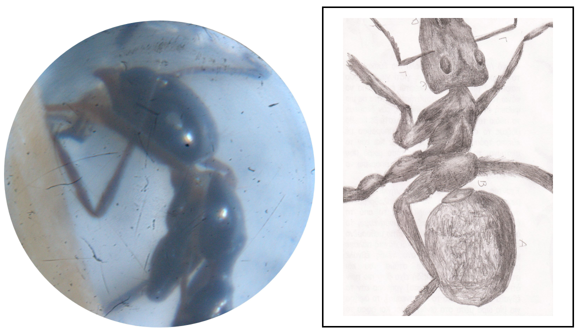

Figure 14: A digital photo of an ant held down with a tooth stick (left) and a drawing of an ant by a child, with letters in various parts of its body for text descriptions (right).

One child mentions that *"the ant was very difficult for me to draw, since it did not easily stay in its position. When I took the ant out of the* *alcohol lotion it was asleep and I could observe it for a while and I started drawing it, but after 15 minutes it woke up and started moving again. The shape of its head is triangular and its eyes are sticking out. It has a big mouth with bumpy sawing teeth and it also has two long horns in front. The biggest part of its body was its belly, which is connected to its legs with some sort of small waist. Over all, it is a very strange insect under the microscope and it surprised me when I saw it so big for first time".*

The children decided to look at another very common insect of the school garden, which was the *isopod* (*Armadillidium nasatum*). They knew that they could find them in dark and wet places, under rocks or grass. So, now they went for "isopods hunting" in the garden and they also collected them in small plastic pots filled with alcohol lotion. Similarly to the ants, the isopods fell "unconscious" for a while, but then again they revived after 15 minutes or so. The children observed the isopods in whole, but also some of their parts like their legs, heads etc.

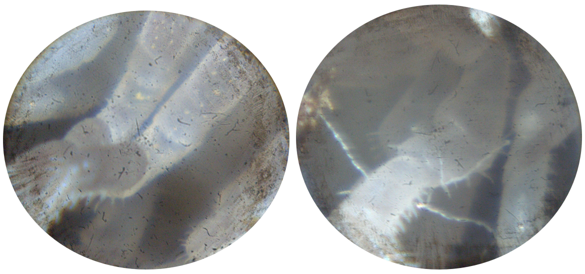

Figure 15: The legs of the isopods under study.

A child, describing the isopod, comments that *"it is like an insect with a suit of armour all over. Its body also reminds me of a stair, challenging me to climb up the steps. Its front part has two horns, which have something like joints. There is also something like a mouth in front and a sort of tail at the rear part of its body; a strange insect indeed."*

Figure 16: Drawings of an isopod & its legs.

3.4. A free microscope study

By this time, the children had performed several investigations and they had developed interests in various organisms, plants and insects, they wanted to examine more carefully. Hence, they went once again to the school garden to collect their specimens and examine them under the microscope. They brought back different kinds of leaves and flowers, but also all kinds of insects from bees to spiders etc. They observed them thoroughly and they created their own final worksheet.

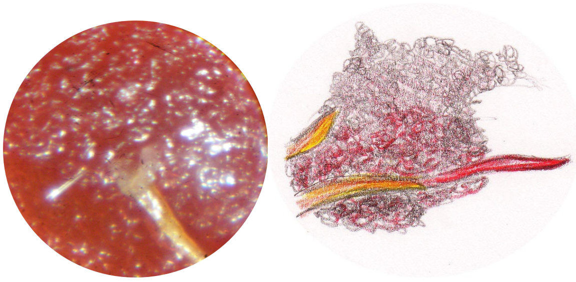

Figure 17: Photo and drawing of a raspberry with "some sort of tinny horns hanging out of it".

One child, for example, collected and observed a raspberry and was impressed by its *"bright red colour, which looks like a small red ball with some sort of tinny yellow horns hanging out of it. Observing them more carefully I found out that they look like yellow hair magnified by the microscope"* (*see fig. 17*).

4. Concluding remarks

It appears that the children have been mentally and emotionally involved in their microscope studies and they have been led with interest into their investigations and observations. The microscope studies, as approached through the texts and drawings of Hooke, appear to enroll elements of intentionality with an increased interest for the outcome and the recorded observations. During the process of recording the observations and/or descriptions, it was noticed that they came about smoothly, whereas the framework of the activity seemed to have facilitated and enhanced the text production and drawings.

The descriptions produced seem to have an initial influence from those of Hooke, whereas they are simultaneously developed and enriched within a concurrent field of language and communication. The drawings, either simple or more complex and more descriptive, appear to be created by children with interest and commitment, because they claim that they want to work in a "scientific" way as Hooke has done. Even if some children complain that they cannot make "nice drawings", they get into the endeavour of "drawing something" and attempt to comment on it verbally.

It appears that the whole framework of these microscope studies has elements of authenticity and the children get into the process of *"doing science themselves"*. The character and nature of science is being demystified as it becomes an everyday activity dealing with an instrument, the microscope, constructed by children themselves with simple and common materials. Yet, it appears to introduce them "naturally" to a framework of scientific study and investigation.

5. References

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Geoenviromental Knowledge as Frame Foundation of Environmental Conscience

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Abstract. *In the framework of the present research is attempted to explore the provided geological knowledge in the modern Greek school with emphasis on the use of this knowledge in Environmental Education. The results of the research, come from the content analysis of school handbooks of secondary grade education, that contain elements of geology with base of a check list that was created as well as the analysis list that is proposed by the Greek Pedagogical Institute with the issues of Environmental Education. We state that geology is not related to the sensitive field of environmental education in Greek High School.*

Keywords. Environmental Conscience, Geoenviromental Knowledge, Geology, Text books.

1. Introduction

We are in a critical transient period, where the rapid growth of Information and Communications Technologies (ICT), causes a real revolution with enormous and unanticipated consequences, in various sectors of human's activities. In these changes, progress and realization of science has contributed considerably.

The above changes influence also the school, which in order to remain an alive and creative institution, should convert in instructive strategies, modern pedagogical perceptions and created needs and requirements of society. More specifically, for Natural Sciences' course, these changes will be supposed to lead to changes on Curriculum, on instructive strategies that are followed in Natural Sciences' course so that the education in the Natural Sciences will be in harmony with the nature of Natural Sciences as well as with society [1].

In last decades, it was presented in the didactic of Natural Sciences an international tendency, called "scientific literacy". This tendency leads to locomotion of Natural Sciences' didactics, from the clearly academic orientation, to a new prospect that takes into account the usefulness of knowledge in daily life. This new prospect gives accent not so much in this knowledge itself, but in its relation with the individual [2].

The connection of Natural Sciences with the environment and the environmental subjects is particularly important because there are enough common points with the suitable exploitation of which can be beneficial for both fields. For the configuration of systematic proposals, it is required a systematic investigation of questions that concerns so much in the frame of didactics of Natural Sciences and also the Environmental Education (E.E.).

2. The term ''Environmental Education''

The Environmental Education emanated from the international environmental movement that was developed in decades of 1960 and 1970 [3]. The term "Environmental Education" was formulated for the first time in 1970 in Nevada of USA during the congress of

IUCN (International Union for Conservation of Nature and Natural Resources) on the subject E.E [4]. There was given also the first definition of E.E, as the process of values' recognition and clarification of significances, in order to develop dexterities and attitudes necessary for the comprehension and estimate interrelation of person, culture and biophysical environment.

The main axis of E.E for citizens and particularly young people is, as it has been determined in most important International Congress that the students apprentice and re-define their relation with the environment and become participants of the efforts for its protection. Nowadays, the E.E aims not only to the acquisition of knowledge and sensitization of citizens towards the environment, but also in the growth of faculties and attitudes and, foremost, in their attendance, so that there will be prevention and confrontation on environmental problems [3].

The E.E constitutes an educational process, which is directed in an environmental problem or subject. It includes case studies, actions and investigates alternative solutions [4].

3. The innovative character of Environmental Education in Greece

The Greek educational system corresponded to the prompts of international community in the dues of 70's, importing E.E, which was applied experimental, up to the end of 80's. The course of E.E in Greece constitutes an example of educational innovation, which began and advanced by the initiative of teachers themselves. Actually it consists for Greek teachers an alternative proposal to give vent to their concerns about the culture of teaching and learning that prevailed at the school. The E.E constitutes, for Greek teachers, an alternative proposal that gives an exit in their reflections, with regard in teaching and learning culture that prevailed in school. The E.E manages to shape a critical mass of teachers familiarized with different instructive approaches, from those that prevail in school [4].

The study of environment has interdisciplinary character and its knowledge is the subject of cultural and product, that has elements of culture from each population and reflects immediately in the action of society in the nature and reversely [5]. As the purpose of the study of the E.E affecting the daily lives of students, it is obvious that the most appropriate teaching approaches are those that directly involve students in exploring issues to find solutions to them and to implement solutions.

The school programs of environmental education are materialised optionally, to differ completely from the school courses as for the planning, the issues, the educational methodology, the evaluation, and because of this these are characterized as innovative actions, because also their objectives and their methodology differ from the traditional education. These programs include various activities outside of the teaching rooms and after the school program.

The main axes of the cognitive content of E.E's programs are summarized in following: atmosphere - climatic changes, air, water, soil, forests, energy, biodiversity - disappearance of types, management of litter and outcast, human activities, human relations and values. Basic principles of E.E's programs constitute the interdisciplinary regard, the experiential approach, the opening of school in the society, the common work, the growth of the democratic dialogue and the culture of critical thought [6].

The E.E shapes a rich aspect for the growth of action and the culture of attitudes and values are related with those of the Natural Sciences [7]. As supported [8], it is an important ask, in now days, that the pedagogical core of the E.E., impregnates the course but also the teaching of Natural Sciences.

4. Methodological frame

Main source of data for our research constituted the written texts, which is material that has written form and official character, as the Curriculumand the school handbooks of High School and Lyceum, drawing different information of this document [9] and creating various categories. The categories should be exclusive and exhaustive, in regard to the plenitude representation of the subjects that examine [10].

The above elements constitute main inquiring material also for our previous studies [11]. In present research we studied also the proposed list from the Pedagogical Institute with issues and main axes of the E.E. Afterwards we categorized the proposed subjects of the Pedagogical Institute's list depending on the content of their object in 3 basic categories that are presented in the table 1:

Table 1: Categories of E.E's subjects

Subjects of the E.E. that their study		
1	presupposes	geological and geoenvironmental knowledge
2	requires	
3	does not require	

5. The Inquiring method

According to the current Curriculum, in Greece autonomous Geology course does not exist in High School and Lyceum, thus it was selected for analysis, the school handbooks that contain elements of Geology. These books are: "Geology-Geography" and the exercise book of A΄ class [12] and "Geology-geography" and the exercise book of B΄ class [13] for high school, and "Beginnings Environmental Sciences" [14] and "Management of Natural Resources" [15] for B΄ class of Lyceum. For the content analysis of these books, is only fixed an aspect, which is the investigation of presence of Geology in these school handbooks in order to be connected with the E.E.

The analysis of the present research's content is limited, due to the level of Geological and Geoenvironmental provided knowledge. The page is considered as unit of analysis. Due to the categorization, the pages that contain or do not contain information are recorded, with regard to the content that each category examines. The content of school handbooks was examined separately by two specialists with the aide of an appropriate control list that constitutes the main methodological tool of our analysis.

6. The control list

Due to the above methodological frame, there was developed a tool for the analysis of four school handbooks of Natural Sciences that we reported in the previous department of our article. This tool concerns in the creation of a control list and criteria for the classification of the information, in its subclasses. There are determined four main categories of the proposed list of control (Table 2).

Table 2: Main categories of the control list of the research

I.	Clearly Geological content
II.	Exist certain elements of Geology (immediately or indirectly) and could be much more
III.	Do not exist elements of Geology but could exist (immediately or indirectly)
IV.	There is not possibility to exist, elements of Geology

The final form of the control list resulted after overall research from colleagues, teachers that teach in High school and Lyceum and have enough instructive experience in corresponding rungs of education as well as in Environmental Education.

7. Results - Perspectives for the Environmental Education

From the elements of table 3, about subjects of the E.E. with clearly, geological content as well as table 4 about subjects the E.E, in which is required geoenvironmental knowledge, in Pedagogic Institute's list becomes explicit that Geology can be promoted considerably through the E.E, but also reverse. However, by our previous researches, the absence of geological and geoenvironmental knowledge from the current educational system [11], [16], can mean also, failure of the E.E, because of the applying without the geological element of environment.

Table 3: Aspects of the E.E with clearly geological content, in Pedagogical Institute's list

	Thematic axis	Aspects of the E.E with clearly geological content
1	Protection of atmosphere and climatic changes	Cross-correlation of climatic conditions with the production, the layout, the erosion, the floods, the natural and anthropologic traits.
2	Water	Operation of circle of water. Factors that disturb him.
		Surface and aquatic resources.

3	Ground	Study local, national, world bas-relief (natural, geological and historical).
		Management of bas-relief, cultures, layout, tunnels, drainage work, dams, piscicultures.
		Types of soil and rocks - Excavation of rocks, mining
		Erosion of ground
4	Forests	Dangers of forests and their protection Erosion of grounds
5	Management of wastes	Management of solid waste, watery sewages, chemists toxic, radioactive waste etc.

Table 4: E.E.'s subjects, for which is required geoenvironmental knowledge, in Pedagogical Institute's list

a/a	Thematic Axis	E.E's subjects, for which is required Geoenvironmental knowledge
1	Protection of atmosphere and climatic changes	Clarification of significance Climate- Constractions of simple meteorological bodies - Experiments - Recording and treatment of measurements.
		Relation meteorological and climatic with the movement of ground, changes of conditions of as resulting from human interventions.
		Imminent climatic changes because of the alleviation of layer of ozone, his appearance phenomenon of greenhouse.
		Exploitation of texts and semeiology of nature.
2	Water	The water as vital component of life.
		The water as biotope.
		Protection of rivers, lakes, seas, oceans and rational use and growth of living resources.
		The priceless value of water and his inopportunity.
		The water shortage.
3	Ground	Consequences from the bad management of ground
4	Energy	Energy production - consumption – Economy.
		Energy and Natural Resources.
		Exploitation of natural energy resources.
		Pumping, treatment, transport of first matters of combustion of raw material.
		The natural reserves are not inexhaustible.
		Nuclear Energy of use – Dangers.
		Renewable sources of energy - Soft forms of energy.
		Exhaustion of not renewable sources of energy.
		Overexploitation of natural resources.
5	Forests	The statement of beginnings on the protection and growth of forests.
		Forest- Growth – Environment
6	Biodiversity - Disappearance of species	Trophic chains of factors abiotic-biotic
		Consequences of human activities in the perturbation of diversity of nature.
		Respect in each form of life.
7	Management of litter	Recycling of paper, glass, aluminium.
8	Human activities	History of urban departments and manufactures.
		History of geographic places.

	Study of structured spaces and operations that are carried out in them
	Planning of buildings, cities, big work concerning the environment.
	Safety and functionalism in combination with the environmental and aesthetic perception for the manufactures and the transports.
	Relations of used materials of - pollution - economy.
	Relations between the layouts - pollution economy of quality of life.
	Cross-correlation of structured/technical environment with the natural destructions.

Afterwards we mention a qualitative analysis of E.E's subjects' content of the table 4, with the aspects of the E.E that are included in Pedagogic Institute's list, based on two categories of table 1; aspects that their study presupposes geological knowledge and aspects that their study requires geological and geoenvironmental knowledge.

Beginning with the subjects of the table 4 that their study presupposes geoenvironmental knowledge, this category has enough big frequency of appearance in five of ten main axes of E.E. These are:

(a) protection of the atmosphere and climatic changes,

(b) water,

(c) soil,

(d) forests and

(e) management of litter.

We consider that the clarification of significances and the comprehension of environmental problems that is related with the erosion of coasts-ground, layout, floods, protection of aquatic and mining resources and their management as well as the management of solid or radioactive outcast, aquatic sewages and chemists toxic, is impossible to be achieved unless students know basic geological knowledge. This knowledge is not provided in students, according to the current Curriculum of High schools and Lyceum and is difficult to be covered through the optional programs of E.E, because in this case, E.E is in danger substantially and loses its innovative character and is changed in one still teaching course.

Since the interpretation of many environmental problems was reported more, as well as the processes that cause them, escape from the direct observation and often require increased faculty of abstract thought and combination of data; it is considered necessary, that students who will deal with some of these subjects, should already have acquired the pre-requisite knowledge in daily program's courses. Thus, possessing the cognitive background of environmental problem, through the E.E's program, might practice themselves in the process of decision-making, in the configuration of the code of values and behaviors that are also the final objective of the E.E.

For the subjects of the table 4 that their study requires geoenvironmental knowledge, it will be supposed to be marked that the category has the biggest frequency of appearance in eight per ten main thematic axes of the E.E. Thus, in the five main axes of the previous category are added also other three, which are:

(a) energy,

(b) biodiversity - disappearance of species and

(c) human activities.

It must be noted that for the approach of all proposed aspects of these axes, is required basic geological knowledge. If this becomes easily perceptible for the aspects of the unit "Energy", after being connected immediately with raw material that we take from the subsoil (mining coals, oil, geothermics etc.), we will examine the connection with the two other axes.

Geodiversity is expressed by the number or the crowd of types of landscapes that are presented in a region or in a country. Greece is a country that besides its small extent has big geodiversity and because of this, allocates big genetic diversity of species and ecosystems. It is recognized that the geological history, the multifarious topography and the bioclimatic variety of our country constitute the main reasons, for the wealth of Greek flora [17]. Biodiversity of Greece in the level of plant species, as it is expressed by the relation of the species' number and the extent of the country, is between the highest of Europe and Mediterranean [17].

It is obvious that despite the discrimination of biodiversity in different levels, protection should be faced as united, because the protection of each level depends from the protection of the previous or the next level. Meaning that the students should have basic geological significances so that “they see” the environment also geological, which means that there is not only alive plants and animal organisms, but also abiotic factors that are found in permanent interaction and interdependence with each other, rejecting thus, the isolation of cognitive fields and one-track causalities [17].

We examine also the main axis of E.E, “Human activities”, which according to the results of our research, all the proposed under review subjects presume basic geological knowledge and mentioning certain from the reasons, why we support this.

In Table 5, we present quantified, the results as have been registered in the three categories of the list, for the subjects of each fundamental axis of E.E, as they are reported in Pedagogic Institute’s list and in which they entirety are 58. In the first category of table 5, there are registered subjects with clearly geological content and there have been recorded 9 subjects (15,5%), of which 4 correspond in the axis “Ground”, 2 correspond in the axis “Water” and by 1 the axes “Climatic changes”, “Forests” and “Management of litter”. In the second category, there are registered 36 total subjects that require, for their approach, basic geological and geoenvironmental knowledge (62%), which correspond in the main axes “Energy”, “Biodiversity” and “Human activities”. In the third category, for which geological knowledge is not essential, there are found 13 subjects (22,5%). Concisely, only 2 axes by 10, contain subjects that does not require geological elements, which are “Human relations” and “Air” and in the remainder 8, 45 subjects by 58 (77,5%), require knowledge of Geology and Geoenvironment.

Table 5: Quantitative elements for the categories of subjects of [P].[E] in the list the pedagogical Institute

a/a	Thematic axes of the E.E. in the list of P.I.	Subjects of Environmental Education		
		with clearly geological content	that require geological knowledge	that does not require geological knowledge
1	Protection of atmosphere and climatic changes	1	4	-
2	Air	-	-	3
3	Water	2	6	-
4	Ground	4	2	-
5	Energy	-	9	-
6	Forests	1	2	4
7	Biodiversity - Disappearance of Species	-	4	-
8	Management of litter	1	1	-
9	Human relations	-	-	6
10	Human activities	-	8	-
TOTAL		9/58 (15,5%)	36/58 (62%)	13/58 (22,5%)

8. Conclusions - Perspectives

Teaching of geology, as independent cognitive object in Analytic Programs of High School has progressively been disappeared over the recent years in Greece and has been fixed as additional department of other courses [11], [18]. Moreover, it has been decreased considerably its content in these courses, acquiring thus a fragmentary completely marginalized role in school. The disappearance of Geology, the abridgment of matter and its fusion with other courses, deprive students from important knowledge that is related with Geoenvironment, undermining simultaneously and the E.E, which as central axis has the integrated viewing of the environment. It should also be marked, of course, that according to the improvement of the program of study (OFFICIAL JOURNAL OF THE HELLENIC REPUBLIC 304t. the b'/13-3-2003) [19], the title of the course Geography A' and B' grade of High school, changed in “Geology-geography” and so be it, with some delay, it has been circulated in the schools of our country, the new materials of teaching in September 2009. We consider important that with the new instructive parcels of courses (book of students, exercise book of student, book of professor and the material in digital form (CD) by the Pedagogical Institute), there is the will, from the State’s side, for renewal of the school’s role and the upgrade of concrete school objects.

This is also strengthened with the presence of the “Geology-Geography”, as one of the four training objects in the attempted integrated application of teaching in the digital class of the A' grade of High school. Thus, it is recognized the particular character of objects and the need for their teaching, via modern optical means that can represent changes that become in big spaces and years. An effort that gives the opportunity to teachers, to teach Geology-geography with modern digital material (projection of training material via CD, internet and more) and use of PC with students in the classroom. Also, student has the possibility for further research in the house, so that he is initiated in the inquiring learning with effortless and pleasant way. The aim is that the modern class is corresponding in the requirements and the visions of now days for an education of open horizons, which “equips” suitably current student and prepares him respectively, so that he is included as citizen in a small world but simultaneously big.

Even if the intention of new handbooks’ writing was to change the philosophy of teaching geology-geography, the writers of school book of A' class declare that their aim is the upgrade of geographic education and, always accordingly with the writers, they try to strengthen the geological knowledge that has direct relation with Geography. They explain their decision, with the argument, that the causes of geological phenomena are not in direct observation and consequently they require important faculty of abstract thought, which the students of the two first classes of High school do not allocate. That is why geological knowledge was added, with base the new curriculum, were limited in phenomena, which influence immediately the form of the Ground surface.

For the upgrade of school geology, the structure of the lesson should follow a continuous flow in all rungs of education, in order that student becomes capable to shape perceptions for the life and the environment and to evaluate new knowledge under the light of his new perceptions.

We argue that current school, in order to be modern, should include in obligatory knowledge’s subjects that are related with natural destructions and their management, the management of aquatic resources and mining materials, the activities in the surface of ground that influenced the development of life until the appearance of human and subjects of nature’s monuments’ maintenance. Our country, in all its extent, has places that are suitable to explain natural processes, and also history of the ground with real way. However, it is needed regulation on the hours of teaching in such a way, that the united time spared in classroom, ensures not only the quantity offered knowledge, but mainly the quality. The enrichment of school laboratories of Natural Sciences with material suitable for laboratorial exercises of Geology is essential in combination with possibilities which the ICT offers. Today such thing is feasible because most of schools in our country allocate laboratories of computers and access in the internet.

From the total regard of the results of this study, it is realized, that today, in High School of our country, Geology is not useful in nothing and is not related with the sensitive sector of E.E. Geology as environmental and intersectorial science should acquire in school, the place that deserves in order to contribute in E.E.’s upgrade. We appreciate that the conclusions of present research could constitute starting line for reflection subjects that concern in the place that Geology has in Greek school, and its presence in E.E. Also it can be taken into account at planning and concretization of proportional researches and generally, enriches the inquiring data in the space of education.

9. Epilogue

Summarizing what it was mentioned before, it is judged advisable to say that it is essential, the E.E. maintains its basic characteristics traits, which, although, lend its particularity in the modern educational reality. Most important, however, is to include itself in each curriculum as an additional course. A such prospect, knowing the incomplete briefing on one side but also the already over-loaded program on the other, will change E.E in a formal course of traditional form - if it is neglected completely - reversing thus, each news to environment's dynamics, that is possible via E.E to exist. However, it will be supposed, that we remain optimistic for the expected results of E.E, because E.E alone cannot constitute "panacea" for the resolution of environmental problems. Problems that are characterized by complexity, because of the large quantity of factors (finances of - policies - social etc.) that contributes in their appearance.

Due to the above elements, our analysis lead to the conclusion that there is required training of teachers, of all specialties on geological subjects, so that they will be capable to import also geological component in the intersectorial work of Environmental Education's programs. Geology today in Greek Curriculum and school handbooks remain a marginalized object that is fragmentarily faced. We consider that Geology as environmental and intersectorial science should acquire in school, the place that deserves in order that teaching of geology, in the frames of environmental education, does not constitute other one lost occasion.

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Learning Computer Programming: Start from Scratch!

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Abstract. *The Greek Technical High School curriculum includes a senior-year course in Computer Programming which most of the students, with no prior schooling, confuse with basic computer skills.*

To motivate them, we used Scratch, a programming tool that encompasses modularity, object-oriented-programming and multi-threading.

Student response was highly encouraging. All were engaged in the activities and many continued on their own.

Scratch enabled the students to focus on the method rather than the syntax. As a result students earned a better look and a deeper understanding of the basics of computer programming.

Keywords. Scratch, Computer Programming, High School.

1. Introduction

The Greek Technical High School curriculum includes a senior-year course in Computer Programming. Basics are taught using “pencil-and-paper”, thus maintaining the strict rigidity of the discipline. Later, students get to use pseudocode, still on paper, with no tangible results available. As an introductory programming language, Pascal is taught later in the semester. None of the students have prior computer programming schooling and most confuse basic computer skills (e.g. surfing the internet) with it. Most book examples involve math equations, thus adding to the frustration - especially of female students. Worse, the curriculum simultaneously includes a Visual Programming course and a Databases course in the same year thus endlessly confusing students between flow charts, pseudocode, Pascal, Visual Basic, SQL etc.

To face these challenges, we used Scratch, an application by the MIT Media Lab, available as Free and Open Source Software. Scratch shows the results of your code immediately. Scratch comes in a variety of languages and has a user-friendly intuitive interface that encourages experimenting. Although tailored to younger children, it is a powerful programming tool that encompasses modularity, object oriented programming and multi-threading. There is also a thriving online community with the motto “Imagine–Program–Share”.

We used Scratch to teach conditional statements, both simple and nested. Instead of the usual “if-then-else”, students were encouraged to create an interactive game with two figures chasing each other. Moving the figures posed problems that needed solving, including setting conditions and constraints.

In the next sections we introduce the Scratch programming environment, describe in detail the methodology and the working examples used and give a discussion on the usefulness of the approach.

2. The Scratch Project

Scratch is a fairly new educational programming environment, publicly launched in 2007 [1]. It was created by the Lifelong Kindergarten Research Group of the MIT Media Lab Team in an attempt to make programming accessible and easy to learn for everyone.

To this end the user interface is divided into three main panes: on the left is the blocks palette, in the middle the current sprite info and scripting area, and on the right the stage and sprite list.

Sprites are images that can be put on the screen. Users can draw them in a built-in version of painter, choose from a wide variety of supplied images or import their own. On opening a new project a trademark friendly smiling cat is the default sprite as seen in Fig. 1.

Scratch uses an intuitive programming block system to help novices get a head start as also illustrated in Fig. 1. The basic programming blocks are organized and colour coded according to function and much like traditional puzzle pieces have connectors that suggest how they should be put together. The blocks are shaped in such a way that only syntactically valid combinations are possible.

Users “write code” simply by moving programming blocks into the scripting area and putting them together. They can program different sprites by selecting them and can easily copy “code” simply by dragging-and-dropping it onto a different sprite.

Figure 1. Scratch programming blocks

Once a programming stack of blocks is built, it can be executed just by double-clicking on it. Multiple programming blocks can be built at the same time thus providing parallel task execution. The emphasis is on a bottom-up approach and on iterative incremental design.

Another concept high on the minds of the creators was collaboration and sharing. To this end the user interface and Scratch programming blocks have translations in over 40 languages. This approach allows users from different countries to build Scratch projects and then share them, each viewing the Scratch programming blocks in their own language. The Scratch Web Site is widely successful with, on last count, over a million projects uploaded from around the world [2]. The projects published are licensed under a Creative Commons attribution. There is also ScratchEd, a community for educators.

3. Visual vs Structured Programming

The author teaches senior-year students who have chosen the Technical High School computer related specialty of System, Network and Software Support. These students have basic computer skills literacy and have taken basic computer courses in their previous year, mostly focused on digital design, hardware and networking. As mentioned in the introduction the senior-year curriculum includes two obligatory programming classes “Visual Programming” and “Structured (Procedural) Programming” in the same year [3].

Each class has its own course material introducing different concepts in different times. This results in re-iteration and student confusion. In the previous year, the teachers of both classes in coordination tried a restructuring of the course material so that key concepts were introduced at the same time.

Teacher coordination even proceeded to the extent of handing out and working with the same set of example problems. As students get more fluent with programming in the second semester, they get to program the same example both in Visual Basic and in Pascal.

This approach had mixed results. Seemingly at first, students would benefit from two different approaches as they can get a glimpse of the bigger picture. Thus variables in Pascal and variables in Visual Basic are two aspects of the same thing. But mastering the concept of variables alone is hard enough. With no prior programming background the students become confused as parallel teaching progresses on to the syntax and program coding. This leads to general misconceptions and common mistakes (e.g. no end-if in Pascal as opposed to Visual Basic, begin-end necessary for statement blocks in Pascal but not in Visual Basic etc).

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4. Why choose Scratch?

What students were missing despite the teachers’ best effort was the bigger picture. Students need to realize that both structured and visual programming applies the same basic programming principles. An “all programming is equal” approach seemed fit and to that end the common set of problems was devised.

However since the “Structured Programming” class is the one examined nationally for achieving University admittance, it is crucial to follow its own strict schedule including all the examples in the book.

These book examples are filled of math problems (finding grade averages, summing up salaries, calculating fares of car tolls etc). They make interesting programming tests in the academic sense of the word but are not nearly as good enough in motivating teenage students to care about the outcome of their programs.

Worse yet, trying to learn well two new variations of the same thing is much harder than trying to learn only one. Students were bogged down by the syntax errors as they tried to switch between two or more programming languages.

In contrast, the Scratch programming environment highlights the bigger picture by not focusing on syntax at all. It also makes for highly interactive and personalized programming examples. On top of that its build-in object oriented programming is intuitive in a way that Visual Basic controls and code are not. Plus it encourages step by step programming and allows the user to see results of their work immediately without compiling or switching between user and programmer interfaces..

For all the above reasons, the author decided to use Scratch in the "Visual Programming" class.

5. Methodology and examples used

Scratch was used to teach conditional statements. Rather than give the same old problem of characterizing a student based on their grades (if grade>10 then PASS else FAIL) students were asked to program an interactive game with two characters: a cat-and-mouse chase.

The students were first shown how the game should work once all the programming had finished. They were then asked to figure out, write down and program the necessary constraints for the game to work as expected.

Taking advantage of Scratch's inherent ability for incremental design, rather than the teacher handing out all the constraints at the start, the approach followed was a step by step one with the students coming up with the necessary conditions each time.

Students were first introduced to the Scratch interface. After a quick tour of the controls they were asked to decide which programming block would move the cat to the right and test it out. They were then asked to move the cat continuously to the right, again choosing the appropriate programming block.

The first constraint was set as our cat "hit the wall" of the display and had to be made to turn around and move in the other direction. This set the first conditional statement (*if on edge, bounce*).

Next we wanted our cat to seem like really walking, not just moving. That led students to discover how to switch sprite costumes.

Now was the time to bring on the second sprite. Students were asked to place an icon of a mouse on the screen and make it move up and down this time.

The last crucial step was defining when the cat catches the mouse. Students again had to construct a conditional statement, this time using the *touching* block.

Having mastered the basics, the students were then asked to redesign their project so that the mouse icon movement could be controlled by the user. This led them to discover the *when ... key pressed* block and incorporate its implementation in their project.

The next day the game was enhanced by adding variables and more conditions. Specifically the students were asked to place bits of cheese along the screen and keep score of the number of cheese pieces that the mouse managed to eat (subsequently making them disappear from the screen). As an extra penalty, if the cat catches the mouse the score counter should be set to zero.

6. Discussion

The above examples were taught in two consecutive days for a total of four teaching hours (two two-hour periods). They were taught on two separate occasions to classrooms of 12 and 18 students respectively.

Up to that point the students had experience in designing simple Visual Basic forms and writing simple code on Command Buttons- e.g. image1.Visible=False on Command1_Click().

Apart from the requirements, students were not given specific guidelines as to which command to use. Neither were they given a tutorial on the use of Scratch. They were however given ample time to experiment both during programming and after completing their project.

All of the students got actively involved, tried to solve the problem given and make the game work.

Although they had never come in contact with Scratch before, the students all managed to complete both the assignments. Indeed most of them improvised and added more blocks and more sprites.

Additions included having two cats or two mice running in different directions; having numerous animal sprites running up and down the screen; upload their own photos instead of cat and mouse; making the cat speak or the mouse scream upon colliding; using sound effects for the cheese-eating and mouse-catching; changing the background.

One went as far as using *wait ... secs* and developed an introductory animated story which he then proudly exhibited to the rest of the class.

None of these additions were prompted explicitly by the teacher; the guideline given was "seek and you shall find".

Students of the first class told students of the second class about these activities. As a result the second class was expecting "that cool definitely not VB thing".

About half of the students asked to have a copy of the program for use at home and were surprised that they had to pay no licence fee for it. This led to a discussion on Free and Open Source Software and its communities. They were also all directed to the Scratch Web Site for further reference.

Both classes wanted to do more projects in Scratch so we dedicated an extra two-hour period to design a game of Pong (racket moved by the user; ball bouncing off in random direction each time it hit the racket, score counting and end game if ball is dropped).

7. Conclusions

Scratch definitely was a success with students but did it enable them to better grasp the fundamentals of programming?

Upon reverting to the usual curriculum we continued with several if-then-else problems with most of the students grasping the required constraints correctly without much difficulty (note here that they were also of interest to students e.g. finding body mass index given weight and height).

Although developed with a younger age group target in mind, its inviting appearance and its diverse possibilities made programming with the Scratch programming environment a compelling task for the students.

Scratch also motivated the students to think about the steps necessary for solving a given problem rather than worrying about fitting the commands in the right order.

Coupled with examples suited to students' interest and a sound pedagogical approach Scratch can be a powerful tool when it comes to teaching computer programming.

8. Acknowledgements

The author would like to thank the Greek Logo Community for introducing her to the wonderful world of Scratch.

And thanks as always go to my students who never cease to amaze me.

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eTwinning in the early childhood as starting line of innovative practices for the didactic of natural sciences

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Abstract. *The educational action of electronic twinning (eTwinning) is defined as a collaboration of a long duration where at least two schools from at least two European countries use the Information Communication Technologies (ICTs) in order to bring joint a pedagogical activity to an end. The didactic of natural sciences in the early childhood education is an instructive subject that differs from adult science. The basic aim of our research constitutes the investigation of the assumption that the pastime of pupils of early childhood with the program eTwinning can constitute a starting line of innovative instructive practices for the teaching of natural sciences. Based on the content analysis of 7 interviews with teachers of early childhood education it appears that pupils of early childhood education that materialized etwinning programs show particular interest for the natural sciences.*

Keywords. eTwinning, Natural Sciences, Early Childhood, ICT.

1. Introduction

In our days, the empowering of the European dimension of education and the efforts for international collaborations and growth, constitute basic elements of modern Greek educational policy. The growth of possibilities of the internet for the improvement of, on one side, access to education and training and on the other side the quality of learning is of decisive importance for the construction of a European society of knowledge.

In the present research framework, which constitutes a case study, and by realizing a short retrospection in the programs of European action eTwinning ("electronic twinning") we will report certain rewarded work in the field of natural sciences for the precocious children's age (preschool and early school age, that is to say children of 5-9 years). Also, conducting a research with teachers of precocious children's age that materialize the action eTwinning we attempt to investigate their opinions for the action and to confirm or not the research hypothesis of whether this pastime can constitute starting point for innovative instructive practices for teaching of natural sciences.

2. Theoretical Framework

The didactics of natural sciences in the precocious school age is the instructive subject that differs from the science of adults [1]. General speaking, it is desirable that ICT (Information Communication Technologies) to contribute in the build up of knowledge and with the help of ICT the knowledge of natural sciences is cross-subject approached [2]. In several cases, the preferences of children on the use of ICT reflect the everyday routine they experience at school and family environment, an element that is related to their spontaneous need for exploration of a "new" game [3], [4]. Children still need active learning experiences involving real objects they can manipulate [5]. According to Clements and Sarama [6] children can work cooperatively at the computer and they can be positive learners and helpers. Through the child-computer interaction, the teachers provide guidance including encouragement, focusing, affecting, and expansion.

Cooperative learning is a learning strategy that involves children working collaboratively in small groups, ensuring that all members master the assignments [7]. Through cooperative learning, children will realize that one needs to rely on and have connections with others to be successful in their computer work.

Due to limited number of computers in most preschool classrooms, young children have many opportunities to share a computer with one or two partners. There are several ways in which computers can be part of the collaborative experience of learning. For example, collaboration at computers refers to that children not only work with computer, but also support each other.

Preschool children have more positive and rewarding experiences with keeping conversation going, cooperating and planning with peers than with adults or siblings [8]. These positive and rewarding experiences of social interactions have been demonstrated that young children would love to share using the computer with their partners.

Due to limited number of computers in most preschool classrooms, young children have many opportunities to share a computer with one or two partners. Children share their discoveries and give help to others. They also display more positive emotion and interest when working together [3], [4].

2.1 The eTwinning action

The children of precocious children's age, which are the basic recipients of twinning between the schools, will consider in the future the pastime in a digital environment, simply as a natural way of work [10]. The European Union promotes the action eTwinning with a view towards developing and strengthening the creation of networks between the schools. The students at their study in primary and secondary education, have the opportunity to participate, along with their teachers, in a educational plan with their counterparts from other European countries [11]. Since November 2004, eTwinnig constitutes one of the actions of the eLearning program of the European Committee. Collaborative online activity experiences foster the European goal for a multilingual, multicultural society. Web-based learning communities contribute to improving intercultural awareness, dialogue and understanding [12].

In the framework of the eTwinning action, schools from two or more European countries, using ICT, collaborate in order to acquire pedagogic, social and cultural benefits. Etwinning seeks to develop and strengthen networking among schools [12]. European students with the help of their school teachers, participate in common educational work with some school from other European country, learning the school and social culture of other countries and practicing their dexterities in the ICT [11].

The action's eTwinning fundamental aim is to improve the pedagogic process, add value to learning, while simultaneously by exceeding the narrow significance of thematic school collaboration, it aims to a complete and systematic collaboration on all levels. The electronic twinning of schools can be realized on the occasion of city twinning, students/teachers exchanges or the wish for a new collaboration that will strengthen the significance of the European dimension within the school.

The improvement of knowledge for teachers and students in the use of ICT constitutes an important objective of the eTwinning action. At the same time, it offers to the teacher additional means in order to provoke the interest of his/her students, get informed about the educational systems of other European countries, exchange pedagogic ideas with other European teachers, strengthen his/her knowledge in a particular subject, practice his/her knowledge in the foreigner languages, improve his/her teaching methodology. Thus, the professional growth of teachers is promoted, as well as the osmosis of systems, opinions and proceedings, in combination with the collaboration between the partners, motivates teachers in their work [13].

The eTwinning European Internet portal (http://www.etwinning.net) provides all information, tools, materials and texts required for the preparation and development of a collaboration. The various forms of communication between the schools with the exploitation of ICT, educates the students in the use of ICT as training and expression tools, mobilizing at the same time their critical faculty, via the transfer and distribution of information - ideas as well as connecting previous knowledge with new.

Since the initiation of the program in 2005 Greece is found constantly within the 5 top places in the number of attendances in collaborations, between 28 states that take part in the eTwinning action. Furthermore, the pedagogic quality of Greek work is important and recognizable and is proved by the awards Greek schools have received in pan-European competitions of eTwinning work since 2006 to date.

2.2 Natural Sciences and eTwinning

As cognitive subject matter the natural sciences present difficulties in approach for the teachers of precocious children's age due to their abstractive character, their strict layout, the special terminology, the experimental approaches and their bi-directional interactions with the social and cultural reality, creates in the duration of educational processes hindrances reversely proportional to age of students [14]. It is a fact that there are teachers who are resistant to discover the possibilities or even the opportunities that a international work based on the internet for the teaching and learning of natural sciences provide. For this reason, work on the subject of natural sciences is more popular compared to those that are directed to languages and ICT [15]. However enough examples exist for the manner in which the teaching and learning of positive sciences can be incorporated in the instructive practice.

For the teaching of natural sciences the choice of suitable methodology, as well as the knowledge of preexisting perceptions and also the training obstacles children face when approaching the subject play an important role in the approach of each scientific term [2], [14]. The role of ICT in the work of natural sciences is multidimensional [16]. The content of education in the positive sciences is catholic and independent from cultural influences. However, it is particularly beneficial for the teachers to observe how the differences between the educational systems influence the teaching of natural sciences [15].

Below, we report certain eTwinning work in the field of natural sciences which have been rewarded with European signs of quality or even pan European awards in competitions in mathematics and science in the years 2008 and 2009.

- *1, 2 Buckle my Shoe* is an example how to introduce science in kindergarten. At their website all the activities are presented for the followers: http://twinmath.wikispaces.com/
- In the project *The Entertaining Physics Class* - the title speak for itself. It is an example how to make learning physics fun, http://twinspace.etwinning.net/launcher.cfm?lang=en&cid=34218
- *The world is more than catches the eye* deals with chemistry. At their website they write: *"We aimed at showing that Chemistry is a very important subject .... We prepared the lesson plan 'Chemistry in English' with some experiments which is very innovative in my school."* http://www.etwinning.pl/konkursy_polskie/laureaci-konkursow-etwinning-2009-pelna-lista
- The project *Alternative energies* is described as follows: *"Why do we have to search for sources of alternative energies The partner groups look for alternative, ecological sources of energy, make their description, prepare Power Point presentations and put them on the Twinspace. Among all of them they choose three sources of energy, which will be the subject of research: solar, wind and water power"*, http://www.energy-etwinning.org/

2.3 Early childhood students & eTwinning

In our days the traditional school that was based on the teacher that possessed information and knowledge and transmitted to the student, is transformed to a new type of school, where the role of the teacher is instructive - advisory. Student acquires information and knowledge by functioning as a researcher, guided by the teacher often with the help of ICT [17].

Does the interactivity attribute, on which the ICT are based, offer to the student the possibility of participation along with the teacher in the planning of training activities and express freely the perceptions and his/her sentiments [6]. Moreover, the utilization of the internet from teacher and student abolishes the geographic limits, with result the learning being transmitted from region to region around the world, as well as interact with the perceptions of children via the exchange of work and their activities.

The use of ICT in an important range of school activities contributes to the cross-curricular approach of knowledge and to the application of active methods of learning, providing the possibility of adaptation of programs of study in new, modern instructive methods [4].

It also develops the general faculties of students, strengthening the mood for real participation in the classroom, by activating curiosity, as it is proven that the computer does constitutes the most attractive means, because the possibility for direct access of students to information, provokes the interest of the majority of the school community and creates an environment, for creative research prone and experiential learning [23].

With the entry of ICT in the educational process the student shows higher interest in each cognitive subject that is taught, after now it has the possibility of participating actively by presenting his own personal work, utilizing the modern technological means, utilizing at the same time his/her dexterities [17]. Collaboration in relation to computers means that small groups of children work on the same computer activity at the same time [19].

3. Methodological Framework – The aim of research

In a previous section we presented certain international eTwinning collaborations in the field of natural sciences in the precocious children's age that were distinguished for the innovation and the quality of their work. However, the opinions of the teachers themselves which constitute the "ambassadors of innovation" of this activity are of particular interest.

With basic methodological tool the content analysis [20] of 7 semi-directed interviews (3 with nursery teachers and 4 school teachers) which participated in the eTwinning action during the time period 2008-2010 in the region of Crete, we tried to investigate their opinions for whether the pastime of students and teachers of precocious children's age with the program can constitute a starting line of innovative instructive practices for the teaching of natural sciences.

4. Results

On the basis of the thematic content analysis of the interviews [20] with the teachers that materialize or materialized eTwinning programs the above research hypothesis appears to be confirmed. The pastime of students and teachers of precocious children's age with the eTwinning action, according to the teachers of the sample constitutes starting line for innovative instructive practices for the teaching of natural sciences. Also, as they reported in their interviews, through an extra - curricular process as the eTwinning action, certain more general educational objectives are achieved that are summarized in following:

(a) enrichment of knowledge, possibility of investigation of information and acquisition of new knowledge as well as exacerbation of interest for search of knowledge beyond the established models of taught material,

(b) socialization of students not simply with the significance of acceptance and adoption of rules of social behavior but with the significance of approach of the "different" schoolmate, which through the joint pastime with the same object of study, becomes familiar,

(c) creative exploitation of ICT, adding in their informative, recreational and commercial potentially role a pedagogic, sociopolitical and cultural dimension.

The teachers of the sample concluded that the students of precocious age produced knowledge via their active attendance in training processes and their entanglement in exploratory processes, in processes of resolution of problems and decision-making, critical thought and rethinking. In regard to the use of ICT, it was reported that with the various creative activities, the children get to know the possibilities of computer use, mainly as tool of creation and entertainment. Also, they demystificate its use, discover the dynamic characteristics of multiple representations of information and more generally a lot of possibilities beyond the static form of printed means.

In a social level the students, according to the interviews of teachers of our sample, acquire the sense of common responsibility and common aim, conscience of common identity and resolve problems with dialogue and interaction. They also cultivate sentiments of mutualism, aiming at the achievement of common objectives but also equivalent pastime with the computer.

5. Conclusions - Perspectives

In the modern pedagogic theory and action the collaboration of students is considered a particularly effective way for the growth and cultivation of communication dexterities and faculties, of search, analysis, expression and exchange of opinions and ideas between each other. In the present research, we realized that via the eTwinning action the students of precocious children's age show particular interest for the natural sciences. The teachers appreciate that the action provides the students with the possibility of active participation while presenting their own personal work, utilizing the modern technological means, utilizing at the same time their dexterities.

Also, each student shows interest to function responsibly and in the spirit of the team work they have undertaken, and via dialogue within the team and the exchange of ideas and information, he/she improves his/her achievement. Nevertheless, in the process of learning with collaboration, the child can express itself spontaneously, due to the creation of a friendly environment. Developing a positive attitude towards learning, after he/she escapes from the traditional methods of teaching and passes in more modern techniques of education and learning that entails the important element of the creation of friendly climate between the student team. eTwinning offers an alternative method of science teaching which involves discussion, investigation and motivation for learners of all educational levels

With regard to the future of action in the Greek educational reality the teachers of the sample present themselves particularly optimistically while stressing the increasing rhythms of attendance from year to year. Also, with the changes the central team promotes of work the electronic environment-platform is expected to become friendlier to the users, allowing the real social networking of students and teachers. It is also worth to report the positive contribution of a potential planning from the national service of online internet courses for teachers aiming to train them in subjects that are related with the incorporation of work in the teaching schedule, the free tools of web 2.0 that they can be used by teachers and other relative training action.

The experience of interviewing teachers in the scope of the research on the eTwinning action reveals that learning in collaboration with students from other countries is attractive and advantageous. The existence of international learning communities, within which persons collaborate for the growth of knowledge and dexterities in the field of science, are no longer limited strictly to academic personnel. Moreover, it appears that the process of individual discovery of the natural world, for students is as fascinating to them as it was for the pioneers of physics.

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The Theoretical Approaches to Improve Performance in Genetics and Develop Related Attitudes in Taiwanese Secondary Schools

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Abstract. *This study aimed to review younger secondary students' learning problems in genetics and attempted to improve their knowledge and literacy through the presentation of theoretical approaches. A review of literature on genetics learning was provided to explore the specific areas of difficulty and to relate these to the measured working memory capacity of Taiwanese students (age 13-14). Results pointed to that working memory capacity was the critical factor in learning genetics at this age. Based on the findings, a set of curriculum materials of genetics was deliberately constructed in line with the theoretical approaches, which were to minimise demands on the working memory, as well as to encourage attitude development.*

361 students from two secondary schools were included by purposive sampling in Taipei County, Taiwan, which were assigned to the experiential group (theoretical approaches) and control group (traditional approaches) respectively. The results showed that (1) the performance of the experiential group was found to be significantly better than the control group (p<0.001). (2) Numerous comparisons of attitudes between two groups revealed that attitudes of social awareness as well as attitudes towards aspects of the learning processes involved were more positive for the experiential group. All of this revealed fascinating insights into the development of learners' thought as well as highlighting the value of the theoretical approaches in bringing significant benefit to learners.

Keywords. Attitudes, Genetics learning, Performance, Theoretical approaches.

1. Introduction

Learning is not just the transferring of knowledge from the teacher to the learner. It is an understanding process where relatively permanent changes are caused by information and experience. These changes do not solely refer to outcomes of the learner's behaviour that are manifestly observable, but also to attitudes, feelings and intellectual processes that may not be so obvious [1]. Learning for understanding can be achieved if educators make the effort to find out what students' conceptions of learning are and what constitutes understanding.

Genetics is often thought of as a subject or a topic in biology that is important and even more in these days and age where its applications are ubiquitous and even the cause of many debates. However, due to the nature of the subject matter and the way learning processes occur and, possibly, the way it is being taught, the understanding of genetics ideas of the majority of students is thought to be very poor and full of confusions and alternative views. Thus, this study had sought to explore the learning difficulties in genetics and to identify possible ways forward.

2. Literature Review

Science education aims not only to transmit the knowledge and prepare for advanced study or a possible future carrier, but also to cultivate students to be citizens in modern societies which are now highly dependent upon scientific and technological advances [2], which means it aims to promote a positive attitude towards engaging with science and cultivate a person's development of scientific literacy [3]. This implies helping students to be interested in and understand the world around them, to engage in the discourses of and about science, to be sceptical and question of claims made by others about scientific matters, and to make informed decisions about the environment and their own health and well-being [4].

The study of genetics can offer insights into the way the living world works. However, any review of the literature about school and university students in learning genetics leads to the inescapable conclusion that students consider genetics difficult to learn and many misconceptions and misunderstandings can arise. Overall, genetics is an important theme for all learners but it is an area where there are major difficulties in understanding [5]. Literature reviews about school and university students' difficulties when learning genetics and several major reasons as being problematic were extracted:

2.1 Genetics subject itself

- *Nature of scientific knowledge*: Genetics is one of the most dynamic research disciplines within the natural sciences. It is a steady accumulation and might be changing in time and open to debate [6].
- *Complexity*: Genetics concepts refer to different levels of biological organisation (Figure 1) and students have difficulties with linking these different genetics concepts and processes with these different levels [7]. It is because several levels of organisation must be integrated in order to understand the processes underlying genetic phenomena and to grasp the overall picture of genetics. In addition, the levels of organisation, sometimes, lie both within a single discipline of the same/different chapter(s) while also involving other disciplines [8]. Because the working memory has a limited capacity, this is likely to bring about an information overload.

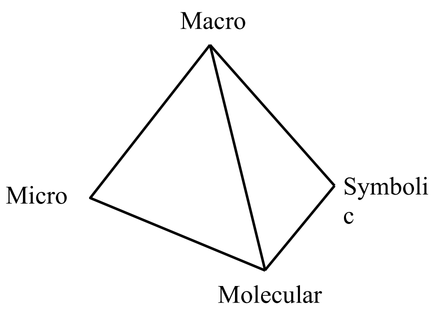

Figure 1. The pyramid of genetics concepts.

- *Terminological language*: Language development and conceptual development are inextricably linked. Firstly, understanding science is more than just 'knowing the meaning' of particular words and terms, it is about 'making meaning' through exploring how these words and terms relate to each other. One of the biggest problems of language in genetics is the complex and vast technical vocabulary. Students have the problem of learning the new and abstract words, and at the same time learning new concepts in that vocabulary [9]. According to Johnstone (1991), an unfamiliar word or known word in an unfamiliar context takes up valuable working memory space [7].
- *Mathematical requirement*: Bahar *et al*. (1999a) noted that mathematical expressions, which are symbolic, cause problems. In addition, students have difficulties in transferring the mathematical knowledge and insights from one context to another [5].

2.2 Differences in an individual cognitive developmental nature

According to Piaget's cognitive development theory, a student's ability to deal with abstract concepts in meaningful learning is correlated with his/her stage of cognitive development. Many genetics concepts require abstract thinking. Unless the student's has reached the level of thinking, he/she will not be able to cope adequately with these ideas. In order to learn meaningfully, students must relate new knowledge to what they already know [10], 1968). The existing knowledge and how it interacts with new knowledge determine the degrees of meaningful learning. If these are in conflict with accepted scientific ideas, new learning will be affected and misconceptions may establish, and further, these alternative conceptions and misconceptions will interfere with later study [7]. Obviously, these should be taken into account by teachers when teaching.

From the information processing perspective, the working memory can easily be overloaded in learning situations when the amount of information exceeds the upper limit of the working memory space [11]. For adolescents, this can happen more easily because of their undeveloped capacity. Nevertheless, by chunking, it is possible to reduce the load on the working memory although the capacity of the working memory cannot be changed [12]. That means the working memory improves if the pieces of information are familiar, frequently used, or logically related to each other. On the other hand, it can be easily overloaded when the new knowledge is large, unfamiliar, irrelevant or abstract and thus cause learning difficulties [11]. Moreover, various researches found that working memory capacity has significant effects on students' problem solving performance (e.g. [13]). Thus, the working memory capacity can be considered to be likely to be one of the key factors effecting the learning of genetics in secondary schools. However, if the teaching strategy can take into account a student's limited working memory capacity as a limiting factor in order to help a student to operate beyond his/her capacity, a student with a small working memory space still could be able to learn successfully [14].

2.3 Purpose of the study

Thus, the purpose of this study is to investigate the situation relating to learning of genetics in secondary schools, to offer strategies and approaches which will reduce students' difficulties in genetics, these being based on the accepted understanding of psychological reasons which bring about difficulties for students. Using established models of learning and research evidence about learning in sciences, the aim is to test some ways forward which are likely to improve the situation in the learning of genetics. This testing will involve not only the investigation of student performance in genetics tests but will also seek to explore the ways attitudes are affected by the new approaches.

3. Methodology

The participants of this study included 361 first year students of public secondary schools in the north of Taiwan. These students, typical secondary school students, had a mean age of 14. The new teaching material was applied to 180 students from 6 biology classes in two schools as the experimental group. The control group was 181 students from 6 biology classes who were from the same two schools as but taught by the traditional way. They were taught by the same teacher in one school, so two teachers in total were involved in this study. This study used comparing the experimental group and the control group to explore how theoretical approaches promote students' conceptual understanding and attitudes development about genetics.

3.1 The study instruments

Based on student-oriented interactive approach learning [15] and the information processing approach introduced by Johnstone (1993) [16], we developed a new teaching instruction that support students' acquisition knowledge by interacting in groups and make connections between the academic genetics content and the student's everyday world. The lessons were presented under five themes: basic terminology, theory of heredity, human inheritance, sex determination, and genetics in our lives (nine hours of teaching involved) (Three examples shown in Appendix). It was deliberately constructed to:

- Organise the teaching materials carefully to relate to students' prior knowledge and experiences enabling pupils to build on existing knowledge and enabling them to assimilate and transfer new learning into the long-term memory. In the learning situation, students are encouraged to describe their observations about the phenomenon, gain an intuitive comprehension of it, and connect it to their personal experiences [17].
- Minimise demands of the working memory by highlighting the information to which the subject must attend, carefully sequencing and presenting the ideas step by step, and reducing to a bare minimum numbers of items of information that requires the attention of students. The information should be presented to the students in a language which should be easy enough to understand, and even use learners' language by setting them to interact in groups [16].
- Support students' ability to make sense of their observations and intuitive comprehension, and to use various representations to guide the direction of their thinking. Students are encouraged to manipulate and link multiple representations and generate simple rules or hypotheses to explain what they have observed [18].
- Relate closely to life and society and involve the learners in some interaction and discussion over key issues. By experience different views of the same issue, students are encouraged to recognize the many facets of real-life decision taking [15].

3.2 Procedure

The main experiment focused on secondary school students who were separated into the experimental group and the control group. The experimental group was taught using new teaching approaches and the control group was taught by normal teaching ways. Very often, the traditional strategies for teaching biology/ genetics rely on the teacher explanation and textbooks. After instruction, both groups were evaluated in terms of performance and attitude development in order to find out whether the teaching approaches were helping students in their learning and understanding in genetics as well as whether attitudes toward genetics and its social implications were developing.

3.3 Data collection and analysis

The following assessment tasks were used:

1. The measure of the working memory space capacity of the learners was used the figural intersection test [19];
2. The learners' performance included the scores of school examination and word association test [20]; and
3. The attitude questionnaire was used to investigate various students' insights into how they think and the way they evaluate situations and experience about genetics [21].

After collecting the data, every student' responses to each question were converted into a code and the data stored in a spreadsheet. Using the spreadsheet, the codes were used to calculate frequencies, percentages, and comparison groups.

4. Result

First of all, Taiwanese students' results of the figural intersection test for measuring the working memory capacity was 5.2±1.4 (age 14), which was consistent with the findings of other research studies [22]. Also, there was a significant correlation between students' outcomes in learning genetics and their working memory capacity ($p<0.001$). High working memory students performed better in the genetics examinations than low working memory students. Pamela Reid's (2002) showed working memory will only show correlation if the teaching or the assessment makes a demand on the working memory, so that those with higher working memory capacity have an advantage. Because of the structure of the genetics knowledge, genetics certainly has the potential to generate an information overload.

After instruction, students were evaluated in terms of performance and attitudes development. The results showed that the experimental group performed significantly better than the control group in both school examination and word association test (Table 1). Also, the improvements of two tests in the mean scores are large (6.4 and 7.6). The effectiveness of the new teaching material has therefore been shown to bring about a marked consistent improvement in students' performance.

Table1. The performances of students in genetics learning.

	Experimental group	Control group	t-test
School Examination	56.5±21.4	50.1±19.7	3.0 $p<0.01$
Word Association Test	26.9±12.8	19.3±10.9	6.0 $p<0.001$

Another important factor influencing success in learning relate to attitudes. In general, it is encouraging that around 50% of both the experimental group and the control group from secondary school enjoyed and could understand the genetics course as well as over 60% of students tended to see genetics as interesting, important, and related to their life, even they thought genetics is difficult, too mathematical, and too much to learn.

Comparing the experimental group with the control group about their feelings about the genetics course, it was found that more than 48.3% students of the experimental group had enjoyed the genetics course and they tended to enjoy the genetics course more than the control group ($p<0.01$). More students in the control group thought the genetics course was too much to learn. ($p<0.001$). The new teaching material, in fact, covered the same ground. This may reflect of way of minimising demands of the working memory. When students were asked if he/she can understand genetics in the class, the pattern of difference between two groups is quite complex. The experimental group tended to agree more or be neutral. However, less of them strongly agreed. Perhaps, quite a few of the experimental group were more confident that they understood genetics than the control group students, with some of the experimental group being more realistic: they appreciated more that genetics is difficult.

Studying students' attitudes and opinions about genetics applied in our lives, the results showed that the experimental group were more conservative. As shown on Table 2, in (a) question, although around 60% of students in both groups agreed that biotechnology will benefit our lives, there is a trend for the experimental group to move in towards the central position. It is possible that they were exposed to several social issues about genetics and realized the realities. In addition, students in the experimental group thought about ethic and moral issues more. In addition, it is worth noting that the experimental group students doubted if they will buy GM food, but the control group students tended to be even more hesitant. The experimental group strongly disagreed about cloning very talented people to benefit the society. Only 35% of students believe government has good intentions to the society.

Table 2: The results of questionnaire about genetics applied in our lives.

%	Strongly agree	Agree	Uncertain	Disagree	Strongly	X^2
(a) Biotechnology will benefit our lives.	19 23	40 40	36 29	2 5	3 3	6.6 (df3) p<0.05
(b) Science research will progress slowly if government imposes strict rules about biotechnology.	3 8	15 9	47 46	22 24	13 13	0.6 (df3) No sig.
(c) Parents have right to terminate pregnancy when they find the fetus with genetic disease.	17 22	25 27	32 30	17 13	9 8	5.5 (df4) No sig.
(d) I am willing to buy GM food.	3 3	8 14	60 45	17 21	11 17	19.1 (df4) p<0.001
(e) Cloning should be allowed to help cure diseases.	10 18	18 32	34 32	22 10	16 8	53.2 (df4) p<0.001
(f) It would be good to clone very talented people for the benefit of society.	5 12	9 13	24 29	18 16	44 29	25.4 (df4) p<0.001

5. Discussion

The new teaching material developed was based on evidence derived from former research. The aim was to improve pupils' learning in genetics, especially conceptual understanding, to develop positive attitudes and growing awareness of the social implications of genetics. The new materials were deliberately constructed to minimise demands of working memory in that this is known to be a key factor which hinders understanding. They were also designed to relate closely to life and society and to involve the learners in some interaction and discussion over key issues.

Generally, students enjoyed and could understand the genetics course. They tended to see genetics as interesting, important, and related to their life, even they thought genetics is difficult, too mathematical, and too much to learn. Students who had experienced the new teaching material have improved positive attitudes and social awareness. They expressed more enjoyment, were more satisfied and realistic and thought more about ethical and moral issues. On the other hand, students who were taught by the traditional way tended to have more complaints, such as too much to learn, too much mathematics, and boring.

Overall, although the new teaching material had had a significant impact, there is clearly more to be done. Genetics still stands out poorly when compared to other parts of biology. The curriculum in genetics is abstract with much terminology and symbolism. These really have no place in a school syllabus and the students are clearly more perceptive than the curriculum planners. According to Hussein (2006), *a poor curriculum and teaching will tend to generate negative attitudes and this may lead to poor performance in tests and examinations. Good performance in tests and examinations will tend to generate better attitudes. Thus, attitudes and success are highly linked and each affects each other* [23].

However, it should be pointed out that all conclusions derived from this study must be treated tentatively. Inevitably, any new approach will have a novelty factor which may enhance performance. Nonetheless, the evidence taken together does support the hypothesis that learning arranged in line with information processing insights is more effective. In addition, the strategies used were designed in line with understandings of the ways attitudes develop and the effectiveness of these approaches has been demonstrated. In sum, the use of the teaching material had clearly generated better attitudes and improved performance. This was an example showing how the application of a well-attested educational model can bring real benefits for the learners.

In the light of the findings of the present research, the following strategies are recommended for implementation in genetics course of secondary school:

1. Attractive teaching material is a universal way for inspiring learning motivation.
2. Students' prior knowledge often does not conform to scientifically accepted principles and these ideas may serve as a foundation upon which new learning may be built. Obviously, these ideas should be taken into account by teachers; if they are not, and if they are erroneous, they could interfere with new learning. The results from this study can serve to help teachers plan more effectively and to select the best ways for introducing learners to genetics.
3. Cognitive styles may influence the learning of genetics. However, it is almost impossible to meet the needs of all the learning styles in a class of students. Nonetheless, the teacher should be aware that there will be variations in learning styles.
4. The nature of genetics knowledge certainly has the potential to cause the working memory to overload. When a new concept is introduced to the learners, the teacher should control the amount of useful information which the learner has to process and can also limit the extraneous distracting information in a learning situation, so that the working memory overload is minimised.
5. The teaching materials can be designed around applications and life experiences to create a more familiar context for the learning process (to concrete thinking). The learners can construct new concept based on the knowledge they already have. These should help learners developing positive attitudes, minimise working memory overloading, facilitate cognitive development toward formal thinking, and/or enable students to build on existing knowledge and assimilate and transfer new learning into the long-term memory.
6. Learning by means of groups with the materials can provide opportunities for learners to participate and learn through peer's language and group competition in order to increase motivation and improve understanding, which will lead to improve students' attitudes towards a subject.
7. The focus in teaching genetics should be more applications-led and should enable the learners to realise how genetics could be used positively in making decisions and choices.

As in any other research, questions have arisen from this study and they can be point of departure for further research. There are some suggestions offered: Firstly, the study has revealed that an understanding of certain key topics is extremely important for further study in genetics. For example, an understanding of mitosis and meiosis is very important for understanding Mendelism. Thus, more research is needed to explore the reasons for these relationships and, more importantly, how to improve the learning of these foundational concepts. Secondly, as mentioned in the last section, the research can go further. The longer term effects of such teaching approaches needs explored as well as the need to check the findings by means of, perhaps, interviews.

Moreover, the new teaching material developed in genetics is an example, which relates to effective and efficient learning as well as the development of positive attitudes. The approach can be used as a means for applying to other cognate subjects. If there was a consistent development across many subject areas, following parallel approaches, then there would be the need for a major research project to measure the outcomes and to pinpoint further areas needing exploration and development. Finally, it is hoped that this study will be able to contribute to the development of genetics as a school discipline so that students who complete courses will be equipped and motivated to make genetics learning more meaningful and practical to students, as well as being able to make future contributions based in genetics as well as many other career options.

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Appendix

Three examples of the genetics teaching material in this study

Example 1: Genetics in our lives

Teacher's guide:

(a) Form groups of three pupils and allow them to sit around a desk.
(b) Give each group a set of reading information for further discussion.
(c) Give each student a copy of the sheet entitled, "Cloning Humans: Right or Wrong?"
(d) Allow pupils abut 30 minutes to discuss the questions and write down their agreed answers.
(e) After the group work, ask how many groups favoured human cloning and how many were against it.
(f) Select some groups and ask them for the most powerful reasons they had for or against it.
(g) If time allows, let the students start the exercise, "Homework". This can be completed at home.

Students' material:

Cloning Humans: Right or Wrong?

> Please read the papers that your teacher gives you and discuss the following questions.
> You will be working in a small group of about three.
> Do not try to work on your own!!
> After you have discussed each question, you can take it in turns to record your agreed answers.
> One of you may be asked to report back on your answers to question 6.

(1) As a group, list as many benefits you can think of which could come from human cloning.
(2) What are the drawbacks which might occur with human cloning?
(3) Do you think cloning can cause ethical (things about right and wrong) problems?
(4) There are three types of parents: gene parents, delivery parents, and care parents.
What kinds of legal problems might arise?
(5) What do you think different religions might have to say about human cloning?
Will it change our beliefs?
(6) As a group, do you think human cloning is a good idea? Give your reasons.

. Homework
Please write a letter to the British Queen (no more than 6 sentences).
Tell her your opinions about human cloning.
Give her some reasons why you recommend or reject that human cloning should be allowed in the UK.

Example 2: Genetics in our lives

Teacher's guide:

(a) Take students to the computer room.
(b) Give each student the sheet entitled, "Genetics in Our Lives"
(c) Allow students to follow the instructions, finding the web sites and completing the answers.

Students' material:

Genetics in our lives

Shrek said:
I'm going to marry Princess Fiona. The king of the kingdom of far far away asks us to do genetic counselling in the hospital.

Princess Fiona said:
I saw some food in the supermarket is labelled GM Food. What's that? And if I eat that, does that make me become normal both day and night.

Prince charming said:
Last week's news indicated that scientists are researching on human cloning! If it is possible, I am going to clone a lot of myself, charming human being.

Donkey said:
I heard genetic engineering and biotechnology are very hot nowadays. They can help agriculture breeding, but also produce medicines. Maybe I'll become a horse one day!

Genetics is more and more important in our lives.
Please surf the following websites and answer questions.

Part 1: Genetic counselling
http://sp1.cto.doh.gov.tw/doctor/book/ch02/book2_2.htm
(1) What is genetic counselling?
(2) Who needs to do this?
http://nature.ckps.tpc.edu.tw/6b/%BF%F2%B6%C7/tree-chap8.htm
(3) What is the carrier of a genetic disease? Answer: __________
 (A) A patient with a genetic disease.
 (B) A healthy person who has a disease gene. (e.g. genotype is Aa)
http://www.commonhealth.com.tw/New_Life/baby/exam2.htm
Pedigree is very important when we do genetic counselling.
(4) How do doctors know you are not a carrier of genetic disease?
http://content.edu.tw/junior/bio/tc_wc/textbook/ch08/supply8-6-1.htm
(5) How is genetic counselling carried out?
(6) If you needed it, where could receive genetic counselling?
 (Choose one where is the nearest your home.)

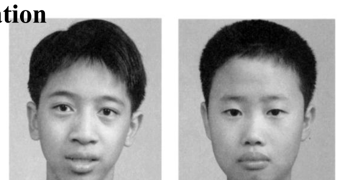
Example 3: Human inheritance

Teacher's guide:
(a) Form groups of four and give each pupil the papers entitled Gamete Combination.
(b) Allow the groups to work through the exercises for the whole lesson.

Students' material:

Human Inheritance (1): Gamete combination

Using Punnett squares allows us to predict the ratios in crosses.
These ratios may differ from those in experimental crosses.


Double-fold eyelid/Single-edged eyelid

Part 1
The double-fold/single-edged eyelid is a trait inherited from our parents (see the figure). The gene for double-fold eyelid is dominant (R) to that for single-edged eyelid (r).

If the genotypes of a couple are Rr x Rr, please use the Punnett squares to predict the ratios in crosses.

The types of offspring genotype ______ ______ ______ ______
The phenotype ratio of offspring ____________________________

Part 2

Use the cards to represent chromosomes. The letter on the card represents a gene:
R is the gene of double-fold eyelid and r is the gene of single-edged eyelid.

R **r** x **R** **r**

(1) You will be working in a group of three:
One member will act as the *father*;
One member will act as the *mother*; and
One member will act as the *child*.

(2) The father will hold the grey cards and the mother the white cards. The grey cards represent the chromosomes in the father's cell, and two white cards represent those in the mother's cell.

(3) One student is to play the father taking two grey cards, and the other student is to play the mother taking two white cards. Place the cards face to yourself.

(4) The third student (playing child) picks one card from the father and one from the mother without looking and then links them together. (So he/she will get one grey card and one white card). This means the gene combination of the first offspring.

(5) Record this result on the following table, and then give the cards back to the parents.

(6) Repeat 3 times.

(7) List the genotypes obtained. Beside each genotypes state the phenotype.

(8) Repeat 16 times.

Number	Genotype	Phenotype	Number	Genotype	Phenotype	Number	Genotype	Phenotype	Number	Genotype	Phenotype	Number	Genotype	Phenotype
1			5			9			13			17		
2			6			10			14			18		
3			7			11			15			19		
4			8			12			16			20		

Answer the following questions.

1. Work out the ratio of phenotype from data 1 to 4.
   The double-fold eyelid's number: __________
   The single-edged eyelid's number: __________
   The double-fold eyelid : the single-edged eyelid = __________
2. Work out the ratio of phenotype from data 1 to 20.
   The double-fold eyelid's number: __________
   The single-edged eyelid's number: __________
   The double-fold eyelid : the single-edged eyelid = __________
3. Collect all data from all classmates and work out the ratio of phenotype.
   The double-fold eyelid's number: __________
   The single-edged eyelid's number: __________
   The double-fold eyelid : the single-edged eyelid = __________
4. Arrange your data:
   Punnett square to show the ratio phenotype is __________
   From data 1 to 4 the ratio of phenotype is __________
   From data 1 to 20 the ratio of phenotype is __________
   From all classmates' data ratio of phenotype is __________
5. If we compare the ratio of dominant and recessive in four children family and twenty children family, which result is close to the theory?
6. After collecting the data from all classmates, how does the ratio of dominant and recessive compare

between this experiment and theory?

7. Explain why the actual ratios may differ from the predicted ratios.

In-service training programs concerning Physics Education in Elementary School. A one year Seminar Course promoting the role of experiment as a form of PCK in Science Education performed in the Science Education Laboratory Centre (SELC) of Piraeus

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Abstract. *Long-term professional development projects have been designed in order to change the classroom practices of teachers, especially the role of experiments within them*

Some of them are based on the principles of distance education and/or contact training while others on the effort to introduce the idea of PCK to student-teachesr.

A one year in-service training program for teachers of Primary Education has been designed and performed by the Science Education Laboratory Centre (SELC) of Piraeus in order to enhance both subject knowledge and pedagogical content Knowledge based on the role of laboratory experiments in physics education in particular.

After the intervention teachers' lesson plans had a stronger conceptual base and also teachers seemed to have developed a sense of confidence.

Keywords. Science teaching, Primary Education, In-service training programs, Experiments, PCK,

1. Introduction

Because elementary teachers can teach a dozen subjects, they require (but do not necessarily have) a rich, integrated, flexible knowledge base (Ball, 2000). Their knowledge base needs to include pedagogical knowledge, subject matter knowledge across numerous disciplines, and pedagogical content knowledge.

Many different training courses, concerning science teaching, have been designed based on the principles of distance education and/or contact training. Some include e-mail discussions, lectures, exercises and seminars, private work and group discussions. (Lavonen, 2004). Others have been based on the effort to introduce the idea of pedagogical content knowledge - (PCK, the ways of representing and formulating the subject that makes it comprehensible for others (Shulman 1987)- to student-teachers using issues of particular science content as well as specific ways of teaching that content captured and portrayed for students-teachers. ITPT- In-Service Training for Physics Teachers- has been designed in order to change the classroom practices of teachers, especially the role of experiments within them as a form of PCK in this specific domain. Other proposals have chosen to focus on three goals in their elementary science methods course related to inquiry-oriented science teaching, the use of curriculum materials and students ideas as crucial –but not the only- areas of focus for elementary science teacher education (Davis, 2007).

Epistemic beliefs, though, affect the way in which the teachers use experiments in a school laboratory, or indeed whether they utilize experiments at all (Hodson 1992, Lumpe 2000). Teachers should choose experiments so that conceptual and procedural understanding of students could be developed. Resistance to change the beliefs of the teachers is one of the reasons for the slow rate of change in physics education (Haney 1996). Various approaches have been suggested to help change unfavorable teachers' beliefs and to assist the adoption and use of new models of teaching (Fullan 1991). Educational reforms and improvement in science teaching through in-service training are much more complex tasks than seems at first sight (Fullan 1991).

Students-teachers are commonly disappointed with their teacher education programs (Korthagen 2001) and educational theory – included PCK– courses provided by Universities (Skillbeck 2005). Most student-teachers have preconceived views about teaching, and about what they need to learn about teaching, that are at odds with those of their teacher educators (Pajares, 1992). For student-teachers, there often seems to be a big gap between the practice of teaching and the theories being espoused by their teacher educators, which are seen as having little value (Holt-Reynolds, 2000). Student-teachers tend to underestimate the cognitive aspects of teaching. As school learners, they did not have access to their teachers' thinking and decision-making as they were being taught (Munby, Russell 2001).

An additional problem for science teacher educators arises from the intertwined nature of PCK and subject-matter Knowledge. Studies suggest that student-teachers often lack a deep conceptual understanding of the content they are supposed to teach, and that their subject matter knowledge is fragmented, compartmentalized and poorly organized making it difficult to access this knowledge efficiently when teaching (Gess Newsome 1999). But a teacher who does not both understand and have a real affection for a subject will never be able to teach it well. (Berry 2008)

Therefore, in spite of all such efforts, reported development of teaching practice remains low. Real development occurs particularly in those few groups that follow the recommendation to involve their own students, and to try out the experiments in real classroom situations. Teachers should be helped to examine their pre-existing knowledge and beliefs, and to be assisted by both physicists and educationists (Jari Lavonen, 2004).

In-class discussions, recommended, provide opportunities for intellectual and expertise development and give a strong potential for fostering change (Grossman 2001). Teachers educators, also, can provide experiences that prepare teachers to develop PCK a preparation known as PCK readiness (Smithey, 2008). In this way a teacher can learn about the content, how to represent content to learners, and common ideas their learners bring to science class. This initial knowledge is developing gradually to PCK and eventually, usable knowledge (Smithey, 2008).

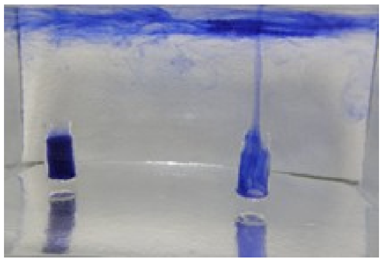
2. Intervention

Taking these parameters into account a training program was designed and performed in the Science Education Laboratory Centre (S.E.L.C.) of Piraeus during academic year 2009-2010. Totally, two hundred in-service teachers coming from eighty five different elementary schools attended twenty five seminars. Every participant attended a cycle of three seminars concerning experimental activities in teaching Heat, Electricity and Optics in Fifth and Sixth Grade of Elementary School. A group of about twenty teachers each time attended all three seminars lasted for two hours every Thursday or Friday 12.00 to 14.00. During seminars teachers in group of five performed fifteen experiments under the guidance of the educators related to the Session of the course book to be taught in the classroom. Discussion involving interpretation and comments took place after each experiment had been performed.

The purpose of these seminars was not only the performance and interpretation of the experiments as another topic of Physics but also as a procedure for teaching experience exchange. Alternative ways of teaching methodology were described and specific spots were highlighted so that difficulties in classroom could easily be overcome. A characteristic number of experiments are presented in tables 1, 2 and 3.

Table 1. Experiments concerning Heat.

1 Heat transfer: Convection



Hot colored water rises while cold colored water stays inside the little bottle.

2 Expansion of gases

Bubbles coming from a pot as the air inside expands when glass comes in conduct with our palms.

Table 2. Experiments concerning Electricity

1 Attraction between neutral and charged body

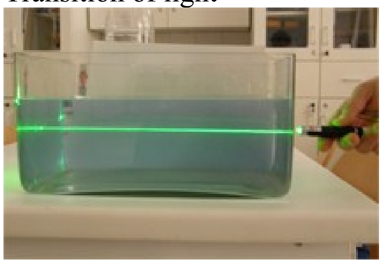
The little pieces of paper jump as they are attracted by the plastic surface of the box being charged as we rub it with a piece of cloth.

2 Attraction between neutral and charged body

A tin is rolling towards a charged ruler.

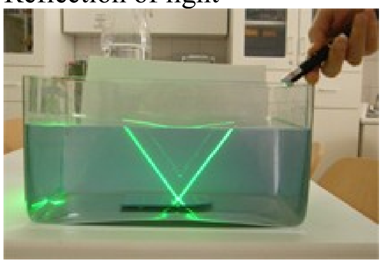
Table 3. Experiments concerning Optics

1 Transition of light



We can detect the light beam coming from a laser pointer traveling in straight line through colored water.

2 Reflection of light



The light beam is reflected when strikes the surface of a mirror inside a pot of colored water.

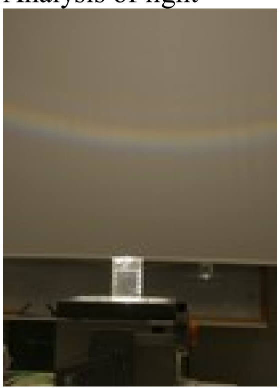
3 Pin-hole camera

We can see objects upside down looking through a hand made pin-hole camera.

4 Refraction of light

We can see a coin at the bottom of a glass rising as we fill gradually the glass with water.

5 Analysis of light



The light beam coming from a transparency reflector passing through a prism or a glass of water is analyzed.

3. Discussion

Although data analysis of the questionnaires given is still in progress, after the intervention, student-teachers' lesson plans seem to have a stronger conceptual base. Teachers performed most of the experiments presented in the training program having developed a sense of confidence. In a future version though seminars are planned to be more balanced as it was observed that in-service teachers lack a great amount of content knowledge as science is concerned. It is important for the participants of the seminar to have enough time so as to deal with the information provided and make the connection between theory and practice.

4. Acknowledgements

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Cloud Wheel

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Abstract. *Cloud is one of the beauties of nature we could observe in daily life. It is composed of mass of little drops of water or frozen crystals suspended in the atmosphere. Cloud formation is influenced by atmospheric conditions such as humidity, temperature, and air pressure. Clouds, in many cases, foreshadow incoming weather and assist in forecasting. Learning cloud is another activity for student to connect science and real world.*

Students can stare into sky and with their imagination they can find endless shape of cloud in sky, but many of them are clueless if they are asked about types or names of clouds they are looking at. Clouds have been classified in 10 categories, and each of them has difficult name and complex characters to remember. Students get bored easily to remember these cloud categories before they learn more about them.

The Cloud wheel was designed to help students to learn cloud with fun. Student can learn characteristic and name of the cloud easily by using the Cloud wheel.

The Cloud wheel is composed of 3 circle papers in different size stacked together into 3 layers, and each layer moves or spins independently from the others. These layers contain names, characters, pictures, and heights of clouds. Student can determine name of clouds they see by moving the top layer of the Cloud wheel to match the closest cloud picture on the Cloud wheel, and the cloud's name will appear in a name box. Student can learn more about that cloud by moving the wheel to see characteristics of that cloud. The Cloud wheel is colorful and easy to use. With the Cloud wheel, student can play and learn science at the same time.

Keyword: Cloud wheel, Cloud.

1. Introduction

One of the secondary science curriculums for students in Thailand is to learn about nature of atmosphere such as weather, and composition of atmosphere such as pressure, humidity, rain and cloud.

Clouds play as the important role in our atmosphere and have influence to other atmospheric compositions. Learning cloud is the way to understand atmosphere and our environment.

There are many ways to study the clouds but observation by eyes is one of the best ways for the secondary students. Observing cloud is to observe both quantity and shape of them then data are collected as quantity and name of those clouds. Clouds have been classified in 10 categories. Therefore they are very complicated and difficult for secondary students who are about 13-14 years old to learn and understand the nature of clouds.

Cloud Wheel was designed to help student to learn about the characteristic, shape and name of clouds. Designing cloud wheel was base on the knowledge of form and level of the clouds. Clouds are classified in 3 big shape; mass, sheet and feather with a 3 levels; low, middle and high.

2. Composition of Cloud wheel

The Cloud wheel is composed of three circle papers in different sizes stacked together into three layers, and each layer moves or spins independently from the others. The smallest paper is on the top of the set and the largest paper is on the bottom of the set.

Figure 1. Cloud wheel

3. How to use cloud wheel

Students can use cloud wheel in 2 ways. First, observe cloud in the sky then move middle circle paper to match cloud picture with the character position at the smallest circle paper and move the bottom circle to select cloud level. Name of that cloud will appear in the name box at the bottom part of the cloud wheel. Second, move circle paper to change the name of the cloud in the name box and then the characters and the picture of that cloud will move to the character position.

Figure 2. Character position

Figure 3. Cloud Level

Figure 4. Name box

4. Development of the Cloud Wheel

From the beginning of invention, cloud wheel was made from paper. Later on, the paper version has been developed to cloud wheel version 2 in which three circle papers stacked together have been changed to be the package of cloud wheel. In addition, new version cloud wheel also consists of the stack of a little book containing the details about each of ten clouds.

Figure 5. Cloud wheel version 2

5. Conclusion

Cloud wheel was design to help students in learning cloud and science with fun .One of the purposes of cloud wheel is to motivate them to open their mind in gaining the new knowledge.

Cloud wheel has been tested by many teachers and students and it was found that cloud wheel helps students not only learning more about clouds but also learning with fun.

6. Acknowledgement

It is a pleasure to thank those who made this work possible, IPST secondary science staff, and also my friends who support my grammar.

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An Optical Model to Help Improving the Functioning of a Political Coalition

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Abstract. *Sometimes, following stiff general elections, a country, a state or a province is governed by a "grand" coalition of two parties which has a cozy majority in Parliament, but, the two allies have been strongly opposing during their old and recent history. How could work efficiently such a Cabinet?*

To model the structure and functioning of such a coalition and to generate hints how to improve it, the authors introduce and develop wave models, based upon the interference of partially coherent, two- and multiple- transverse waves, used in Electromagnetic Optics and by using correspondences between social and optical quantities. The models seem to fit the reality, f. e. in Romania or in Germany. They may be used in many fields where the leadership is split, but there is present a general common interest.

Keywords. Modeling of functioning of political coalitions, Grand Coalitions, Modeling Cabinet Relationships, Optical models in Sociology, Partially coherent transverse wave models, Econophysics, Modeling split leadership, Physics for Society, Systems theory.

1. Introduction: A possible social command for Physics models

As resulting from the November 30, 2008, parliamentary elections in Romania, there have been leading two political forces: the Democratic Liberal Party (PD-L) which had 115 (D) mandates in the Chamber of Deputies and 51(S) senators, totally 166 mandates and Social Democratic Party (PSD, allied with the very small Conservatory Party) which have163 mandates, 3 mandates less than PL-D: 114 D mandates and 49 senators, out of a total of 334 deputies and 137 senators in the present Romanian Parliament [10].

As the number of votes was concerned, the hierarchy after the elections of November 30, 2008 was reversed, with a difference in favor of PSD of about 1%, of the expressed and valid votes (39.2% of the total electors participating in the pools, only).

Both PL-D and PSD parties pledged the victory in the parliamentary elections.

No one of these two parties could arrange coalition with the two smaller parties, previously members of the minoritary Romanian Cabinet and represented in the newly elected Parliament: the National Liberal Party (PNL), with a total a 65 D + 25 S mandates and an ethnic party, the "Democratic Union of the Magyars in Romania" (UDMR) having 22 D + 9 S mandates.

The solution found to insure stability in the country, in a time of a deep world crises (sub-prime mortgage, financial and economic, crises), has been to arrange a grand coalition, a Cabinet made out of ministers belonging to the main two opposing parties, PD-L and PSD, (with the exception of the Ministry of Justice, managed by an independent), parties having together a large majority in the Romanian Parliament (~70%), apparently, a cozy parliament majority to govern the country.

But, the two allies do belong to different European Parliament political families, have been strongly opposing, at national and local levels, during there history, during the previous Cabinet and during the electoral campaign.

How to model the possibility to work efficiently of such a Cabinet?

Physics is concerned mainly with modeling nature, but, by its wealth of modeled phenomena and due some similarity in structures and in relationships in nature and in society, Physics may offer solutions [2-9, 11, 12] for modeling social structures and relationships, forecasting behaviors and contributing to promoting HANDS ON . . . SOCIETY.

2. Mechanical models

To model the functioning of such a coalition Cabinet and to generate hints how to improve it, the authors have tried to develop some models by making analogy with models for physical phenomena.

To explain the action, A, of such a grand coalition Cabinet, the compounding, like in Mechanics, of actions A_1 and A_2 of the two components:

$$A = A_1 + A_2 \qquad (1)$$

as a scalar addition of the two superposed mechanical actions, is non adequate, when considering the present day Romanian political scenery.

Mechanical vector models are based upon compounding of momenta or of forces, like:

$$\vec{F}(\vec{r},t) = \vec{F}_1(\vec{r},t) + \vec{F}_2(\vec{r},t) \cdot \qquad (2)$$

Such mechanical models are not useful to model such a grand coalition Cabinet, too, because the actual two allied main political forces are almost equal in module, clearly opposing (acting in opposite directions) and consequently, the resultant action would be close to zero.

More, such time independent mechanical models might eventually describe only slowly evolving, rather coherent variations and therefore could not explain frequent political decisions subjected to fast internally and externally influenced mood oscillations and that the behavior of the political class is rather cyclical.

Such mechanical models could not explain and model the structure and the functioning of the Government of a grand coalition of divergent parties.

3. Wave Optics models

The authors think that, in order to model the interactions: between the political parties, inside political parties and the Cabinet's political structure and functioning, it is useful to introduce and develop wave models [2], particularly models of the interference of partially coherent waves used in Optics [1].

To explain such models and to be able to introduce the correspondences between optical quantities and the social ones, let us firstly consider the compounding of two waves.

The resulting elongation $\vec{E}(\vec{r},t)$ due to the two present and interacting waves of known elongations, $\vec{E}_1(\vec{r},t), \vec{E}_2(\vec{r},t)$, would be of the form:

$$\vec{E}(\vec{r},t) = \vec{E}_1(\vec{r},t) + \vec{E}_2(\vec{r},t) \cdot \qquad (3)$$

Because of the slow response in the Cabinet's or Parliament actions (the detector), as compared with the high frequency of the waves (positions of the constituent political parties of the alliance) the measurable quantity (the effect) could not be associated with the resulting instant elongation of a wave , but with the intensity of the resulting compounded wave:

$$I(\vec{r},t) = C^* < /\vec{E}_1(\vec{r},t) + \vec{E}_2(\vec{r},t)/^2 > \qquad (4)$$

where C is a dimensional constant and < > stands for time average, during the duration of a detection process (duration of producing an effect: a law, a decision of the Cabinet, for example).

From (3) and (4) we get:

$$I(\vec{r},t) = C^*(< /\vec{E}_1/^2 > + < /\vec{E}_2/^2 > +$$

$$+ < /\vec{E}_1 \cdot \vec{E}_2^{\,*} / > + < /\vec{E}_1^{\,*} \cdot \vec{E}_2 / >) \qquad (5)$$

or

$$I(Q) = I_1(Q) + I_2(Q) + I_{1,2}(Q) \qquad (6)$$

where, Q stands for the place and time of action, $I_1(Q)$ and $I_2(Q)$ are the intensities due to each wave contribution if alone in Q and $I_{1,2}$ (Q) (compounding term, interference term) stands for the contribution to the resulting action of the interaction of the two optical waves – political forces .

4. Scalar two-wave models

If, for the instant, one assumes the two waves would be real and scalar (or if transversal, they have parallel elongations only, the waves having parallel polarizations), socially - forces acting in the same way to the same end -, the intensity would be:

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2} * \gamma_{12} * \cos\theta \qquad (7)$$

where γ_{12}, the degree of mutual coherence between the two waves, might vary between [0, +1] and the phase factor, $\cos\theta$, is varying

$I(\vec{r},t) =$

between [-1, +1], because of the possible difference of phase between the two waves implied (of the gap of time between the oscillating action of the two political forces).

For a partial coherence of the interfering waves, the most common situation, the degree of mutual coherence is sub unitary:

$$\gamma_{12\,pc}<1. \quad (8)$$

The optical resulting field would be insensitive to totally incoherent, interaction of the waves (the allied parties) when, for each pairs of points in the field, S_1 and S_2 and for each instant t, the mutual degree of coherence would be:

$$\gamma_{12nc}(t) = 0 . \quad (9)$$

In this case, of non coherence, the resulting intensity becomes:

$$I_{nc} = I_1 + I_2 . \quad (10)$$

The resulting intensity here is the summation of the intensities resulting from the two political parties if each one acting separately, non coherently and non disturbed by the other one.

But, is there possible that political parties not to interact?

If the two waves interact totally coherent (the two parties preserving their phase difference in their positions during interaction until reaching the effect), then

$$\gamma_{12tc} = 1 \quad (11)$$

and if the two waves be in phase one another (socially, both allies acting at the same instant in the same direction, with maximum amplitude),

$$\cos\theta = 1 \quad (12)$$

and due to the quasi equality of amplitude of the two components, in our case:

$$I_1 = \sim I_2 = \sim I_j \quad (13)$$

the interference term may become equal to:

$$I_{1,2} = \sim 2\, I_j \quad (14)$$

and the resulting intensity, in case of total coherence and of in-phase action, becomes

$$I_{tc} = \sim 4\, I_{j,} \quad (15)$$

resulting, due to additive coherent interaction (constructive interference, efficient alliance) in quadrupling the effect due to only one component, if that one would be acting alone.

The primacy of the national interest, if accepted by the allies, expressed by total coherence and in phase action, might ensure the optimum functioning of such a coalition.

If the interaction would be totally coherent, but the political forces always would act in opposition of phase,

$$\cos\theta = -1 \quad (16)$$

and preserving the conditions (11) and (13), the result of the superposing of the two equally intense, coherent, waves, from (7), in a destructive interference, would lead to:

$$I_{di} = I_1 + I_2 - 2\,(I_1 \,.\, I_2)^{1/2} = \sim 0 . \quad (17)$$

That would mean, under unfavorable circumstances (mutual coherence, but opposition of phase, $\cos\theta = -1$), the diminishing of the resulting intensity up to the reciprocal annealing of the contribution of the two components, to no visible result in the Cabinet’s activity.

This scalar two-wave approach may model a good performance of a system through a good co-operation between its components, coherent and in phase actions, a failure of the governing, due to opposition of phase, but not a coherent action in case of a opposition of phase approaches, which happen, sometimes, in the actual political life, where political forces have different reaction delay time.

It would be necessary to model the functioning of the mentioned Government, subject to common interest but under opposition of phase parties’ actions.

5. Vector two-wave models

To model the working of such a coalition of two opposing forces the authors suggest to consider vector transverse waves.

In this case (8), one may consider the polarization of the vector transverse plane waves with the two elongations of the wave vectors making the angle α, as in the Fig.1:

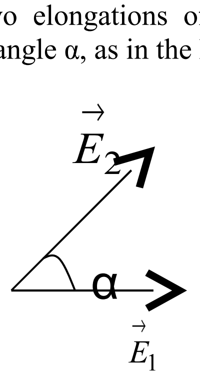

Fig. 1. Vector compounding of elongations

In such a case one has:

$$\vec{E}_1 \cdot \vec{E}_2 = E_1 E_2 \cos\alpha \qquad (18)$$

the cosine of the angle α between the directions of polarization of the waves varying between [0, 1].

Eq. (5), (6) and (18) lead, in case of transverse waves, to:

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\,.\cos a.\gamma_{12}.\cos\theta \qquad (19)$$

which is a generalization, for vector waves, of the Eq. [7], valid for scalar waves, only.

One may see, from Eq. [19], that, when there is total coherence, $\gamma_{12} = 1$, and even opposition of phase [16], $\cos\theta = -1$, there is possible to have a significant resulting effect:

$$I = I_1 + I_2 = \sim 2\, I_j \qquad (20)$$

if the two waves be polarized perpendicularly, each other, because the interference term is annealed:

$$\vec{E}_1 \cdot \vec{E}_2 = 0,\ for\ \alpha = \frac{\pi}{2} \qquad (21)$$

This vector approach could model, for perpendicular elongations (20, 21), an acceptable level of efficiency of the Cabinet:

$$I = \sim 2\, I_j,\ \text{for}\ \alpha = \pi/2 \qquad (22)$$

not the maximal possible one ($I_{tc} = \sim 4\, I_j$), but avoiding the minimal one ($I = \sim 0$).

In the case of perpendicular polarizations (actions), the interference term being zero, an opposition of phase between the two waves (parties) is not more annealing the result of the activity of the considered system (Cabinet, Parliament).

6. Political conclusions from a vector two-wave model of a coalition

In case of a grand coalition between two opposing parties, it is to be supposed a strong opposition between ministers representing the two parties forming the grand coalition.

The model suggests that there it is necessary to ensure, by a clever distribution of tasks and jobs within the Government:

a. The disjunction of the fields of competence of members of the two parties having responsibilities within the Government; they having to manage ministries which are not having influence in the same socio-economical field.

b. Simultaneously there would be necessary a strong coherence inside a ministry (or department) considered as a subsystem; to ensure the co-operation inside a ministry there is necessary to be managed by the representatives of the same party, at all decision levels, to ensure, as much as possible, the same type of political leadership in the hierarchy of the respective minister or department.

To disjoin the fields of activity managed by the ministers in the Cabinet or by prefects, in the country's administrative departments belonging to the two opposing (antagonist) parties participating in a grand coalition Cabinet, the ministries have to be thoroughly allotted to each partner in the grand coalition.

The allotment may vary in different countries, in different periods, depending of the tradition, culture, political maturity, relationship with the past or opening to their future, priorities in political debates and fights, the fields of previous expertise and the existence of professionally and politically competent people within a party.

Probably, some domains have to be managed by experts not politically affiliated.

The time perspective is very important. Electoral Campaigns may change the options of the parties depending of the characteristics of the electorate favorable to that party and of the perspectives to conquer electorate to the next poll.

But the perception is different in different countries, in different periods and different political and economic contexts.

The repartition of ministries is specific to each grand alliance and to each considered period.

From the choice of ministries there could, eventually, be possibly to understand the position of each partner in a grand coalition and the priorities given to concrete issues of different social domains by each partner: investment, infrastructure, pollution, education, research.

7. A few examples of repartition of ministries between the allies by two grand coalitions in Europe

There are, following, a few examples of allotting ministries to partners in a grand coalition from the expertise of two grand coalitions, in Europe:

- Angela MERKEL's Cabinet of Germany between 2005-2009, which was the result of a grand coalition between Christian Democratic Union (CDU) allied with the Christian Social Union (CSU), its Bavarian sister party, and the Social Democratic Party of Germany (SPD), grand coalition established after the German federal polls of November, 22, 2005 (DE) and
- Emil BOC's Cabinet of Romania, 2008-2009, which was a grand coalition between the Democratic Liberal Party (PD-L) and the alliance of the Social Democratic Party (PSD) with a very small Conservatory Party (PC), resulting at the initiative of the new president of Romania, Traian BASESCU (PD-L), from the November 30, 2008, parliamentary polls in Romania (RO).

The coalition leaders, possibly, agreed that ministers from different opposing parties would have to manage domains as much as possible not directly connected between them, not having large influence in the same socio-economical field, like, f. e. ministries which contribute mainly to the Government revenue vs. ministries which ensure the spending of the Government or ministries which regulate those activities which contribute to increase pollution vs. ministries which are charged to decrease pollution.

As ministries which contribute mainly to the Government revenue vs. ministries which ensure the spending of the Government are to be mentioned:

- The Ministry of Economy (PD-L) vs. the Ministry of Labor, Family and Social Protection PSD (RO, 2008-9) and
- The Ministry of Economics and Technology (CSU) vs. the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (DE, 2005-9).

The approach of the two grand coalitions was, here, the same, in both Germany and Romania.

As regards ministries which supervise activities which contribute to increase pollution vs. ministries which are charged to decrease pollution, the same perception was prevalent for both coalitions:

- The Ministry of Economy (PD-L) vs. Ministry of Environment and Sustainable Development (PSD), in Romania and respectively,
- Ministry of Economics and Technology (CSU) vs. Federal Ministry for Environment, Nature Conservation and Nuclear Safety (SPD), in Germany.

In both countries, the national security responsibilities were distributed between the partners in the same way:

- The Federal Foreign Affairs Ministry (SPD) vs. the Federal Ministry of Defense (CDU), DE and
- The Ministry of Foreign Affairs (PSD) vs. the Ministry of National Defense (PD-L), RO.

Ministries of Justice, of Foreign Affairs or of Defense could be given to any of the parties partners in a grand coalition or to experts, there acting national interest.

In Romania, the Ministry of Justice is managed by a lawyer, politically not affiliated.

Ministries in the same side of the Government balance sheet were being given to the ministers belonging to the same party:

- The Ministry of Public Health and the Ministry of Labor, Family and Social Protection have been given to PSD (RO, 2009), and
- The Federal Ministry of Health and the Ministry of Labor and Social Affairs belonged to SPD, DE.

Ministries dealing with close issues (eventually with intersection of tasks) were managed by members of the same party:

- The Ministry of External Affairs and the Department of European Affairs, managed by PSD (RO) and
- The Federal Foreign Ministry and the Federal Ministry of Economic Cooperation and Development were managed by SPD, in DE.

The previous examples illustrate the same view, attitude and approach of the role of the mentioned ministries in both countries, but in other cases, some ministries were distributed differently by the two coalitions because of different perception on the roles of the ministries in the respective fields, with respect with the main criteria of selection, f. e.:

- The Ministry of Economics and Technology belonged to CSU, as well as the Federal Ministry of Food, Agriculture and Consumer Protection in Germany, but not in Romania where,
- The Ministry of Economy was lead by PD-L, but the Minister of Agriculture and

Development belonged to the antagonistic partner, PSD, possibly because, in the two countries, the two fields have an opposite contribution to the Government balance sheet.

The relationship between economy and transportation was approached differently, in DE and RO:

- The Ministry of Economy and the Ministry of Transport and Infrastructure were managed by the same party, PD-L, in RO, but
- The Ministry of Economics and Technology was managed by CSU and the Federal Ministry of Transport, Building and Urban Affairs were managed, in DE, by the opposing party, SPD.

The strategy of development was different in the two countries with respect to sustainability:

- The Federal Ministry of Transport, Building and Urban Affairs and the Federal Ministry for Environment, Nature Conservation and Nuclear Safety were managed in Germany, by the same party, SPD, but
- The Ministry of Transport and Infrastructure was managed by PD-L and the Ministry of Environment and Sustainable Development was managed by the opposing party, PSD.

A completely different approach by the two grand coalitions refers to the position of Education and Research:

- The Ministry of Economy was lead by PD-L vs. the Ministry of Education and Research which was managed by PSD, in Romania (possibly, Education and Research being considered a consumer of nation resources) and
- The Ministry of Economy and Technology was lead by CSU and the Federal Ministry of Education and Research was managed by CDU (Education and Research being considered in Germany, a generator of resources).

8. Other possible political considerations induced by the two - vector wave model of a coalition

The introduced model, implies that always should be desirable a simultaneous coherence, parallel and in-phase action inside a ministry considered as a subsystem.

Because a Cabinet includes many levels of decision and is a dynamical hierarchic structure, there must be ensured the efficiency of the alliance at each level of decision, by ensuring the same party leadership for a branch of a hierarchical structure, at all its political decision sub levels.

Within a ministry (lead by members of only one party), must be ensured the maximum of co-operation and coherence. For example, both in Germany Cabinet 2005-2009, and Romanian's one 2008-9, all secretaries of state and state ministers, at all ministries, belong to the same party: PD-L or PSD/PC in RO, respectively to the CDU/CSU or the SPD, in DE.

The prefect (RO – highest representative of the Cabinet in a regional administrative department - judet) and his (her) vice prefects, in the same department belong to the same party.

Socially, a fast proof of the validity of such a vector wave interference model, would be the presence of oscillating decisions of the Government and of the Parliament, in case of superposition of responsibilities belonging to the members of the two allied parties, resembling to the generation of interference fringes in the case of superposition of partially coherent optical waves. Such oscillating decisions have been present, in both RO and DE.

Due to the relative volatility of the relationships between the two components of a grand alliance – the variability of the interference term (see Eq. [5] and [19]), it is possible that the efficiency of the activity of the Cabinet, due to apparition or of new issues or changes in positions on different existing issues may vary in large limits, if the interference term becomes significant and when there are, both, a parallelism of actions and an opposition of phase in their actions.

More, for real alliances, the correlations between the actions of the partners in the alliance may change in time, the allies could reconsider their positions and interests and redistribute the ministries between the two parties.

Two socio-economic domains which at a given instant could be considered as not connected, later become strongly connected and an efficient governing with respect to the national interest would require an other distribution of ministries as that was at the beginning of the activity of the Cabinet.

The Cabinet itself might become very labile in time, leading to a breaking of the grand coalition itself, depending not only upon the external environment evolution but on the evolution of relationships between the leaders at lower hierarchical levels.

It is important too to ensure the same political leadership to regional administrative departments' branches of state companies belonging to a ministry. There could appear contradictions, when doing such a distribution of tasks with the requirement suggested by the introduced model that all structures in an administrative department have to be subordinated to the same party. These contradictions may lead to local quarrels which may propagate upwards with possible deep consequences on the coalition.

A solution to avoid such possible difficulties would be to ensure the management of local services and companies as well as of lower level units in ministries by professional managers selected upon competition without the interference of political parties partners in a shorter or a longer coalition.

Possibly, the duration of o grand coalition is rarely as long as the whole mandate of the Parliament (which has happened in RO, in the autumn of 2009).

In Romania, in 2008, during the negotiations for the construction of the new government, it was clear that, in spite of some understanding and comprehension at the top, regarding the national interest (like: developing the integration into European Union and diminishing the effects of world financial and economic crises), it was lack of trust at lower levels.

To be able to build the Government in due time, it was decided that the two political parties, PD-L and PSD:

- have an equal number of ministers, the two allies choosing the ministries alternatively one by one and that:
- each minister has the right to choose, for the inferior political positions in his (her) ministry, members of his (or her) party, only.

For the Government be the most efficient, under the present model rules of governing, it would mean:

No interference for perpendicular polarizations!

Maximum interference for parallel polarizations!

9. Conclusions

To conclude, as the structure and the rules of functioning of a grand alliance of opposing political parties are concerned, it is to be convened and observed by the partners:

- a, as small as possible, superposition of the domains managed by ministers, in the Cabinet of the opposing but allied political parties (to ensure the smallest interference through "parallel polarizations") and
- coherence and in-phase action, maximal co-operation inside each ministry (and between prefects and their sub-ordinates) - maximum interference for subsets interfering with parallel polarizations!

A ministry has to be entirely allotted to a partner not only a position of minister.

A sociological survey in different countries (Germany, Romania also.) and at different levels (nation, state, province or region) may contribute to quantify the proposed model and to thoroughly check and evaluate it.

The introduced Physics models may be also useful in explaining and helping to improve the management of companies under divided leadership.

The conclusions drawn from these models could help political class and respectively the management of companies to insure stability in the system during, f. e., a deep world crisis (sub-prime mortgage, financial, economic, crises) or in a stiff competitive environment.

The developed model shows the perennial value of the saying "union is strength", a coherent, parallel and in phase compounding of two actions producing up to the squared of the simple addition and explaining the success of some grand coalition Cabinets during external threats or natural catastrophes, of well trained sport teams, of specially trained army forces or of some criminal organizations.

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The Effectiveness of Teaching Mathematical Prerequisites on Student learning Light Refraction in Physics Conventional Classes

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Abstract. *From historical point of view, there is a close relationship between physics and mathematics and it can't be ignored in educating and learning these sciences. This article analyzes the effectiveness of reviewing and educating mathematical prerequisites on learning light issue, in fact, this study tries to show the effect of teaching mathematical prerequisites such as trigonometric relationships on learning reflective index, critical index, total reflection and also mathematical prerequisites including fractional numbers sum, the solution of first degree equation, on learning lens formula in physics conventional classes. This study has been done by using Salomon four groups using two experimental and control groups. After analyzing data using MAONVA and SPSS , the positive effect of learning prerequisites on learning physics has been shown. The results can be useful for both teachers and students.*

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Keywords. Teaching, Mathematical Prerequisites, Learning, Light Refraction, Physics conventional classes.

1. Introduction

Physics is a science representing the rules governing over nature worlds. Therefore, it is necessary that a physicist be familiar with rules and principals of mathematics for presenting these rules in the form of equations and mathematical relations [1]. Since mathematics is considered as the language of physics, full understanding of physics concepts requires full domination over mathematical language. Then, one of the main issues in teaching each topic of physics is noticing to mathematical prerequisites related to that topic. If we look at the relation of physics and mathematics from the viewpoint of history, we can see that history clearly shows the close relation of concurrent advancement of physics and mathematics that cannot be ignored in teaching and learning these sciences [1]. Therefore, at first we should be fully familiar with the mathematical language dealing with the presentation of these concepts for acquiring full understanding of physics concepts. However, most of the students work weakly in fulfilling the assignments of mathematics problems. We can at least point to two probable and distinct reasons for this problem: 1- these students do not have mathematical skills for solving the physics problem or they have a small familiarity in this regard. 2- The do not know how to use their skills in solving different physics problems [2]. The weakness of students in solving math problems propounded in physics course caused most of the institutes and physics teachers remove some of the main physics problems enjoying more complex math but these physics concepts make them familiar with most of the other main concepts of physics and students lose the opportunity of facing with these problems with removing them [3,4].

2. RESEARCH HYPOTHESIS

Hypothesis 1: Teaching mathematics prerequisites such as trigonometry functions, inverting fractional numbers, etc has positive effect on learning the refractive index, critical angle, apparent and actual depth and total reflection.

Hypothesis 2: Teaching mathematics prerequisites such as algebraic addition of fractional numbers, 1st grade equation solving, etc has positive effect on learning the lens formula.

3. RESEARCH METHODOLOGY

This research is in fact a quasi-experimental one, which is fulfilled with the method of four-group of Salomon; two experimental groups and two control groups.
In two experimental groups, math prerequisites are presented before teaching and then the main

topic is presented while one group take pretest but the other does not take any pretest. In two control groups, only the main topic is presented while one group take pretest but the other does not take any pretest.

4. STATISTICAL SOCIETY AND SAMPLING METHOD

The statistical society of this research is all the secondary 1st grade boys students of Abdanan town, one of Ilam province suburbs passing physics I and laboratory In the academic year 2008-09. This society enjoys 625 members. The sampling method in this research is randomly. The experimental and control samples are according the following model:
Sample 1: This is the first experimental group, experiencing pretest and post-test (28 persons)
Sample 2: This is the second experimental group, only experiencing post-test (29 persons)
Sample 3: This is the first control group, experiencing pretest and post-test (30 persons)
Sample 4: This is the second control group, only experiencing post-test (28 persons)

5. DATE COLLECTION TOOLS

The researcher made a test, including 20 questions, for collecting data related to the research subject. This test is given in two forms of pretest and post-test at the beginning and ending of course respectively. Since we want to control the effect of individual intelligence in physics learning process, the Rion intelligence test is given to the studying students before the pretest.

6. VALIDITY AND TOOLS RELIABILITY EXAMINING

For examining the educational advancement tests conceptual validity, they are prepared according to the lessons provided from the intended topics and we deal with the tests formal validity with the help of enquiry questionnaires from professors and secondary 1st grade teachers and for assigning the reliability of the tests, five coefficients are applied. These coefficients are as follows:
1-Difficulty Coefficient (P), 2- Distinction Coefficient (D), 3- rpbi Coefficient, 4- KR–20 Coefficient, 5- Ferguson Delta Coefficient

It shall be mentioned that the Rion intelligence test has a distinct reliability and it was relied on the same.

7. STUDENTS' INTELLIGENCE SCORE ANALYSIS

Since we want to control the intelligence variable and should see whether there is a meaningful difference among the samples mean or not, we used F basis. Table 3 shows students' intelligence scores variance analysis results.

Referring to the table of F, F for df1=3 and df2=111 in 5-percent level is 2.70. Since calculated F (F=0.474) is less than F of the table (F=2.70), the hypothesis of zero, representing the equality of averages are confirmed. Therefore, it is concluded that the sample is congenial.

8. EXAMINING THE EFFECT OF PRETEXT ON LEARNING THE REFRACTION OF LIGHT

Regarding the fact that the 4-group method of Saloman is brought forth with this hypothesis that the pretest has different random effect in experimental and control groups, we deal with this claim now.

As you see in Table 4, regarding the meaningful mutual influence of the teaching method and the pretest, which is more than 5 %, it can be said that there is no mutual influence between the teaching method and the pretest. Therefore, it can be said that the pretest has no different effect in two experimental and control groups and only two experimental and control groups experiencing pretest and post-test are examined in continuing analysis for examining the effectiveness of the teaching method.

9. RESEARCH HYPOTHESIS EXAMINING

Our statistical calculation shows that we can use t parameter test for comparing first and third sample according to the first hypothesis because both first and second sample follow the normal distribution according to the first hypothesis. However, since the third sample in the second hypothesis does not follow the normal distribution we cannot use independent t statistics and we should use it equal nonparametric test, i.e. Man Vitni test.

Regarding the results mentioned in table 5, the variance of difference average of learning pretest and post-test scores is 7.18 in the first experimental group and the variance of difference average of learning pretest and post-test scores is 1.73 in the first control group. Regarding the results mentioned in table 6, the amount of bilateral test meaningfulness is equal to zero which is less than 0.05. therefore, the zero hypothesis are not accepted that is it can be said that there is a remarkable difference between the modern teaching method and the common one and on the other hand the amount of t is equal to 13.708 which is positive amount. Regarding this issue that the experimental group scores have deducted from the control group in this research, it can be said that the new teaching method has more effectiveness in learning progress of high school 1st grade in refractive index, critical angel, apparent and actual depth, and total reflection of physics course and the first hypothesis is fulfilled. The rectangle charts of error and differences average confirm this issue.

According to the results mentioned in table 7 and 8 and according to the zero meaningfulness amounts which is less than 0.05, zero hypothesis representing indifference of in average rank of two groups is rejected that is the remarkable difference in average ranks and average scores of two groups is certified. Therefore, it can be said that the new teaching method is more effectiveness in improving the high school 1st grade students' learning in lens formula topics rather than the common teaching method and the research second hypothesis is fulfilled. The rectangle charts of error and differences average confirm this issue.

10. EDUCATION SUGGESTION

1. The required mathematical concepts of each chapter are presented as a note in the beginning of each chapter in physics textbooks.
2. The required math prerequisites should be considered in writing physics textbooks. For example, the student should learn Derivation in math course before learning Instant Speed and Acceleration or learn Trigonometrical Ratio before reading critical angle.
3. Regarding the volume of material, learning and teaching the required concept, the time of teaching is short. Therefore, it is suggested that physics weekly teaching period be increased.

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Table 1: Brief Result of Original Version Coefficients

Acquired amount average	Standard Amount	Consistency Coefficient
0.58	0.3-0.9	Difficulty Coefficient
0.4	< 0.3	Distinction Coefficient
0.36	< 0.2	pbi Coefficient
0.92	< 0.7	KR–20 Coefficient
0.93	< 0.9	Ferguson Delta Coefficient

Table 2: Students' Intelligence Score Analysis of All the Samples Together

Statistical Index	All Samples
Number	115
Median	108
Mode	105
Mean	109.35
Variance	124.053
Standard Deviation	11.138

Table 3: Students' Intelligence Scores Variance Analysis Results

Changes Source	Freedom Degree (df)	Sum of Squares (SS)	Variance ms= ss/df	F Basis
Between Average of Groups	k-1=4-1=3	178.952	59.651	0.474
Inside of Groups	N-K=115-4=111	13963.135	125.794	

Table 4: Testing the Effects among the Testable on Learning Refraction of Light Variable in Post-Test

Changes Source	Sum of 3rd Type Squares	Freedom Degree	Squares Average	Statistics Amount F	Meaningfulness
Total Model	1857.027 (a)	3	619.009	266.566	.000
Width From Origin	10267.315	1	10267.315	4421.448	.000
Teaching Method	1822.316	1	1822.316	784.750	.000
Pretest	50.602	1	50.602	21.791	.000
Pretest * Teaching Method	6.391	1	6.391	2.752	.100
Error	255.438	110	255.438	-	-
Sum	12439.000	114	-	-	-
Total Sum	2112.465	113	-	-	-

Table 5: Differences Average Statistics According To the First Hypothesis in First Experimental and First Control Group

Group	Sample volume	Differences average	Standard deviation	Average Standard deviation
First experimental	28	7.18	1.278	0.247
First control	30	1.73	1.701	.0310

Table 6: Independent T Test for Comparing the Averages Based on the Research First Hypothesis

Educational Progress Score Difference	Levance Test For Equality Of Variances		Average Comparing Test					
	F Amount	Meaningfulness	Amount Of T	Freedom Degree	(Bilateral)Meaningfulness	Differences Average	Reliance	
Supposing That Variances Are Equal	2.550	.116	13.708	56	.000	5.445	4.649	6.241
Supposing That Variances Are Not Equal	-	-	13.842	53.627	.000	5.445	4.656	6.234

Table 7: Average Rank of Two First Experimental & Control Group

Group	Sample Volume	Average Rank	Total Ranks
First Experimental	28	42.25	1183.00
First Control	30	17.60	528.00
Total	**58**	**-**	**-**

Table 8: Wilkakson- Man- Vitni Test

-	Experimental Group
Man-Vitni U	63.000
Wlkakson W	528.000
Z Statistics	-5.669
Meaningfulness (2- Continuation)	.000

Physics Learning with Personalized System of Instruction (PSI) in Heat and Gases law

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Abstract. *To improve the learning process and the consolidation of learning, paying attention to individual differences among learners is required. Personalized System of Instruction (PSI) is an educational method that clearly takes individual differences into account for learners. In this research, physics learning by PSI in Heat and Gases Law is compared to learning by traditional method in this topic. The lesson plan based on the PSI for the topic of heat and gases law in secondary school textbook has been designed and two groups of high school students in Sari (a city in Iran) were randomly selected . One of the groups was taught by Personalized System of Instruction (PSI) and the other group by traditional methods. This study is a semi-experimental research and the results show personalized system of instruction (PSI) is much better than traditional method.*

Keywords. Personalized System of Instruction (PSI), The traditional method, Learning, Heat and Gases Law.

1. Introduction

In our classrooms, some students learn fast and some students learn slowly. When methods of teaching are not suitable to teach all of the students, a group may be learning but certainly the other group may not. According to researches, most schools in different countries, have the old educational system in which the teacher teaches and students just listen [18]. While in accord with the psychological research on learning, students should not be only listeners, but also should participate in other activities such as problem solving, discussion and analysis, and evaluation levels [2]. If teachers consider their students' individual differences in their educational methods, each student enjoy the educational conditions coordinated with the conditions that he is learning. Therefore, the amount of learning to all students peaks [3]. Fred Keller in 1960 established a method of teaching that today is named the Keller Plan or Personalized System of Instruction (PSI) He expressed this plan in the famous article "Goodbye Teacher". Very extensive researches have been done to evaluate the performance of PSI and most of them have been successful [4]. Slavin reviewed these studies to examine the success of this project and found positive results [5]. Teaching method that has been examined in this study is Personalized System of Instruction (PSI).

2. Methods

The study of two independent variables (two teaching methods) and dependent variable (Learning Physics) has been reviewed. Two groups of students were selected. Students of this study were high school students. They were chosen from two available classes, fully randomized and also simple sampling was selected. Transference class was completely random. Tools for gathering data were standardized tests HTCE and valid tests and the tests which have been made by the teacher. The topic of Heat and Gases Law from the secondary high school textbook was divided into six parts. For every part the lesson plan was prepared based on the PSI. This course was taught in eight sessions, each 1.5 hours (four weeks of training). One of the groups was taught by PSI and the other group was taught by traditional method. In the first session of both classes Pre-test and in the final session Post-test were given. Pre-test and Post-test were consisted of 20 multiple choice questions (four choices for each question were available). The number of students in both classes was 22.

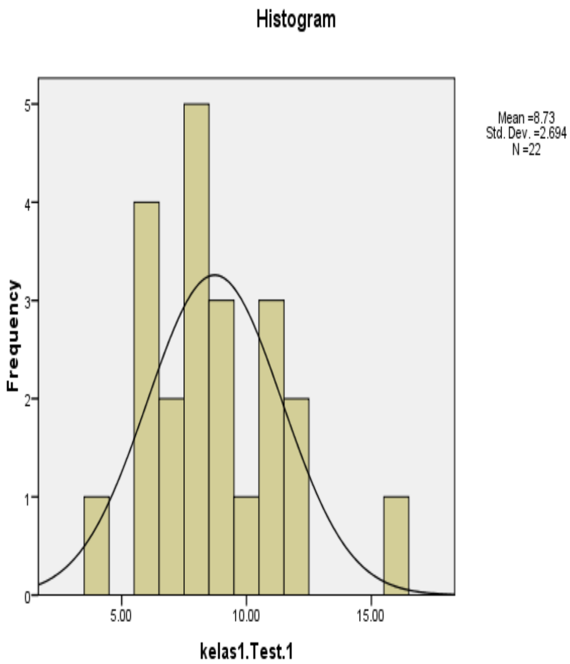
3. Analysis of the data

To analyze the data and compare mean marks, T-test study improvement was used.
When students' learning was compared, we realized that students taught by PSI had succeeded better than the students taught by

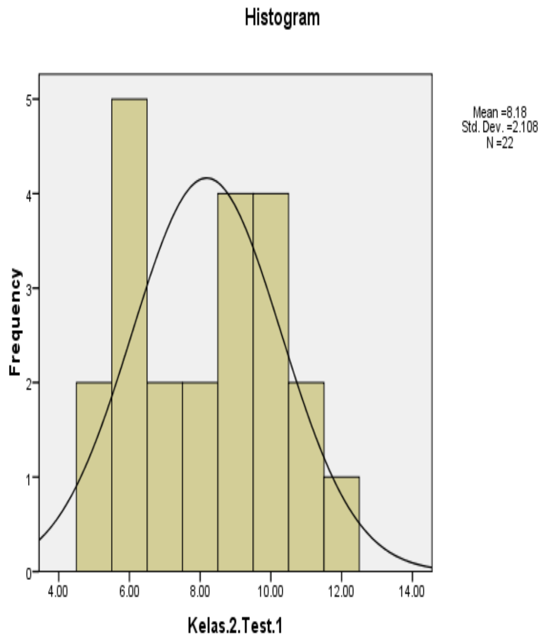
traditional method. The charts, in the next page, show this difference.

4. Conclusion

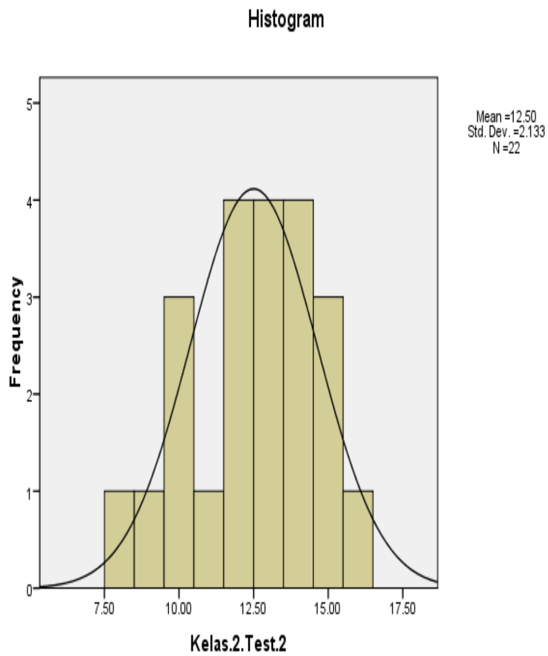
The results of this research show that students, taught by PSI method, learn more effectively. In other words, if we consider our students' individual differences in our educational methods, each student enjoy educational conditions and he/she learns better than before.



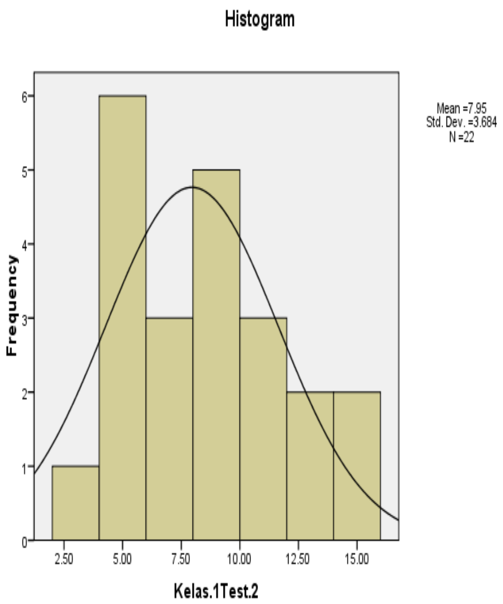
Pre-test. Group1 (traditional method)



Pre-test.Group2 (PSI)



Post-test. Group2 (PSI)



Post-test. Group 1 (traditional method)

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The effects of instruction by using experimental hand-made instruments on high school students' achievement in light-refraction

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Abstract. *The current traditional method of teaching physics is not able to do its serious task of public learning and training students. The use of laboratories and laboratory equipment for teaching physics is necessary [3]. But the laboratory facilities are unhandy and insufficient in schools and are unfamiliar in daily lives of students, Therefore, using simple tools that made by simple tools via teacher and students and (hand-made instruments) is suggested.*

This study evaluate the effect of using the experimental hand-made instruments on the first year high school girl students' academic achievement about light-refraction. This study was quasi-experimental in design. And is Solomon four groups design in method. The samples are four groups altogether including97student. School selecting among high schools girls of city as well as groups selecting and assigning them to experimental and control groups in the Solomon design, was simple random sampling.Two experimental groups taught with the use of the hand-made instruments, and two control groups has been experienced by the traditional education in order to assess hypotheses of study was used thepre-test and post test made by researcher. Results of the analyses showed that there was a significant difference (p< 0.05) between the experimental and control groups in development of students' academic achievement.

Keywords. Laboratory Hand-made instruments, Academic Achievement, Conceptual Learning, Build Knowledge, Schema.

1. Introduction

Among the experimental sciences, the physics as the science of nature is the most fundamental science. Therefore, Physics Education should be able to pursue relationship between human and nature in their goals. Considering the importance of physics education and it's objectives, and the current traditional method of teaching physics, is not able to do it's serious task of public learning and training students, benefiting from active teaching methods in order to make physics closer to natural living environment of students and communication between them and to make physics tangible and objective for students is required. This led to the realization of conceptual learning and help students to build the correct schema in their knowledge structure [1]. Because according to many behavioural psychologists, including Thorndike, formal education should be similar to real life situations as much as possible. He believes that the amount of "simulation" between a classroom situation and a real life problem determines how much of the classroom learning can be transferred to the real life.

In cognitive theory, what the student is going to learn now should be related to what he already knows. A famous Chinese proverb says: I hear I forget, I see I understand, I do I learn. This is exactly what Kennet W. Spence believes.

The followers of Gestalt theory suggest that formulas, symbols and scientific laws are not very meaningful for learners unless they are closely linked to a person's practical and daily experience.

Constructivists believe that useful knowledge is indeed what the person can produce from his own experiences and actions. Certainly, it will follow that an efficient system of education will strongly depend on the learner characteristics and his/her learning environment.

Therefore, the use of laboratories and laboratory equipment for teaching physics is necessary [3]. The laboratory has been given a central and distinctive role in science education, and science educators have suggested that rich benefits in learning accrue from using laboratory activities.

The *National Science Education Standards* in the United States and other contemporary science education literature continue to suggest that school science laboratories have the potential to be an important medium for introducing students to central conceptual and procedural knowledge and skills in science (Bybee, 2000) [6].

But the laboratory facilities are unhandy and insufficient in schools and are unfamiliar in daily lives of students, Therefore, using simple tools that made by simple things and simple objects via teacher and students (hand-made instruments tools) is suggested “figure1”.

Figure1. Simple things to hand made.

This study evaluates the effects of using the experimental hand-made instruments on the first year high school female students' academic achievement about light-refraction.

2. Method

2.1. Hypothesis

The hand-made instruments and pre-test and post-test hypotheses were conducted in this study to address the following hypothesis:

- There is difference in students' academic achievement about light-refraction between the students are taught by experimental hand-made instruments and the students that are not taught by experimental hand- made instruments.

2.2. Subjects

The study involved 97 first-year high school girl students in Dehgolan city. They were randomly divided into two control groups (undergoing traditional learning, 3and 4 groups. N=46), two experimental group (undergoing Laboratory hand-made instruments learning with experiment prompting, 1and 2 groups. N=51).

Groups selecting and assigning them to control and experimental groups in the Solomon design, was simple random sampling. In one control and one experiment groups (1and 3) was processed the pre-test. We found any difference between these groups.

This study was quasi-experimental design and Solomon four groups design in method. In this study, the independent variable was the teaching method, which was divided into traditional teaching and teaching by experimental hand-made instruments. The dependent variable was the academic achievement, and MANOVA was obtained from the pretest performance in order to eliminate and control the influence of the learners’ previous knowledge on their learning performance.

2.3. Tools

The following tools were employed to evaluate the teaching method:
(1) Experimental hand-made instruments.
(2)Pretest and posttest questions: These questions were formulated based on the topic of the basic characteristics of light refraction in the physics course of a high school. The content of this topic mostly comprised the narration of cognitive knowledge. Two experienced teachers of physics examined and amended the pretest and posttest questions in order to ensure content validity. There are 18 test items. The test–retest reliabilities were .70 and the coefficient for concurrent validity was .37. And in order to investigate reliability tests, Cronbach’s alpha is used (r_α=.70).

2.4. Procedures

All learners in 1and 3 groups underwent a pretest prior to the commencement of the research. The control groups have taught by traditional teaching and experimental groups 1and 2 performed laboratory learning activities by hand-made instruments. The posttest was applied after the teachings were completed. After the pretest, subjects of experimental groups worked with the experimental hand-made instruments individually. Participants are encouraged to explore the basic concept of light refraction by conducting the experiments by hand-made instruments context. When conducting the experiment, participants can use the simple things too made simple tools to do experiments and see the effects of light refraction, figure 2.

Figure 2. Hand made by simple things.

Also, they can adjust the original hypothesis based on the concepts discovered in the experiment and get the final conclusion. In contrast with experimental groups, subjects of control groups learned with traditional teaching without hand-made instruments individually.

The posttest was applied after the different teachings were completed.

3. Results

According to significant in table 1 can be said that does not exist the interaction between teaching methods and pre-test. Thus, pre-test does not have different effect on experimental and control groups.

Table1. Test the interaction of variables on academic achievement in light refraction.

Source of changes	Sum of squares	Degree of freedom	Mean of squares	F value	significance
Pre-test* teaching method	0.3	1	.3	.042	.8

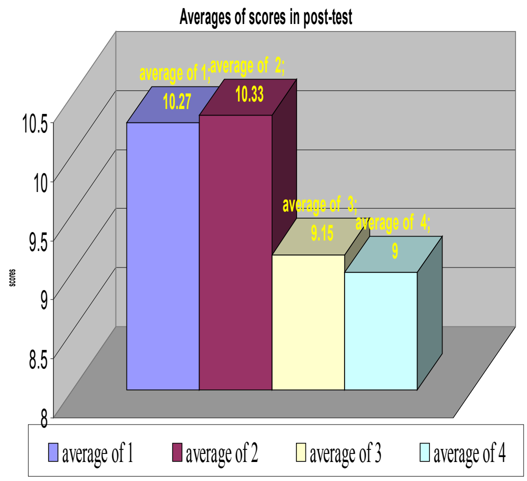
Considering the amount of p value in statistic Anderson-Darling test for normal data can be said that the difference between pre-test and posttest score follows the normal distribution.

As indicated from the results of an independent T-test as listed in Table 2 assumption of equality of variance in experimental and control groups are accepted (F=1. 050, p= .36, p > .05). Considering the significance of two-way test (p=.003<.05) and amount of t (t=2.000) in level less than .05 that is significant. So the hypothesis is confirmed.

Table2. Independent T-test for different of scores

sd	p	t	df	N	Lvans test		group
					P	F	
	.003	2.000		25	.360	1.050	experiment
				25			control

Chart 1. Scores frequency distribution of control and experimental groups post-test.



4. Conclusion

We found that the learning results are better for teaching by experimental hand-made instruments than traditional teaching, which is consistent with the results of previous studies (Elizabeth Aronsohn (2003) Ying-Shao Hsu (2000), Clora Mae Baker (1980), Dave. H. Jonassen (1996), Richard R. Taylor (1991) and some of scientists and researcher that worked in this field [2, 3, 4 and 5]. We also found that the learning performance was better when using experimental hand-made instruments. In other words, the cognitive learning of learners who learned how to made hand-made instruments and use them to see the effects of light refraction law, was progressed. Because seeing and studying that how light enters the different environment, helps the learners to focus on learning the concepts. Based on the findings of this study, we recommend using of experimental hand-made instruments in a teaching system.

When learners made hand-made instruments by simple tools and things, they learn what characteristics of light cause action of light in different transparent material. Students learn how to use the light refraction law in a phenomenon.

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Effectiveness of Interactive Software on the Conceptual Learning in the Subject of Geometric Optic

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Abstract. *In this research, the results of teaching "Geometric Optic" with the aid of interactive software on the conceptual understanding and academic achievement of students is analyzed. The statistical society of this research is the whole male senior high school student in Dolat Abad (city of Iran). The number of this study population is 726. Due to the existing academic and research limitations we chose 120 available cases which are divided to four thirty-person groups. This research will be done in "Solomon four group method" with two test groups and two control groups. The two test groups experience learning with interactive soft ware and the two control groups get the traditional training. One of the test groups and one of the control groups take a pre-test. We saw that the groups were almost homogeneous. Data analysis of this research was done by SPSS software and ANOVA. We used the dependant T-test to compare results of the pre and post test. We found which the effectiveness of teaching Optics with the aid of interactive soft ware on academic achievement and conceptual understanding of students is more than the common traditional methods.*

Keywords. Interactive soft ware, Traditional teaching, Conceptual learning, Academic achievement.

1. Introduction

Everyone knows about wonderful role of education in Human's life and there is no a doubt about its necessity. Because the correct education in learning science can lead to happiness, having a happy and idealistic life. It causes that the man uses his capacity in different situation. Studies show that the deep comprehension of phenomena will have effect on learning of science [1]. Different phenomenon s and meaningful experiments can be achieved through both real laboratories and experiments in abstract environment such as laboratories based on computer simulation [2, 3, and 4]. Here, we decide to study the effects of teaching by interactive soft ware on science learning.

2. Method

This study is in fact a quasi-experimental study which will be carried out based on SALAMON method with two experiment groups and two control groups. In two experimental groups, interactive software is used while one of groups take pretest but the other does not. The two control groups will be taught traditionally. This study is done on four classes of the junior high school in Dolat Aabad (a city of Iran).

3. Participants

The Statistical society at this study is all mate student of a junior high school of Dolat Aabad who is studying physics and laboratory in 2008 – 2009. The population of this research is 726, according to Dolat Aabad department of education.

4. Instruments

In this work, the time of teaching was one mount and half (including 8 sessions) for each class. Multiple –choice questions are used (for both per-test & past-test) to analyze students Conceptual Understanding and Academic Achievement.

The goal of the research is to check the amount of students learning in Geometric Optic. In order to determine the validity of the tests. We consider:

1 – Difficulty coefficient
2 – Denotation coefficient
3 - Rpbi coefficient
4 - KR-20 coefficient
5 - Fergosen coefficient

of tests. As we see Cronbach's Alpha coefficient is 0.702 which is standard.

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.722	.702	30

5. Procedure

In this study Salomon method is used that four groups are selected, two experimental groups and two control groups. It is important to mention that one of experimental group and one of control group are taken pre-test and all groups past-test. In this research, the first sample is taught by interactive software, taken the pre-test and is called the first experimental group. The second sample is taught by interactive soft ware but is not taken the per-test and is called the second experimental group.

The other two groups are taught traditionally taken the per-test and called the first control group. Finally the fourth sample is taught traditionally and only taken past-test.

The data obtained through the tests are analyzed by means of T-test. By studying the results, we found effects of instruction by using interactive soft ware on students learning.

6. Conclusion

The results show that the effect of teaching optic by means of interactive software on junior high school students' conceptual learning in comparison with the traditional method is more. On the other hand, since the time of teaching in each class was a little, we don't find any different in Academic achievement of groups.

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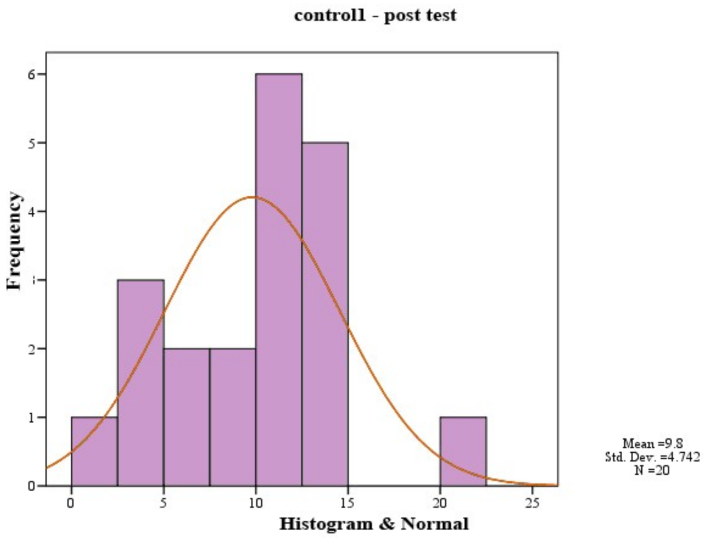
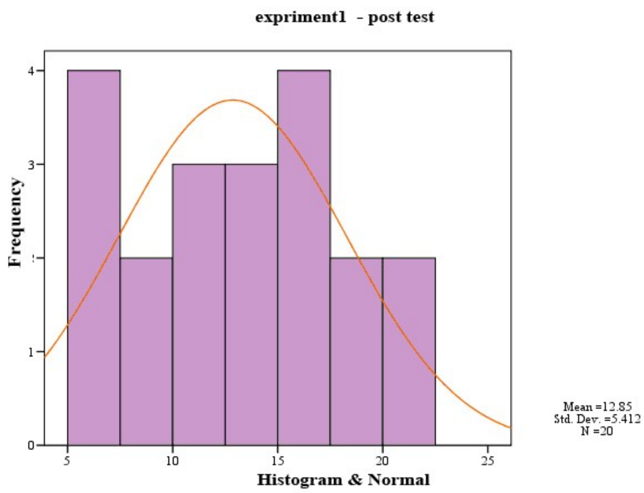
Statistics					
		control1	**control2**	**expriment1**	**expriment2**
N	**Valid**	20	20	20	20
	Missing	0	0	0	0
Mean		12.85	12.75	9.80	9.50
Median		13.00	13.00	10.00	9.50
Mode		5	8(a)	10(a)	7(a)
Std. Deviation		5.412	3.796	4.742	3.332
Variance		29.292	14.408	22.484	11.105
Skewness		.080	-.004	.135	.251
Std. Error of Skewness		.512	.512	.512	.512
Kurtosis		-.985	-.248	.406	-.046
Std. Error of Kurtosis		.992	.992	.992	.992
Range		17	15	20	13
Minimum		5	6	1	4
Maximum		22	21	21	17
Percentiles	**25**	8.25	8.50	6.25	7.00
	50	13.00	13.00	10.00	9.50
	75	17.00	15.00	13.00	11.75


control1 - post test
Frequency
Histogram & Normal
Mean =9.8
Std. Dev. =4.742
N =20


expriment1 - post test
Frequency
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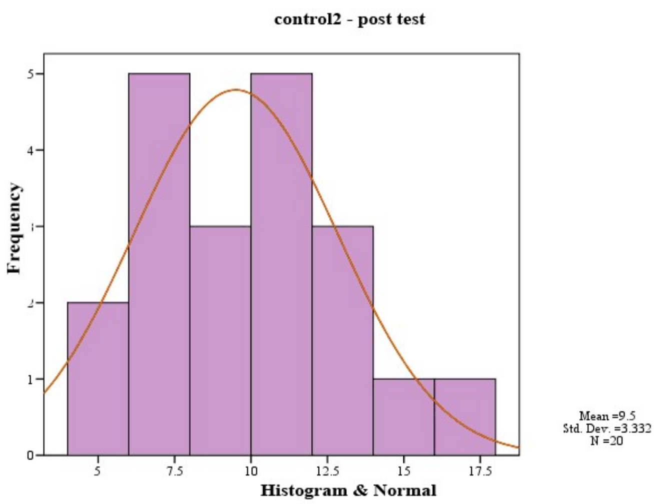
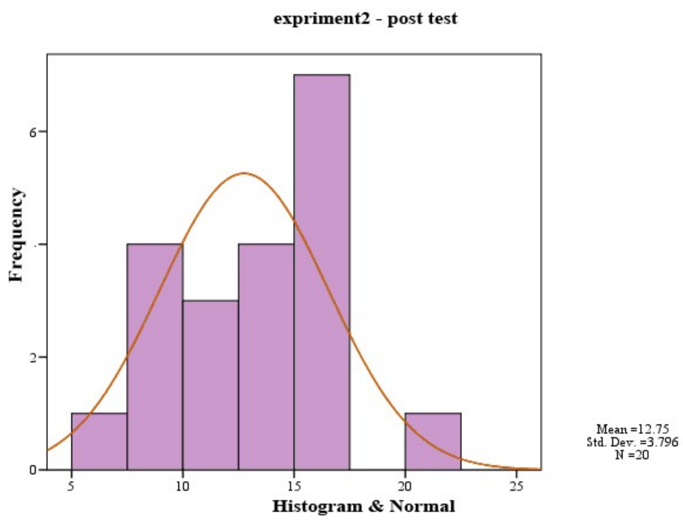
Mean =12.85
Std. Dev. =5.412
N =20


control2 - post test
Frequency
Histogram & Normal
Mean =9.5
Std. Dev. =3.332
N =20


expriment2 - post test
Frequency
Histogram & Normal
Mean =12.75
Std. Dev. =3.796
N =20

The Use of Thought and Hands-on Experiments in Teaching Physics

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Abstract. *The history of science shows that experimentation is an important component of the work of scientists. Scientists use not only real-world experiments (REs), but also thought experiments (TEs). Likewise, in teaching physics, as it results from relative studies in textbooks, these two types of experiments are also used.*

In the present study, differences and similarities between the two types of experiments are detected, mainly according to their use, not only in the field of physics but also in the field of physics teaching so that gainful conclusions can be drawn about the possibilities of the use of both REs and TEs in physics teaching.

Keywords. Hands-on Experiments, Thought Experiments, Physics Teaching, Secondary Education.

1. Introduction

The study of history of science shows that experimentation is an important component of the work of scientists. Scientists use not only real-world experiments (REs), such as the Oersted's or Michelson-Morley's experiments, but also thought experiments (TEs), like "Newton's cannon" or "Einstein's elevator". REs are broadly used in science education. This can be found in curriculum and textbooks study. In Greece textbooks in particular are accompanied by a separate book with experiment instructions. As it results from relative studies in textbooks, TEs in addition consist an integral part of physics textbooks, even if they are used in a percentage lower than REs [1].

In the present work, an attempt was made so that differences and similarities between the two types of experiments be detected, mainly concerning their use, not only in the field of physics but also in the field of physics teaching in order that fruitful conclusions can be drawn about the possibilities of the use of both REs and TEs in the classroom.

2. REs and TEs in Physics

According to Sorensen [2], an experiment is a procedure for answering or raising a question. A TE, in contrast to a RE, achieves its aim without the need of being performed. In addition, Sorensen maintains that TEs are limiting cases of REs, that is to say, TEs evolved from REs by a process of continuous abstraction of parameters and idealization of devises and situations. For example, Galileo [3], in order to show the law of inertia, used two inclined planes. He would leave a ball move from a point of the first plane and go up to the second inclined plane. Then he would keep decreasing the angle of the second plane and observe that the ball's travelled distance was continuously increasing. In the end, Galileo, before formulated the law of inertia, he posed the question: what happens if the second plane is horizontal, completely smooth and endless? With this example it is obvious how a TE evolves from a RE with a continuous abstraction of parameters.

Miller [4], on the contrary, alleges that all experiments, REs and TEs, in the first step are created intellectually and consequently we can claim that in their initial stages all experiments are TEs. However, according to Sorensen [2], the experiments which are planned and for some reason they are not performed in reality (e.g. for financial reasons) can not be characterized as TEs. Whichever of the above views would be accepted it is resulted that there are not only differences but also similarities between the two types of experimentation. Some important differences between the two types of experimentation are [2],[5]:

(I) *TEs are planned and "performed" usually by one scientist whereas REs (especially in our days) require a team of scientists and technicians from different fields*.

According to Nersessian [6], the scientist who plans a TE constructs a mental simulation and makes inferences from it, in other words, she/he constructs a dynamic model in her/his mind and imagines a sequence of events and processes and infers outcomes. Then she/he creates a narrative "to describe the setting and sequence" in order to communicate the TE to others aiming at getting them to construct and run the corresponding simulation and "presumably obtain the same outcomes". Although language is used to construct that simulation, the "operations thought experimenters perform in executing the experiment are not on linguistic representations, but are on the model the narrative has enabled them to construct" [6]. So, it is possible for a person to plan and "perform" a TE. On the other hand, it is impossible that a complete RE, especially in our days, can be planned and performed only by a single person. This happens because there are many factors which should be taken into consideration that concern issues related to economics, technology, safety and collection or exchange of information etc as for example the experiments performed in CERN.

(II) *During the development and performance of a RE (and not a TE), many times, knowledge is produced not only in the field for which the RE was planed but also in other fields*. Indeed, during the solution of technical problems that appear in REs (e.g. the creation of an appropriate superconductive) a body of knowledge is produced which is not relative to the aiming result of the experiment. A characteristic example is the Internet which was created by the need of transferring experimental data and scientists' intercommunication.

(III) *Quantitative measurements are not taken during the performance of TEs* in order to complete, for example, a table of values as it happens in REs.

(IV) *TEs, in contrast to REs, do not include real apparatus and consequently we do not take into consideration (during the planning) factors which are related with attributes of materials or with questions of safety*.

(V) *During a RE, contrary to a TE, various damages or distortion of its results can happen because of unanticipated exterior factors*.

(VI) *TEs have no limitations during their "performance" which are caused by the "physical system" in which they take place, contrary to REs that cannot be implemented in any situation*. For example, a RE, contrary to a TE, cannot be performed near a black hole.

Except for the differences between REs and TEs which were referred to above, there are similarities the most important of which are [2], [5]:

(I) *Both types of experiments are used for checking physics theories aiming at their confirmation or disconfirmation*. It is usual for the scientific community to plan a RE in order to have a proposing hypothesis or theory checked. One of the most characteristic examples is the Michelson-Morley's experiment by which the hypothesis of ether was checked. However, there are cases in the history of physics that instead of a RE, a TE was used for checking a theory. For example, when Galileo [7] aimed at refuting Aristotle's allegation that the heavier body falls (in a free fall) faster than a lighter one, he invented the following TE:

Let us suppose that we have two metallic balls, the one is a cannon ball H (heavier) and the other is a pistol ball L (lighter). If the balls are released to fall from the same height (from the top of a tower), according to Aristotle's view, the ball H will move "faster" than the ball L. Then, we tie the balls with a weightless cord and we release them from the top of the tower to fall. On the one hand, based on Aristotle's allegation, the ball L acts on the ball H, because the speed of L is smaller than the speed of H, thus the system of balls moves slower than ball H. On the other hand, based on the same view, the system of balls is heavier than ball H and consequently it is faster than ball H. Obviously, it is a contradiction which is cancelled only if we accept that the balls fall simultaneously.

(II) *The results of the two types of experimentation can contribute to introduction of a new theory*. There are examples in the history of physics where the results of a RE or of a TE helped scientists introduce new theories. For example, the Oersted's experiment was critical in the introduction of the electromagnetic theory. Also, Einstein in his autobiography [8] explains a TE he thought at the age of sixteen which played an important role in the genesis of the special relativity [9]. He wondered what he would observe if he pursued a beam of light with the speed of light. It would be like running towards the shore from the end of a pier stretched out into the ocean with a wave coming in; there would be a hump on the water that is stationary with respect to the runner. However, it cannot be like that because if either the electric or the magnetic field is static it will not give rise to the other and thus there will be no electromagnetic wave.

(III) *Both REs and TEs are presented for the evaluation by the scientific community in similar ways* (e.g. conferences or journals).

3. REs and TEs in physics teaching

The experimental work in the school lab and in the classroom is an indispensable part of physics teaching and many reforms have been made in order the practical work in physics classroom to be more profitable [10]. According to Koponen and Mäntylä [10], a significant number of researchers in the field of science education put to the question the degree of effectiveness of REs in learning scientific concepts (not the gained practical skills) when experiments are used in the classroom to confirm simply what has already been taught or they have an oversimplified inductive use, as in the so-called 'discovery learning' originating in the 1960s. These researchers, who are based more or less to the theory of constructivism, agree at least with the following goals of the practical work in teaching physics: Students should have an opportunity to participate in the acquisition and construction of knowledge, see how that knowledge is reached and justified, and understand how the meaning of concepts and laws in physics is generated. In reaching these goals, students' social interaction has a crucial role. Students should have an opportunity to express their ideas in their own words, to reflect about one's own learning and correct errors, and make explicit their own intuitive reasoning. In addition, two epistemological goals need to be specified, requiring that experiments are conceived as a source of knowledge, but not only this; it needs to be recognised that experiments as a form of reasoning are conceptually comparable to theorizing [10]. These goals can be also achieved by using TEs in teaching physics. According to Reiner and Burko [11], the use of TEs in physics learning is important, because, beyond the 'elegant mental manoeuvers', it allows students 'to experience the role - supportive or destructive - of physical intuitions, incompleteness, and the importance of relevancy'. They suggest that TEs are crucial in learning, both in order to 'think physics' and in order to develop general argumentation tools, because (i) TEs help students become familiar with the culture of physics for they are inherent to physics thought, (ii) TEs, in a way, lead learners to access unspoken intuitions, knowledge both explicit and implicit, as well as help students derive logical strategies, so that they may integrate them into one working thought process, and (iii) through social discussion of TEs, thought processes and conclusions may lead to the refinement of concepts, as it happens in the physics community.

As REs and TEs in science present similarities and differences, likewise in teaching physics the above two types of experiments present similar but also different characteristic elements. For the needs of the present work it is essential that we focus mainly on the similarities and differences of the two types of experiments concerning their use, a knowledge of which (differences and similarities) may be useful for the teacher of physics. The use of TEs by authors of physics textbooks has already been studied in our two previous works [1],[12]. For the purpose of pinpointing differences and similarities concerning the use of REs and TEs (so as to cover the needs of the present work), in addition, REs that are included in two Greek textbooks of the upper secondary school and particularly in the chapters of Newtonian mechanics, relativity and quantum mechanics were studied [13],[14]. The choice of the specific areas of physics was done so that there should be a correspondence with the chapters in which TEs were studied in our previous works. From this study it results that the basic differences and similarities between REs and TEs used in teaching physics are the following:

(I) *TEs are used in contrast to REs, in cases where*:

- *there is no proper technology*,
- *the relevant RE cannot take place in the daily environment of students* (e.g. an astronaut in orbit around the Earth).
- *an imaginary world is required* (e.g. a horizontal plane with no friction with infinite dimensions or a world without gravity).
- *there is risk or material damage* (e.g. a booth with a student inside is dropped from a considerable height)
- *the implementation of the experiment has nothing to offer for the desired result*, which may be achieved only through logical reasoning (e.g. the sense of gravity of an insect at the bottom of a box rotated by a student)

(II) *REs are used, in contrast to TEs, for quantitative measurements* and specifically in cases of

- verification of quantitative laws or finding quantitative relations between physical quantities,

- finding values of physical quantities or constants, as for example the determination of the work function in the photoelectric effect, or the measurement of Plank's constant, or the measurement of *g*.

(III) *In REs, in contrast to TEs, students*

- take measurements

- use real instruments

- take into consideration measurement errors and

- make quantitative calculations.

Apart from the above mentioned differences between the "educational" REs and TEs, there are also similarities the basic of which are the following:

(I) *Both REs and TEs are used for the introduction or the formulation of physics laws and principles*.

TEs are mainly used in textbooks in cases of teaching laws and principles of physics where it is required that students mentally transcend their every day experience, as for example the teaching of the principle of equivalence or the law of inertia or the teaching of placing a body in a steady orbit around the Earth. Also, REs are used for the introduction or formulation of physics laws and principles as for example the formulation of the second Newton's law. The use of REs in textbooks does not necessarily require students to perform the experiment; the RE may be described and its results be given for processing by students, as for example the experiment of the free fall in the vacuum tube.

(II) *Both TEs and REs are used for avoiding the use of complex mathematical formalism*.

In some cases the authors of textbooks use TEs for drawing the mathematical form of some laws, as for example the formulation of the uncertainty principle by using the TE "Heisenberg's microscope" or drawing the form of dilation of time in the special relativity by using the TE "Einstein's train" and not through the use of transformations of Lorentz. In other words, it seems that according to the authors of textbooks it is educationally more beneficial to draw a law by the help of the TE rather than by the use of purely mathematical formalism. Perhaps these authors believe that to come up with a physics law with the help of a TE, which includes narration and description of a setting composed by elements of the real world (process that according to Reiner [15] considerably decrease the use of mathematical formalism), helps students to better understand the physical meaning of the law. Also, the authors of textbooks use REs as well, for the examination of phenomena of which theoretical study demands a complex mathematical formalism, as for example the study of forced oscillations.

(III) *Both TEs and REs are used for the application of laws and principles of physics that already have been mentioned and the finding of consequences of these laws and principles*.

Both types of experimentation are used to lead students to conclusions by applying laws which they have been previously taught. For example, students apply the principle of linear momentum conservation and they explain the propulsion of rockets by performing a RE in which a balloon is propelled by taking out the air it contains, or students are led to weightless conditions by mentally performing a TE in which they apply the 2nd Newton's law to a child within a booth that falls freely.

(IV) *The prediction of results in both types of experiments helps considerably in the exploration process of student's ideas.*

It is of great value in teaching science the process through which students are asked to mentally predict the results of an experiment, whether this may take place in the school lab or not [16]. This process encourages students to express their ideas for the concepts they are about to be taught. This method, according to Mach [17], is the best for the teacher to understand the ideas and the way of thinking of his/her students. If some experiments may be done in the lab and their results are different from what students predicted during their mental performance, students will not be satisfied by their views, a fact that will considerably contribute to the conceptual change [18].

(V) *The performance not only of REs but also of TEs in the classroom should be done in groups and in collaboration.*

As already mentioned, in science TEs, in contrast to REs, are usually planned and performed by a single scientist. Yet, as research indicates [19], in the classroom not only REs but also TEs are educationally more beneficial if "performed" in collaboration.

4. Discussion

From this study it results that the two types of experimentation make it possible for their multiple uses in teaching physics and not only for the verification of already taught physics laws and theories, something which is the usual practice of traditional instruction. The use of both types of experiments in the classroom could aim at the introduction, the formulation, the verification and the application of the laws of physics that are taught. Also, both types of experiments can be used for reaching conclusions by students of the secondary education which otherwise would be difficult to be theoretically drawn because of the demand of the use of a complicated mathematical formalism.

From the already mentioned, in this work, similarities and differences between REs and TEs the teacher may draw useful conclusions for the cases in which the use of the one or of the other type of experiment is recommended. The use of TEs is recommended in cases where the performance of a RE is impossible, harmful and dangerous or has nothing to offer in the end result. TEs can also be used in the teaching of laws and principles of physics the understanding of which requires that students mentally transcend their every day experience. At this point it would be noteworthy to mention that the two types of experiments are "symbiotic". During the performance of a RE students are also mentally experimenting [20].

In the modern teaching of physics, it is useful for students to "perform" not only REs but also TEs by working together in groups. There should also be a process of students predicting the results of the experiments so that the teacher could be aware of the students' views as students could also be aware of their own ideas. A modern practice in teaching physics makes experimentation useful so that students are given a chance to participate in the acquisition and construction of knowledge

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To get familiar simply with higher dimensional space and time as a 2d quantity in physics

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Abstract. *It is a never-ending desire for human to understand the world around him as more as he could. Because of this essential curiosity, he could describe the universe and its building-blocks, the elementary particles, by using mathematical and scientific methods. During recent decades, he has made many progresses in physics, such as higher dimensional space in string theory and calculation of second dimension for time that is originated from F-theory, one of the theories which is able to answer lots of unknowns. In this paper, we have tried to introduce a simple educational model which is used to teach the complicated scientific issues for undergraduate students of physics. The aim of this paper is that the students obtain an enjoyable but simple and comprehensive view of the physical world.*

Keywords. F-theory, Higher dimension, Physics education, Second dimension time, String theory.

1. Introduction

Higher dimensions in popular culture: As a result of the efforts of Helmholtz and others like him, the public began speculating wildly about beings from the fourth dimension, who would be able to walk through walls, reach through solid barriers, appear or disappear on a whim, and materialize in whatever location they pleased. To understand this idea, imagine a flat sheet of paper with some two-dimensional beings living on it. A three-dimensional human's powers to change shape (his cross-section in two dimensions), see through "impenetrable" walls (lines or circles), and lift the beings off their paper would seem magical to the two-dimensional beings, who cannot conceptualize the idea of "up." The same applies to humans: we cannot conceptualize the fourth spatial dimension, so its inhabitants would seem omnipotent to us. The public did not readily understand the complex physics questions raised by the fourth dimension, but they did recognize the powers of a four-dimensional being. They immediately correlated such beings with the only familiar entities reputed to walk through walls, appear and disappear at will, etc. - ghosts. Similarly, mystics and magicians long claiming supernatural powers latched on to this new, seemingly reputable claim: to be able to access the fourth dimension!

The 1877 London trial of Henry Slade provides an excellent example of this phenomenon. Slade, an American psychic, was visiting London and holding seances when he was arrested for fraud. However, many prominent London physicists suddenly came to his defense, maintaining that his supposed psychic powers derived from ability to access the fourth dimension. Johann Zollner, in particular, defended Slade's abilities and suggested several experiments impossible to complete successfully in three dimensions, but elementary in four: intertwine two separate, unbroken rings; reverse the twisting pattern of a sea shell; tie a knot in a circle of rope without cutting it; tie a right-handed knot in a left-handed position without breaking a wax seal atop it; and remove something from a sealed bottle without unsealing it. Though Slade was eventually convicted of fraud, Zollner and his compatriots did demonstrate that four-dimensional creatures can execute feats obviously impossible in three dimensions Religious groups also wholeheartedly embraced the idea of higher dimensions after they saw the powers held by a hypothetical four-dimensional being. They had long been at a loss to answer such seemingly logical questions as, where do angels live? where are heaven and hell? if atmosphere and finally space are above us, where does God reside? With the advent of the fourth dimension, they had an out. A. T. Schofield, a Christian spiritualist, stated that God, heaven, and other religious locales resided in the fourth dimension. Theologian Arthur Willink took the idea one step further, claiming that only an infinity of dimensions was glorious enough for God. Literature was also infused with the idea of the fourth dimension. Oscar Wilde contributed a clever spoof on the gullible Society for Psychical Research, which had believed Slade, in his 1891 play *The Canterville Ghost.* H.G. Wells, renowned for his science-fiction stories, added another literary contribution - his 1894 novel *The Time Machine,* which disseminated the idea that the fourth dimension could be viewed as time; it was not necessarily space. He also published a number of short stories adding other ideas and speculations on the fourth dimension. Perhaps the most lasting of all the contributions of the fourth dimension to popular culture came in the form of a bestselling novel. Written by clergyman Edwin Abbott, the book, called *Flatland: A Romance of Many Dimensions by a Square,* combined the popular interest in dimensions with a biting social commentary. It was the first mathematically correct description of such matters to reach a wide audience.

2. Higher Dimensions after Riemann

After Riemann's work, research into higher dimensions blossomed, but theorists of the time lacked essential equations necessary for the completion of a geometric theory of gravity, electricity, and magnetism. Despite this, study and especially popularization of Riemann's idea continued even after his death. William Clifford, a British mathematician translating Riemann's work in 1873, furthered Riemann's insight by theorizing that electricity and magnetism as well as gravity are also the result of bending of higher dimensions. Thus, his rudimentary speculation preceded Einstein and Kaluza by 50 years. Hermann von Helmholtz, a renowned German physicist, spent a great deal of time speaking to the public about the import of Riemann's work.

3. The Fourth Dimension and Relativity

The Albert Einstein, arguably the greatest physicist of all time, created two of the most famous theories of physics: special and general relativity. They showed that time can be viewed as a dimension and combined our three spatial dimensions with one temporal dimension to form the idea of space-time, the fundamental fabric of our universe.

Using time as the fourth dimension, four-dimensional beings would see humans as an infinite series of static forms that represent all motions of life moving through time as seen all at once; (a section of such a world-sheet is seen in the image at right.) Relativity, a description of gravity, was one of the first theories to simplify the laws of nature in higher dimensions and was based on Riemannian geometry.

Maxwell's famous theory of electromagnetism consists of a total of eight equations when space and time are treated separately; these simplify to one equation when written relativistically. Relativity has one consequence important to the current topic: it implies that space itself is curved. Einstein's theory of general relativity and the equations of quantum theory are very accurate at describing all the nuances of matter and other forces, from magnets to strong and weak nuclear forces, but his theory of gravity doesn't fit with quantum theory. In 1915, Einstein changed completely our notion of gravity by leaping to the extra dimension of time.

Also in 1919, the German mathematician Theodor Kaluza used the Riemann metric tensor, expanded to fit five dimensions in a 5 × 5 array [1], to unite Einstein's and Maxwell's theories - that is, the theories of gravity and electromagnetism. Kaluza's theories [2] were later refined by Oskar Klein. This was a great step forward in the search for a geometrical description of the universe, but fundamental problems in the theory arose, and it was abandoned in favour of point-particle quantum mechanics. Only in the 1980s did physicists return to this idea to create superstring theory.

One intriguing feature of string theory is that it predicts the number of dimensions which the universe should possess. Nothing in Maxwell's theory of electromagnetism or Einstein's theory of relativity makes this kind of prediction; these theories require physicists to insert the number of dimensions "by hand". Instead, string theory allows one to compute the number of space-time dimensions from first principles. Technically [3], this happens because Lorentz invariance can only be satisfied in a certain number of dimensions. This is roughly like saying that if we measure the distance between two points, then rotate our observer by some angle and measure again, the observed distance only stays the same if the universe has a particular number of dimensions.

4. Extra dimension space

Extra space dimensions are not easy to imagine in everyday life, nobody ever notices more than three. Any move you make can be described as the sum of movements in three directions-up-down, back and forth, or sideways. Similary, any location can be described by three numbers(on Earth, Latitude, Longitude and altitude), corresponding to space's three dimensions. They claim that a subatomic particle might detect the presence of extra dimensions, and that certain properties of matter's basic particles, such as electric charge, may have something to do with how those particles interact with tiny invisible dimensions of space.
They believe that the Big Bang that started the baby universe growing 14 billion years ago blew up only three of space's dimensions, leaving the rest tiny.

Physicists around the world are still trying to come up with a universal theory that could unify every other already existing law and equation, but have so far come up empty. It seems some piece is missing in the picture puzzle of physical reality.

5. Need to second dimension for time

A theoretical physicist is stating that a second dimension of time could help physicists better explain the laws of nature. Now, the dimension of time has an important role in describing matter, gravity and other forces of nature, but something doesn't fit. So they have been pondering the role of time in basic physics for a long time and thinks one of the missing pieces is a hidden dimension of time. They believe that our universe can have two times, which could make many of the mysteries of today's laws of physics disappear, As strange as it may seem. Also they think that other dimensions could exist, curled up in little balls, so tiny to notice that if you moved through one of those dimensions, you'd get back to where you started so fast you'd never realize that you had moved. It's a concept extremely difficult to grasp with our limited perception, almost like asking a two-dimensional character drawn on a flat piece of paper to describe that width, when that's world has none. "extra dimensions of space could really be there, it's just so small that we don't see it,"
For now, these opinions are controversial, but if they are right and could prove it, it will change the way we think of some of the most basic processes in physics, like velocity, mass and the resulting momentum of a particle.

The pioneer physicists effort to discern how a second dimension of time is not enough. You also need an additional dimension of space. In fact, extra dimensions of space have become a popular way of making gravity and quantum theory more compatible. Something as simple as show particles move, for example could be viewed in a new way. In classical physics (before the days of quantum theory), a moving particle was completely described by its momentum (its mass times its velocity)and its position. But quantum physics says you can never know those two properties precisely at the same time. The physicists alter the laws describing motion even more, postulating that position and momentum are not distinguishable at a given instant of time. Technically, they can be related by a mathematical symmetry, meaning that swapping position for momentum leaves the underlying physics unchanged (just as a mirror swiching left and right dose not change the appearance of a symmetrical face).

In ordinary physics, position and momentum differ because the equation for momentum involves velocity. Since velocity is distance divided by time, it requires the notion of a time dimension. If swapping the equations for position and momentum really dose not change anything, then position needs a time dimension too. "If make position and momentum indistinguishable from one another, then something is changing about the notion of time," the pioneer physicists said. "If demand asymmetry like that, must have an extra time dimension." "So this task has been especially difficult because mathematicians have not worked out the topology and properties of these higher dimensional universes. Time is no longer a simple line from the past to the future, in a four dimensional world consisting of three dimensions of space and one of time. In the quest for that all embracing theory, scientists have been adding extra dimensions of space to their equations for decades. As early as the 1920s, mathematicians found that moving up to four dimensions of space, instead of the three we experience, helped in their quest to reconcile theories of electromagnetism and gravity.

6. Changing of time picture

Changing our picture of time from a line to a plane (one to two dimensions) means that the path between the past and future could loop back on itself, by using a new kind of symmetry - a mathematical property to work out the relationship between the quantities of position and momentum. It is this symmetry that might help reconcile the two mighty pillars of 20th-century physics, quantum mechanics and relativity.

Although we cannot experience the extra time dimension directly, we can effectively notice it through the different perspectives of the different "shadows". In this sense, he points to already existing evidence of physical phenomena at both macroscopic and microscopic scales. Furthermore, he believes that more evidence for his theory could emerge next year, when particles are smashed together in an accelerator.

6.1. The work poses a question: is this proposal a mathematical fix, rather than a real physical entity?

Simply adding an extra dimension of time dose not solve everything, however. To produce equations that describe the world accurately, an additional dimension of space is needed as well giving a total of four space dimensions. Then, the math with four space and two time dimensions reproduces the standard equations describing the basic particles and forces. In a similar way, the observable universe of ordinary space and time may reflect the physics of bigger space with an extra dimension of time.

In ordinary life nobody notices the second time dimension, just as nobody sees the third dimension of an object's two dimensional shadow on a wall. Today, theoreticians are studying a theory of everything called M-theory [4] that adds yet another dimension, taking the total to 11: 10 of space and one of time. Efforts to formulate a clear and complete version of M theory have so far failed. “Nobody has yet told us what the fundamental form of M theory is,” the pioneer physicists said. “We just have clues — we don’t know what it is.”

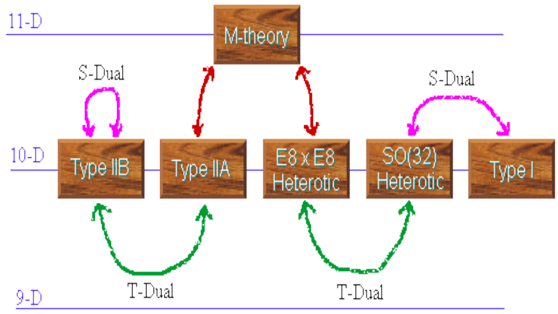

Figure 1. There’s just one theory

F-theory is a branch of string theory developed by Cumran Vafa. The new vacua described as F-theory were discovered by Vafa, and it also allowed string theorists to construct new realistic vacua — in the form of F-theory compactified on elliptically fibered Calabi-Yau four-folds. The letter "F" stands for "Father". F-theory is formally a 12-dimensional theory, but the only way to obtain an acceptable background is to compactify this theory on a two-tours. By doing so, one obtains type IIB superstring theory in 10 dimensions. The SL(2,Z) S-duality symmetry of the resulting type IIB string theory is manifest because it arises as the group of large diffeomorphisms of the two-dimensional torus. More generally, one can compactify F-theory on an elliptically fibered manifold (elliptic fibration), i.e. a fiber bundle whose fiber is a two-dimensional torus (also called an elliptic curve). For example, a subclass of the K3 manifolds is elliptically fibered, and F-theory on a K3 manifold is dual to hetrotic string theory on a two-torus. (Eight dimensions are large.) The well-known large number of semirealistic solutions to string theory referred to as string theory landscape, with 10^{500} elements or so, is dominated by F-theory compactifications on Calabi-Yau four-folds..

7. Extra time dimensions in F-theory

F-theory, as it has metric signature (11,1), as needed for the Euclidean interpretation of the compactification spaces (e.g. the four-folds), is not a "two-time "theory of physics. However, the signature of the two additional dimensions is somewhat ambiguous due to their infinitesimal character. For example, the Supersymmetry of F-theory on a flat background corresponds to type IIB (i.e. (2,0)) supersymmetry with 32 real supercharges which may be interpreted as the dimensional reduction of the chiral real 12-dimensional supersymmetry if its spacetime signature is (10,2). In (11,1) dimensions, the minimum number of components would be 64

7.1. Is there a Final Theory in physics?

Will we one day have a complete theory that will explain everything from subatomic particles, atoms and supernovae to the big bang? In the 1980s, attention switched to superstring theory as the leading candidate for a final theory. This revolution began when physicists realised that the subatomic particles found in nature, such as electrons and quarks, may not be particles at all, but tiny vibrating strings. Superstring theory was a stunning breakthrough. It became one of the fastest growing and most exciting areas of theoretical physics, generating a feverish outpouring of thousands of papers. Then, in the early 1990s, progress seemed to grind to a halt. People became discouraged when they failed to find the answers to two key questions: where do strings come from, and is our universe among the many solutions of superstring theory? In superstring theory, the subatomic particles we see in nature are nothing more than different resonances of the vibrating superstrings, in the same way that different musical notes emanate from the different modes of vibration of a violin string. (These strings are very small-of the order of 1035 metres.)

The trigger for this excitement was the discovery of "M-theory", which may answer those two vital questions about superstrings. " In one dazzling stroke, M-theory has come close to solving superstring theory's two long-standing questions, M-theory, moreover, may even force string theory to change its name because, although many features of M-theory are still unknown, as we said, it does not seem to be a theory purely of strings. Other strange beasts seem to emerge, including various types of membranes. But, of course, all this takes place in 10 dimensions. Physicists retrieve our more familiar 4-dimensional universe by assuming that, during the big bang, 6 of the 10 dimensions curled up (or "compactified") into a tiny ball, while the remaining four expanded explosively, giving us the Universe we see. What has consumed physicists for the past ten years is the task of cataloguing the different ways in which these six dimensions can compactify and These efforts have revealed millions of compactifications, each of which yields a different pattern of quarks, electrons and so on.

8. Acknowledgements

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The elementary teaching of Bosonic String Theory

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Abstract. *This paper is about one of the important theories model constituting an introductory concepts designed for students acquaint some basic facts for need to beginning this theory.*

The aim of this paper is intended as preparation for the more advanced understanding on simplest aspects of string theories such as "Bosonic string theory".

Keywords. Bosonic String theory, Physics education, String theory.

1. Introduction

String theory uses a model of one-dimensional strings in place of the particles of quantum physics. These strings, the size of the Planck length (i.e. 10-35 m) vibrate at specific resonant frequencies. (NOTE: Some recent versions of string theory have predicted that the strings could have a longer length, up to nearly a millimeter in size, which would mean they're in the realm that experiments could detect them.) The formulas that result from string theory predict more than four dimensions (10 or 11 in the most common variants, though on version requires 26 dimensions), but the extra dimensions are "curled up" within the Planck length.

String theory can be formulated in terms of an action principle, either the Nambu-Goto action or the Polyakov action, which describes how strings move through space and time. In the absence of external interactions, string dynamics are governed by tension and kinetic energy, which combine to produce oscillations. The quantum mechanics of strings implies these oscillations take on discrete vibrational modes, the spectrum of the theory.

On distance scales larger than the string radius, each oscillation mode behaves as a different species of particle, with its mass, spin and charge determined by the string's dynamics. Splitting and recombination of strings correspond to particle emission and absorption, giving rise to the interactions between particles. [1]

2. What is String?

An analogy for strings' modes of vibration is a guitar string's production of multiple but distinct musical notes. In the analogy, different notes correspond to different particles. The only difference is the guitar is only 2-dimensional; you can strum it up, and down. In actuality the guitar strings would be every dimension, and the strings could vibrate in any direction, meaning that the particles could move through not only our dimension, but other dimensions as well.

String theory includes both open strings, which have two distinct end points, and closed strings making a complete loop. The two types of string behave in slightly different ways, yielding two different spectra. For example, in most string theories, one of the closed string modes is the graviton, and one of the open string modes is the photon. Because the two ends of an open string can always meet and connect, forming a closed string, there are no string theories without closed strings. [2]

Figure 1. Strings

2.1. String Vibrations

To get the hang of string theory, think of a guitar string that's been tuned by stretching it between the head and the bridge. Depending on how the string is plucked and how tense it is, different musical notes are created. These notes can be thought of as excitation modes of the guitar string under tension. Similarly, in string theory, the elementary particles observed in particle accelerators correspond to the notes or excitation modes of elementary strings. One mode of vibration makes the string appear as an electron, another as a photon, and so on.

In string theory, as in guitar playing, the string has to be under tension in order to become excited. A big difference is that the strings in string theory aren't tied down to anything but instead are floating in space-time. Even so, they're under tension – by an amount that depends, roughly speaking, on one over the square of the string's length. Now, if string theory is to work as a theory of quantum gravity, then the average length of a string has to be in the ballpark of the distance over which the quantization of space-time – the granularity of space and time – becomes noticeable. This outrageously tiny distance, known as the Planck length, is about 10-33 centimeters, or one billion trillion trillionth of a centimeter. So much tinier is it than anything that current or planned particle physics technology can hope to be able to see that string theorists have to look for craftier, more indirect ways to test their ideas.

3. D-branes

Another key feature of string theory is the existence of D-branes. These are membranes of different dimensionality. D-branes are defined by the fact that world-sheet boundaries are attached to them. Thus D-branes can emit and absorb closed strings; therefore they have mass (since they emit gravitons) and — in superstring theories — charge as well (since they emit closed strings which are gauge bosons).

From the point of view of open strings, D-branes are objects to which the ends of open strings are attached. The open strings attached to a D-brane are said to "live" on it, and they give rise to gauge theories "living" on it (since one of the open string modes is a gauge boson such as the photon). In the case of one D-brane there will be one type of a gauge boson and we will have an Abelian gauge theory (with the gauge boson being the photon). If there are multiple parallel D-branes there will be multiple types of gauge bosons, [3] giving rise to a non-Abelian gauge theory.

D-branes are thus gravitational sources, on which a gauge theory "lives". This gauge theory is coupled to gravity (which is said to exist in the bulk), so that normally each of these two different viewpoints is incomplete.

4. World-sheet

A point-like particle's motion may be described by drawing a graph of its position against time. The resulting picture depicts the world-line of the particle in spacetime. By analogy, a similar graph depicting the progress of a string as time passes by can be obtained; the string will trace out a surface, known as the world-sheet. The different string modes (representing different particles, such as photon or graviton) are surface waves on this manifold.

A closed string looks like a small loop, so its world-sheet will look like a pipe or, more generally, a Riemann surface (a two-dimensional oriented manifold) with no boundaries (i.e. no edge). An open string looks like a short line, so its world-sheet will look like a strip.

5. Bosonic String Theory

The earliest string model, the bosonic string, incorporated only bosons. This model describes, in low enough energies, a quantum gravity theory, which also includes (if open strings are incorporated as well) gauge fields such as the photon (or, more generally, any gauge theory). However, this model has problems. Most importantly, the theory has a fundamental instability, believed to result in the decay (at least partially) of space-time itself. Additionally, as the name implies, the spectrum of particles contains only bosons, particles which, like the photon, obey particular rules of behavior. Roughly speaking, bosons are the constituents of radiation, but not of matter, which is made of fermions.

6. Supersymmetry in String Theory

Some qualitative properties of quantum strings can be understood in a fairly simple fashion. For example, quantum strings have tension, much like regular strings made of twine;

this tension is considered a fundamental parameter of the theory. The tension of a quantum string is closely related to its size. Consider a closed loop of string, left to move through space without external forces. Its tension will tend to contract it into a smaller and smaller loop. Classical intuition suggests that it might shrink to a single point, but this would violate Heisenberg's uncertainty principle. The characteristic size of the string loop will be a balance between the tension force, acting to make it small, and the uncertainty effect, which keeps it "stretched". Consequently, the minimum size of a string is related to the string tension.

String theories are classified according to whether or not the strings are required to be closed loops, and whether or not the particle spectrum includes fermions. In order to include fermions in string theory, there must be a special kind of symmetry called supersymmetry, which means that for every boson (a particle, of integral spin, that transmits a force) there is a corresponding fermion (a particle, of half-integral spin, that makes up matter). So supersymmetry relates the particles that transmit forces to the particles that make up matter.

Investigating how a string theory may include fermions in its spectrum led to the invention of supersymmetry, a mathematical relation between bosons and fermions. String theories which include fermionic vibrations are now known as superstring theories; several different kinds have been described, but all are now thought to be different limits of M-theory.

Supersymmetric partners to currently known particles have not been observed in particle experiments, but theorists believe this is because supersymmetric particles are too massive to be detected using present-day high-energy accelerators. Particle accelerators could be on the verge of finding evidence for high energy supersymmetry in the next decade. Evidence for supersymmetry at high energy would be compelling evidence that string theory was a good mathematical model for nature at the smallest distance scales.

In string theory, all of the properties of elementary particles – charge, mass, spin, etc – come from the vibration of the string. The easiest to see is mass. The more frenetic the vibration, the more energy. And since mass and energy are the same thing, higher mass comes from greater vibration.

7. Gravity and the development of string theory

How get gravity into the scheme? A clue to this emerged while researchers were working on the quantum field theory of the strong force. Along the way, they came up with a wonderfully creative explanation for the observed relationship between the mass and spin of hadrons. Called string theory, it treats particles as specific vibrations or excitations of very, very small lengths of a peculiar kind of string. In the end, quantum chromodynamics (QCD) proved to be a better theory for hadrons. Yet string theory wasn't consigned to the trashcan of ideas that had passed their sell-by date. It made one extremely interesting prediction: the existence of a particle – a certain excitation of string – with a rest mass of zero and an intrinsic spin of two units. Theorists had long known that there ought to be such a particle. It was none other than the hypothetical exchange particle of gravitation – the graviton.

With this discovery, that one of the essential vibrational modes of string corresponded to the graviton, string theorists realized they had a bigger fish to fry than trying to explain the ins and outs of hadrons. Their notions of elemental quivering threads might, it seemed, bear directly on the much sought-after quantum theory of gravity – and not just because the graviton is predicted by string theory. You can stick a graviton into quantum field theory by hand if you like, but it won't do you any good because you'll be blown away by infinities. Particle interactions happen at single points in space-time, so that the distance between interacting particles is zero. In the case of gravitons, the mathematics behaves so badly at zero distance that the answers come out as gobbledygook. String theory gets around this problem because the interacting entities aren't points but lengths, which collide over a small but finite distance. As a result, the math doesn't self-destruct and the answers make sense.

8. Varieties of string theory

String theories come in various forms. All of these assume that the basic stuff of creation are tiny wriggling strings. However, if the theory deals with only closed loops of string, like Spaghetti Hoops, then it's limited to describing bosons – the force-carrying particles – and so is called bosonic string theory. The first string theory to be developed was of this type. If open strings, like strands of ordinary spaghetti, are allowed into the theoretical picture then these provide a description of fermions, or particles of matter. But a very interesting thing happens when string theory is extended in this way to let in fermions. It demands that there must be a special kind of symmetry in the particle world, know as supersymmetry. In this expanded masterplan of things, there's a corresponding fermion for every boson. In other words, supersymmetry relates the particles that transmit forces to the particles that make up matter. A supersymmetric string theory is called, not surprisingly, a superstring theory.

Theorists uncovered three different string theories that were mathematically consistent and therefore made good sense. Two of these were bosonic, the other of the superstring ilk. But in order to make any of them work, they had to resort to a strategy first employed by Kaluza and Klein in the days when Einstein first started wandering down his blind unification alley: they had to call upon higher dimensions, rolled up so small that they're way below the threshold of detection. The bosonic string theories needed an awesome 26 dimensions (25 of space plus one of time) in order to work properly, which seemed a bit of a stretch even for scientists who enjoyed some wayout sci-fi in their off-hours. Compared with this, the mere ten dimensions of space-time required by superstring theory seemed positively modest. Six of the ten would have to be curled up, or "compactified," to leave visible the four normal spacetime dimensions (three of space plus one of time). But these compactified dimensions, far from being an embarrassment to be swept under the cosmic carpet and forgotten about, come in very handy if string theory is to aspire to become a theory of everything: motion in them can be used to explain the values taken by important constants in nature, such as the charge on the electron.

Combining the best features of bosonic and superstring theory has led to two other consistent schemes known as heterotic string theories. So, there are five viable string theories in all [4], which, if we're hoping to arrive at the one true TOE, is a tad too many. Fortunately, it's beginning to look as if the quintet of finalists for the Miss Universe Theory competition is really the same contestant dressed up in five different costumes. This supersymmetric mistress of disguise has been given the rather enigmatic name M-theory.

Some say that the M is for Mother of All Theories. Others that it stands for Magic or Mystery. But, although no one seems to know for sure, there may be a more prosaic reason for this particular choice of initial.

Before string theory rose to scientific superstardom, the most popular unified theory in town was supergravity, which was basically supersymmetry plus gravity without the string. Like any respectable quantum gravity candidate it boasted a surfeit of spacetime dimensions – in this case, eleven (the compactified ones all wrapped up neatly on an itty-bitty 7-dimensional sphere). Unfortunately, it had to be abandoned because of the problems mentioned earlier involving point particles and string.

But along came M-theory. Still under development, it carries the hopes of many that it will combine the various flavors of string theory soup into one single, satisfying broth. The cost of this in conceptual terms is the addition of a single dimension: M-theory is 11-dimensional but with the unusual trait that it can appear 10-dimensional at some points in its space of parameters. Supergravity rides again – but this time with strings attached.

And the M in M-theory? We omitted to say earlier that while strings, with their one-dimensional extension, are the fundamental objects in string theory, they're not the only objects allowed. String theory can accommodate multidimensional entities, called branes, with anywhere from zero (points) to nine spatial dimensions. A brane with an unspecified number, p, of dimensions is called a p-brane. In M-theory, with its extra dimension, the fundamental object is an M-brane [4], which resembles a sheet or membrane. Like a drinking straw seen at a distance, the membranes would look like strings since the eleventh dimension is compactified into a small circle. Membranes, M-branes, M-theory.

Table 1. String theories

String theories		
Type	**Space-time dimensions**	**Details**
Bosonic	26	Only bosons, no fermions, meaning only forces, no matter, with both open and closed strings; major flaw: a particle with imaginary

		mass, called the tachyon, representing an instability in the theory.
I	10	Supersymmetry between forces and matter, with both open and closed strings; no tachyon tachyon; group symmetry is SO(32) Supersymmetry
IIA	10	between forces and matter, with only closed strings bound to D-brane; no tachyon; massless fermions are non-chiral
IIB	10	Supersymmetry between forces and matter, with only closed strings bound to D-branes; no tachyon; massless fermions are chairal
HO	10	Supersymmetry between forces and matter, with closed strings only; no tachyon;hetrotic, meaning right moving and left moving strings differ; group symmetry is SO(32)
HE	10	Supersymmetry between forces and matter, with closed strings only; no tachyon; hetrotic, meaning right moving and left moving strings differ; group symmetry is $E_8 \times E_8$

8. Acknowledgements

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Learning by Doing – Doing by Passion

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Abstract. *The paper is presenting the experience of Romanian SPIE (Society for Photo Optical Instrument Engineering) Student Chapter in organizing ISWLA '10 (International Student Workshop on Laser Applications) 25-28 May 2010 a conference organized by students for students. The SPIE Student Chapter, organized in Romania since 2001 is a professional association for students (under graduated, MSc. PhD, young researchers) affiliated to SPIE USA. SPIE is adopting a policy to enhance the interest for optics and photonics mainly among young people, by facilitating scientific contacts, grants, awards etc.. The paper is discussing this first experience faced by the team of students involved in the organization of a conference a challenge to develop new skills.*

Keywords. Student chapter**,** Grants, science, Competition, Good practices, Innovation, International contacts, excellence

1. Introduction

This year is the "laser celebration" at 50 years since the discovery of the first laser beam, a very prolific scientific period in the field of optics, photonics, chemistry and engineering.
This is the opportunity to recall the steps in the evolution of a modern domain of physics and interdisciplinary sciences, with a large diversity of applications. Charles Hard Townes from the University of California, Berkeley, California, one of the 4 scientists who received in 1964 the Nobel Prize for laser is the 2010 recipient of the SPIE Gold Medal of the Society **.**
In Romania the first laser He-Ne beam was obtained in 1962 and since, the domain was developed all along the years till nowadays. All along the years there were many scientists generations involved in laser design, fabrication and developing different laser applications: education, industry, medical etc.

The policy of the institute [1] was the formation of new generations of young scientists and the involvement in this modern domain of science. Many students developed MSc and PhD stages in the laboratories of the institute and became researchers, some already working abroad in States or Europe, with very good results.
The opportunity opened to Romania, as full member of EU since 2007 is of high importance as the access to EU funds allows the development of the scientific domain, by improving the scientific endowment and also to enhance the professional level of the scientists in the frame of the different human resource programs.
The possibilities to continue the professional development in high prestige universities and institutes, having access at modern equipment and facilities was a huge advantage especially in the last 20 years and after the EU joining of Romania.
The conference ISWLA '10 (International Student Workshop on Laser Applications) Bran, 25-28 May, 2010 http://iswla10.inflpr.ro is this year, the first scientific event devoted to lasers in Romania and the initiative belongs to SPIE Student Chapter.
There were several reasons to organize this conference: the laser celebration in the world, to present recent results in laser physics and applications, to discuss about new projects supported by EU among which the project ELI – Extreme Light Intensities a project that will involve different specialists- an opportunity for undergraduate student to think about a career in science.
The conference was supported by SPIE USA, OSA, the National Agency for Scientific Research, national institutes for research and development and other associations.

2. Results

The SPIE Student Chapter, affiliated to SPIE USA http://spie.inflpr.ro/ was organized in 2001,

the members are students (MS and PhD) enrolled in the research institutes from the physics campus in Magurele.
It is not only an honor to belong to an international professional association and of high prestige on the side of famous scientists all over the world, but the membership facilitates the scientific contacts and many opportunities, especially for the young scientists. Such contacts represent not only a privilege for the members, but also a moral duty to be ever in competition with other scientists and with you yourself.

Fig. 1 Certificate of Recognition of the Romanian Student SPIE Chapter

The ever increasing interest of the international SPIE Board for the Student Chapters is realized by many ways: facility to attend conferences, grants offer, conference support, different publicity materials, participation of the elective president of the chapter at Annual SPIE Meeting organized every year in USA on the occasion of Photonics Conference in San Diego.
If the activity started quite slow because of lack of information and hesitations step by step students surpassed the doubts, mainly after the visit in Romania in 2004 of the SPIE elected president Professor James Bilbro and of the executive director Prof. Eugene Arthurs.

Fig. 2 Dialog between students and SPIE guests

During this visit in the laboratories and a seminary held in the institute, the dialog was very useful as the SPIE leaders encouraged students to apply for different projects and never give up, when the first trial failed. Since 2004 every year the elected president of the Student Chapter was able to attend the Annual SPIE Meeting This first contact and the sincere dialog with the SPIE board members enhanced the confidence of the chapter members, who became more active and interested to use the opportunities offered by the professional society. It was possible to receive books from the available list and the news sent to members was useful. In 2009 Professor Pereira was invited to visit the institute and give lecture to students. Since 2008 ongoing the Polish Student Chapters invited Romanian students to attend their conference in Wroclaw and Turin and these contacts have been of high important to enhance the consciousness as researcher.
This conference was organized by students for students (MSc, PhD, undergraduate) and members from other similar chapters from

Armenia, Poland, Ukraine and Russia have been invited.. The conference was supported by SPIE USA, OSA (Optical Society of America) the National Agency for Scientific Research and the national institutes for research and development.

Besides the scientific research in a national institute continues the activity of education for the formation of the young researchers and this is the duty of the senior scientists the leaders of research teams, by the coordination of the scientific activity, discovering the real skill of each of the team members and survey their development according to the natural gifts[2]. It is important that this coordination to be a friendly one and the young people to feel the interest of the leader for himself and to establish a collaborative and confidence relationship. Such a relationship is for both a constructive one. The young researchers have to feel the interest for their development and the support in order to be integrated into the team and participate to the team building.

The program was conceived for delivering courses, presentations from senior scientists regarding the status art of some very modern topics, oral presentations of the young researchers, students (MSc and PhD) but also under graduated students, working to elaborate the license thesis and poster session.

The lectures given by an expert regarding the craft of scientific presentations and writing held in a very interesting interactive way was much appreciated by the attendees. The illustration of the talk with convincing examples, the case studies, the concrete problems and situations asked to be solved by students by collective discussions, the professional authority of the professor was felt as a generous and friendly offer and had a strong impact.

Fig. 3 Comments and discussions during the interactive course

The common lunches, dinners and pleasant evenings favored the contacts and relationships. This is another form of communication in science, enhancing the approach of new ways of development in science, but also in the quality of human resources.

A complex and interesting experience

The organization of this conference was an experience both for students as for the senior scientists since every one discovered some features probable more difficult to be revealed in normal conditions in the daily activity.

The students prepared the papers and were coordinated and advised by their laboratories heads in order the conceived papers to be accepted for publication in ISI journals.

Among the projects supported by EU, the pan European ELI project - Extreme Light Infrastructure, in which Romania is one of the partner seems to be an attractive opportunity. The very high complexity of the project means the participation of experts from different specialties. Discussing about the project in this conference could enhance the interest for this project and the prospective for under graduated students attending the conference to choose a career in science.

The scientific program was seriously selected to cover a large topics – 9 invited conferences, 21 oral presentations held by young researchers and 3 undergraduate students and 27 posters. Imposing order in respecting the program, presence and evaluations in the poster session by senior scientists, the competition for the best oral presentations and best poster enhanced the interest of students.

It was not a classical conference, mainly with senior researchers presenting topics reviews, it was dominated by the presence of young people at the beginning of the career open to learn, to be better informed about scientific news and their opportunities. What is new is the youth spirit, the innovation, the interest to impose good practices, change ideas and establish scientific contacts in a friendly, joyful atmosphere.

All students, from under graduate to post–graduate level were encouraged to presents the ideas and projects at the conference by oral and/or poster presentations.

In this conference there were, as well, teachers from the pre university system and high school students involved in the project “Hands on science” coordinated by the Center for Science

Education and Training. http://education.inflpr.ro/
The social interactions between participants have been promoted, as well, through the different entertainment activities, organized for each conference evening: welcome party and karaoke, visit to Bran Castle (named by many people Dracula Castle), traditional Romanian evening, dances and interactive demonstration of preparing a traditional sheepfold meal.
The conference was announced as well on our collaborators websites and also on the different important websites involved in optics and photonics such as: SPIE, OSA, IOP (http://physicsworld.com), National Institute for Laser, Plasma and Radiation Physics (http://www.inflpr.ro/module_Events/action_showEvent/id_13), International Association of Physics Students: http://www.iaps.info/2010/03/05/international-student-workshop-on-laser-applications-iswla10-25th-28th-of-may-10/,students chapters website from Poland, Armenia
Communications group websites had been used to announce the conference (Facebook and Yahoo Groups).

Fig. 4 Happy people at the end of the workshop

Conclusions

The responsibility assumed by the students was a very creative one, as they solved new problems, besides conceiving scientific papers and they managed wonderfully.
The presence in the conference of the invited professors supported by SPIE from the list of traveling lecturers was highly appreciated by the students. The very friendly and warm atmosphere of collaboration and the franc communication was another benefit of every attendee in this conference.

It was a pleasure duty to guide the event, encourage and advice the students. Personally, I tried to suggest, not impose, let students to decide according their options, to assume responsibilities and initiatives. I could say that it was a pleasant surprise to notice the ability to manage the economical problems, since nowadays it is not easy to face situations, when the budget for scientific research is every year lower, ongoing 2009in Romania.
I have to say that young people is more flexible, has the skill to better accommodate to new situation and during the university studies increased the skill to manage the very different life situation in an economy in transit. For me it was surprising to discover the ability to manage. I enjoy noticing the capacity to collaborate, to share the tasks and do every thing easily, in a fair way.
On the other hand it is definitely sure that they still have to know and appreciate the results obtained by previous generations, select good practice and go on. In other countries the mentoring system is more frequent and useful.
This is not the first time to tell about the benefit of working on bridging generations for both partners. The benefit of the advisor is to notice growing up “the seeds“-informing, supporting, counseling, advising the young colleagues.
Probably it is too early to envisage the results but, what they did learn being engaged in this conference organization is a new professional lesson very useful in the future. This new experience of my young colleagues shows that they really have qualities as researchers and make me positive to believe, that they will manage well in all the future projects.
The responsibility is creative this is my conclusion and more confident we are in our young colleagues, higher are their possibilities to verify their skills.

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The conduct of laboratory courses in Secondary Technical - Vocational Education in Greece: Current situation - Proposals to upgrade the implementation of the laboratory exercises in the Vocational Schools

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Abstract *The Technical - Vocational Education (TVE) is the second pillar of secondary education in Greece, while is the main educational provider of Technical and Vocational Education. Until now it's trying to determine its exact role and to give it the substance and the prospect that it promised to Greek society. The offer of substantial practical experience, although is one of the primary purposes of the TVE, it seems that so far has failed to implement successfully.*

This paper will attempt, in the sense of upgrading the educational process to the Vocational Schools, to present a series of proposals, which are designed to optimize instruction of laboratory exercises for their students' trainees to gain substantial practical experience. The submission of these proposals hopes to contribute to efforts to promote the educational work of the TVE and the improvement of the level it deserves.

Keywords. Laboratory courses, Technical - Vocational Education, Vocational Schools.

1. Introduction

The establishment and operation of Technical - Vocational Education (TVE) in our country dictated by the need to develop and support the technological infrastructure, while providing the opportunity to acquire practical and theoretical technical - vocational skills to those who wanted something like this. The time course of public secondary TVE in Greece determined from regressions, haphazard planning, inefficiency, and indifference for its substantial support [1]. In this cloudy educational landscape for TVE, the offer of substantial training in the context of Curriculum, will contribute constructively to the effective presence of TVE to the educational needs of the community to provide substantial Technical - Vocational Education.

2. The current situation in secondary Technical - Vocational Education in Greece

The period after dictatorship meets the tee in an effort to determine its identity. Reform efforts in order to upgrade the quality of service from this training and its educational role generally, does not seem to have a positive effect.

During the transition, the very low participation rates in secondary TVE [Fragoudaki, 1977:26] [2], along with the ever increasing demands of work, led to Law 576/1977, which established the Technical Vocational Schools (TEE) and Technical Vocational Faculties (TES). The Technical Vocational Schools, equivalent to General High Schools, and providing the opportunity in higher education and the opportunity to enter to the labour market, sought to reclaim the trust of the Greek people to them, though the entrenched attitudes of society in general education does not allow yet optimistic prospects for the TVE. Unfortunately, even the designs of the state for the purpose of operating the TVE are based on false grounds, because in the TVE's role was to address the overcrowding in the Gymnasiums also the massive accumulation of graduates at the entry to universities [Bouzakis, 2006:144][3]. Moreover, both the negative colouration of manual labour in connection with the spiritual in beliefs of Greek society and the lack of interest of the State for TEE about to inadequate logistics, to convenience and often asynchronous curricula, to lack of care the training of teachers, were negative factors for determining the route of TVE.

In 1985, by the Law 1566, next to the Technical Vocational Lyceum and to Technical Vocational Faculties are created the Uniform Multi-sector Schools (EPL), which are designed to integrate the General education with the Technical - Vocational training, linking theory to practice. But this was not crowned with success since the life of the EPL was brief.

In 1998, with the Law 2640, established the Technical Vocational Schools (TEE) in place of Technical Vocational Lyceum and the Technical Vocational Training Schools. The Explanatory Report of the law speaks - as the others earlier - for an enhanced and flexible Technical - Vocational education, which aims to provide appropriate qualifications for professional membership, but also for continuing education [4]. It is true that the Law 2640 sought a substantial integration effort of the practice of education - of students in real working environment, providing that: "... may be awarded contracts with public or private sector for laboratory exercises and practical application of skills for the pupils of Technical Vocational Schools [Article 5, paragraph 2]. This provision of the law about the possibility for the placement of the students of Technical Vocational Schools in businesses and organizations was presented in the next period of its publicity with great intensity, creating the feeling of those directly concerned in technical education major hopes of connecting with the labor market for the benefit of TVE's pupils in practical terms. Unfortunately, this call has become unworkable. Although the need for education of students of TVE in the real business environment continued to be stressed in any way, unfortunately, the activation of the above provision has never been settled to provide Technical - Professional Training in dual dimension, although the same law defines that the purpose of secondary Technical - Vocational Education is: " the combination of General Education with specialized technical and professional knowledge to employability in the labor market" (Article 1). In Ministerial Decision G2/6098/13 - 11-01 is referred: "The visits by students and train them in work environment is considered essential to the educational process and must be at regular intervals and well scheduled" (Article 14, paragraph 5). Furthermore, the Head of Department B' TVE of Ministry of Education, Mr. Lagos, speaking at the launch of the International Conference: "The Technical Vocational Education in Europe" [5] stressed that desire of the Ministry of Education is the Vocational Rehabilitation of students in TVE after practice and joining the labor market in the new enlarged area of Europe.

Unfortunately, the course attendance of pupils at the Technical Vocational Schools and the striking rates of student leaking from them came as a natural reaction of society to the continuous depreciation of the state. It is significant that for the cohort of pupils for 2000 - 2001 the leak in the A' course of TEE was identified in 20.28%, while taking into account the corresponding course in B', then flashed off the leak even higher, at 28.81 %, where the same in general upper secondary schools is just 3.32% [Pedagogical Institute, 2007:147] [6].

The continued indifference of the Greek State to actively and effectively support the Technical - Vocational Education, creating negative reactions, which result in the conversion of Technical Vocational Schools in Vocational upper secondary schools (EPA.L.) and Vocational Training Schools (EPA.S.) by the Law 3475/2006. The reactions and objections to this new type of Technical - Vocational Education does not take long to appear [7], while the swift enactment of EPA.L and EPA.S in place of TVS created unfavourable reviews.

It is obvious that the attempt to be tied the practice of students of TVE with the labor market has not received the sustained attention of the state. This had a dual effect: on the one hand the disappointment of those who come to the Technical - Vocational Education, that has leading to dramatic reduction of students potential, in contrast to bright prospects and forecasts generated by the announcement of substantial interaction with the labor market [8]. On the other hand, this powerful weapon to all-round education and training of students of TVE to remain undeveloped, a negative event, not only those directly involved in it, but for the comprehensive benefit of society.

3. The necessity to connect the TVE to the labor market

The need to tie training to the labor market is the constant changes taking place in every business sector, a development that the labor market focuses on it with consistently. This fact makes the labor market call itself as the necessary and essential area of vocational experience and additional education and - the most importantly - training.

In this context, it seems imperative the need to find solutions - proposals that will be required to mitigate, to the extent they can, the irreplaceable vacuum created by the lack of practical experience in real working environment.

The catalytic role of education for a country's Technical Vocational development and for the economic and vocational improvement of its people is evident because of the current social structures are determined largely by the rapid growth and development of technology in all areas. Under this perspective, the TVE is required and is able to contribute substantially in this direction, provided its role to be completely accepted by society and supported in all its dimensions from the state.

The delineation of the role of TVE in the Greek reality is determined by the needs that required meeting and by responding positively to the offer substantive responses to the request for Technical - Vocational education. In this context, the TVE does not seem to have managed to win the bet, having continued and continues to remain isolated from the real mission, if not managed so far to link creative theoretical training with practical, action that the binary system promises to implement successfully.

According to the binary system, the theory of Technical - Vocational Education is at the school, some of the practical application - practice in the school laboratory, and the substantial practical experience - education is at real working conditions, in a company. During the practical exercise the apprentices are paid, they are secured against employment risks and for the health and care. The State will ensure the necessary contracts with companies that will undertake to provide practical training to trainees, while law regulates relations and student - company.

The application of dual system in technical - vocational schools in our country do not apply even today, despite occasional official declarations and commitments by law to do so, and despite the positive educational outcomes that the system has led to the respective educational levels of other European countries such as Germany, Great Britain, Ireland, Denmark, the Netherlands [16]. In addition, the ratings employed in TEE in most cases not directly related to the relevant labor market needs. Result of this is the vast majority of graduates of TVE (to 80.4% for males and 64.1% for females) employed on an object which is not related to his specialty who studied at Technical - Vocational Education [9]. In addition, several studies have show that there is a gap between workers' skills and needs of the business, a gap that is mainly determined in terms of lack of skills of workers [17].

The student leak which the TEE showed during the time, despite initial promising forecasts [8] is indicative of the reaction of Greek society on the above.

The decline in student potential of the Technical Vocational Schools is determined embossed on the relevant statistics, which show the relevant statistics which show the potential of the student records for the first class of the first course of TVE, whereby the total change in 1999 - when TVE established for the first time - until 2006 was 53.54% of the student population [10].

The needs for equipment of laboratories of EPA.L, which were inherited from dismantled of TEE [11], continue to hamper the operation of the Technical Vocational Education against the announcements about the: "create very modern and new laboratories" [10] appear to delay characteristics in the time of their implementation.

The financial support of the TVE, both in logistical infrastructure, also in implementing programs aimed towards the acquisition of practical experience of students is a necessary prerequisite to create a second - parallel – school network.

Systematic and planned effort to connect the tee to the labor market requires the adoption and implementation of appropriate measures. In this context the implementation of the various announcements will reinforce the position of the graduates of TEE in the labor market and the assessment of Greek society in this type of education.

The care of coordination of Technical - Vocational education with the labor market so that the first is not strongly deferred and detached from the current developments, is an integral necessity in the direction of the continuous modernization, but of course this does not mean that it's a suggestion which serves the labor market and training disposable workers.

4. The role and the functionality of the incentive in the educational process

The incentive is defined as anything that moves, push or drag the man into action. The incentives could push the person acting internally or externally. Thus, incentives regarded as the internal causes of behaviour (instincts, impulses, feelings, goals) and external causes such as the awards, the lures or respectively the scarecrow, and the repulsive sore [Kostaridou - Euclidis, 1995:17] [12].

The "theory of achieving" by Atkinson distinguishes all individuals by two learned incentive about motivation to achieve success and that of avoiding failure. Especially the first, it appears that is what drives a person into a closer engagement with the work entrusted to him [Atkinson, 1957, 1964] [13-14]. Additionally, increasing the motivation of students leads to more systematic engagement with the subject of their teaching and better performance from their side [15].

5. Description of proposed teaching approach

The fact that each school is an independent small community with all those needs and functions of the corresponding real community is the occasion and the start of a series of proposals which, in the context of Curriculum, they hope to contribute to activate the practice of students of TVS in the school grounds, at actual conditions. This activation is a strong incentive for further learning and an involvement of students in all-round and comprehensive approach to the learning process related with their education.

Under the assumption that each school identified as a functional social cell with all those needs of a small autonomous society, a series of proposals can be implemented at school sites, activating the students of Technical - Vocational Education and involving them in creative activities that simulate those of the labor market.

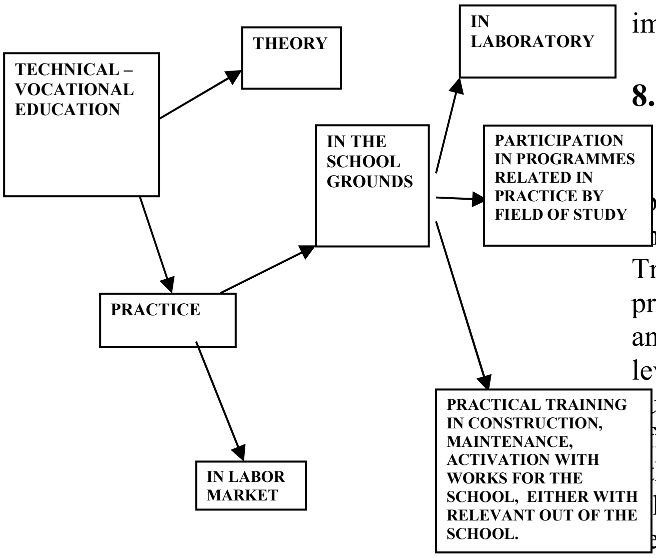
The assumption of maintenance, repair, construction and installation on the premises and for the needs of the school, is a strong incentive and an important opportunity to enable students to gain professional experience through the implementation of laboratory practice. Thus, maintenance of central heating installation of the school building, also the installation of water species and the repair them can be very interesting practical items for apprentices on Central Heating Maintenance. for the needs of the school are strong incentives, also important opportunity activation for the students to have work experience in the implementation of laboratory practice. There are also many cases the school calls a plumber with the corresponding financial cost to repair a related damage. The maintenance and the repair of air conditioning equipment of the school, of the cooling equipment, also the installation new air conditioning units, falls within the scope of training of students in specialty on refrigeration plant and on air conditioning. In addition, many operations, construction and repairs at the school, related to the practical exercises of the Department of Mechanical Engineering, and the subject of education specialty Mechanical and Construction (electric welding, oxygen welding, manufacture samples of various types of metal) can be achieved by trainees, of course, always under the direct supervision and technical advice - guidance of their teacher. Moreover, repairs of electrical faults, lamp's replacement, installing a new electrical supply, are ideal subject for the specialty of Electrical Industrial Sites and Buildings. Furthermore, And yet, the accounting requirements of the school may be undertaken by the relevant specialty of EPA.L. It wouldn't seems over the proposal to extend this training laboratory at neighbouring schools or municipal buildings from the City hosting this school (Hall, Cultural Center, etc.) or neighbouring municipalities, of course, after the necessary training relevant regulatory framework that governs such movements and actions outside the school laboratory space.

Additionally, the repair and maintenance of car of teachers of and motorcycles of students, to the extent that is technically feasible to do that in the school's laboratory, and of course under the supervision of persistent of their teacher, is an ideal practice for students of the Department of Vehicle under actual working conditions. The screening and the measurement of factors related to the smooth and economical operation of the engine and other mechanical and electrical parts for cars or motorcycles of teachers and students, also of citizens, who wish to check the condition of the truck, are also ideal opportunities for a practical approach to the corresponding laboratory object.

6. What are the benefits?

The active involvement for students under work environment conditions will provide for them an ideal opportunity to put into practice what is taught in theory and implement in the relevant laboratory, while the satisfaction that gain the students, seeing the construction, repair or maintenance conducted to function properly, it will be the incentive for them on their school experience in TVE. The degree of difficulty of carrying out some projects, will work positively to their approach from the students. It is also known that the interest in the performance of an activity increases with the difficulty of this activity.

Proposed chart for studies in Technical – Vocational Education



7. Enlargement of the proposals

The enlargement of these proposals in the school premises, also the wider local community to operate service businesses with apprentices as employees, of course under the limits of their laboratory experience, will probably seemed unrealistic in the current context of TVE, although its implementation would lead to multiple and multifaceted benefits to the student community of TVE and thus the whole local community. The framework that identifies the function of schools is prohibitive for such business in their area. But in Europe it is known that students perform at the school - and beyond - the actual functioning of enterprises in the teaching of entrepreneurship and effective interactive activation. Features such examples come from Finland, Hungary, Spain, Great Britain [15]. The operation of business premises of the school and their association with the local community, under the initiative and the substantial support of the educational community, will provide multiple integration efforts in the effective training of students of technical-vocational education, while the saving money to strengthen the infrastructure of educational workshops will be an important benefit.

Like any innovative attempt, this could not escape from the rule of dealing with possible reactions. But the detailed and systematic information to stakeholders in this effort, teachers, students, local community, will lay the solid foundations on which will build on the success of these proposals. Moreover, in the present circumstances in Technical-Vocational Education, the success of this effort seems imperative.

8. Conclusions

The TEE offers a variety of disciplines - ecialties, which they hope to fill skills and nployment needs of society. This presence at a Training school of many professions in the process of learning, enables creative activation and also use them in the school on a practical level with extensions at factual situations whose itcomes will be twofold: On one hand, the ffective practice of students of TVE and on the her hand saving money on school resources hich will be used for medium and long term eeds of the school, which was second priority due to lack of funds for implementation. Furthermore, the involvement of students in a subject that directly affects with their specialization is for them a real challenge, also a powerful incentive for learning. Moreover, it is known and continuously displayed in the eyes of teachers the fact that the application of learning objects in real working conditions is a challenge for apprentices and a high-grade learning tool in the arsenal of the teacher.

Certainly, the above proposals aren't a contrary proposal to the effective implementation of the dual system in the TVE, neither of course is a proposal for a permanent replacement.

However, in implementing a program for the students practice in real working environment conditions will be a valid option, not only until to implement the dual system in TVE, but also as a learning extension and an educational supplement too.

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Renewable Energy Sources - Current Situation in Romania

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Abstract. *In my school is running a Comenius multilateral project 2009-2011, "Renewable Energy Sources – Friends of the Environment". In this paper I will present our findings on current situation of using renewable energy sources in Romania. The most promising renewable energy resources here appear to be wind, biomass, and hydro. There are well-documented wind resources, including a large off-shore potential.*

Keywords. Comenius, Renewable Energy Sources

1. Introduction

Starting with 2009, in my school is running a Comenius multilateral project, "Renewable Energy Sources – Friends of the Environment". Partners are schools from Romania, France, Italy, Poland and Bulgaria. The schools will work and cooperate when studying the renewable energy sources. The project working language will be English. All the documents will be typed both in English and in the respective national language. The project products will be presented in a school newspaper, a CD and a website. The pupils will work out a multilingual glossary of energy – connected vocabulary with English being the unifying language. They will also draw regional maps with locations and opportunities for creating alternative energy sources on each country's territory.

In this paper I will present our findings on current situation of using renewable energy sources in Romania.

2. What Renewable Energy Means?

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished).

Advantages and disadvantages of renewable energy

Advantages:

– minimal environmental impact compared to fossil fuels;
– we can use it repeatedly without depleting it;
– no contribution to global warming;
– no polluting emissions;
– low cost applications when counting all costs;
– saving on health and its costs.

Some of the present disadvantages are:

– solar - panels are expensive. Not all climates are suitable for solar panels.
– wind -turbines are expensive. Wind doesn't blow all the time, so they have to be part of a larger plan.
– waves - different technologies are being tried around the world.
– tides - barrages (dams) across river mouths are expensive to build and disrupt shipping. Smaller turbines are cheaper and easier to install.
– rivers - Dams are expensive to build and disrupt the environment. Smaller turbines are cheaper.
– geothermal - Difficult to drill two or three kilometers down into the earth.
– biofuel - Often uses crops (like corn) to produce the bio-alcohol. This means that more land has to be cleared to grow crops, or there is not enough food, or that food becomes more expensive.

3. Current Situation in Romania

In Romania, the most promising renewable energy resources appear to be wind, biomass, and hydro. There are well-documented wind resources, including a large off-shore potential. Total estimated wind potential is 3 000 MW. There are also good opportunities for biomass development, building off a very large base of existing capacity (over 4 000 MWh). The western region of Romania seems to be a good region for geothermal heat applications. There are very good opportunities to develop small hydro projects in Romania. Over 2 600 MW of Romania's electric capacity is generated from small hydro plants (100 MW or less).

4. Wind Energy

Romania's wind resources are well-documented, and there are a broad range of existing applications from small autonomous units for rural areas to large off-shore potential. Installed wind capacity for the country is approximately 2.5 MW. However, Romania currently has approximately 636 MW of wind capacity under construction. A majority of the capacity under construction is from the Fantanele and Cogeleac wind park, with 600 MW. The wind park is located in the southeastern region of Dobrogea, 17 km from the Black Sea. This park will account for approximately 30 percent of Romania's renewable energy.

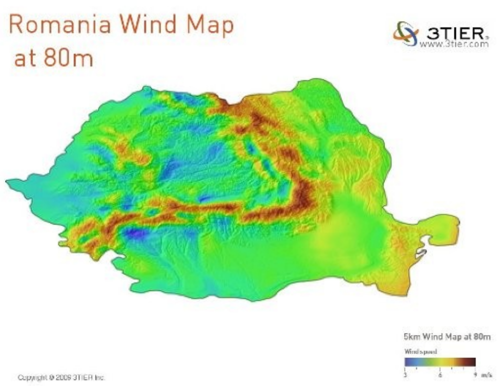

Figure 1. Romania wind map at 80m

Until December 2010, Romania will add around 440 MW to its installed wind capacity from two wind farms: Fântânele and the EDP Medgidia. A total number of 170 wind turbines will be installed in 2010 enough to power over 500 000 homes. The first offshore wind-power project in Romania will be constructed by the United States–based Blackstone Group, which will invest $1.4 billion in a 500 MW wind farm located in the Constanța County sector of the Black Sea on a 40 km2 area situated 6 km from the shoreline. Constanța and Tulcea counties have the second-highest wind potential in Europe. The Romanian company Blue Investment will invest US$ 84 million in a 35 MW wind farm in Baia, Tulcea County that will have turbines with a capacity of 2.5 MW each. Several companies are interested in investing in wind farms in Romania. The Italian company Enel plans to build several wind farms with a total capacity of 350 MW. The Swiss conglomerate Cofra Group will build two wind farms, one that will have a capacity of 700 MW in Dobrogea and one that will have a capacity of 400 MW in Neamț and Suceava counties; the total investment will amount to $1.65 billion.

5. Biomass

Romania has great biomass potential, which is estimated at 88 000 GWh per year. In 2004, about 43 percent of the biomass potential in the country was exploited. Heat generated from wood biomass was approximately 54 percent, and heat generated by agricultural biomass was about 46 percent.

Direct burning in stoves for space heating, cooking and hot water preparation is about 95 percent of the biomass use. The rest of the biomass is used in thermal plants to generate industrial steam and hot water in sawmills and in other industries equals about 5 percent of biomass usage.

The largest biomass plant in Romania is in Radauti. The plant has a total capacity of 22 MW, 17 MW of heat and 5 MW of electricity, and is the outcome of a 20-million-euro investment of an Austrian company.

Figure 2. Radauti biomass plant

6. Solar Energy

Romania has exploited a significant amount of solar resources in the past, but since 1990, the manufacturing, installation and research and development has virtually ceased. The potential market for solar applications is very large but specific incentives will be needed in order for this potential to be realized. The average solar radiation in Romania ranges from 1 100 to 1 300 kWh/m2 per year for more than half of the country's surface.

Romania has moderate solar potential throughout the whole of the country. Its best solar resource is located in the southern portion of the country.

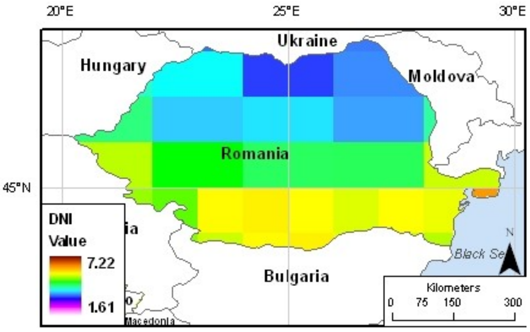

Figure 3. Romania Solar Direct Normal Insolation (Source: NASA)

Area	Size [MJ/m²/year]
Black Sea coast	5.384
South plain	5.147
Danube Delta	5.046
Western plain	4.815

Figure 4. Romanian Areas/Projects with High Potential for Solar Energy

One of the most important solar projects was the installing of a 30 kW solar panel on the roof of the Politehnica University of Bucharest that is capable of producing 60 MWh of electricity per year. Another Romanian city, Alba Iulia, installed a total of 1 700 cells on several public buildings that produce 257 kWh of electricity per year. The Covaci Solar Park will be Romania's largest solar power plant at completion having a total of 480 000 solar pannels with a combined capacity of 35 megawatts and will be located in Timiş County. Another important site is the Gura Ialomiței Solar Park in Ialomița County which will have a capacity of 10 megawatts. Rominterm, a Romanian company, will install until 2011 a total of 600 solar panels in Mangalia, Constanța County that will make the city self sufficient in terms of heated water during the summer months and provide around 70% of heated water in the winter months and another 1 150 solar panels used for the generation of electricity spread over an area of 1 400 square metres.

6. Geothermal Energy

Geothermal energy is energy obtained by tapping the heat of the earth itself, both from kilometers deep into the Earth's crust in some places of the globe or from some meters in geothermal heat pump in all the places of the planet.

Romania has the third highest geothermal potential of European nations, with major potential locations on the Western Plain, South Plains in the region of Bucharest, and in the Carpathian regions. The exploration and research for geothermal resources began in Romania in 1962. Over 200 wells have been drilled, proving the existence of low enthalpy geothermal resources with temperature between 40-120 °C.

Figure 5. Geothermal Resources map for Romania

7. Hydroelectric Energy

The installed capacity of hydropower is 6 715 MW, representing a third of Romania's total installed electricity generating capacity. The country's hydropower potential is extremely large, with an estimated additional potential of over 9 GW. Lack of funding is the greatest barrier to increasing current capacity. The total theoretical hydroelectric potential of Romania, given optimum technological conditions, has been calculated at some 70 billion kilowatt-hours in an average year, but for technical and economic reasons only a fraction of this potential has been developed. Geographically, the hydroelectric reserves of Romania are concentrated along the Danube and in the valleys of rivers emerging from the mountain core of the country. The most important water basins are: Olt, Lotru, Bistrita, Somes, Dragan, Arges, Dambovita, Raul Targului, Sebes, Raul Mare, Cerna, Bistra, Buzau, Motru, and Danube.

8. Conclusion

I conclude that Romania has a great potential, but, unfortunately, the renewable energy sources are very little used at the present moment.

The results from the project activities will be included in the theoretical and practical training at the school: there will be incorporation into the syllabus of geography classes (opportunities for creating alternative energy sources on the territory of the country (a map of the location of these sources), technical English classes (working out a multilingual glossary of vocabulary connected with the alternative energy sources), computer science classes (preparing Power Point presentations and electronic documents about RES), economics classes (analysis of the economic effectiveness of the various energy sources), chemistry and preservation of the environment classes, vocational subjects classes (study of technical parameters of the systems for production and realization of energy).

This project is a great opportunity for students, teachers and local communities from five countries to work together on renewable energy sources theme.

7. Acknowledgements

I would like to thank the "Hands on Science" coordinator Manuel Felipe Costa for his support and encouragements.

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Mathematics in the Knowledge Based Society

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Abstract. *In this paper I will exemplify the IntelTeach method of teaching mathematics through projects for the lesson "Integers". I participated in the training course "Intel Teach-Training in the Knowledge Based Society." This course helped me to make my lessons more attractive by integrating resources and IT tools in teaching mathematics. I present this lesson and in terms of a math teacher in a rural school. Children in this environment have many disadvantages compared to those from urban areas, in particular economic, social and technical. AEL laboratories recently broke into this environment. The project represents an alternative assessment method.*

Keywords. AEL, IntelTeach, Mathematics

1. Introduction

In this unit, students learn the concepts of:

- Integer, representing the number line, opposite, absolute
- Comparing and ordering integers
- Representation of a point with integer coordinates in a system of orthogonal axes
- Assembly integers
- Decrease integers
- Multiplication of integers. Integer multiples of a
- The division of integers when the divider is a multiple of the divisor
- Divisors an integer
- integer power of a natural number with exponent
- Rules for calculating with powers
- using the order of operations and parentheses
- Resolution of equations in Z
- Resolution of inequality in Z.

Essential Question:

How math helps us in solving practical content?

Unit Questions:

Why we need to know the concept of integer?

How help us use these concepts in problem solving?

Content Questions:

How do we define an integer?

What is the opposite of an integer?

What is the absolute value of an integer?

What is the axis of integers?

How it compares and how orders are integers?

What are the operations with integers?

What is the order of operations in Z?

How to solve problems that arise in operations with integers?

How to calculate the power of an integer?

What are the rules of computing power?

What are prime numbers?

What are irreducible fractions?

How to solve equations and inequalities in Z?

Students will participate in solving individual and group applications, the degree of difficulty gradually differentiated learning styles and level of understanding focused on:

-Identification of issues involved;

-Find real-life problems solved with integers, the development of the graphical representation;

-Identify problem situations, which can be transcribed into mathematical language, using algebraic calculations to determine an unknown period of an equation in Z.

2. Unit's Objectives

1. Use algebra to simplify computing elements calculations and for solving equations.
2. Identify-problem situations, to transpose them into mathematical language and effectively organize how to solve them.
3. Build problems, based on a model (graph or formula).
4. Consistently provide the solution to a problem, using various modes of expression (words, mathematical symbols, diagrams, tables, various construction materials).
5. Identify uses of mathematical concepts and methods studied in solving practical problems.
6. To assume different roles within a learning group, arguing ideas and mathematical methods,

using different sources of information to verify and support opinions.

3. Operational Objectives

Students will be able to:
- To write, read, compare and represent whole numbers axis;
-Solve problems that arise in operations with whole numbers;
-To calculate the power of a whole number;
-To know the rules of computing power;
Divisors-calculate an integer;
-To solve equations and inequality in Z.

4. Didactical Strategy

First hour:

To achieve the unit's portfolio, students must have theoretical knowledge on the concepts from this unit. Will divide students into three groups and will complete homogeneous KWL chart. Students seek information about the concept of individual integer which it saves a folder "Resources". It uses a brainstorm. It makes a whole number and note definition. Activity students will continue to search for information about the opposite concepts of integer, absolute value of an integer, representing the axis, comparing and ordering integers. For each concept will write the definition. Students in each group will be asked to complete their work schedule which will include exercises No.1 degree of difficulty gradually differentiated for each group. Within each group, students can work individually by distributing the workload. Each group will post on the forum worksheet to get an overview and to view and work groups and other forums will complete a checklist on progress. This activity begins in the classroom and will be continued at home. The teacher will continuously observe and work groups will help students when difficulties.

Examples:

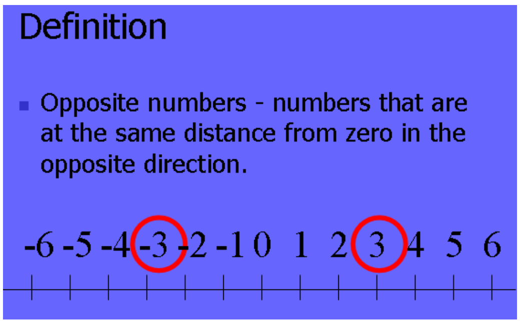

Figure 1. Opposite numbers definition

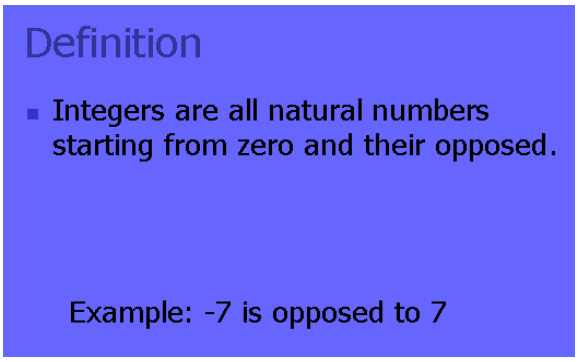

Figure 2. Integer's definition

Second hour:

Students collect information about addition and subtraction of integers. Using examples of worksheet # 2, students will solve such operations. Students will be divided into three groups and the forum will publish results of their work. Examples:

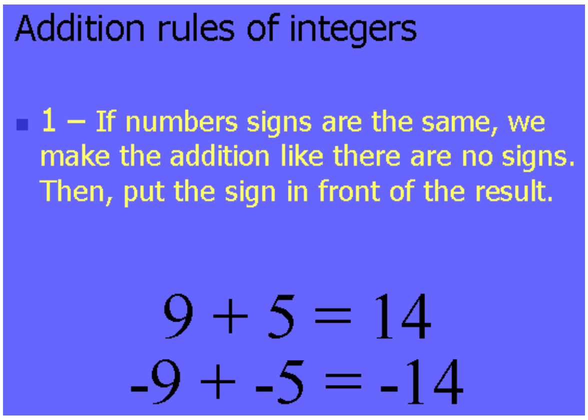

Figure 3. Integer's addition rule 1

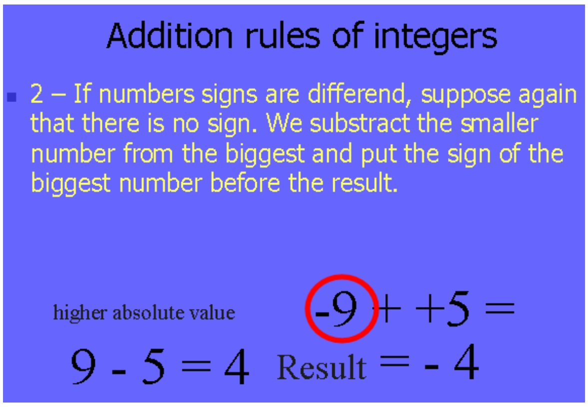

Figure 4. Integer's addition rule 2

Third hour:
Information is collected about multiplying and dividing integers. Using examples of worksheet # 3, students will solve such operations. Students

will be divided into three groups and the forum will publish results of their work.

Fourth hour:

It collected information on operations with whole numbers and the order of their Z With examples No.4 worksheet, students solve exercises such operations. Students will be divided into three groups and the forum will publish results of their work.

Fifth hour:

It collected information about the power of an integer exponent and the natural rules of computing power. Using examples from the worksheet No. 5, students solve exercises. Students will be divided into three groups and the forum will publish results of their work.

Sixth hour:

Divisors information is collected about an integer, prime and irreducible fractions. Using examples from the worksheet No.6, students solve exercises such operations. Students will be divided into three groups and the forum will publish results of their work.

Seventh hour:

It collected information on equations and inequalities in Z. Using the worksheet examples 7, students solve exercises such operations. Students will be divided into three groups and the forum will publish results of their work.

Eighth hour:

Presentation of the final products of groups, carry out evaluation / self-presented product. After the presentation, teacher discuss with his students in order to analyze the extent to which students have acquired knowledge and developed skills of collaboration, communication, creativity.

5. Evaluation

Students will fill in a KWL chart to identify knowledge needs of students. The teacher will ask students to write in the first column what they know about integers and the second who want to know about it. Students will be divided into groups according to their level of understanding, will work differently from completing worksheets developed by teacher and will complete lists of progress. To communicate, exchange views or improving certain content, to view products, it will be used discussion method and the forum.

Analyzing portfolios will be as follows:

- Presentation - the key criteria for presentation

- Students will complete and the table-I know I know - I learned to appreciate progress.

- Each student will complete a feedback form on the forum for presentations colleagues.

Made on presentation of the valuation work has produced a guide to scoring. Each student will be assessed with a mark.

I used initial assessment, formative assessment and summative evaluation.

6. Conclusions

I noticed that students are very attracted to this type of learning, though I repeated some clips of the lessons because we obtained initial results. Things started hard, students of rural beneficiaries had not benefited from the advantages of urban students. KWL chart (I know, I know - I learned) and the stock has been very effective tools and highly appreciated by students. They have learned to express ideas, knowledge, learned to discuss, collaborate in teams, something new for them. It is difficult initially to make them think about themselves, take initiative and to express ideas, brainstorm method is to start very fun for them. To explain the concept of integer, I use many applications and examples from real life, because, as I only managed to attract attention and make him understand.

Examples:

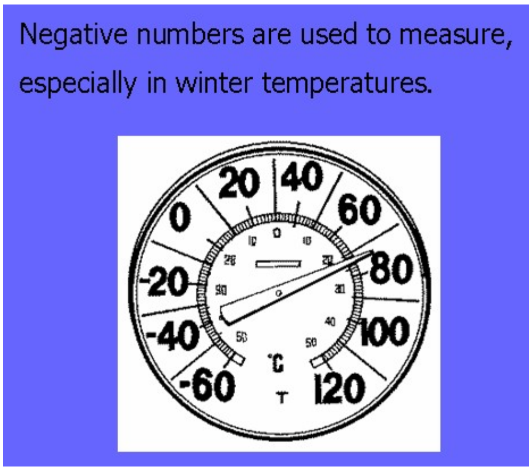

Figure 5. First application

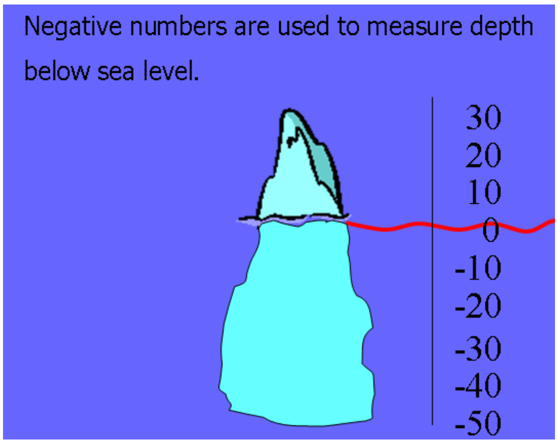

Figure 6. Second application

I concluded that only if you consistently apply this method to several materials and at least over a full cycle of four years, results can be achieved with these students. And to give children the same opportunities in the country to provide schools.

7. Acknowledgements

I would like to thank the “Hands on Science” coordinator Manuel Felipe Costa for his support and encouragements.

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Teaching Thermochemistry with Two Simple Experiments in Constructivistic Context

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Abstract. *This paper presents two experiments on thermochemistry. The teaching sequence consists of a theoretical study of the subject, a first experiment "estimating the heat of dissolution of $CaCl_2$" and a second experiment "estimating the heat of combustion of butane". Experimental procedure proved to be more fruitful in revealing misconceptions or alternative conceptions than the theoretical part. In addition experimental procedure appeared to be more effective in helping the students change their misconceptions to scientifically correct concepts. The proposed experiments are simple and easy to perform, the experimental set up is not complex and the students have enough time to think and discuss in a "minds-on" procedure as well.*

Keywords. Thermochemistry, Heat of combustion of butane, Heat of dissolution calcium chloride, Alternative conceptions

1. Introduction

This paper presents two experiments on thermochemistry. In the second class of our experimental high school, students of age 16-17 attended a teaching sequence in thermochemistry, which consisted of three stages: A) The theoretical study of the subject B) The first experiment in which the students estimated the heat of dissolution of $CaCl_2$ in a styrofoam cup calorimeter C) The second experiment in which the students estimated the heat of combustion of butane in ordinary camping gas apparatus. The first theoretical part is not presented here as the conventional method and content was followed. The two experimental stages are analyzed and special emphasis is being put on the benefits of the second.

2. Experimental procedure

The experiments are as follows:

First Experiment :

We pour 150 cm^3 of water into a styrofoam cup calorimeter. We register the temperature measured by a thermometer, we add 2 g of $CaCl_2$ and we register the higher temperature reached. From the above data we estimate the heat of dissolution of $CaCl_2$. We use the equation: $Q = m \times c \times \Delta\theta$ where Q stands for the estimated heat that is released during the dissolution, m stands for the mass of the water in the calorimeter, c for specific heat of water and $\Delta\theta$ for the change in temperature of the water before and after the dissolution of $CaCl_2$. With the proper calculations per mol the enthalpy of dissolution derives. This estimation is based on the principle that, the total heat produced from the dissolution of the salt is absorbed by the water in the calorimeter. It is worth noted that when the salt re-crystallizes in an endothermic process, a rapid decrease of the temperature is observed.

Second Experiment:

We pour 100 cm^3 of water into an empty aluminium refreshment can, which hangs over a butane camping gas apparatus. We register the temperature of the water in the refreshment can. We weigh the camping gas apparatus and then we light it and heat the can until the water's temperature increases up to 60-70 ^oC. We register the exact increased temperature and we weigh the gas apparatus again. The heat produced from the combustion of butane is rapidly absorbed by the mass of the water in the metal can. We use the equation $Q = m \times c \times \Delta\theta$ in order to estimate the heat produced during the combustion of the butane gas. The change of the mass of the butane gas apparatus gives the total mass of the gas burnt. We use this mass and the heat we have already found in order to calculate the heat produced per mole and the enthalpy of the combustion of butane.

Fig. 1 depicts both simple experimental setups.

Figure 1. Experimental setups: (1) left (2) right

3. Alternative conceptions and difficulties

Some of the data concerning the alternative ideas and difficulties derived from the theoretical part and the first experiment are summarised below:

1. Students think that the temperature of the water in the calorimeter before the dissolution of the salt is much lower than the temperature of the surrounding atmospheric air.
2. Students can not distinguish between the "system" of the reactants and the surroundings. They have the idea that the total amount of water in the Styrofoam calorimeter belongs to the system and that the atmospheric air forms the surroundings.
3. Students cannot give coherent explanation of the energy changes during dissolution and are surprised when they observe the endothermic procedure.

The second experiment in the sequence offers the following opportunities

1. The students are able to distinguish between the "system" of the reaction and the "surroundings" because the reactants are enclosed in the camping gas vessel and the water that absorbs the exhausted heat is in a totally separated area, in the refreshment can.
2. The clear separation of the two areas gives teachers the opportunity to make students transcend from the macro-level of the empirical observation to the symbolic level of the written chemical equation of the combustion. With a proper computer simulation and three-D modelling teachers can help students to transcend to the micro-level of the reactants and products of the reaction, without having the "noise" of other substances included.
3. The higher or lower quantities of heat that is lost according to different parameters of the experimental setup give students the opportunity to repeat the procedure in order to find the best parameters as well as to reach to a good accuracy, following the scientific method.

4. Discussion

The evolution of each of the three stages led to the reveal of alternative conceptions or misconceptions [2], some have already been included in former works [3]. It is worth noted that both experimental procedures were more fruitful in revealing misconceptions than the theoretical part of the procedure. At the same time each experimental procedure appeared to be effective in helping the students change their misconceptions to scientifically correct concepts. It is obvious that this is one more reason among others [4] [5] of which hands-on-practice is of great value in chemistry teaching.

The teaching sequence proposed may become more creative if the two experiments are embedded in a different mode. For the first experiment we may construct a working sheet in a rather guided mode, and the second experiment may be given in an open procedure of scientific method. For the second experiment the students may be asked to use former knowledge which derives from both, their experience of the theoretical part and of the first experiment and invent a way of estimating the heat of combustion of butane.

Both experiments are convenient in discussing inter- and intra- molecular forces, as the first includes an ionic substance and the second a covalent substance, as well as energy changes that take place during the reactions that these two substances are involved.

They are also offer to the students the opportunity to trace the scientific background of everyday experiences and actions, as dissolution and combustion, and to give explanations of phenomena in the world around them.

The first experiment is not included in the formal curriculum. However, the curriculum suggests a similar to the first experiment, in which NaOH is used. By using $CaCl_2$ we have the benefit of observing an endothermic phenomenon as well. Modification is suggested as a practical alternative to completely laboratory activities in ways constructivism suggests [1].

The proposed experiments are simple and easy to perform with available and inexpensive materials. The time constraints do not affect the procedure because the experimental set up is not complex and the students have enough time to make the proper calculations, as well as to think and discuss [6]. This means that there is a “minds-on as well as hands-on practice” being carried out [5].

Of course certain precautions must be taken to protect the students because $CaCl_2$ is slightly irritating and butane is extremely flammable.

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Thermal entanglement in a three particles system

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Abstract: *Entanglement of quantum systems changes under environmental conditions like temperature, magnetic field, noise and so on. In this paper the thermal entanglement in a spin chain with three particles by exchange interaction is investigated in terms of the measure of entanglement called 'negativity'.*
We find that the entanglement is decreased with increasing temperature; entanglement is increased with increasing change interaction. Also we find that the entanglement maybe is enhanced under a uniform magnetic field with increasing magnetic field in constant temperature.

Keywords: Exchange Interaction, Negativity, Magnetic field, Thermal entanglement.

1. Introduction:

Entanglement is the behavior of some quantum systems which first interacts each other and then separate. In quantum mechanics knowing about one part leads to have information about the other one. At first entanglement just was a theoretical subject but now it has many application in quantum information and computation such as teleportation [1], super dense coding[2], quantum computation [3,4] and some cryptographic protocols [5,6] and so on.

There are several definitions of entanglement measure of system .In this paper, we use negativity $N(\rho)$ which was shown to be an easily computable measure pure as well as mixed states [7]. In definition is based on the trace norm of the particle of ρ^{T_A} of bipartite mixed state ρ . Negativity as an entanglement measure is motivated by the Peres-Horodecki positive partial transpose separability criterion and is computed as follows:

$$N(\rho) = \frac{\left\|\rho^{T_A}\right\|_1 - 1}{2} \qquad (1)$$

with this definition $N(\rho)$ is the absolute value of the sum of the negativity eigenvalues of ρ^{T_A} .Where ρ^{T_A} is partial transpose of ρ with respect to A party.

2. The model:

The state of the system at thermal equilibrium at temperature T is characterized by the thermal density matrix $\rho(T) = \frac{1}{Z}\exp\left(\frac{-H}{K_B T}\right)$ where Z=Tr $\left(\exp\left(\frac{-H}{K_B T}\right)\right)$ is the partition function and K_B is Boltzmann constant. The entanglement in $\rho(T)$ is called thermal entanglement [8].

In This paper we consider a chain composed of three spins which two particles are spin-half (particle numbered one and three) and second particle has spin-one. For this system under external magnetic fields and with nearest neighbor interaction and next nearest neighbor interaction, the Hamiltonian is [9]

$$H = J_1(S_1.S_2) + J_2(S_2.S_3) + \sum_{i=1}^{3} B_i S_{iz} \quad (2)$$

In which the neglected exchange coupling term along the Z-axes is assumed to be much smaller than the coupling the X-Y plane, the magnetic field is assumed to be along the Z-axes, J_1 and J_2 are the coupling constants nearest neighbor and next nearest neighbor. We investigate the thermal entanglement of this system with a uniform and nonuniform magnetic field.

3. Uniform magnetic field

$$\vec{B}_1 = \vec{B}_2 = \vec{B}_3 = B\hat{Z}$$

To evaluate the thermal entanglement, we first of find the eigenvalues and corresponding eigenstates of the Hamiltonian which are seen to be:

$$E_1 = \frac{1}{4}J_2 - B + \frac{1}{4}\sqrt{\alpha}$$

$$E_2 = \frac{1}{4}J_2 - B - \frac{1}{4}\sqrt{\alpha}$$

$$E_3 = \frac{1}{4}J_2 + B + \frac{1}{4}\sqrt{\alpha}$$

$$E_4 = \frac{1}{4}J_2 + B - \frac{1}{4}\sqrt{\alpha}$$

$$E_5 = -\frac{1}{2}J_2 + B$$

$$E_6 = -\frac{1}{2}J_2 - B$$

$$E_7 = 2B$$

$$E_8 = -2B$$

$$E_9 = \frac{1}{4}J_2 + \frac{1}{4}\sqrt{\beta}$$

$$E_{10} = \frac{1}{4}J_2 - \frac{1}{4}\sqrt{\beta}$$

$$E_{11} = -\frac{1}{2}J_2$$

$$E_{12} = \circ$$

Where

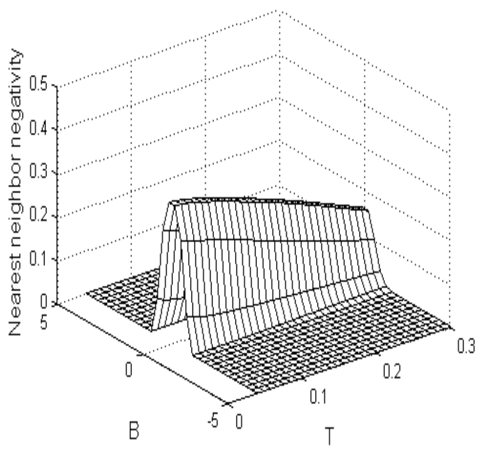
$$\alpha = J_2^2 + 16J_1^2$$

$$\beta = J_2^2 + 32J_1^2$$

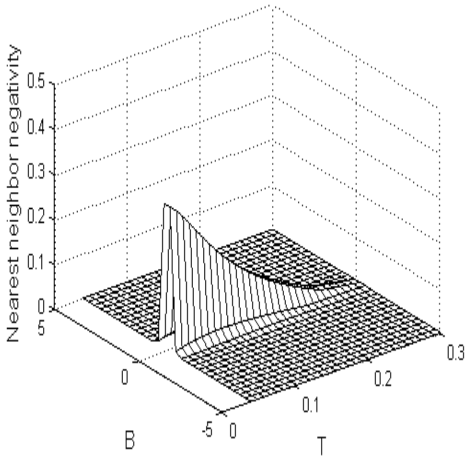
Then with use of these eigenvalues and eigenvectors, we construct the total density matrix (ρ_{123}), and evaluate the entanglement between nearest neighbor and next nearest neighbor.

3.1 Nearest neighbor entanglement

In this case, we evaluate negativity with use of the density matrix $\rho_{12} = Tr_3(\rho_{123})$ and then we plot nearest neighbor negativity in terms of temperature and magnetic field for J_1=1 and a) J2=0.5 b) J2=1.5



(a.1)



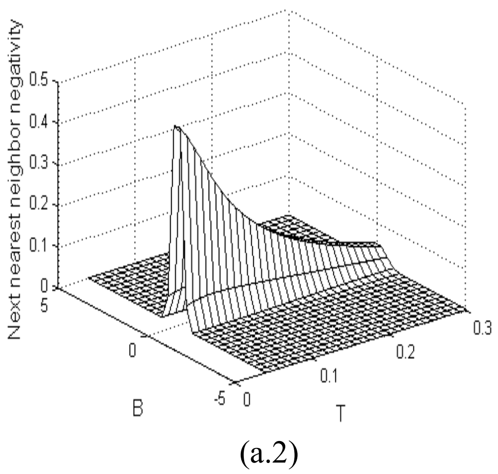
(b.1)

Fig1.The nearest neighbor negativity in terms of B and T for J_1=1 and a)J_2=0.5 b)J_2=1.5

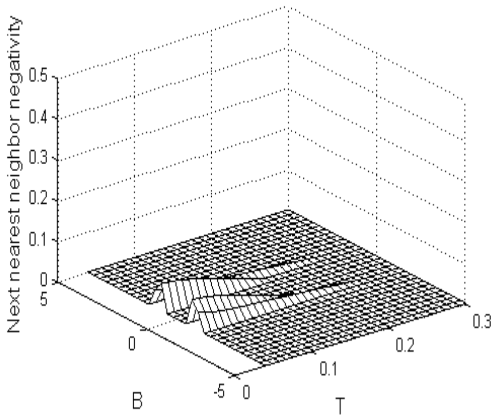
Figure 1 shows that with increasing temperature, entanglement is decreases also entanglement is decreased with increasing magnetic field in constant temperature. Furthermore with increasing J_2 the amount of entanglement decreases and the region which has nonzero entanglement become smaller. For any temperature the entanglement is symmetric with respect to zero magnetic fields.

3.2 Next nearest neighbor entanglement

We evaluate negativity with use of the density matrix $\rho_{13} = Tr_2(\rho_{123})$. We show our calculation result in fig 2 for J_2=1 and a) J1=0.5 b) J1=1.5



(a.2)



(b.2)

Fig2.The nearest neighbor negativity in terms B and .T for J_2=1 and a) J_1=0.5 b) J_1=1.5

We can see that with increasing temperature, the value and the region of entanglement becomes smaller, and with increasing of magnetic field, entanglement is decreased in constant temperature. With increasing J_1 (in equal T and B), entanglement is decreased. In fig 2(a), there is one peak and for any temperature entanglement is symmetric with respect to zero magnetic fields, also with increasing temperature, entanglement is decreased. But in fig 2(b) we can see two peaks, with increasing temperature, the left and right peak, disappear.

4. Nonuniform magnetic field $\vec{B}_1 = -\vec{B}_2 = \vec{B}_3 = B\hat{Z}$

In this case, eigenvalues of Hamiltonian are given by

$$E_1 = E_2 = \frac{1}{4}J_2 + \frac{1}{4}\sqrt{a_1}$$

$$E_3 = E_4 = \frac{1}{4}J_2 - \frac{1}{4}\sqrt{a_2}$$

$$E_5 = \frac{1}{6}\sqrt[3]{a_4} - 6\left(-4/3B^2 - 2/3J_1^2 - 1/36J_2^2\right)/\left(1/6J_2 + \sqrt[3]{a_4}\right)$$

$$E_6 = \frac{1}{6}\sqrt[3]{a_4} - 6\frac{\left(-4/3B^2 - 2/3J_1^2 - 1/36J_2^2\right)}{\left(1/6J_2 + \sqrt[3]{a_4} + 1/2\sqrt{3}i\left(1/6\sqrt[3]{a_4} + 6\left(-4/3B^2 - 2/3J_1^2 - 1/36J_2^2\right)\right)/\sqrt[3]{a_4}\right)}$$

$$E_7 = \frac{1}{6}\sqrt[3]{a_4} - 6\frac{\left(-4/3B^2 - 2/3J_1^2 - 1/36J_2^2\right)}{\left(1/6J_2 + \sqrt[3]{a_4} - 1/2\sqrt{3}i\left(1/6\sqrt[3]{a_4} + 6\left(-4/3B^2 - 2/3J_1^2 - 1/36J_2^2\right)\right)/\sqrt[3]{a_4}\right)}$$

$$E_8 = -\frac{1}{2}J_2 - B$$

$$E_9 = -\frac{1}{2}J_2 + B$$

$$E_{10} = -\frac{1}{2}J_2$$
$$E_{11} = E_{12} = \circ$$

Where

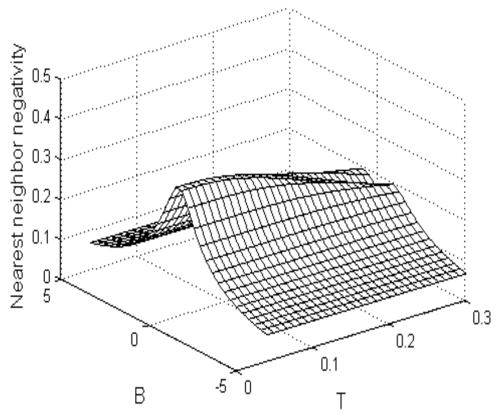
$$a_1 = J_2^2 + 16J_1^2 - 8BJ_2 + 16B^2$$
$$a_2 = J_2^2 + 16J_1^2 + 8BJ_2 + 16B^2$$

$$a_3 = -768B^6 - 1152J_1^2B^4 + 96B^4J_2^2 - 576J_1^4B^2 - 120J_1^2J_2^2B^2 - 3J_2^4B^2 - 96J_1^6 - 3J_2^2J_1^4$$
$$a_4 = -144J_2B^2 + 36J_2J_1^2 + J_2^3 + 12\sqrt{a_3}$$

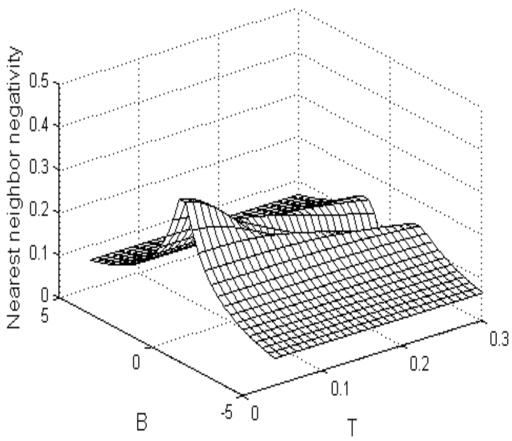
As the same as former case, we investigate entanglement for nearest neighbor and next nearest neighbor.

4.1 Nearest neighbor entanglement

We plot fig 3 with the same condition in fig 1



(3.a)



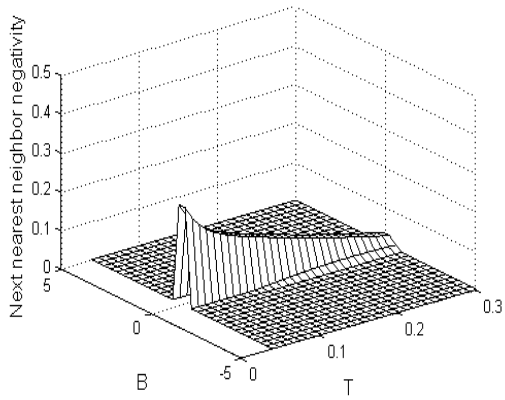
(3.b)

Fig3.the next nearest neighbor negativity in terms B and T for J_1=1 and a) J_2=0.5 b) J_2=1.5.

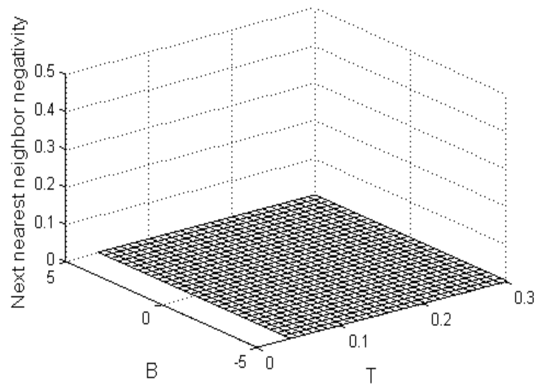
Figure 3 shows that with increasing temperature, the value and region of entanglement (in same B and J) become smaller, with increasing magnetic field , entanglement is increased at the high temperature, and with increasing J_2 (in same T and B) entanglement is decreased.

4.2 Next nearest neighbor entanglement

We plot fig 4 with the same condition in fig 2



(4.a)



(4.b)

Fig4. the next nearest neighbor negativity in terms B and T for J_2=1 and a) J1=0.5 b) J1=1.5.

We can see that with increasing temperature, magnetic field and J_1, entanglement is decreased.

5. Conclusion

In this paper, we focus our attention on a spin chain with two spin one-half and one spin one, and investigate the affect of temperature, magnetic field and exchange interaction on the entanglement in uniform and nonuniform magnetic field. We find that in both cases ($\vec{B}_1 = \vec{B}_2 = \vec{B}_3 = B\widehat{Z}$ and $\vec{B}_1 = -\vec{B}_2 = \vec{B}_3 = B\widehat{Z}$), with increasing temperature, entanglement is decreased .With increasing magnetic field, entanglement is decreased (with the exception of case nearest neighbor $\vec{B}_1 = -\vec{B}_2 = \vec{B}_3 = B\widehat{Z}$) in constant temperature. Furthermore, entanglement between any of two particles, is increased with increasing their exchange interaction, but for the same particles is decreased with increasing the exchange interaction for two other particles and vice versa.

6. Acknowledgements

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Improvement of Science and Technology Literacy by means of ICT-Based Collaborative Action Research Including Hands-on Experiments

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Abstract. *Science and technology literacy improvement is a necessity for the development of society. Innovations of teaching/learning methods should contribute to bridging the science and society gap. Research findings, based on video-study, describe the roles of experiments in science education and show that experiments used by teachers are not always appropriate for the development of students' knowledge and skills. Action research is an important event-based method for the upgrading of teachers' professional competencies and students' motivation. ICT-based collaborative action research uses a web-environment and international collaboration between teachers and students. Innovations of action research lead to an emphasis on hands-on experiments.*

Keywords. Action research, Collaboration, Hands-on experiments, ICT, Science education.

1. Introduction

Science and technology literacy improvement is a necessity for the development of society. Science education plays an important role in educational systems and has the goal of enhancing scientific literacy in students [1]. Scientific literacy provides support for citizenship in a democratic society [4]. Science education has the potential for enabling students to interrelate science with economical, technological and environmental aspects.

Innovations of teaching/learning methods should contribute to bridging the science and society gap. Students' learning through school science is expected to be the core focus in defining and developing teaching strategies in the context of a constructivist approach to science education. During the lifetime of a teacher's professional teaching duties many new science discoveries appear and innovative educational technologies emerge. However science teachers tend to create their own individual pedagogical content knowledge [6] with little influence by poor quality in-service training. High quality in-service science teacher training for practising science teachers is very important in reducing the gap between scientific and educational research and the development of curricular materials and evidence-based teaching methods for school practice [2].

We try to improve in-service science teacher training by the application of innovations in action research. ICT-based collaborative action research, such as our modification, uses a web-environment and international collaboration between teachers and students.

2. Video studies of the role of experiments in science education

Video study as a research method was applied to the study of experiments in school science education (physics) in lower secondary schools. The basis of the video-study method is an analysis of video recordings of lessons. The Centre for Pedagogical Research in the Faculty of Education, Masaryk University, deals with the video-study method in the project „Physics Video-study“[5]. This method was transferred from universities in Germany (Kiel) and Switzerland (Zürich, Bern). The video-study method used consists of several phases:

(i) Making video recordings with the assistance of classic camcorders located in the class-room.

(ii) Software processing of recorded data by use of Videograph (a multimedia player of computerised video recording).

(iii) Record transcription, which means word-for-word transcription of an audio record into text.

(iv) Video recording coding is systematic registration and classification of phenomena stored on the video recording. For this process, it is always essential to adopt and/or create a relevant categorical system first.

(v) Evaluation of acquired data in a chosen statistics program (Statistica).

We analysed physics video-lessons recorded by the Centre for Pedagogical Research in lower secondary schools (the 7th and 8th grade) [5]. The coding of experimentation phases was completed according to the categorical systems. The process of coding was accomplished on 62 video-recordings of physics lessons, the topics „Composition of forces"(27 lessons; 8 teachers) and „Electric circuit"(35 lessons; 11 teachers) were concerned; all were filmed in 2004-05.

Two important research results are presented:

(a) Roles of experiments in science education

Research findings based on video-study describe phases of the use of experiments and show that experiments used by teachers are not always appropriate for improvement of students' knowledge and skills [7] (see Fig. 1):

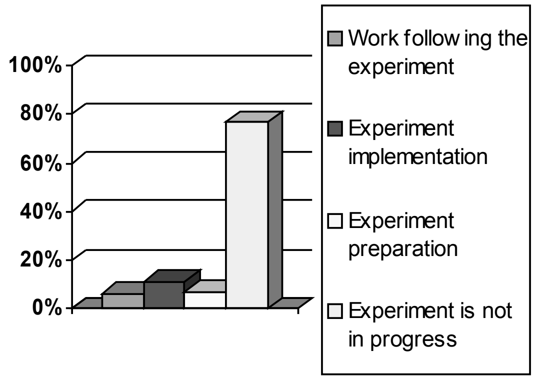

Figure 1. Representation of experimentation phases in physics lessons

The category "experiment is not in progress" is the most frequent one (77%) in the analysed lessons. If we compare the results of all phases, there are unsatisfactory results: the total time spent on experimentation is insufficient and the proportion of the phases is unreasonable.

(b) Frequency of simple experiments in science education

Our next research using video-study was aimed at the identification of simple experiments in physics education. The categorical system for the identification of simple experiments was created:

Table 1. Categorical system for coding – simple experiment

1 - Simple experiment	Characteristics: (a) – **transparency** (clear description of the phenomenon) (b) - **no additional phenomena** (no other parasitic phenomena) (c) - **easy realisation** (no intricate equipment)
2 - Non-simple experiment	One or more of (a), (b), (c) characteristics are missing

The outcomes of this video-study research are presented in Fig. 2 and Fig. 3:

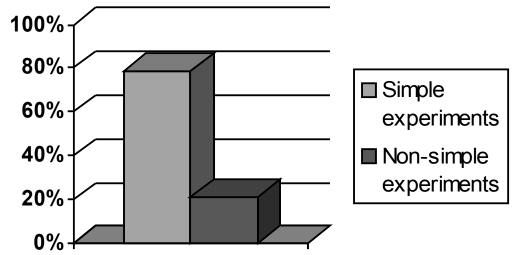

Figure 2. Electric circuit: Frequency of simple and non-simple experiments

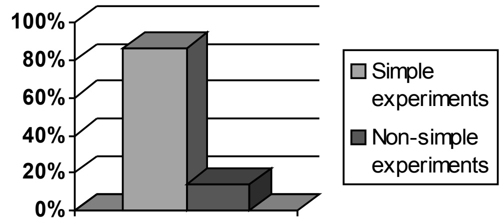

Figure 3. Composition of forces: Frequency of simple and non-simple experiments

The diagrams in Fig. 2 and Fig. 3 indicate that the category „simple experiment" is the most frequent one (79% and 86%) in coded physics lessons. It is interesting to find out that the simple experiments are the most used experiments in physics education. It is also a stimulating fact that the frequency of simple experiments depends on the topic.

The common results of both video-studies give us two crucial issues: (a) experiments used by teachers in science education are not always appropriate for the improvement of students' knowledge and skills and (b) simple experiments play an important role in science education.

3. ICT-based collaborative action research

Action research is known by many other names, including participatory research, collaborative inquiry, emancipator research, action learning, and contextual action research, but all have the same basis. This method is "*inevitably threatening to the traditional professional cultures of both teachers and academic teacher educators. As a form of mutual professional learning it requires a transformation of both school and academic* *cultures"* ([3], p.45). Action research is simply "learning by doing": to identify a problem, to do something to resolve it, to see how successful their efforts were, and if not satisfied, to try again. The diagram (Fig. 4) demonstrates this process:

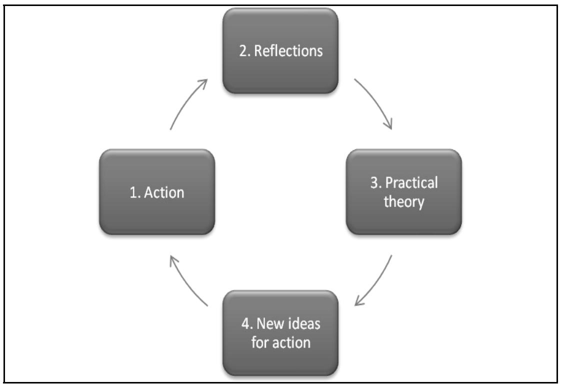

Figure 4. A simplified diagram of action research methodology (Elliot, 1997)

A particular action is conceptualized and applied, structuring routines for confrontation with data. A plan of action based on the information from the data collection and review of current literature, will allow the teacher to make a change and to study that change. It is necessary to determine which action is responsible for the outcome. So, it is crucial to develop a time-line to gather evidence (data) to be collected. Evidence includes such methods and tools as questionnaires/surveys, observations (video or written notes), collaborations (video or audio tapes of meetings, peer coaching) interviews, tests, students' portfolios, etc.

Action is central in the teachers' activity, but reflection should be in the core of their professional development. From the interaction between practice and reflection (see Fig.4) in action research, theory informs practice and practice refines theory in a continuous cycle. The ensuing practical applications that follow are subjected to further analysis, in a transformative cycle that continuously alternates emphasis between theory and practice.

Our innovative idea is to use action research in a web-based environment realised through the international collaboration. Expected positive outcomes are targeted in two developmental directions: in-service science teacher training and students' learning of science.

Our study has its origin in the project "European Teachers Professional Development for Science Teaching in a Web-based Environment" (Comenius project - 129455-CP-1-2006-1-PT). Project outcomes are a set of curricular materials for science teachers' professional development in a web-based environment.

ICT–based collaborative action research (ICT-BCAR) in science education is defined and described by modified conditions. Action research is mainly used by one teacher in one class, but can be explored in modified conditions for example by two collaborating teachers, working on-line in two classrooms, in two different countries, using English in addition to home languages, and on-line instruction by use of ICT. An important aspect is that participants in collaborative action research are co-researchers. The principle of collaborative co-researchers presupposes that each participant's ideas are equally significant as a potential resource for creating interpretive categories for analysis, as negotiated among the participants.

Our research produced results that ICT-BCAR offer meaningful and motivational support for the development of professional competencies of science teachers and for the process of students' learning. The "action" factor of action research (see Fig. 4) was ICT-BCAR in action among teachers and students from Portugal and the Czech Republic. This collaboration was intended to upgrade teaching and learning using motivational methods and the introduction of innovative school simple (hands-on) experimentation. Students were involved in the process of learning and were encouraged to play a teaching role with respect to their peers. Two selections were necessary:

(1) Selection of topic and objectives: All science topics are not equally suitable for ICT-BCAR. We used the following criteria for the topic selection: the position of the topic in the curriculum of the countries, the importance of the topic for students' cognitive development, and the level of interest for students. Based on these criteria, the topic chosen was "photosynthesis". In the teaching of the topic of photosynthesis it was agreed between the two teachers that the objectives of the collaborative action research were to: motivate the students to learn about photosynthesis; develop knowledge and skills relevant to this topic; improve the interactions among students, between teacher and learners and, finally, instigate interaction between the teachers.

(2) Selection of students: The factors important for the selection of students were age and ability. The students should be approximately the same age, promoting an interest to collaborate, communicating in the English language and skilled in the use of ICT. Students were selected from secondary schools and 15-16 years of age.

Clearly ease of communication strongly influences the collaboration between teachers and students. To communicate internationally, the teachers and also the students used email, ICQ, Skype, and video-conferencing. The teachers prepared a schedule of their own and their students´ activities for each of the collaborative lessons. In this way the teachers collaboratively developed (in their own language and in English) worksheets, power-point presentations, videos, experiments, learning tasks, etc. Reflection is a very important part of collaborative action research. In seeking evidence they used tests, questionnaires, observations, interviews, portfolios.

The analysis of inquiry outcomes supported the fact that ICT-BCAR offers meaningful and motivational support for the development of professional competencies of science teachers and for the process of students' learning. As example of the research results we present only those based on the questionnaires [8] (Tab. 2):

Table 2. Questionnaires results

Do you believe that the online environment influenced your performance and learning? N =27/21	
Yes	89% / 90 %
No	11%/ 10 %

In the statements listed below are some of the aspects related to the activities shared with your Czech colleagues. Choose the option which best expresses your opinion.					
N=27/21	***Disagree***	***Partially Agree***	***Agree***	***Strongly Agree***	***No opinion***
The partnership helped you to better understand certain aspects on this topic.	*7%* *0%*	*33%* *29%*	*42%* *47%*	*14%* *19%*	*4%* *5%*
You would have achieved the objectives of this topic better by interacting only with your classroom classmates.	*33%* *29%*	*52%* *29%*	*4%* *29%*	*4%* *0%*	*7%* *13%*

4. Hands-on activities in ICT-based collaborative action research

Two main barriers in promoting the use of innovative science education technology were identified: the efficient dissemination of information to teachers and the motivation of teachers to learn and use innovative science educational technology. ICT-BCAR is a start towards alleviating these barriers by improving the familiarity of use of ICT for collaborative work with other teachers and students across the world. Our new core idea is to use action research in a web-based environment realised through the international collaboration of science teachers. Expected positive outcomes are targeted in two developmental directions: in-service science teacher training and students' learning of science.

Our innovations in action research lead to the emphasis on hands-on experiments. There is a methodical link between hands-on activities and action research. Hands-on activities we simplify as "learning by doing". Action research we can also assume as an analogical "education by doing". The main actor of action research is the teacher, who "is doing" the new "action" to discover an innovative method in education.

Hands-on activities can be applied as the changed parameter in action research in science education. The using of ICT provides an additional good opportunity for the dissemination and upgrading of new hands-on activities or unknown variants of these activities amongst teachers. It is proposed that a web-based environment can provide a very effective technology for initiating and substantiating science teachers' collaboration. Our study used the benefits of an ICT environment to change the normal conditions of implementation of hands-on activities.

We achieved collaboration between Portuguese and Czech students. We divided them into collaborative groups using of ICT technologies. Students implemented hands-on activities in the web-based environment. We created several types of the applications in school science education:

(a) On-line implementation according to peer instructions: Some hands-on activities were implemented by one group of students according to the instructions of the second group through Skype.

(b) On-line joint implementation: Some activities were done by both groups at the same time together and they consulted about their results.

We present examples of these two applications of hands-on activities into ICT-BCAR:

(a) On-line implementation according to peer instructions which was implemented by Czech students according to the instructions of the second group of Portuguese students using Skype. The Portuguese students performed role of teachers. They had to prepare peer instructions, they created and tested a hands-on activity at first and they studied the theory of photosynthesis to be able to explain it. The Portuguese students prepared the below mentioned procedure of the hands on activity.

Pigments in plants

Procedure:

1. Put in a pestle 20 grams of fresh leaves of the plant selected and add a small amount of fine sand.
2. Crush the leaves with the aid of mortar, gradually adding 50 ml of alcohol. Mix. Record the colour of the solution (see Fig. 5).

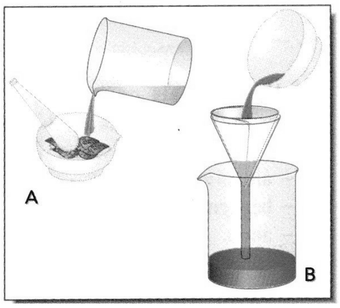

Figure 5. Scheme of procedure

3. Filter the mixture to a beaker, throwing away solid waste in order to obtain "crude chlorophyll."

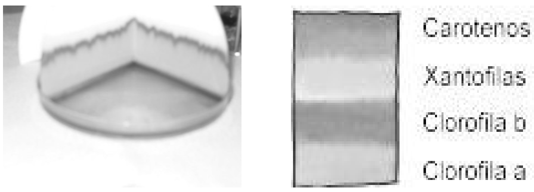

Figure 6. Chromatography

4. Place the filtrate of a Petri dish. Introduce a rectangular piece of folded chromatography paper, as shown in Fig.6.
5. Wait 15 minutes and observe.
6. Using pencils make a diagram that describes exactly what is shown on the paper.

Examples of students´ discussion on-line using Skype after implementation of the activity:

A Czech student asked: Why did you crush the leaves?
A Portuguese student explained: It is necessary to extract the pigments found in the thylakoid membranes of the chloroplasts.
A Czech student asked: Why is alcohol added?
A Portuguese student explained: Alcohol is used to extract the pigments from the leaves.

According to our findings (observation, questionnaire, pre-test and post-test) both Czech and Portuguese students were motivated very much and they learned more in comparison with usual lessons (see Fig. 7).

Figure 7: Czech students on Skype

(b) The on-line joint implementation had the form of activities which were done by both groups at the same time together and they consulted each other about their results. The Czech and Portuguese students put plants in a dark place on the same day. They implemented the hands-on activity described below. They communicated during their work using Skype, e-mail, they consulted and helped together. All groups took photos for documentation. At the conclusion of the hands-on activity all groups of students presented their results by means of video-conference.

Starch formation and photosynthesis

Procedure:

1. The watered plant is placed somewhere dark, e.g. a cupboard, for 3 days.
2. After removing the plant from the cupboard, cover some leaves with dark paper or aluminium foil and hold it in place with paper clips. Cover some leaves with dark paper and aluminium foil with a shaped hole in the centre. Envelopes must be placed over both sides of the leaves, and the edges of the hole must be fastened so that light only reaches the exposed part of the leaf.

3. Expose the potted plants to sunlight for a day.
4. Cut 3 leaves: one which was completely covered by aluminium foil or dark paper, one which was covered with aluminium foil or dark paper with a hole, one which was uncovered.
5. Place each leaf in the boiling water for 1-2 minutes or until soft and limp.
6. Prepare a water bath and put it inside a beaker with alcohol and heat it gently until boiling. Introduce the leaves one by one in alcohol until they become whitish in colour, and then immerse them in cold water.
7. Put a little iodine water in three glass (Petri) dish. Spread out the leaf. Wait a few minutes for colour to develop.

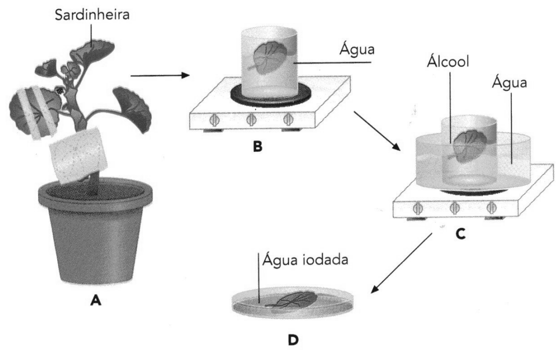

Figure 8. Scheme of procedure

Based on our findings (observation, questionnaire, pre-test and post-test) this method of explanation was very effective and motivational for students and teachers as well.

5. Conclusions and implications

We have presented an innovative method for how to improve science and technology education by ICT-BCAR in a web-environment and by use of international collaboration between teachers and students. Our research supports the notion that ICT-BCAR is important for upgrading science teaching and learning.

The main advantages of ICT-BCAR for science and technology education are [8]:
1. Strong motivation of students and teachers especially by communication with colleagues in other countries, new information, applications of knowledge from abroad, personal contacts etc.
2. Exchange of experiences between teachers (teaching methods) by comparing curricular material (textbooks, learning tasks, experimentation etc.).
3. Inserting of new educational methods based on research by teachers' application of action research monitored by educational experts.
4. Acquisition of subject knowledge and skills.
5. Team collaboration among teachers inside the partner schools (support with ICT, English, organisation of lessons etc.).
6. Team collaboration among students within the partner schools (support with ICT, organisation of lessons etc.).

Action research in a web-based environment and hands-on experiments can be a very effective technology for science teachers' and students' collaboration leading to improvement in science and technology education. Such innovations of teaching/learning methods should contribute to bridging the science and society gap.

6. Acknowledgements

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POSTER
MOSEM Project – Experiments on Magnetism, Electromagnetism and Superconductivity

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Abstract. *The MOSEM project aims to promote lifelong training of active science teachers at the upper secondary level, in order to update them with modern pedagogical principles for learning physics. It also aims to furnish school laboratories with simple experiments on magnetism and electromagnetism as well as experiments on modern applications of superconductivity. The involvement of top-level national universities, working on didactics methods, will assure teachers with experimental kits and knowledge through a wide pallet of methodological skills based on active learning. Main outcomes of the project are: low-level kit, high-level kit, teacher training seminars, photo and video database of experiments.*

Keywords. Electromagnetism, Experimental kits, School experiment, Superconductivity, Teacher training.

Economic estimation of the benefits from the protection of the long Anastasian Wall

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Abstract. *The paper outlines the basic methodological and practical problems concerning the benefits of the protection of the long Anastasian Wall located 65 km on the West of Istanbul, Turkey. The author indicates the principles of applying cost-benefit analysis for this case and the necessity of complex approach to the problem. It is expected that such an approach would reveal benefits, which considerably outweigh the costs of conservation works. A system of such complex valuing is presented based on estimation of general economic value and its attributes. The conclusions from this paper can be used as an argumentation for raising funds for further more detailed research and conservation works*.

Keywords. Economic benefits, Contingent valuation, Cultural-historic monuments, General economic value.

1. Introduction

The cultural-historic heritage in the Balkans is huge and unique composed by many civilizations constituting great contribution to the world culture. It includes original folklore, numerous historic monuments, rich written materials left from the Thrace, Slavonic and Ottoman cultures and a lot of other documents playing important role of formation of the modern culture of the Balkan states.

Monuments of great cultural significance of the world history are located on the territory of the Balkans. Many of them were destroyed over time, others survived many centuries. Now most of them are object of intensive tourists' invasion, which have controversial effects on their physical state. In all cases however there is a need of costly conservation works, which faces the financial restrictions of mobilizing the necessary funds.

For most effective use of the restricted resources there is a need of ranking the restoration works. Economic science since a long time tests various methods of valuation. The present paper is an attempt to overcome some of the principal drawbacks of valuation procedure and to propose new alternative for consideration. We leave cost side of the problem for other discussions. The long Anastasian Wall is an excellent case to illustrate the problem [1].

2. The Long Anastasian Wall and its present state

The period of construction of the wall was time of high pressure over the Byzantine Empire from almost all frontiers. It was constructed urgently to protect the rich capital Constantinople from the Western invaders [2]. 512 AC is regarded as a birth year of the wall.

This unique for the late Antiquity surrounding was abandoned after about two centuries and gradually disappeared. Now one can observe only some remains from the long almost 56 km wall [3]. This is however sufficient to turn the area into an object of cultural tourism. A profound estimation of the costs and benefits of such initiative is to be carried out. The present paper can be regarded as the first step in this direction.

The long Anastasian Wall undoubtedly is one of the most unique architectural buildings from the late Antiquity [4]. It is stretched between Marmara and Black seas in an area, which now is important ecological reservoir of the region. This is one additional argument in favor of initializing of conservation works and turning the whole area not only into an object of cultural tourism but also in protected zone with restrictions of any activity, which could harm the ecology of the region. This would protect the wall at least in the state it is at present.

3. Methodological background of the study

The application of the principles of cost-benefit analysis for the protection of cultural-historic monuments has already accumulated good experience [5]. The basic argument of using these principles is that the resources for restoration are very restricted and there is a need of ranking priorities with funding these projects, which have highest efficiency. Although there is some impression that valuable historic monuments may remain outside the conservation work due to the myopic of the economic assessment, this is not necessarily true.

The economic consideration of the benefits from protection is based on the consumer surplus created by the objects of estimation. The neglecting of some valuable historic monuments can take place only in cases this consumer surplus is underestimated, which is very common problem. Regrettably the economic theory has not yet prepared very distinct vision about the benefits estimations and juxtaposing them with the corresponding costs. In many cases this is practically difficult due to the uniqueness of many cultural-historic monuments and the access to them by a broad audience.

The common assessment procedure is based mainly on valuing elements of so called total economic value regarded as a sum of several sub-values estimated as various consumer surpluses created by the object of estimation. We leave the critics of this approach for other discussions.

Our starting point in understating the benefits is the idea of general economic value expressed in terms of willingness-to-pay (WTP) for a given good. Following the logic of economic science every good as soon as it is regarded as economic good possesses a given WTP by the side of its consumers. Lancaster theory of attributes [6] however showed that as a matter of fact consumers buy the good not per se, for its general economic value, but for its attributes. Thus, if we would like to have more complete picture of the value of goods we have to analyze the general economic value together with the WTP for its attributes. Valuing cultural goods is difficult to put into this scheme. Most of these goods are public, with restricted access to some of them. Subtracting the real WTP from their consumers is not an easy task.

Which are the attributes of cultural heritage for which the customers (actual and potential) would be willing to pay? We can outline several basic attributes. They are named values in economic theory although as a matter of fact they are various attributes of the same good.

We start with the benefits not connected with the direct or indirect use of cultural heritage, but with the fact that this heritage exists and can be used later. This is extremely important aspect of the benefits as it gives the most general possible estimation of the benefits synthesizing the whole lot of tangible and intangible attributes into a single estimation expressed as WTP.

Two aspects are important in this issue. Cultural heritage creates some general benefits, that is, benefits as a whole from the very fact that the cultural heritage (cultural-historic monuments in our case) can be visited any time we would like to. This is like a fruit, which we can consume any time we would wish and the benefit of it is created by the option that it exists. We call it general economic value, which is close to so called option value in the literature [7], [8]. In such a way we receive a general picture of the benefits, without the necessity of looking for other information, which often is impossible to receive. The consumer surplus created by the monuments absorbs all the benefits of them by expressing the willingness to pay of the real or potential visitors.

Similar to it are so called non-use benefits created by the fact that they also originate consumer surplus. It comes from the expectations that we may wish to preserve the cultural heritage for our children and the next generations or just to know that it exists (that is something different from the general economic value, when we just postpone the opportunity to use some of their attributes now or later). In this case we distinguish between two kinds of values: **bequest value** - the respondent may have no intention to use the good, but may be willing to preserve it for the future generations thinking basically of his/her children and their children, etc. and **existence value** - the benefit emerges from the very fact of the existence of the heritage, understanding or intuitively perceiving their multifarious importance.

Finally some returns can also come from the forgone benefits connected with cost avoidance and the opportunity costs of the location of cultural heritage.

In summary all benefits of cultural heritage can be presented in the following scheme:

TEB = UV + GEV + NUV = (DUV + IUV) + OV + (BV + EV), where

TEB – total economic benefits

UV – use value, including

DUV – direct use value

IUV – indirect use value

GEV – general economic value

NUV – non-use value including

OV – option value

BV – bequest value
EV – existence value.

It is very important to note that TEB is not a mathematical sum of all components; it just expresses that the total economic benefits consists of use-value, general economic value and its attributes (non-use values).

We have to underline the difference of our value considerations in comparison with other authors. Our aim is not to produce integral indicator of value, which in our opinion is not possible for cultural heritage at least at the present stage of knowledge. Our model integrates various attributes of value around its general economic estimation. In our next discussion we will concentrate on valuing historic monuments, as they are the most endangered part of cultural heritage. The conclusions from this study can be extended to the rest of the cultural heritage. Thus we are preparing scheme which will sum up the biggest part of the benefits of the cultural heritage in economic terms in two groups: use values and non-use values, which complement the general economic value of cultural heritage.

4. The results of empirical studies

A project for complex estimation of the costs and benefits of the protection of cultural-historic heritage on the Balkan area was initiated, part of which is the estimation of the benefits from the protection of the long Anastasian wall located on about 65 km from the biggest city in the area – Istanbul.

This can be regarded as a continuation of the initiated during the 1990's study on the valuation of the benefits from the protection of Bulgarian monasteries in the initial stages on the transformation process, when the everyday needs for survival could blur the value of cultural heritage. The project funded by the EU PECO program was coordinated by CSERGE-UCL, the UK and included interviewing of 483 Bulgarian citizens from 17 cities and towns. The results of this study have been published in a collective monograph on valuing cultural heritage [9].

This study allowed drawing important theoretical and practical conclusions, which have been tested in the next studies. This facilitates now strongly the organization of the study on estimation of the public interest in the conservation of the long Anastasian Wall.

As a starting point interviewing of local population was initiated with the ambition to extend it to other Balkan countries. At this time 158 interviews have been collected, which can be regarded as a good initial position. The construction of the questionnaire and the training of the enumerators have been carried out by the author.

The sample is not representative, but in the following stages we plan to tighten the interviewing following the restrictions of the quota control. As criteria for this control we use education, age, gender, place of living and working experience. The choice of these criteria is motivated by the results of our past observations. They indicate that normally the attitude to the protection of cultural heritage differs depending in bigger degree on the indicated above criteria than for example on such indicators as income, origin, religion, etc.

Due to space restrictions we report only part of the results. The first question we have been interesting in was the level of awareness of the wall. Surprisingly few people know about it. Only 2.1% of the respondents pretend to know it very well - most of them live in the area close to the wall. On contrary 32.5% of the respondents have not heard about it, 18,1% have some idea about it, 35.1% have heard about it, and 12.2% have some information about it.

Next the survey includes questions as should cultural heritage by protected with almost 100% of respondents supporting it despite the culture they belong to.

The most difficult part of the survey is the extraction of general economic value and its attributes. It is too early to comment the results as this is only the start of the interviewing, but even these preliminary steps show that the social support in favor of protection will be high.

Of course we need to take into account the fact that the interviewing takes place in Istanbul, which is a center of many cultural-historic monuments of global importance. Besides, there is high economic and social upheaval in the country during the last ten years. It naturally creates preconditions to higher WTP for the cultural-historic monuments than in the rest of the Balkans.

This however may not be necessarily true. When for example the Bulgarian study on the monasteries was initiated, the interviewing took place in the riots period in Sofia and the big cities. Taking into account the situation we anticipated low or even zero WTP for the monasteries conservations. Contrary to the expectations however people gave high vote to the conservation declaring unambiguously the needs of their protection despite the crises.

This is an indication that the attitude to such objects as cultural-historic monuments is formed as result of endogenous preferences. They are stable, have deep roots in the humans' minds and are not strongly influenced by the market conditions. The WTP in terms of constant prices varies slightly over time and is normally strongly correlated to the income. For this reasons even a small group of respondents may give information very close to the results of the representative study.

The estimation of the general economic value is however not sufficient to reflect the overall benefits coming from the conservation of the wall. There are many secondary effects, which have important influence on regional development. Examples are so called development benefits, which include the benefits from research activity of cultural monuments in terms of producing new knowledge about the history and national culture. It would increase the regional R&D potential and create additional employment for the local population both in highly educated specialists and in services.

There are also benefits from organization of scientific meetings in the area of cultural monuments using the created hotel capacities as a nice venue for discussing. It would create additional payments for the hotels. Finally there are definite benefits for the educational activity as it would allow initiating of training courses for the young generations in various disciplines of historic and cultural knowledge and particularly in the significance of the cultural monuments.

Increased level of knowledge about their sustainable use potentially reduces the relative cost of supporting the cultural monuments. It would stimulate their sustainable use, the better understanding of their cultural importance and preventing any damage during their visits.

Finally we should mention the induced benefits from increased demand of goods and services in the adjacent areas as a result of visiting the area. It includes a broad spectrum of goods and services produced as a result of activities related to the direct use of the cultural monuments and their resources: new kinds of food, beverages, entertainment, etc. Producing movies in the cultural monuments areas is a good example of induced benefits as a result of expected increased demand for their visit and potential benefit of their conservation.

The induced benefits of the cultural monuments are enormous and they should be subjects of separate study. Some of the induced benefits are actually forgone benefits of alternative uses of resources.

The long Anastasian wall as the other cultural- historic monuments located on the Balkan territory produce global benefits as there are significant parts of the world culture. These facts can be used as a persuasive motivation for the search of financial support for the conservation works by various national and international sources.

The interviewing also included the way the funds for the conservation work should be collected. For technical reasons this discussion remains for other presentations.

The interest in the wall is increasing also in connection with the 1500 anniversary of its birth date. Anastasian Wall Research Community [10] has been organized with open the door for broad social discussions of the necessity to undertake conservations work to protect the wall from further deterioration.

5. Acknowledgments

I owe a lot for the preparation of this paper to the project **“**Managing human capital for the aims of sustainable development (case study of some Balkan countries**)**" supported by the Scientific Research Fund of Fatih University under the project number P51010901_1. Although not directly oriented to the topic it allowed collecting valuable information for the theoretical explanation of the endogenous motivations for the WTP for cultural monuments generalizing the effect of the human capital accumulation. We express our thanks for the ability to use this support.

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Demonstration of the Hands-on Experiments
Introductionary lecture of the cross-media textbook on Economics of Culture

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Abstract. *The introduction of cross media in education is a new promising experiment aimed at adjusting the modern technologies for better understanding of knowledge by the young generations. The modest practice already indicates that when properly organized it can contribute significantly the clearer perception of the teaching material. This is especially useful in the courses which have cross-disciplinary application. Economics of Culture is one among many examples. It is part of so called process of humanization of education, aimed at acquainting students with the global dimensions of human behavior, habits, and traditions for better awareness and overcoming of barriers of communication created by the cultural differences. The paper presents the introductionary lecture of the Economics of Culture course as a part of the project of cross-media textbook and comment the technology of its preparation.*

Keywords. Economics of culture, Culture as a good, Economic principles, Public Economics, Welfare theory, cross-media.

1. Introduction

The presented paper is a short version of the introductionary lecture of the textbook named after Economics of Culture to be published after it passed tests with students. It includes the discussion of the following topics:

1. The technology of our joint work or how to have high grade in our classes.

2. What is Economics of Culture? The Origin of Economics of Culture. Culture as an economic good.

3. Basic principles of analyzing economic problems of culture: ceteris paribus, comparative statics. Rationality. Decision makers: household, firm, government.

2. The technology of our joint work

This is the first problem which I discuss with the students when new lesson starts. In my opinion the good economist (and not only he) always is comparing the benefits and costs of a given activity. It means that since the very beginning the students must know what they can expect from the instructor as knowledge and what they should demonstrate on the exams to prove that the knowledge that has been given to them is properly and critically worked out.

As I normally teach foreign students instead of explaining who I am and my origin I show my CV in picture fixing the most substantial moments in my academic carrier.

In the Istanbul campus of Fatih University where I am teaching the last 10 years there are stairs we cross almost every day when we visit our library, cafeteria, and sport centers. These stairs are very good illustration of the road the students and me have to pass during the semester. To grasp with this metaphor better I prepare a short video where climbing up and down I explain the basic stages of our joint work during the semester.

I compare this work with various sport disciplines in which the sportsmen are to collect scores for the final classification. This metaphor is a good illustration for the estimation of the students final results as I give the grades for groups more than 10 -15 students on a relative bases using special distribution calculated by Excel file. In such a way the highest grade is given to the students which first reach the final line that is which collect maximum scores during the semester.

2. Methodology of the study

Teaching in universities, where the students groups were composed by representatives from many countries with various levels of English understanding I came to conclusion that often they spent a lot of time in preparing their lessons due to the fact that the new knowledge was presented in a language, which was different from their mother language. So called "mother" effect of learning can be observed even in students with high level of proficiency in English especially in social sciences. Often in these courses there are many abstract categories, difficult to understand when they are presented not only in perfect English, but even in the native language of the students. This is the one side of the problem.

The other motivation to initiate a video-textbook on Economics of Culture is that this is a topic neglected into the university curricula. The pumping students in Economics with mathematical formula, undoubtedly necessary in our age of intensive information exchange, starts already to produce inverse results. The students forget that their object of study is society and living people with their everyday troubles and needs and start thinking of society in abstract mathematical terms far from reality. This is a dangerous indicator. But it is results of our teaching activity, when unintentionally we try to turn our object of teaching from social to such an exact science as mathematics [1].

The attitude to the inclusion of mathematics in social sciences is often controversial. Mathematics is mainly instrument for modeling, for simplification of the complex social problems into linear and non-linear scheme to capture the essence of the problem. Even the application of the most up-to-date dynamic stochastic approach is often not sufficient to grasp with the essence of the complexity of social life.

With this controversial background the presentation of the introductionary lecture of Economics of Culture in a new form is definitely a challenge. I would be very happy to observe and discuss the reaction on this challenge for finding the best way to reach the minds of the students and by means of my lessons to help them to cope better with the complicated life they have to live in after their graduation. My belief is that studying economic issues of culture would contribute to it.

This is emphasized in the introductionary words of the lecture. After it I present the structure of the proposed course and explain the needs of such studies. Next the lecture gives short overview of the basic categories envisaged for discussion in the course. Our experience indicates that the best educational effect is reached, when the lectures (45 – 50 minutes) are presented in PowerPoint slides with inclusion of no more than 2 -3 video illustrations of the most essential and difficult problems with duration maximum to 3-5 minutes. This makes the lecture dynamic and capturing interest even of the least motivated students. This is actually the logic, on which the whole course is constructed.

2. What is Economics of Culture?

It is traditional to start the lesson with explanation of the quintessence of the course. Correspondingly I explain what it is aimed at and what the advantage for the students to pass it is. "Cultures do not change overnight" [2] and this is what the students need to know since the very beginning.

First we need to define what culture is. Several alternative definitions are presented to the students. Culture is defined as "the total way of life shared by everyone in the same speech community" [3], "the cultivated behavior; that is the totality of a person's learned, accumulated experience which is socially transmitted, or more briefly, behavior through social learning [4].

Correspondingly the Economics of Culture is part of the economic science which aims are to explain the economic dimensions of culture and its effect. Looking on Economics not only as some summation of numbers but as a science to explain the behavior of the economic agents we extend the scope of our discussions including in them the roots of culture, its non-monetary dimensions and global significance. Essential elements in these discussions are the economic assessment of costs and benefits of any action related to culture. In particular we try to explain the category "consumer surplus", which is basic in the valuation of benefits from the protection of cultural-historic monuments. It is not difficult to imagine how important such discussion even for non-economists is as it opens the eyes to understand how we should spend our limited resources dividing them between cultural and non-cultural goods.

The introduction of Economics of Culture courses became feasible after some evolution in the methodology of education. It took time to understand the importance of culture to the socio-economic development and to include this issue in the academic curricula although this was a topic discussed even before the time of the classical economics. Few examples are sufficient to illustrate the present recognition of the link between culture and development at all levels.

Explaining the analysis of household – the initial elements in discussing Economics Chowdhury [5] indicates that "A household is never a complete entity unless the cultural context is taken into account but models fail to integrate these aspects in the description of households". Dubhashi P.R., [6] writes that "cultural norms, in addition to markets and governments, turn individual choices into collective action".

Many universities have made substantial contribution in cultural economics studies, which helped to outline the course and define its basic categories. CSERGE – the Center of Social and Economic Research on the Global Environment at the UCL – London carried out during the 1990s pioneering works in this direction [7] by publishing studies allowing to complete the course of Economics of Culture with valuable sources and ideas.

Two directions of studies are interesting for the further discussion: turning culture into business or culture as economic good and cultural dimensions of business illustrating "how difficult it is to disentangle "economic" from other cultural categories in "economically relevant practices" [8]. It was the reasons to concentrate since the very beginning of the explanation of culture perception as an economic good.

3. On the nature of culture as economic good

Culture and cultural products are very specific kind of goods combining properties of private and public goods. In this aspect they can be regarded as part of Public Economics analyzing normative aspects of social life.

A good way to present the discussion of the culture as an economic good is to use the popular in Public Economics classes scheme of the transition between private and public goods presented in figure 1.

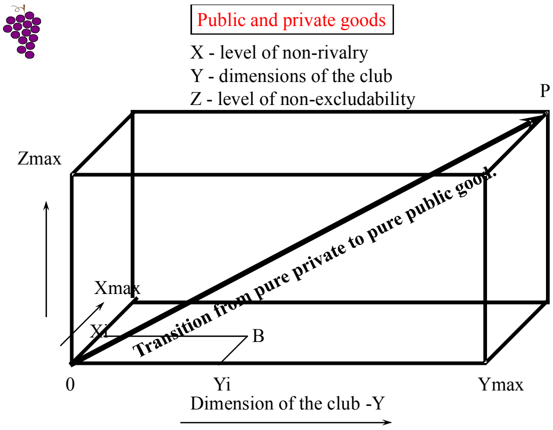

Figure 1. Private and public goods

This scheme allows explaining excludability and rivalry as important features of culture as economic good. Besides it combines the problems of congestion and aggregation which makes it attractive educational instrument.

4. Basic principles of analyzing economic problems of culture

Economics of Culture is part of Economics and as such it follows the logic of economic studies and approaches. As we explain to the Economics' students such fundamental principles as ceteris paribus, comparative statics, rationality so we need to put in the core the same elements in our Economics of Culture classes. This is very important as being elective such course may be the only source of economic knowledge for non-economists. On the other hand if this course is presented to students in Economics it would allow repeating these fundamental questions from other perspective illustrated by such unusual goods as culture.

Taking into account the difficulties in understanding these categories even for students in economic departments we use illustrations with suitable short video clips.

We would like to introduce an Economics of Culture course as related to the normative economics that is the economic in which we not only describe the problems but also indicate the alternatives for their solution. This approach opens the door to the Welfare Economics and Pareto optimality approach to explain the reallocation of resources between cultural and non-cultural goods. This is approach applied in Public Economics and Economics of Culture may be regarded in some aspect as part of it.

This gives the opportunity to present the allocation of resources in the whole economy between cultural and non-cultural goods starting with a given endowment. By means of the well-known Edgeworth box the students will find out the theoretical base of the trading process and optimality in re-allocation of resources taking into account social preferences. Jumping deeper into the Economics water they may find out the link between Pareto optimality and the competitive markets by means of both theorems of Welfare Economics.

In the next last part we explain the role of decision-makers in the creation and conservation of cultural goods starting with the household and ending with the government as economic agent in the distribution and allocation of resources. This opens the door to present to the students such fundamental economic topics as utility maximization of consumption by the households including discounted cultural goods consumption. The last merit of this introduction is the put the fundament of theoretical discussion of the cultural policy as a part of the overall economic policy on government level.

Very important for the success of the course is certainly the interest of the students in its election. To attract them normally I put a short introductory clip in my website where the students see what they can expect from this course as knowledge and which are their obligations to receive high grades. In our pragmatic world this works well but even such seemingly eye-catching measure is often not sufficient to attract the interest in studying economic problems of culture. Students as a rule prefer financial and international issues. The reason is in the misunderstanding how important is culture for our progress and successful development in future. This drawback of the modern education is common for almost all universities all over the world. Our attempts are to break it and to make the perception of culture as such a necessary good as bread and water.

5. Acknowledgments

We express my thanks to Fatih University – Istanbul for the ability to test the Economics of Culture with our students and also to the Pearson education representatives for their supportive role in my endeavors.

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Educating students by means of cross media (Case study of the protection of cultural-historic monuments)

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Abstract. *This discussion puts on the agenda one very important and principal problem for the educators in social sciences – how "social" is our social sciences education. Formulating in details it means "Do we really use the advance of approaches and methodologies in the modern social sciences to train students in better understanding of our complicated world, or we prefer the easy-to-present standard models, which create abstract schemes in the students' minds very far from the problems they are to face after the graduation". Obviously both are needed. In this sense the workshop is only part of a more general discussion about the need to increase the "human" elements in our social sciences teaching. Among the other things it means that students, which receive high education diploma have to be aware also of such fundamental problems as the role of moral, ethics and culture in socio-economic growth and development. The cultural-historic monuments protection is only a small part of this process.*

Keywords: Educational curricula, Cultural-historic monuments, Culture, Visualization.

1. Introduction

Taking into account the present state and advancement in the education methodology the necessity of a workshop devoted to cultural issues is obvious. The discussion of the protection of cultural-historic monuments is only part of it. There is a need of more systematic knowledge of the importance of the protection of cultural-historic monuments not only because our area is very rich with them, but as there is an increasing understanding in society of the role of culture for further progress in development.

The workshop on applying modern technologies in education illustrated by the protection of cultural-historic monuments is aimed at initiating a general discussion going beyond the conservation and restoration works and spreading to the inclusion of the cultural issues in the educational curricula. Many studies have already unambiguously indicated the strong positive role of culture in socio-economic development interpreted in a very broad sense [1], [2]. The protection of cultural-historic monuments is only one illustration of the problem. There is a need of creating of system of knowledge providing understanding in the students about the role of such factors as trust, moral, ethics, culture and other "forgotten" elements of the classical education, which play very important role on micro and macro levels of decision-making process.

In this sense the discussions are envisaged to shed light on teaching students in broader than at present "human" factors of the modern development. This is postulate, which refers not only to the students in social sciences; the other students despite their professional orientation also need clearer vision about the world they live in. It puts to the fore another educational problem: introducing social knowledge in "non-social" sciences.

Indicative in this sense were the archeological works on the discovering of the remains of the long Anastasian wall in the area of Istanbul [3]. Gradually the team involved in this work extended their study trying to analyze the wall in the context of the socio-economic setting of that time and to outline the complex of factors enforcing the Emperor Anastasias to build the wall. The students thus received a broader vision on the origin and functions of the wall, which allowed them to make a bridge with the present. This seems to be the basic educational contribution from the protection of the cultural-historic heritage in our area, which is one of the richest in the world.

2. Methodological background of the study

Any educational study at the present stage unavoidably includes the problem of the media involved in it. This is due to the fact that a big progress has been made during the last decade in creating software allowing easy access and processing of information which earlier was admittance only to the specially trained staff. The inclusion of these technologies into the educational process is not a question of a fashion. It makes sense to include them only if they contribute to increase the educational effect of the materials the students are to grasp with.

By educational effect (EE) we mean the efforts for good understanding of the taught material when media is involved to the same efforts without the media. The criteria for selection of the media for further teaching is EE > 1. In case EE is equal or close to one we are indifferent to the application of media, in case EE < 1 there is no sense to apply the media.

Intuitively one can expect that the application of media should always have high educational effect especially for students for which English is not a mother language due to purely natural conditions. Visual perception is the most efficient than all other insights. There are many connotations in this process. Hunt [4] indicates "the uniquely decisive influence" of media, Robinson [5] recommends expanding values in professional presentations and calls for the development of critical standards in the media.

On the other hand we have to underline the increasing need of "socialization" of education born by the present crisis of values in the modern societies. It increases the need of including into curricula problems as moral and ethics and their role in development, the role of culture, etc. or to introduce special course devoted on these issues.

The last goal is very broad and includes many objectives. The problems of culture are very closely related to the problems of moral and ethics and often it is impossible to decouple them. As Fischer [6] indicates "the challenge of cultural analysis is to develop translation and mediation tools for helping make visible the differences of interests, access, power, needs, desires, and philosophical perspective". This makes education of culture tremendously difficult and responsible activity. To rich maximum effect the education of culture needs various approaches depending on the future specialization of students. Teaching culture to social science and engineering students is not the same, but there are many common elements we try to reveal next. It is well illustrated on the case of cultural-historic monuments.

3. Technological problems of applying cross media in education

At the preset stage there is a huge advance in media technology than some 10 even 5 years ago. Adobe CS5 complex, Autodesk new 2011 suites, Avid 5 advancements, etc. are only few examples. The progress in this area goes far before the evolution of the educational thinking which is traditionally conservative. The reduction of this gap is very difficult as the visualization of education is a question of personal choice of the educator. Besides it requires mobilization of additional investment in education for the creating of the necessary material base and training of educators how to apply the new media instruments. The solution of the second problem is more difficult as it requires new culture of teaching which is related to the changes in the professional status of the educators.

The observations of the applied media in the educational process show increasing application of PowerPoint's presentations. At present this becomes almost international standard for various presentations. This has very big advantages for both students and teachers as it allows exposing the plan of the discussion supported by diagrams, schemes, etc. visual materials.

Much more modest is the application of the cross media and namely the video illustrations although it is intuitively expected to have much higher educational effect in comparison with the other media devices. First this is completely new area of educational technology and there is not yet sufficient experience and second this is principally new technology which requires essentially innovative approach. When we add to it the much higher expenditure and time involved to prepare good quality video illustrations it becomes clear that this is really a difficult task. As this is a pioneering work at the present stage it needs not only good funding but enthusiasm and motivation to introduce it.

The observations of the applied teaching materials show that most of the educators are using them as some substitution of what they explain during the lessons. Most of these materials are just recording the lessons which allow students to see them outside the classrooms. Often they are accessible by Internet. Despite the interest in applying this type of teaching, it definitely has low educational effect. Most of students regard it rather as a boring device and in many cases prefer to obtain their knowledge from such a classical source as the textbook.

This comes for the wrong understanding of the role of media in education – it has not substitution but complement effect. Its aim is not to replace the teacher for a given moment but to visualize some of his ideas or by means of images to make the materials more understandable for students. Teacher and media are part of the same process – teaching. From purely visual reasons the appearance of the teacher in the video materials may be more than redundant – rather the illustration should show examples or metaphors making the complexity of the discussed problems closer to the students' minds.

4. The results of empirical studies

During the last decade serious experimentation works have been done to apply cross media in various lessons with students for most of which English was not a mother language. They have been interviewing about the educational effect of this media during their mid-term exam (the questionnaire was attached to the exam papers explicitly indicating the voluntary character of the interviewing) and the results have been processing by SPSS software.

The following media has been experimented:

- PowerPoint slides. This is already a standard in the educational process as if properly organized since the very beginning it has very high educational effect. These slides are used for the overall presentation of the lecture and this is already established practice in many educational institutions.

- Records of presentations of high professional experts on the issues of discussion. Simple recording however is not sufficient if the video-materials are not edited with inclusion of suitable illustrations.

As a whole the attitude to such type of teaching is positive. More than 90% of students approve the applying of PowerPoint presentation provided the slides are prepared professionally. Negative attitude is expressed when the slides are overcrowded with information, when they are white/black and they repeat the words the teacher is speaking during the demonstration.

The inclusion of video illustrations into the teaching process significantly changes the situation. Initially it increases very much the interest in the lessons as something new and unusual. This is very responsible moment to attract the interest in students and motivating them to profound knowledge. The aim is to move education from informative to creative process in which ideas are generated. The well-prepared video- materials increase this motivation especially when students are involved into its preparation. It means not so much direct participation into the script or editing process but some short discussion of the quality of illustration and the critics to it.

Related to the teaching of the protection of cultural-historic monuments there was a problem in which courses it can be included. Initially it was a part of Environmental Economics classes within the cost-benefit analysis discussion, while gradually a specialized elective course of Economics of Culture curricula has been elaborated and proposed to the students' attention.

Understanding the location of our study all students support the idea of protection of cultural-historic heritage. Very high is also the level of approval that this would have positive effect on the regional development. The global benefits of this protection also have positive values.

The discussion of the protection of cultural-historic monuments is included as part of costs-benefits discussions with illustration of the whole complexity of such assessment. Due to this discussion students receive practical understanding of such important theoretical categories as compounding and discounting, shadow pricing, various forms of values, etc.

Important is also the systemic character of the presentation of regional stock of cultural-historic monuments, their state and the needs of conservation/restoration works. Although this is not new information for most of the students such systematization allows more precisely addressing the problem of priorities in funding the protective works.

There is also another aspect of the problem. As a rule the students groups consist of representatives of various cultures and cultural differences are often substantial barrier for good communication. The discussing of issues as the protection of our common heritages helps to reduce strongly the restrictive effect of cultural differences and to reach more homogenous effect on the perception of the problems without losing the individuality of the views.

As a whole the educational effect of the introducing of cross media in education is high although it is expensive and time consuming work – it makes sense to introduce it providing all other conditions for good teaching are available – suitable classrooms, light, atmosphere, etc. Even when ready cross media is used it requires serious training. The instructors which expect to reach high effect in the beginning are to be disappointed – it takes considerable time of individual training to be able to cope with the techniques without having troubles with the lessons.

The teaching of the protection of cultural-historic monuments in particular is not an easy process also for many other reasons: there are not yet sufficient teaching materials; the place where to include this topic into various curricula is also debatable. The optimal solution seems to be the introduction of Economics of Culture elective course oriented to broad audience supposed to include students with various interests and specialization. This seems at least the easiest solution in the beginning. As however Jernigan [7] underlines "the problem of not teaching culture has more to do with lack of training in teaching culture".

In conclusion it seems now is just the time to initiate discussion of the introduction of cross media in education due to many reasons. The educational process has reached sufficient maturity, in the era of Internet we need to look for more adequate forms of education for the young generation oversaturated with visual information. Using our white chalk and black board technique is obviously not sufficient to motivate students toward a high professional level knowledge.

The protection of cultural-historic monuments is one very good illustration of this problem. This intra-educational issue allows minimizing the cost of vitalization by preparing a cross-media course suitable for many faculties and departments. It requires however as a background a good theory of culture, which "must reflect the fluidity and complexity of the psychological states that underlie the cultural process" [8].

Finally we would like to underline that no technology can replace the vivid presentation and discussions of the problems and first of all we need to be good instructors and then good technologists. The cross media can give us many advantages in education.

5. Acknowledgments

I owe a lot for the preparation of this paper to the project "Managing human capital for the aims of sustainable development (case study of some Balkan countries)**" supported by the Scientific Research Fund of Fatih University under the project number** P51010901_1. Although not directly oriented to the topic it allowed collecting valuable information for the theoretical explanation of the endogenous motivations for the WTP for cultural monuments generalizing the effect of the human capital accumulation. We express our thanks for the ability to use this support. Many thanks to all colleagues which gave constructive critics to the paper.

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Prospective Physics Teachers Design and Develop a Normative Lesson utilizing Hands-on Applications of Digital Technologies - - Preliminary Results

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Abstract. *This quantitative research studies the ability of prospective physics teacher to create educational material consistent with a specific educational methodology, adopting new technologies.*

Fifty students of the University of Athens were voluntary offered to participate in this research, developing a normative lesson. Assisting to their materialization they used PowerPoint, as a platform that can incorporate different formats of information.

First results show that students, although they were willing to integrate technology in their teaching practice, they were not able to manage the mean. They were carried away by its power and therefore the mean dominated their lesson supplanting other important factors such as methodological consistency and experiment's role.

Keywords. Educational methodology, Future science teachers, PowerPoint.

1. Introduction – Framework - Purpose

Research work triggered by previous studies ([4], [8]) showed that Physics Department students, who were asked to design and realize teaching, present the following common characteristics:

a) They frequently dismiss the complexity of realization of a work adopting interactivity and multimedia elements.
b) Even though they present themselves as confident with technology, they face difficulties in using tools and programming environments frequently.
c) Even though they present themselves as confident with internet use, they are not able to search information accurately (validation and form).
d) They are not able to edit files (mainly videos, picture and sound)

Findings become more discouraging when it comes to the point of educational methodology. There it is common place that students:

a) They do not understand the necessity of using any methodology.
b) They do not adopt its philosophy but use its steps mechanically.
c) They do not apply findings of previous steps to futures ones.

These aspects are very critical as researches show that prospective teachers have a special notion of content knowledge and pedagogy and thus their believes will determine their future action [6].

2. Rationale-Research Questions

Experience that has been obtained from previous research efforts ([4], [8]) has raised the question whether graduates of faculties in Greece which deal with Science, acquire the necessary accoutrements, in terms of educational methodology and use of technology as an assisting educational tool.

To put it more clearly, the research questions of this study are:

a) Are the students capable of developping educational material in Science, using PowerPoint (or analogous programs)?
b) Do they follow in this development the required educational methodology?
c) Was their training sufficient for this effort?

3. Methods

This is a quantitative research, based on fifty students of the University of Athens who were studying physics and they were voluntary offered to participate. They were at the second year of their studies and until that time they hadn't attended any class which involved teaching methods in any way. During our class, students had preceded few lessons concerning basic principles of teaching and lessons for technology as a mean.

More analytically at the field of general didactic they dealt with methodological issues, experiment's role, teaching targets design, and use of technology in Science teaching.

At the technology workshop, they dealt with usage of digital technologies in Science teaching, such as classification of technologies based on their teaching use (mostly pairing technologies with proposed teaching methodology), standard tools show, developed with digital technologies and integrated to teaching methodology, developing teaching tools via digital technologies:

1. PowerPoint
2. Html
3. Sound, picture, video editing
4. Java applets

At last, students had attended several presentations and comments on normative lessons, designed on the basis of the proposed methodological standards, which used different technology forms. According to [1], the use of exemplary cases can increase teachers' exposure to other ideas, show existence proof of new methods under ordinary classroom conditions, and demonstration of actions in a real context.

The aforesaid educational methodology is described as scientific / educational by inquiry model. It consists of five steps: a. Triggering of interest, b. Hypotheses' formulation, c. Experimentation, d. Conclusions' draw, e. Application in similar situations/explanation with the microcosm (Fig.1).

The main criterion which would determine the answers of the research questions is a short time lesson that the students were called to make in front of the class.

We assigned them to design and realize a lesson for any field of Science, based on the proposed methodology, using as a tool the PowerPoint. They could also adopt any other technology that it could act beneficially in their effort.

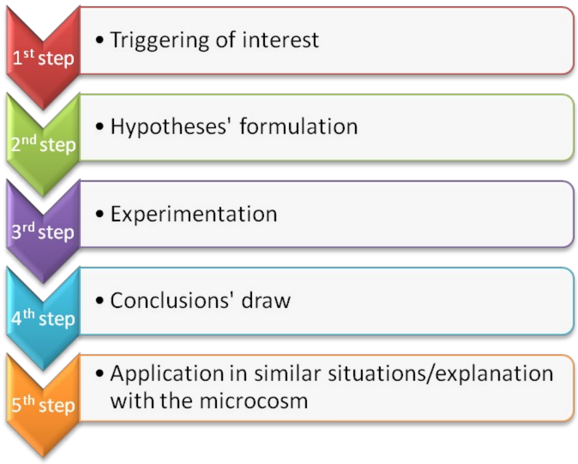

Figure 1. Educational Methodology

As a result, the fifty students brought a cd in the classroom and they taught a lesson. An oral evaluation from all the members of the classroom followed. We videotaped the lessons and we kept written records of the comments that there were made. In parallel, we analyzed the cds on the basis of methodological, elegancy and technical integrity.

The evaluation was made by two independent reviewers in a 5 steps scale (1=inadequate, 5=excellent). When there was a dissension, the disputation was solved with discussion. If that was not efficient, the final decision was made by a third reviewer.

4. Results

Students showed willing to integrate the technology in their teaching practice. They consider technology helpful for their teaching work.

They managed to use PowerPoint as a tool although most of them used it for first time. They included hyperlinks functions importing multiple file formats (like video, picture, sound). The aesthetical result was very interesting fig. 2, fig.3.

On the other hand, they were not able to manage the mean. They were carried away by its power and therefore the mean dominated their lesson supplanting other important factors such as methodological consistency and experiment's role. The impression given was that they were just presenting the material they had prepared instead of feeling the teaching. "Every science teacher has his or her own beliefs about teaching and learning which influence teaching strategies and behaviors" [5].

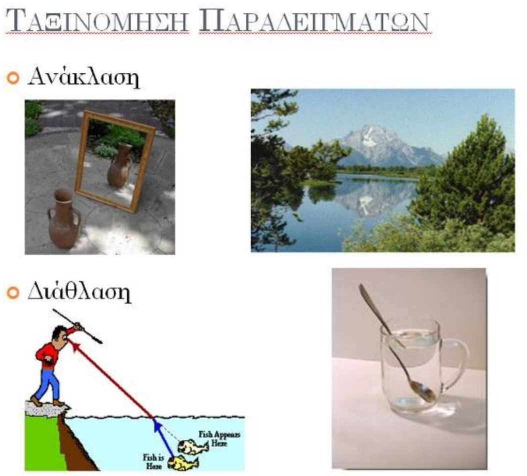

Figure 2. Examples of students' achievements

Figure 3. Examples of students' achievements

By majority, they designed properly their didactical targets, although most of the times were inconsistent with their teaching targets concerning not only teaching practice (as expected) but also teaching material.

They had fundamental methodological problems. They considered that methodological consistency is restricted exclusively at following the steps of the methodology. In practice they did not adopt the philosophy of the methodology that leads the student to discover natural principles and explain the phenomena as a young scientist. This is relevant with other studies where is mentioned that the identified concepts contained several elements which clearly did not correspond with a developed understanding of Nature of Science. The respondents displayed a naïve and unclear understanding of the scientific method and a poorly developed understanding of scientific theory [7].

5. Conclusions-Proposals

Students managed to accomplish the main goals, which were to pose didactical targets, to create educational material by using PowerPoint and to adopt an educational methodology, even though they settled mainly in technical issues. This is consistent with other researches [10] where it has been mentioned that despite continuing efforts to deliver quality training for future teachers, it has been observed that teachers show a marked difficulty in changing their instructional practice in meaningful, deep ways.

They experienced major methodological problems, focused basically in the consistency with basic principles of the educational methodology.

It should be under further research the possibility of differentiations, according to the kind of technology that students use.

Also, it should be estimated the progress in the students' performance, while they will attend a short time seminar of training, so that it could be proposed a kind of a curriculum and a timetable. We should take into account that "no innovation will be sustained unless systematic and ongoing professional development is provided to support the changes required in the pedagogy of science teachers" [9].

The results also imply that some significant changes need to be made to higher education program considering students' motivation in order to get improvement in students' motivation to learn science [2]. Similarly, one can assume that student teachers` beliefs affect both their learning and their understanding of teaching through every step of their teacher education [3].

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Educational Support to Prospective Physics Teachers at the field of Green Energy; First Assumptions

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Abstract. *This qualitive research studies the context we should form in order to guideline future science teachers to create and introduce their original teaching material in their daily teaching experience. More precisely, in this case we cope with the subject of renewable energy approaching it through an interdisciplinary view.*

The tool that was chosen to build the main part of the teaching material was Excel, using those functions that help to create interactive relationships between figures and comprehensive depiction of those relationships.

First results show that we should insistently support students so that they become familiarized with educational methodology and meaningful use of technology.

Keywords. Excel, Future science teachers, Interdisciplinary, Renewable energy.

1. Introduction – Framework - Purpose

Teacher learning has emerged as an important area for research in education [1]. There are a large number of studies on the content of teacher learning, mainly focusing on the knowledge base of teachers (e.g. [2]; [4]; [7], [8]).

The American educationalist Lee Shulman introduced the term ‘pedagogical content knowledge’ (PCK) when he investigated the knowledge base of teachers. He defined it as “a special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding” [8]. He stated that effective teachers need PCK rather than just knowledge of a particular subject matter.

Taking into account that “no innovation will be sustained unless systematic and ongoing professional development is provided to support the changes required in the pedagogy of science teachers” [6], our research team studies the ways the means and methodology in general affect Science teaching practice. Complementary, we study the context we should form in order to instruct future science teachers to create and introduce their original teaching material in their daily teaching experience.

Nevertheless the fact that “… studies confirm that teacher beliefs about the nature of knowledge, teaching science, and the mandated curriculum impede and ‘‘filter’’ innovative practice suggested by professional development...”, [9] showing the great importance for systematic support for prospective Physics Teachers, in order to become more efficient and to promote insightful learning.

At this point the issue of technology arises, providing a new, very promising, outlet but which also demands a lot of attention in order to be meaningful and not just decorative.

More precisely, we study the pathway followed by two future teachers when they were called to present a proposal for teaching green energy-energy conservation through an interdisciplinary view, using as an educational tool the widely known Microsoft Excel (or analogous programs).

We describe the issues raised, the decisions we had to make and the supportive guidance through the entire attempt in order to help the under-testing teachers introduce technically and methodologically the innovative ideas in teaching practice.

2. Rationale-Research Questions

Former research efforts [3], [5] which conducted in previews years, have provided us with useful experience. Concisely, the general assumptions were that students do follow a methological approach in their teaching but they don’t attain the deeper philosophy of it. They just follow the provided steps, oblivious of any further extensions.

It has been also shown that students usually don't manage to use technology in the most beneficial rate, as it is common to be induced by the glamour of technology and finally to become slaves of their own material.

At this paper we are investigating how two students at the University of Athens do manage to materialize an educational proposal for the topic of the green energy-energy conservation, following an interdisciplinary approach and by using Microsoft Excel as a tool. Was the developed material consistent with the educational methodology that they were provided? Did the developed material meet the prerequisite criteria that had been put at the design of the effort?

3. Methods

This is a qualitive research, based on two students of the University of Athens who were studying physics and they were voluntary offered to participate. They were at the fourth year of their studies and they had already attended several classes which involve teaching methods.

The two students were asked to present a proposal for teaching the aforesaid topic. Some barriers were that they had to approach the issue through an interdisciplinary approach, as it was a question to study the physical phenomena that describe the procedures embedded, but simultaneously approach and present the interactive relationships between the phenomena and elements of everyday life, social organization, civilization, history, natural environment and unliving and living matter in general. They also had to develop an educational material in Microsoft Excel 2007 (or similar program) using those functions that would help to create interactive relationships between figures and comprehensive depiction of those relationships. In this way, we consider an experimental approach of figures with crucial social extensions possible, such as the quantity of pollutant emitted compared to society's economical structure e.t.c.

4. The educational material

The educational material that was produced was a set of worksheets accompanied by two files in Microsoft Excel 2007 platform. The scientific fields that there were under review were aeolian energy and biomass (Fig. 1, Fig. 2).

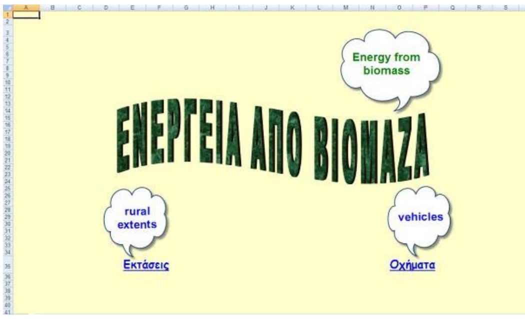

Figure 1. Screenshot of 1st file: "Energy and biomass"

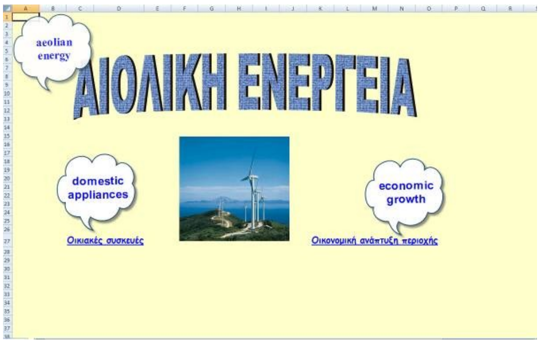

Figure 2. Screenshot of 2nd file: "Aeolian Energy"

Alternatively to Microsoft Excel it could have been used an open source program such Open Office Spreadsheet with no remarkable difference.

The worksheets implement an inquiry educational methodology that it is described as scientific / educational by inquiry model. The methodology consists of five steps: a. Triggering of interest, b. Hypotheses' formulation, c. Experimentation, d. Conclusions' draw, e. Application in similar situations/explanation with the microcosm (Fig.3).

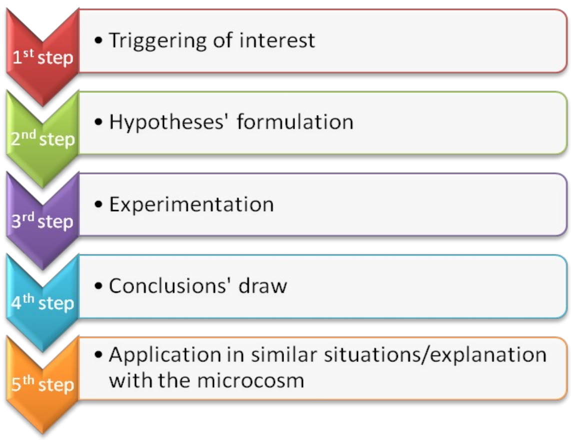

Figure 3. Educational Methodology

The flowchart of the two Excel files is presented bellow (Fig. 4, Fig.5). The first file (Energy and biomass) consists of two dimensions: rural extents and vehicles. At the field of rural extents it is presented a set of possible choices for the user, such as different kind of crops, yield per square kilometer, requisite land, requisite water and the equivalent graphical pies. At the field of vehicles, user has a great variety of possible choices, such as type of economic growth of the region, number of vehicles, type of fuel, price per litre, type of vehicles, estimation of fuel consumption, estimation of fuel cost, estimation of CO_2 emission, estimation of losses and benefits in the case of substitution of fossil fuels with biomass which are accompanied with the appropriate charts.

The second file (Aeolian Energy) also consists of two major components: domestic appliances and economic growth. At the field of domestic appliances one can select to deal with the cost per kwh of production of electric energy via wind generator or via electric power station, the cost of usage for major electric appliances and the analogous CO_2 emission. At the field of economic growth, there are several choices which show the relevance between the economic growth of a region, the population, energy demands and the necessary number of wind generators.

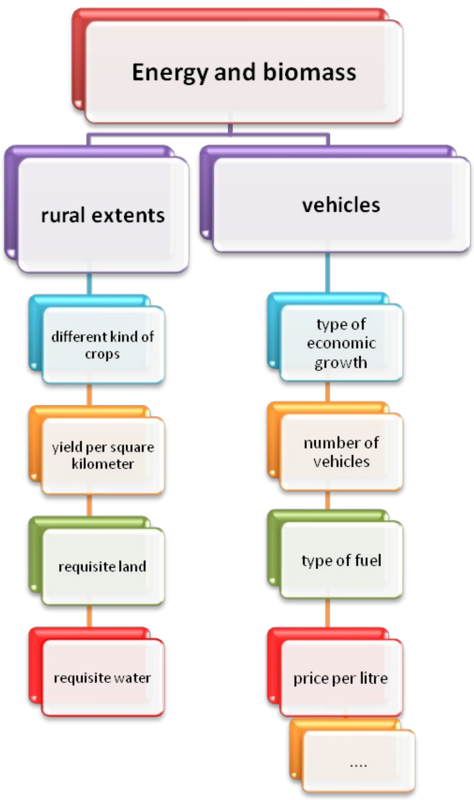

Figure 4. Flowchart of “Energy and biomass”

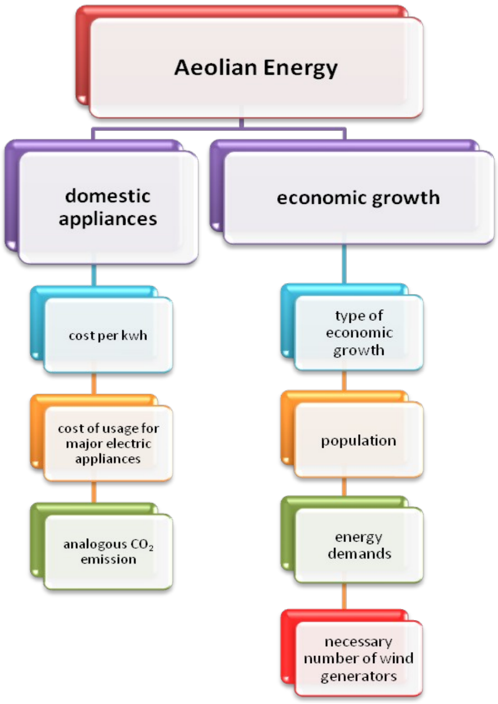

Figure 5. Flowchart of “Aeolian Energy”

These files had been proposed by the two students to play the role of a virtual experiment, as it has been mentioned above experimentation is one of the steps of the followed educational methodology.

5. Results

The findings show that the two students managed to develop teaching material, transforming this new technology into teaching practice. They produced a Microsoft Excel file which incorporated many options which provided the potential to visualize correlations between different figures (fig. 6). It also met with the criteria of functionality and aesthetic that have been put at the beginning of the effort.

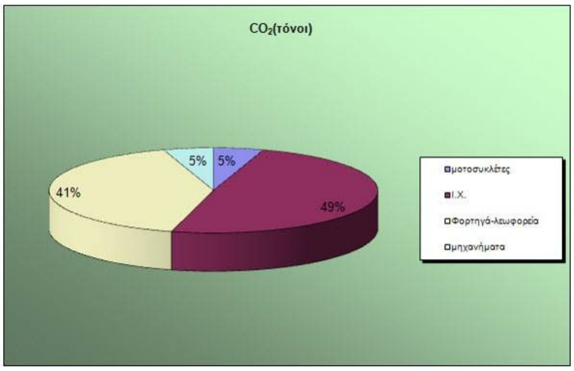

Figure 6. Graphs of physical quantities

They also managed to create a worksheet which integrated the previous material. This worksheet lacks on educational methodology as it follows rather superficially the required steps, leaving outside the deeper philosophy of it. This is a common assumption between several prior researches [3].

At last, their effort to approach the whole issue with an interdisciplinary glance it can be said that it was not fulfilled in the most extended ratio, but it was fair enough, as they embraced a large number of liaisons.

6. Conclusions-Proposals

We consider successful the whole attempt from the side of the students. It was shown that they managed to accomplish the main goals, which were to use technology in order to produce educational material, all though the problematic around the methodology consistence.

A systematic support effort for prospective Science teachers is required in order to exceed the confirmed problems concerning methodology issues, so that they become more ready to experience and thus to use it beneficial in their lesson. This support should include components of PCK, as it is considered to be a crucial issue for Teacher professional development [6], [8], [9].

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Hands-on Experimentation in Educational Physics Laboratory utilizing a Common Mobile Phone – The Case of Decrescent Oscillation

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Abstract. *Our research team's main effort is to study how the means and methodology in general affect Science teaching practice, top-placing motivating and keeping students' interest. In this context, triggered by the growing use of mobile phones by Greek students of all ages, we tried to investigate how efficient, technically and methodologically, is to integrate this tool into Science teaching.*

The material created consisted of worksheets that include an experimental part where the use of mobile phone is integrated.

The very first results are encouraging, as students not only showed interested in the new idea, but they also succeeded to fulfill more didactical targets.

Keywords. Decrescent oscillation, Experiment**,** Logger-Pro, Mobile phone.

1. Introduction – Framework - Purpose

In the last few years, the main goal of our research team is to develop a curriculum and propose a time table for a short time didactical seminar which aims at prospective Science teachers. This seminar should affiliate issues of educational methodology and educational exploitation of technology ([5], [6]). To adopt new instructional methods effectively in science teaching, those methods should be introduced to teachers in their pre-service education [10]. Traditional science teaching is not effective enough in altering student understandings of the physical science concepts [7]. Literature reveals that students who learn science in traditional instructional settings often leave the classroom with misconceptions [9] while Thornton [8] points out that students often perceive science as being difficult, boring and concerned with details.

Research shows that students of all ages learn science better by participating actively in the critical thinking and by interpreting physical phenomena [4].

Under this general direction, we should first study the results of the implementation of a program, which will adopt innovative ideas at the fields of methodology and technology in the everyday didactical practice.

Various studies showed that many students do not enjoy science classes because they find them uninteresting and irrelevant (e.g. [3], [9], and [10]).

This work aims at this target, viz to propose a beneficial use of a gadget that almost every Greek student owns to the everyday reality of the Science class.

Students record a phenomenon with their own mobile phone and then they process the video via Logger-Pro, a computer program, which can estimate the coordinates of a motion and evaluate derivative sizes, such as velocity and acceleration.

The phenomenon that it was chosen was decrescent oscillation, as it develops quite fast and it is not feasible to measure with accuracy the position and the velocity with a conventional (non digitally) way of experiment.

An integrated didactical proposal is developed, comprehending didactical targets, educational methodology, digital experiment phase and a worksheet.

2. Rationale-Research Questions

It was of our intention to investigate firstly the potentiality to incorporate such a tool in Science teaching and secondly to evaluate effects at students' interest.

So, the main research questions are: Is it feasible, in terms of technical efficiency, to incorporate mobile phone as a tool in Science teaching? What kind of natural sizes could be measured through this process? How do students counter this new media?

3. Methods

Because of the innovation of the whole effort, before we advance in the application of the proposal we selected to check each possible parameter. Therefore, after the decision of the field was made, the next step had to do with the recording of the phenomenon.

As an apparatus we chose Newton's disk for decrescent oscillation. The main topics at this apparatus are firstly the transformation of the kinetic energy to potential and vice versa and secondly the loss of the mechanic energy due to friction.

With the use of a mobile phone, we recorded a video of the phenomenon, which lasted approximately twenty seconds.

After that we transferred the video to a pc, via a usb port. Alternatively it could be used a bluetooth connection, so that no cables are needed but it could be more confusing as a short process is necessary in order to establish the connection between the mobile phone and the pc.

Then the video was imported to Logger Pro. As the program recognizes only avi and QuickTime format, a converter may be required, depending on the video format that a mobile phone creates. In our occasion we used A-Z Converter Ultimate in order to convert mpeg file from a Nokia phone to avi.

At the environment of Logger Pro, we chose a set of two vertical axes and after a simple calibration we picked with a mouse click the different position of the disk at different time moments. Simultaneously there were filled two columns with the coordinates of the position of the body. Also, the measure of the velocity at the two axes was estimated.

Further process of the data was made at Microsoft Excel, where graphs of the position, the measure of velocity, the potential, kinetic and mechanical energy were made.

At the next stage, we developed a worksheet, consistent with the proposed of the laboratory educational methodology, which it could be described as an inquiry methodology.

The worksheet was tested in a class of twenty students of the Pedagogical Department of the University of Athens.

4. Results

The analysis of the worksheets reveals that students managed to reach numerous didactical goals. They comprehended the issue of energy transformation through graphical interpretation, while they coped with natural sizes such as velocity, acceleration, resultant force, impetus, period and frequency (fig. 1, fig.2).

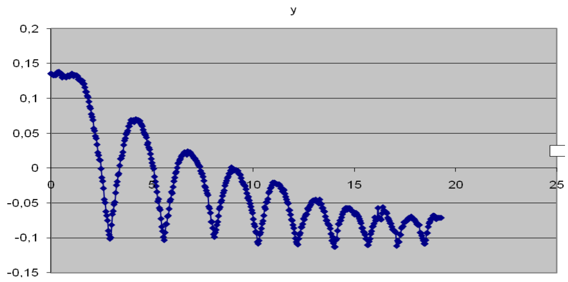

Fig 1. Graphical representation for the position of the body associated with the time.

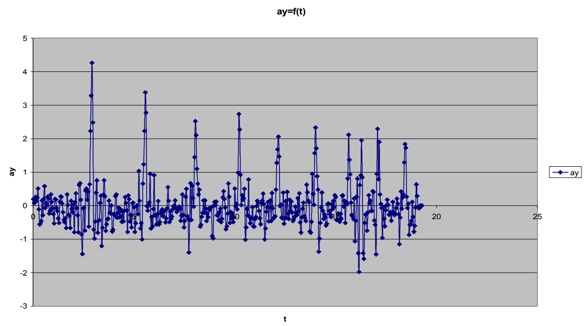

Fig 2. Graphical representation for the acceleration of the body associated with the time.

Also, their attention was tensed as they used two familiar tools for them (mobile phone and computer) in a class that often is described by them as boring.

5. Conclusions-Proposals

There is always enough space in research for innovative ideas at the didactical practice, exceeding conventional media that students find boring. It seems that it is time to test a variety of gadgets that are frequently used by almost everyone, passing the message that above all Science is something diachronic and thus modern that is not 'afraid' of any challenge. This is even more important if we consider that students believe that science is exciting only for scientists.

The main issue is to train prospective teachers at the means of educational methodology and technology, so that they will form the appropriate culture to combine both of them in the most beneficial way.

With this inspiration, other researchers (Bers and Postmore) introduced a partnership model for pre-service early childhood teachers to learn how to develop, implement and evaluate curricula in mathematics, science and technology [2]. They conclude that the partnership models allowed pre-service teachers to realize how technology could potentially improve their educational practices and what skills they need to use technology effectively.

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A "Horizontal" Study of Impedance, found in Different Chapters in Physics Educational Curricula, utilizing Hands-on Experimentation and Educational Simulation

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Abstract. *In this paper, the proposal and the results of formative evaluation of application of "horizontal" Laboratory of Natural Sciences are presented. The exercises and the educational activities in this laboratory are not included in one thematic unit (as they are structured in corresponding laboratories) but are structured so as to study the concept of impedance in many different units of Physics.*
The concept impedance ("empedesi" in Greek) emanates from the word [pedi] = brake and it expresses precisely its natural importance attributing a more general significance that we meet in a variety of thematic areas of physics:

$$impedance = \frac{reason}{result}$$

Key words: Impedance, Horizontal approach, Laboratory activities.

1. Introduction – Framework

It is well known that in our country the science laboratories, in all departments of higher education, are structured in a certain way so that they include thematic exercises related to individual units and subject areas of science (e.g. thermodynamics, mechanics, optics...).

In this paper the proposal and the results of formative evaluation of the implementation on a "Horizontal" Science Laboratory applied to students are presented, emphasizing on the concept of impedance.

In this (horizontal) laboratory, all the exercises and the activities are not included in a certain theme (as in other laboratories) on the contrary; they are formulated to study the concept "impedance" through various natural phenomena. Ultimately, the students can achieve the widest possible understanding of natural phenomenon that includes this particular concept.

The term "impedance" refers to a physical concept which turns up in a number of Physics' subjects and not only in some of them, as it is taught mainly in Higher Education.

Table 1. The formula of impedance in the different chapters of Physics

1	Mechanical impedance (waves)	$\frac{F(\text{Force causing oscillation}}{u\ (\text{speed oscillation})}$
2	Electrical impedance	$\frac{V\ (\text{voltage})}{\mathrm{I}\ (\text{Electricity})}$
3	impedance (in channel flow)	$\frac{\mathrm{P}\ (\text{Pressure})}{\Pi\ (\text{provide})}$
4	Acoustic impedance	$\frac{\mathrm{P(r,t)}\ (\text{Pressure})}{\mathrm{u(r,t)}\ (\text{particle velocity})}$

There is also a general formula that can be used to describe impedance:

$$impedance = \frac{reason}{result} \quad (1)$$

The objective of the application presented in this paper is to propose exercises and experimental activities targeted in the deeper understanding of the physical concept of impedance, in a laboratory environment, where experiments and simulations are applied.

2. Rationale – Research Question

Two exercises were formulated following the rationale of the "horizontal'' laboratory [2] at the Science, Technology and Environment

Laboratory in The Department of Education at the University of Athens, related to impedance and were put in to practice with the help of postgraduate students. For the needs of these exercises, appropriate materials have been used, developed firstly to support and secondly to ensure an effective educational laboratory intervention.

The research question is: Is it possible for the students to comprehend the meaning of impedance using a horizontal laboratory rationale and finally concluding that impedance can be described as it is in (1) ?

3. Methodology

Initially a questionnaire with general and particular questions for impedance was given to the students in order to have a first impression about their knowledge to the material at hand.

Table 2. Part of the given questionnaire

1	Do you know the physical meaning of the electrical impedance?
2	Do you think that the concept of impedance is present in some (more than one) thematic chapters/ themes/units of physics? If yes. Which?
3	The physical concept of impedance is the difficulty of something ... Give us examples.
4	Can you think kind of impedance other than electrical?
5	Can you give us a general formula for impedance?

All the worksheets in the experimental activities are structured with the following scientific / educational model by inquiry [5]:

1. Trigger of Interest
2. Hypothesis Expression
3. Experimentation
4. Conclusions
5. Generalisation

Post-graduate Physics department students were selected because they are more familiar with experimental procedures and they have been taught impedance during their university studies.

The students studied the concept impedance through the exercises and the appropriate worksheets.

The first application was an experiment about electrical impedance in a circuit of AC-impedance capacitor.

The second application was the study of the acoustic impedance through two simulations.

Post graduate students were divided into groups of two and worked on workshop benches equipped with the appropriate equipment for the experiment and computers (one per person) for the simulations.

Initially, a day or two before the intervention, a pre-laboratory preparation sheet was given to the students in order to familiarize them with the following process (experiment and simulation) and with certain terms related to the tasks.

The educational process is structured following these steps:

Trigger of Interest: In order to stimulate the interest of students, in the worksheet were included pictures and text about the general concept of impedance.

Hypothesis Expression: In this step the students have to construct the formula of “impedance” as a result of simple questions and given examples.

Experimentation: In this step of the experimentation, the instruments and the apparatus of the experimental device are described. Initially there is an introduction about each instrument and the equipment used for assembling the experiment. For this reason, on the worksheet there is only the display of instruments and materials used and a brochure about the operation and detailed description of the oscilloscope (if needed). The students should assembly the instruments, the equipment and the materials as given in the description of the circuit.

After that, students record and process the experimental measurements.

Conclusions: During this step students manage to work out their conclusions which are related to electrical impedance. Which natural size represents the reason and which natural size the result, in electrical impedance.

Generalization: Finally the students observed data from various fields (such as technology, medicine) in technological applications which were presented in the worksheet. Through these elements, students succeeded to generalize what was studied in the previous steps.

The second application is about two simulations which deal with acoustic impedance. It is difficult to observe acoustic impedance under normal laboratory conditions (i.e.

expensive devices for the given experiment), so the simulation was chosen as the best way for the students to understand in a short time the natural phenomenon.

The purpose of simulation is to understand the concept of acoustic impedance and particularly how this physical size changes with the alteration of material diffusion of sound. Also with the simulation software, students can intervene and change the various parameters to obtain different results.

With a worksheet structured analogically to the previous one, students deal with acoustic impedance.

Particularly for each step:

Trigger of Interest: In order to stimulate the interest of students, in the worksheet were included pictures and text about the general concept of impedance.

Hypothesis Expression: During this phase, the students answered a series of questions on acoustic impedance.

Experimentation: During this phase the experimentation dealt with alternating the parameters and the energy study of acoustic impedance through the selection of various materials.

Conclusions: During this step students manage to work out their conclusions which are the following: what is the reason and which is the result in an acoustic system in order to achieve acoustic impedance, how it changes with relation to the changes in the transmitting material of sound and of other parameters. Students derive a formula for acoustic impedance.

Generalization: Finally, students deal with the implementation of acoustic impedance as it is used in ultra sound diagnosis. The purpose of this was to gain a global perspective of acoustic impedance which is applied in the medical field.

Following the educational intervention and after two weeks the students were given the same questionnaire -Table 2- and asked to answer the questions again.

4. Results

Both applications flew smoothly with no significant problems. All the students through experimentation concluded to the main formula for electrical and acoustic impedance.

Postgraduate students showed great interest in the "horizontal laboratory" and its experimental activities which generally is accepted as an important motivation for learning.

The students dealt with a number of minor problems, such as operating some electric equipment. These technical problems are understandable if we consider that students do not have much experience from laboratory experiments in general. Firstly it is well known that Greek secondary schools are not familiarized with laboratory experiments as an additional method of teaching the physical phenomena and concepts. Secondly in post-secondary education (most of the times) the whole intervention seems to be an evaluation/access procedure rather than an educational process of familiarization with apparatus, experimental devices and understanding of science concepts/phenomena.

The use of simulations in order to understand the concept of acoustic impedance seems to be very helpful because the students can quickly approach the concept of acoustic impedance as they can easily change parameters and immediately check their hypotheses.

It should also be mentioned that students showed significant comfort using computers, which is probably the result of the spreading use of computers, not only in everyday life but also in the educational process, especially the last few years.

5. Conclusions – Proposals

In the present study, an innovative application of the horizontal laboratory has been established.

We can say that the first signs from the application are encouraging. Of course we must admit that after every educational intervention students' understanding about particular concepts and phenomena seems to be in a higher level. And this was clear evident in our case too.

But through the completed questionnaire (given two weeks after the intervention we must mark) which show us significant change to their knowledge about impedance and our own observations / questions (during the procedure) it seems that students reinforced to relate impedance with difficulty in all themes.

In addition through the above training and experimental teaching methods students were lead to generalization of the concept in some areas of physics using the formula (1) which will eventually help students to comprehend -better than ever- the concept of impedance.

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Early Primary Education Students' First Engagement with Basic Physics Concepts and Phenomena through an Interactive Board and Sandbox Physics Software - - Proposal and Application

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Abstract. *The teaching of basic physics concepts and physical phenomena in early stages of primary education is very limited.*

Mainly it is focused in the reference of natural physical phenomena, such as rain, earthquakes etc. but it does not relate with certain physical quantities and concepts.

The use of interactive whiteboard in combination with free (or low cost) software, which can be supplied from the internet, can be a fun and creative way to motivate students and thus could help them in the deeper comprehension of a plethora of physical phenomena.

In this paper we present a teaching plan that shows how certain activities can help students to comprehend better the motion of physical bodies by painting and playing which will naturally lead them to create a positive view of physics in general.

Keywords. Primary education, Physics concepts, Interactive whiteboard, Sandbox game.

1. Introduction

The students of first classes in Primary schools are not taught Physical concepts at all. The teachings of physics phenomena and/or physical quantities are limited in natural phenomena (earthquakes, rain, etc). However it is commonly acceptable that even the younger students in Primary schools have a perception for a series of physical phenomena and situations as they try to comprehend the world that surrounds them. In addition the most common and creative expression procedure for them is to paint.

In our proposal we use the interactive whiteboard and free sandbox physics software to motivate students with physical phenomena, physical concepts and physical quantities through games that promote kinesthetic and tactile learning.

2. Rationale – Research Question

Is it possible for early primary students to create and check their models about basic concepts of kinematics using an interactive whiteboard and physics sandbox software? In order to check such a hypothesis we applied a lesson plan based on certain educational model which is being used to teach physics to the students of primary classes (fifth and sixth grade).

3. Educational Methodology

We selected students from classes "A" and "C" of "Nea Genia Ziridi" private primary school.

Figure 1. A student testing her hypothesis

These ages (6 to 8) seem to be the most suitable for an educational approach with interactive whiteboard and sandbox physics software.

"A" class students were familiarized with the interactive whiteboard but never used a sandbox physics software before. On the other hand "C" class students had already used the interactive whiteboard (for three years already) and the certain software but just for creative fun.

Our teaching plan is based on the following steps of scientific / educational model by inquiry, [1]:

6. Trigger of Interest
7. Hypothesis Expression
8. Experimentation
9. Conclusions
10. Generalisation

3.1. Educational aims and objectives

Educational Aims

Students should:

11. Acquire positive attitude for science in general.
12. Use and be familiarized with technology.
13. Consolidate the way a scientist approaches a problem.

Educational Objectives

Students should:

14. Try to build models for a series of physical concepts such as weight, velocity, acceleration rotation, balance, orbit, etc.
15. Create models that explain the world that surrounds them.
16. Experiment in a fan and easy way using technology.
17. Try to explain and the behaviour of materials in general.

3.2. Our Teaching Plan

At the stage of trigger of interest we introduced the concept of the third dimension to both classes. With three-dimensional video from youtube and some three-dimensional pictures from 3D books and 3D glasses (cyan-red) the small students experienced the third dimension.

At the stage of hypothesis expression we asked "first" class students very simple and basic questions. We tried this way to make them to express about a number of physical concepts such as the three dimensions, the trajectory of a moving body, the motion of objects in general, balance, etc.

For "C" class students we add the concepts of rotation, velocity and acceleration.

After that we showed at the interactive whiteboard some print screens from the software that showed possible trajectories of a moving ball in order to hit the star, Fig. 2. We asked them to hypothesize which would be the possible one and students expressed their thoughts in the laboratory. After that they had to test their hypotheses using the interactive whiteboard.

Figure 2. Ball Path

We then asked students to use at their computers their sandbox physics software and check this way their hypothesis (step of experimentation) in different scenarios, Fig. 2.

The students working in groups tried to find ways to successfully move objects by drawing shapes, balance scales, etc, and create this way models for the physical concepts in question.

This process led to the final conclusions by students themselves.

During the whole process students worked in groups, discussed each other, and tested their hypotheses.

We also presented many different scenarios that included more physics concepts (Fig.3 and Fig.4), like balancing, rotation, acceleration, etc. asking students to act the same way as described before for these concepts.

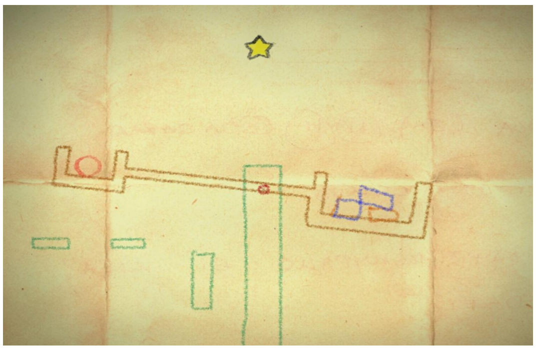

Figure 3. Balancing…

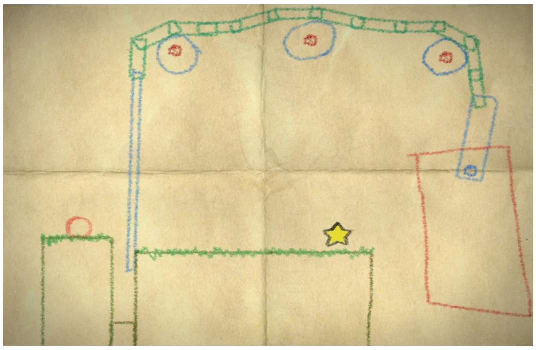

Figure 4. Lifting…

4. The Results

"A" class students that used "crayon physics" software for first time were very excited with the whole process. That way they quickly managed to express their thoughts for a number of physical concepts and physical phenomena by drawing in the interactive whiteboard and discussing about them.

"C" class students were already familiarized with the software as they played its puzzles just for creative (problem solving) fun. They faced for the first time the possibility to talk about physical concepts and phenomena through the software in a fun and easy way.

We observed students to be familiarize with terms and phenomena of physics such as three dimensions, movement, velocity, rotation, etc very quick for both classes. Naturally the students of "C" class seem to be more ready to discuss with us about the phenomena and concepts than the students of "A" class. But even though they could not express their thoughts in a "scientific" way their approach to explain physical phenomena was in the right direction.

It is remarkable that in their effort to explain the phenomena they began to make hypothesis and create models which enhanced their ability in problem solving. Students from other "A" and "C" classes which were used the same software -but just for fun- seems to be less efficient in software's problem solving. The whole process also led the students to use terms of physics in their expressions naturally.

5. Conclusion and Future Work

Through the educational procedure we lead students to make hypotheses, to check them through software and to conclude after team discussion.

Through drawing students create objects and easily test their hypotheses for the movement of the objects they create. In this way students were engaged with a series of physical concepts such as weight, balance, velocity, acceleration, rotation, orbit, etc and the behaviour of materials in general.

The use of interactive whiteboard helped students not only to be focused on the board but also to work in groups in order to present their thoughts about motion, objects, materials, etc in a fun and creative way.

Through these procedures students seem to be helped to have a better understanding of the world that surrounds them.

At this early stage we cannot express general conclusions about their ability to fully use the knowledge they acquired. Although it seems to be possible that the use of interactive whiteboard and sandbox physics software under certain circumstances and with the appropriate educational methodology, could help them to understand some physical phenomena.

For the nearby future we can say that we have already create new lesson plans for the older students of primary school with more (complicated) physical concepts and we will use them with the beginning of the next school year.

We will also try scenarios using the "Level Editor" function of the software as seen in Fig. 5, which can give the opportunity to students to create and test their own levels / "physical" worlds.

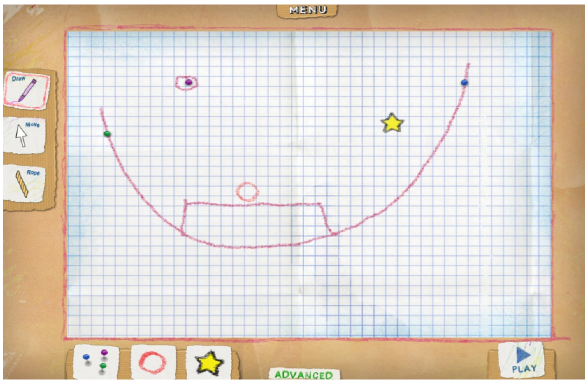

Figure 5. Level editor function

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Hands-on Educational Experimentation with LEDs, Optical Fibers and Photodiodes in a Modern Technology Dependent Society

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Abstract. *In this paper we describe an experiment with LED circuit and photodiode circuit. We take measurements and study the device in both conditions: without and with optical fiber between LED and photodiode. With a second experiment, developed for demonstration purposes, we transport through optical fiber digital signal from transmitter of infrared light, suitably shaped, in corresponding receptor. We describe phenomena like light emission, the inverse square law of light emission, the photoelectric effect, the reflection and transmission of light. Also we mention the significance of LEDs, photodiodes and optical fiber applications in modern technology dependent societies.*

Keywords: Light, LED (Light Emitting Diode), Photodiode, Optical fiber, Fiber optics, Photon, P-N junction, Photoelectric effect, Photovoltaic effect, Emission, Total internal reflection

1. Introduction

The purpose of this study is to propose hands-on experiments with LEDs, optical fibers and photodiodes to non-major science university students. The didactical approach was applied during the academic year 2007-2008 to 143 students of Pedagogical Department for Primary Education of the University of Athens. [1], [2]
At the main experiment in the first case - without optical fiber - there is measurable current at the photodiode circuit only if LED and photodiode are very close each other (almost in touch). In the second case - with optical fiber - there is significantly increased current at the photodiode circuit. Is concisely mentioned the way of LED's and photodiode's operation, is pointed out their uses and is clarified from each other difference in the polarization and in the transformation of energy. Also there is a short report for the operation and the uses of each device. With a second experiment, developed for demonstration purposes, we transport through optical fiber digital signal from transmitter of infrared light, suitably shaped, in corresponding receptor. For the adaptation of voltage that it provides the photodiode is used an amplifier of common emitter while the LED is droved via amplifier of current from generator of square signals to optical fiber.

2. Theoretical framework

Modern fiber-optic communication systems generally include an optical transmitter to convert an electrical signal into an optical signal to send into the optical fiber, a cable containing bundles of multiple optical fibers that is routed through underground conduits and buildings, multiple kinds of amplifiers, and an optical receiver to recover the signal as an electrical signal. The information transmitted is typically digital information generated by computers, telephone systems, and cable television companies.
In recent years it has become apparent that fiber-optics are steadily replacing copper wire as an appropriate means of communication signal transmission. They span the long distances between local phone systems as well as providing the backbone for many network systems. Other system users include cable television services, university campuses, office buildings, industrial plants, and electric utility companies. A fiber-optic system is similar to the copper wire system that fiber-optics is replacing. The difference is that fiber-optics use light pulses to transmit information down fiber lines instead of using electronic pulses to transmit information down copper lines. Looking at the components in a fiber-optic chain will give a better understanding of how the system works in conjunction with wire based systems. [4], [5], [6]

At one end of the system is a transmitter. This is the place of origin for information coming on to fiber-optic lines. The transmitter accepts coded electronic pulse information coming from copper wire. It then processes and translates that information into equivalently coded light pulses. A light-emitting diode (LED) or an injection-laser diode (ILD) can be used for generating the light pulses. The light (near infrared) is most often 850nm for shorter distances and 1,300nm for longer distances on Multi-mode fiber and 1300nm for single-mode fiber and 1,500nm is used for longer distances.The difference between LEDs and laser diodes is that LEDs produce incoherent light, while laser diodes produce coherent light. 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 in the forward direction. For use in optical communications, semiconductor optical transmitters must be designed to be compact, efficient, and reliable, while operating in an optimal wavelength range, and directly modulated at high frequencies.

The main component of an optical receiver is a photodetector which converts light into electricity using the photoelectric effect. The photodetector is typically a semiconductor-based photodiode. A photodiode is a type of photodetector capable of converting light into either current or voltage, depending upon the mode of operation.

A photodiode is a PN junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced. When used in zero bias the flow of photocurrent out of the device is restricted and a voltage builds up. The diode becomes forward biased and “dark current” begins to flow across the junction in the direction opposite to the photocurrent. This mode is responsible for the photovoltaic effect, which is the basis for solar cells-in fact, a solar cell is just a large area photodiode. In photoconductive mode the diode is often reverse biased, dramatically reducing the response time at the expense of increased noise. This increases the width of the depletion layer, which decreases the junction's capacitance resulting in faster response times. The reverse bias induces only a small amount of current (known as saturation or back current) along its direction while the photocurrent remains virtually the same. The photocurrent is linearly proportional to the luminance.

Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communications. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. An optical fiber consists of a core, cladding, and a buffer (a protective outer coating), in which the cladding guides the light along the core by using the method of total internal reflection. The core and the cladding (which has a lower-refractive index) are usually made of high-quality silica glass, although they can both be made of plastic as well. Connecting two optical fibers is done by fusion splicing or mechanical splicing and requires special skills and interconnection technology due to the microscopic precision required to align the fiber cores. [4]

Light pulses move easily down the fiber-optic line because of a principle known as total internal reflection. "This principle of total internal reflection states that when the angle of incidence exceeds a critical value, light cannot get out of the glass; instead, the light bounces back in. When this principle is applied to the construction of the fiber-optic strand, it is possible to transmit information down fiber lines in the form of light pulses. The core must a very clear and pure material for the light or in most cases near infrared light (850nm, 1300nm and 1500nm). The core can be plastic (used for very short distances) but most are made from glass. There are three types of fiber optic cable commonly used: single mode, multimode and plastic optical fiber (POF). The light source is pulsed on and off, and a light-sensitive receiver on the other end of the cable converts the pulses back into the digital ones and zeros of the original signal.

3. Educational methodology

The experiments presented in this paper is a part of an application concerning the light and its applications. For the educational approach of the different actions that take place in this didactical

approach, we suggest the scientific / educational by inquiry model, which includes the following steps: 1. Trigger of interest 2.Hypothesis expression 3.Experiments 4.Formulation of conclusions and proposals - recording 5.Generalisation - feedback - control [1], [2], [3]. The application is a combination of software (simulations, visualizations, theory presentation) and experiments in laboratory (in the classical way). The platform of the lesson is the FrontPage program and the lesson has the five steps of the above mentioned educational model. Vvisualisations and simulations which contains are developed from us especially for this application-study in 3D Studio Max and Visual Basic 6.0. The experiment in the laboratory is based in a simple circuit with use of LED, photodiode and fiber optic. Also the experiment part is supported with seven visualizations and simulations related with the real experiment and explaining difficult topics such as stimulation of an atom, photon, emission of a photon, electric current etc. [2].
The intervention was performed at university students -3rd year students of Pedagogical Department for Primary Education, University of Athens, Greece during the academic year 2007-2008. The number of students participating in this study is 143, three classes of 36 each and one class of 35. In every class they are divided at 12 groups of 3 students each group. For the assessment of the proposal they fulfill pre, post and final tests. A pre-test questionnaire was used, consisting of 10 multiple choice questions, each with four answers (a, b, c, d). Duration of answering the questions: 20 minutes. After that there was a two hours laboratory lesson with the experiments presented.After one week a post-test questionnaire was used, consisting of the same 10 multiple choice questions as the pre-test. Duration of answering the questions: 20 minutes. Two months later there was a final-test consisting of the same 10 multiple choice questions as the pre- and post-test. Duration of answering the questions: 20 minutes. SPSS 10.0 was used for the statistical analysis. [2].

4. Experiments – Measurements

a. First experiment

Materials : power supply 12V or two batteries of 4.5 V, breadboard, cables, digital voltmeter, resistors, LEDs infrared and one red, photodiode infrared (BPW41), fiber optic cable 1m length.

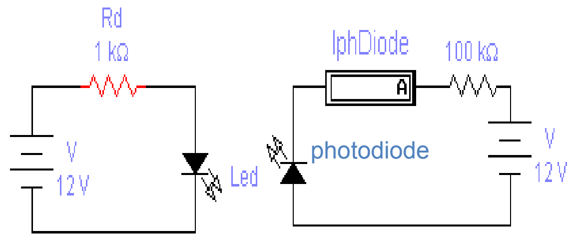

Figure 1 Circuit of the basic experiment

With the distance between LED and photodiode smaller than 2mm (almost in touch) we take the following measurements, whre IL is the LED current and Iph is the photodiode current

Table 1. LED current and photodiode current

R (Ω)	I_L (mA)	Iph (μA)
120	26,4	111
220	13,9	110
470	7,13	109
680	4,90	108
1200	3,32	88
1800	1,96	56
2200	1,55	39

The LED is almost with transparent cover and placed very near the photodiode.

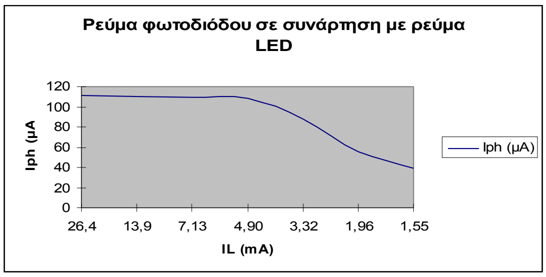

Figure 2. Graphic plot Iph (photodiode current) vs I_L (LED current)

We observe that roughly from value I_L = 4,90mA that corresponds in R=680 Ohm the current of photodiode that up to then was almost constant, it is decreased considerably. In the region 26,4mA> I_L > 4,90mA the number of photons that are incident to the photodiode is roughly constant, while for prices I_L < 4,90mA the number of photons that are incident to the photodiode is decreased considerably.

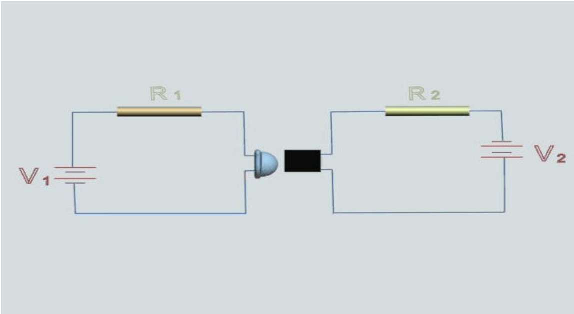

Figure 3. Design of the circuit (in 3D Studio Max)

If the distance between LED and photodiode is bigger than 1cm the photodiode current is very small (about zero). smaller than 2mm Is placed in the place of LED infra red with transparent cover a LED infra red with dark cover. Is not observed essential change in the current through the photodiode. Afterwards is placed in the place of LED infra red one red LED. Now the current through the photodiode is decreased too much. This happens because the photodiode is infra red, that is to say detects radiation in this range of spectrum ignoring the other radiation or presenting very small sensitivity in the other regions of frequencies. Removing LED infra red from the photodiode we observe that the current through the photodiode is annihilated. If however we connect the LED (transmitter) with the photodiode (receptor) via optical fibre then the circuit of photodiode has again current, which is smaller than that of initial topology (LED - photodiode in contact). This happens because in the fibre enters a "narrow" beam of total emitted from the LED radiation. But the light passes through the optical fibre and is transported through this without losses in big distances.

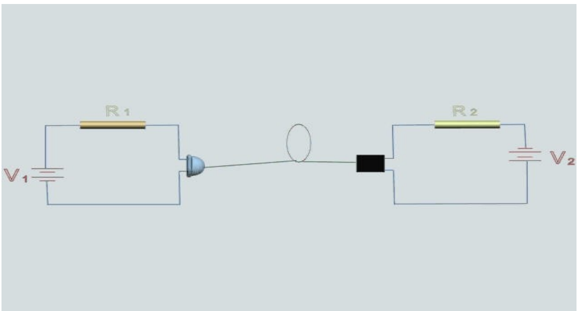

Figure 4. Design of the circuit with fiber optic

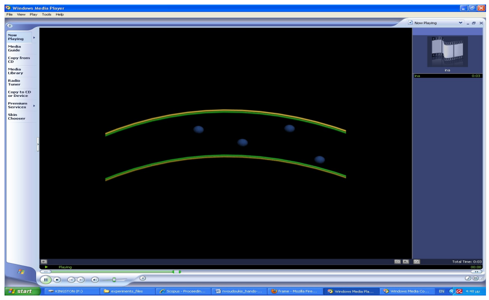

Figure 5. Visualisation of fiber optic and photons

b. Second experiment

Materials : power supply 12V, breadboard, cables, resistors, capacitors, transistor 2N2222A, LED infrared, photodiode infrared (BPW41), fiber optic cable 1m length, digital voltmeter, oscilloscope.

As demonstration experiment-generalisation, we transmit through optical fibre digital signal from transmitter of infrared light, suitably shaped, in corresponding receptor (IR link). For the adaptation of voltage that it provides photodiode (BPW41) is used an amplifier of common emitter while the LED is drived via amplifier of current from generator of square waveform. We regulate the frequency of generator in f=10 KHz with amplitude Vo = 1Vpp. It is used bias 12 V.

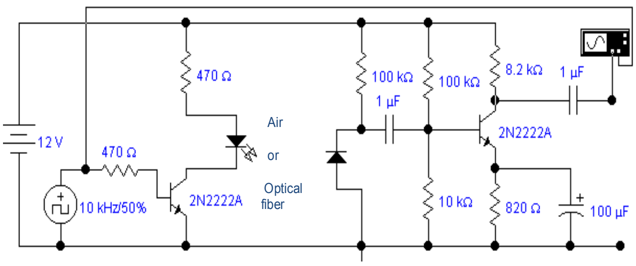

Figure 6. Design of the circuit

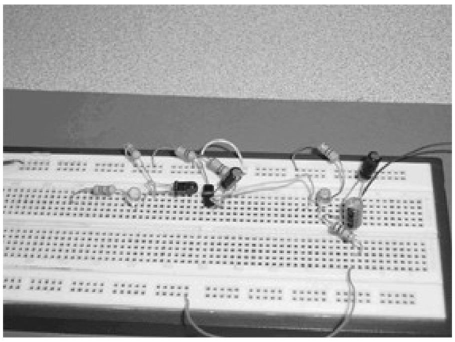

Figure 7. Circuit on breadboard for the second (demonstration) experiment

We observe at the screen of an oscilloscope the voltage waveform at the output (collector) of the transistor in the circuit of photodiode with optical fibre and without this.

Also we have a demonstration experiment with photodiode in zero bias and in reverse bias. We use an LED TSAL6100 and a photodiode BPW41N. We observe at the oscilloscope monitor the voltage waveform across the resistor in LED circuit and the resistor in photodiode circuit. First, in zero bias - this mode is responsible for the photovoltaic effect which is the basis for solar cells - we have the following figure.

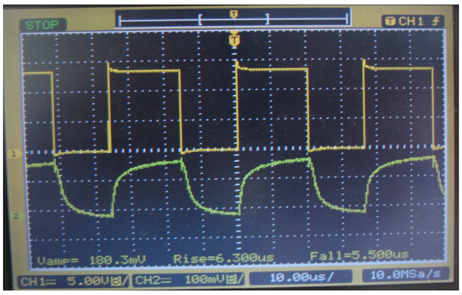

Figure 8. LED (up) and photodiode (down) voltage waveform with photodiode in zero bias

In photoconductive mode the diode is often reverse biased, dramatically reducing the response time.

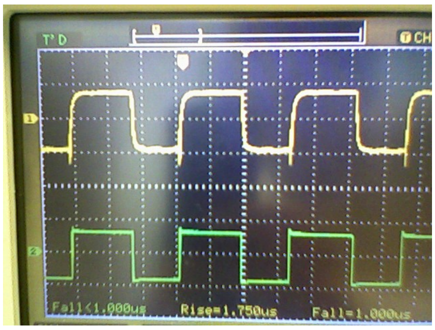

Figure 9. LED (up) and photodiode (down) voltage waveform with photodiode in reverse bias

5. Experiments' discussion –Main points

a. An LED is a special diode that emits light when connected in a circuit and biased in the forward direction. [1] b. A photodiode is a type of photodetector capable of converting light into either current or voltage, using the photoelectric effect. [2] c. An optical fiber consists of a core, cladding, and a a protective outer coating, in which the cladding guides the light along the core by using the total internal reflection for very big distances. d. The losses of light are negligible in his way in optical fibre concerning his way in air. The optical fibre bent in circle does not even present difference in its operation (light continues propagating). e. Light emission in the air follows the inverse square law. [3] f. Fiber-optic communication systems generally include an optical transmitter to convert an electrical signal into an optical signal to send into the optical fiber and an optical receiver to recover the signal as an electrical signal. The information transmitted is typically digital information. g. In photoconductive mode the diode is often reverse biased. h. We observe that the dynamic characteristics of receptor are improved with reverse bias.

6. Results from the tests

The mean value of degrees in pre-test was 5.89 and the mean value of degrees in post-test was 8.81. The mean value of degrees in final-test was 8.69 so slightly lower from it in post tests, which was expected.

7. Conclusion

In general the students worked with interest, systematically and most instructive objectives were achieved. Difficulties had the students in the use of multimeter. Before the exercise the students ignored the way of operation and use of LED, photodiode and optical fiber. The results were very encouranging. The activity is also proposed for the students of High school that have been taught the nature of light and basic

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A Method and Research for Hands-on Measurement of the Propagation Speed of Microwaves through Dielectric Material in Educational Physics Laboratory

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Abstract. *In this paper we describe a hands on activity in order to calculate the microwave propagation speed though a dielectric material. Through this activity we also calculate the refractive index of the dielectric and the microwaves wavelength.*
This exact experiment was given as a problem, using experimental data without taking measurements, to 193, 17 year-old Greek students, who participate in the Panhellenic Physics Competition (2010) for High school students. We analysed all the answers and in this paper we present all conclusions that we reached. Furthermore, in the last part of this paper we propose educational software, based on the "scientific / educational by inquiry model".

Keywords. Competitions, Interference, Microwaves, Problem solving, Scientific / Educational by inquiry model.

1.Introduction

Microwaves are electromagnetic waves with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 300 MHz (0.3 GHz) and 300 GHz.[3] However, there are no precise boundaries separating the microwaves from the neighbouring regions of the spectrum of electromagnetic radiation in the VHF and infrared radiation. Microwaves are divided into three separate zones:
• Decimetre microwave (Ultra high frequency, abbr. UHF) (0.3-3 GHz),
• Microwaves in centimeters (Super high frequency abbr. SHF) (3-30 GHz),
• Millimetre microwave (Extremely high frequency abbr. EHF) (30-300 GHz).[4]

There are many applications of microwaves in everyday life because of their wide spectrum. Microwaves are used to broadcast terrestrial television signals (UHF), satellite television signals and to satellite communications in general. Also they are applied to mobile phones (Wi-Fi, Bluetooth), to radars and microwave ovens.[2]
Microwaves can provide students with a rich variety of opportunities to explore interference phenomena in waves. They provide an alternative to visible light experiments, reinforcing the relevance of wave optics. Because microwave wavelengths are on the order of centimetres, the length scales of the aperture are easily manipulated and measured by students. Diffraction experiments also allow a quantitative evaluation of the theoretical intensity distribution beyond simply locating intensity minima and maxima.[1]

Dielectrics cannot absorb radiation because they lack of free electrons. So, dielectrics are employed as insulation for wires, cables and electrical equipment. The dielectric and the microwave source that we used in this experiment had zero absorption (the dielectric is considered transparent to microwaves, so the radiation intensity does not increase at all).

2. The experimental problem of 2010 Panhellenic Competition.

In a group of students was given the problem of measuring the speed of propagation of microwaves through a dielectric material. In the case of dielectrics the absorption of radiation is small since the dielectrics do not have free electrons. Especially for the dielectric and the microwave source that were given to students the absorption is almost zero (there is no reduction of the intensity of microwave radiation so we can consider the dielectric transparent to microwaves). A microwave receiver and a polymeter are connected. The polymeter's indication (amperage) is proportional to the microwave radiation intensity that reaches the receiver, so when the microwave intensity is high, the polymeter indicates high current. When between the transmitter and receiver is only air, the indication of the polymeter is I. These students thought to place between the microwave transmitter and receiver the dielectric so as to pass through it only half the package of microwaves and the other half arrives at the receiver through the air, as shown in the following figures.

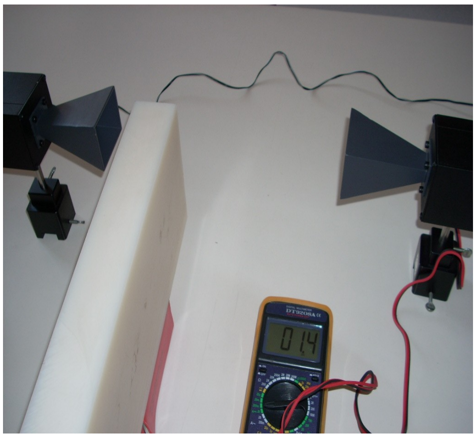

Figure 1. Half microwaves pass through the dielectric.

The students could alter the thickness of the dielectric, by mounting additional bars made from the dielectric. The procedure started from a very small thickness and when the dielectric reached the 25mm, the polymeter's indication was zero for the first time. The questions that were posed to the students of the Panhellenic Competition were the following:

8. Give a full explanation of the phenomenon that was observed when the thickness of the dielectric was 25mm.
9. If the microwave frequency is f=10.7 GHz and the speed of light in air $c_o=3*10^8$m/s, calculate the speed of microwaves in the dielectric.
10. What is the wavelength of microwaves in the air?
11. What is the refractive index of the dielectric for this wavelength?
12. What would the students observe if they had placed the same dielectric in a way that microwaves would pass though the dielectric and then reach the receiver? (See Figure 2.)

Figure 2. Microwaves pass through the dielectric.

<u>Proposed Solution:</u> 1. Half the microwave beam that passes through the material delayed half a period compared with the other half that was traversing the air. The result of this time delay is interference, because when the two beams reach the receiver have phase difference π rad. 2.Microwaves travel through air a distance d=25mm in time t, but when they travel the same distance through the dielectric they spend more time, $t+\frac{T}{2}$. T is microwave period, which is given by this equation: (1) $T=\frac{1}{f}$. The speed of waves in the air is (2) $c_o=\frac{d}{t}$. The speed of waves in the dielectric is (3) $c=\frac{d}{t+\frac{T}{2}}$. Equation (3) by means of (2) gives: $c=\frac{d}{\frac{d}{c_o}+\frac{T}{2}}$ from which we get finally:

(4) $c = \dfrac{2dc_o f}{2df + c_o}$ and if we replace with numbers we get:
$c=1.92*10^8$ m/s.

3. (5) $\lambda = \dfrac{c_o}{f}$ from which we get λ=2.8cm. 4. (6) $n = \dfrac{c_o}{c}$ which is n=1.56. 5. In this case both halves will have the same delay T/2 so the signal at the receiver will be reset and the polymeter will show again I.

3. Data Analysis

The questions posed to the students was within their capabilities as required knowledge of basic concepts of waves, such as wavelength, propagation velocity, refractive index, which they will need at the entrance examinations for higher education. The students should have read the problem carefully, in order to understand the whole procedure.

We examined 193 students' writings, 102 students were able to answer most of the questions but only 40 answered correct to every one of them. After analysing all the answers, we made the following charts (figures 3-7). Every chart depicts how difficult or not was each question for the students. More specifically the green bar represents the percentage of students who responded correctly, the orange one represents the percentage of students who gave a wrong answer and the white one represents the percentage of students who did not give any answer at all.

18. Question 1: 39% answered correctly, 42% answered incorrectly and 19% did not answer. Most of the students who answered incorrectly gave the same explanation for the phenomenon observed at the receiver. They claimed that the zero indication was due to dielectric's absorption of microwaves.

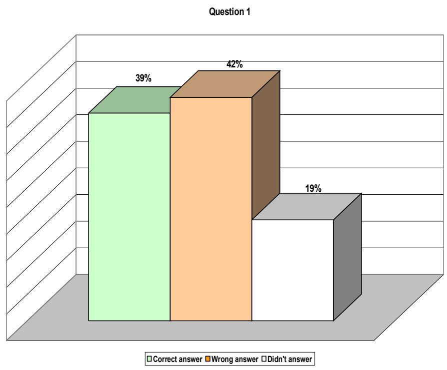

Figure 3. Question 1.

19. Question 2: 19% answered correctly, 21% answered incorrectly, 51% did not answer. We observed that the students were having difficulties in solving equations using only symbols. Additionally, some student's, who had answered correctly the 1st question, didn't succeed in the 2nd one because they did not use the phenomenon that was playing part in their solution.

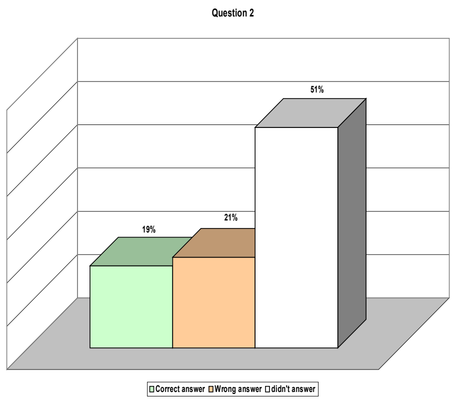

Figure 4. Question 2.

20. Question 3: 51% answered correctly, 39% answered incorrectly, 9% did not answer. Almost every student who answered this question was correct. They were able to use equation (5) and only a few were having problems with conversions to SI units.

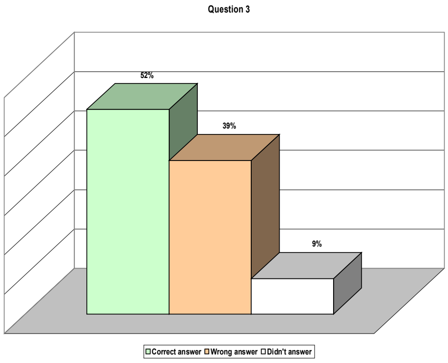

Figure 5. Question 3.

21. Question 4: 19% answered correctly, 42% answered incorrectly, 39% did not answer. Even though 61% of the students were familiar with equation (6), only those who had answered question correctly were able to succeed in this one too.

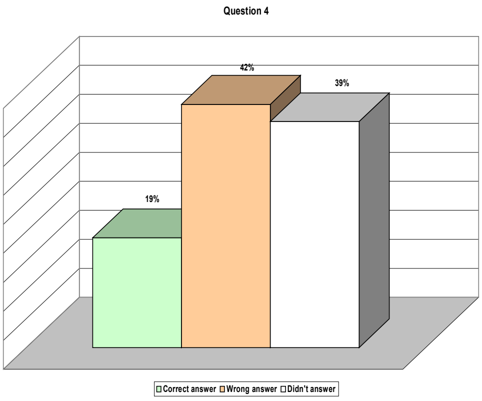

Figure 6. Question 4.

22. Question 5: 31% answered correctly, 22% answered incorrectly, 47% did not answer. Many students were having difficulties speculating about phenomena in physics. Some students justified their answer claiming that the dielectric is absorbent.

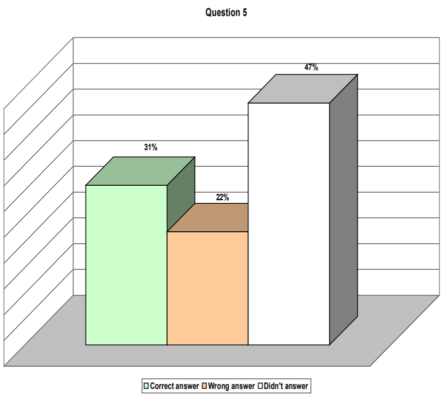

Figure 7. Question 5.

Finally, we gathered in a chart the percentage of correct answer for each question (Figure 8). Question 3 seemed to be the easiest for the students.

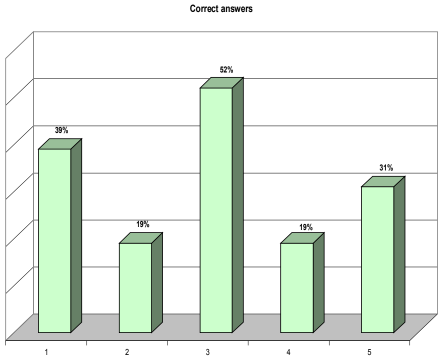

Figure 8. The percentage of correct answer.

4. Conclusions

After analyzing every answer, we came to some interesting conclusions. First, judging from the charts in figures 4, 5 and 6 we conclude that a certain amount of students are familiar with equations that describe phenomena in physics. Unfortunately, based on the chat in figure 3, a lot of students don't pay attention when they read the problem. This means that if they were more careful they would be able to answer question 1. Based on the chart in figure 7 we conclude that the vast majority of the students are having difficulties speculating about phenomena in physics and interpreting experimental results. Perhaps an explanation is that the students are not used to design and perform experiments and the only physics they experience is theoretical physics.

Finally, after taking into consideration all the previous conclusions, we designed educational software, based on the "scientific / educational by inquiry model". The 5-steps which characterise our worksheets are the following:

- Trigger of Interest
- Hypothesizing expression
- Experimenting- testing the hypothesis
- Concluding
- Application

We chose the previous mentioned experiment and other hands on activities in order to study some microwave properties that are used in everyday life. Apart from the experiments that take place in a lab, the software suggests a number of experiments that use interactive simulations.

To sum up, via these experiments students can study some electromagnetic waves' properties using microwaves instead of visible light, which can make it easier for them to follow the continuously advances in Technology, since microwaves are used in communications (antennas, bluetooth etc.), radars and other technological aspects of everyday life.

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A Hands-on Experimentation and Educational Study for a 2000 years-old Puzzle, the Mpemba Effect

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Abstract. *In this paper we study Mpemba Effect, where initially hot water, freezes faster than initially cold water, under specific conditions. This effect is a 2000 years-old puzzle. In order to investigate this unusual phenomenon experimentally, we first had to study all recent theories which have been developed to explain it. After that, we designed an experimental procedure in an appropriate way, so as to study some parameters' influence to Mpemba's Effect appearance. Our study leads us to some interesting conclusions that are incorporated in this paper. Furthermore, in the last part of this paper we propose an educational approach to Mpemba's Effect.*

Keywords. Mpemba's Effect, Evaporation, Convection Currents, Environmental Influence, Gas Content, Supercooling, Scientific / Educational by inquiry model.

1. Introduction

The purpose of this paper was to study the experimental parameters which mostly affect Mpemba's Effect appearance and contribute experimental data to the international bibliography. Moreover, we used Mpemba Effect in order to give an alternative approach to the "heat transfer" teaching at the Greek secondary education.

The Mpemba's Effect was well known in the previous centuries. A characteristic example is that in 350 BC Aristotle wrote:

"If water has been previously heated, this contributes to the rapidity with which it freezes" (Meteorologica)

Aristotle used this observation in order to support his theory called "antiperistasis", according to which there is a sudden increase in the intensity of a quality as a result of being surrounded by its contrary quality.

In the 15th century Clagett described Giovanni Marliani's experiments. More specifically he wrote the following:

"...In order to support his contention that heated water freezes more rapidly, Marliani first points to a passage in Aristotle's Meteorologica affirming it. However, does not depend on Aristotle'sstatement alone. He claims that not only has he often tested its truth during a very cold winter night, but that anyone may do so.

Moreover in 17th century both Francis Bacon and Descartes did experiments in order to confirm or reject Mpemba's Effect.

In the "Novum Organum" Francis Bacon wrote:

"...water a little warmed is more easily frozen than that which is quite cold..."

Descartes wrote in his famous book called "Les Meteores":

"...And we can also see by experiment that water which has been kept hot for a long time freezes faster than any other sort...."

From all the above historical statements, we can see that Mpemba's Effect was well known in the past, and many famous scientists and philosophers have study this strange phenomenon.

Mpemba's Effect was reintroduced by a secondary school student Mpemba in 1963 in Tanzania. Mpemba and professor Obsorne (professor from a local university) undertook several experiments in order to test the effect and published their results.

After this publication, it had been revealed that this phenomenon was well known in the food-freezing industry and for the ice cream makers.

Recently, new theories have been developed which try to explain Mpemba's Effect. So, according to the previous mentioned theories the parameters that possibly lead to Mpemba's Effect appearance are the following:

- Evaporation: Suppose that we have two bodies of water. The initial temperatures for the hot and cold water are 70ºC and 30ºC respectively. Our goal is to measure the time in which cold and hot water reach 0^0C and examine if Mpemba's Effect appears. A parameter that might change during the experiment is the **mass of water**. Both bodies of water initially have the same mass. But if the initially hotter water loses mass due to evaporation, then the 70ºC water cooled to 30ºC will be easier to freeze. In other words, due to the fact that initially hotter water loses mass, less energy will need to be removed in order to freeze it. This is one of strongest theoretical explanations for the Mpemba Effect.

- Convection Currents: Another parameter is the **temperature distribution of the water**. As the water cools convection currents are developed and the temperature becomes non-uniform. Suppose that we study the previous mentioned experiment. When the initially hotter water has cooled to an average temperature of 30ºC the top of the water will be hotter than 30ºC, whereas the bottom of the water will be cooler than 30ºC. This non-uniform temperature distribution with an average temperature of 30ºC will lose energy faster than uniformly 30ºC water. Convection Currents are extremely influenced by container shape, as a results this factor to have different impact to different containers. Moreover, "Convection Currents" parameter can easily be combined with "Evaporation" parameter in order to lead to Mpemba's Effect appearance.

- Environmental Influence: Another important factor for Mpemba's Effect appearance is Environmental Influence. The initially hotter water can change his surrounding environment in such way so as to affect the rate of cooling. In details, suppose that the containers are sitting on layers of frost. Hot water causes the layer of frost to melt, establishing better thermal conduct. This means that initially hotter water cools faster than the initially cooler water.

- Gas Content: Generally hot water contains less dissolved gas than cold water. Gas Content affects water properties. Based on this factor many theories have been developed until today, but none of them can be proved experimentally

- Supercooling: Is the process of lowering the temperature of a liquid or a gas below its freezing point, without becoming a solid. Many experiments have been developed in order to reveal supercooling affect to Mpemba's Effect appearance. Unfortunately, none of them have shown clearly in which way supercooling is significant for Mpemba's Effect.

2. The experimentation

Based on the previous mentioned theories, we designed an appropriate experimental procedure. In details:As a mean of cooling we used a rock salt and ice bath, we measured a chosen volume of water into a pyrex beaker and we used two thermometers and one stopwatch.

We chose 4 different experiments in order to study Mpemba Effect:

i) 50mL water - pyrex beaker

ii) 50mL water with a layer of oil on top of the water-pyrex baker

iii) 100mL water-pyrex beaker

iv) 100mL water with a layer of oil on top of the water- pyrex beaker

Furthermore, we chose 5 or more initial temperatures to test Mpemba Effect and followed the same procedure for each initial temperature:

Firstly, we heated the water to the desired initial temperature, we measured the chosen volume of water into a pyrex beaker and then quickly weighed the beaker and placed it in the rock salt and ice bath. During the procedure we had been recording water's temperature per minute, till it reaches 0^0C. We should underline that we have chosen to measure the time until water reaches 0^0C, since we did not want to involve supercooling in our experiment. Moreover, we should mention that we used oil layer on top of the water so as to reduce evaporation.

The experimental procedure

3. Data Analysis

For each initial temperature we plot the temperature-time graph. Then we created a diagram of temperature differences for each minute. Finally, based on the previous diagram we divided the graph into 2 or 3 parts and we used Logger Pro III software, in order to determine the average rate of temperature for each part.

For instance, at the initial temperature of 22.5°C (50mL water-pyrex beaker) we have the following graphs and diagram:

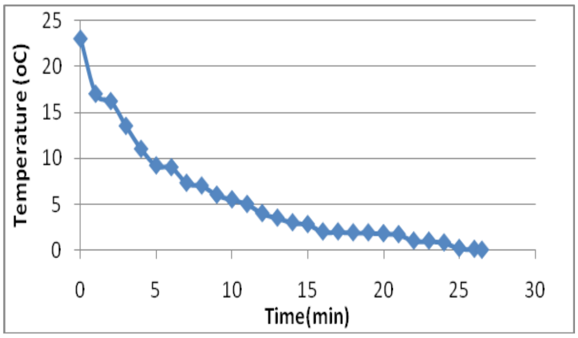


Figure 1

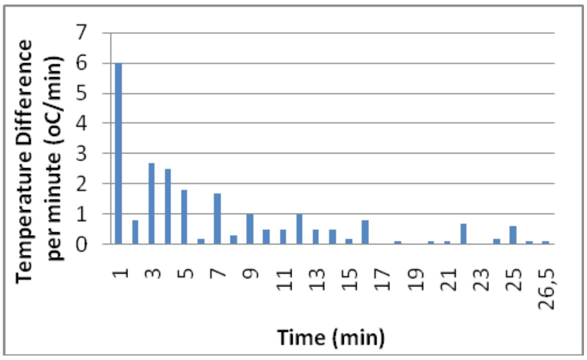


Figure 2

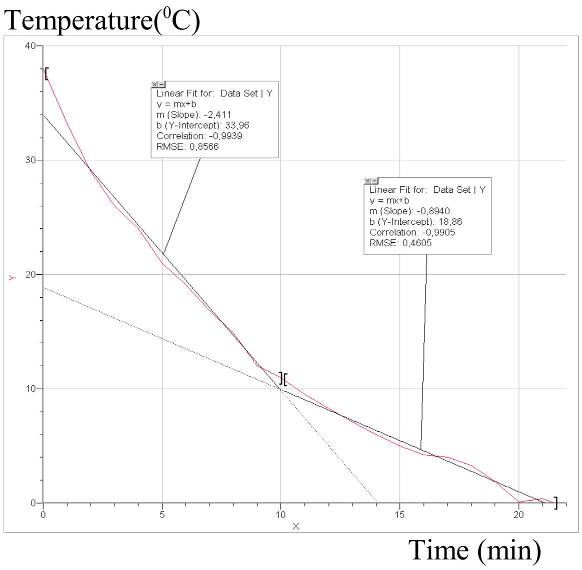


Figure 3

Moreover, at the initial temperature of 38°C (50mL water-pyrex beaker) we have the following graphs and diagram:

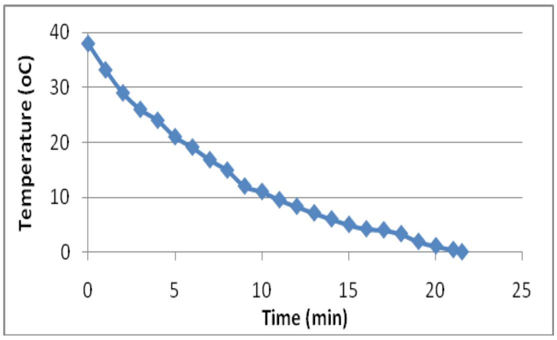


Figure 4

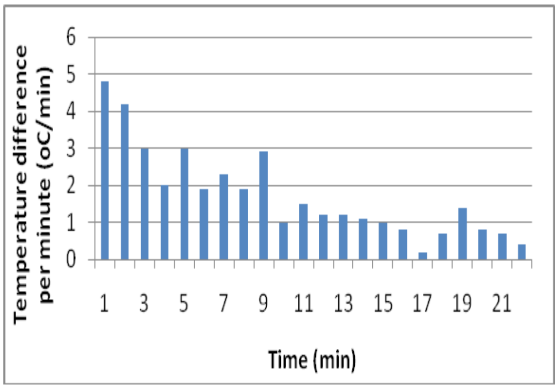
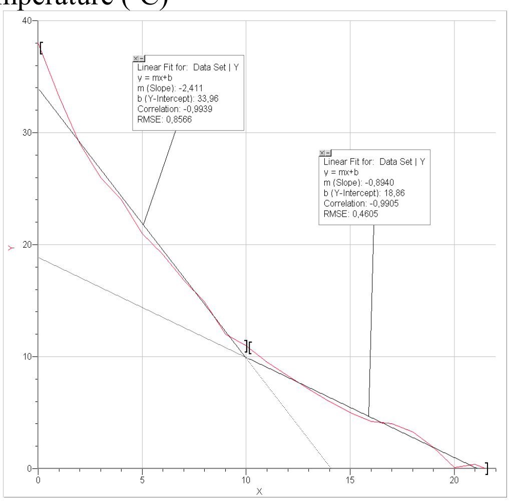


Figure 5

Temperature (^{0}C)



Time (min)

Figure 6

Based on the previous graphs and diagrams we can see that at the 10th minute, the temperature in the 1st case was 5.5ºC and in the 2nd case was 11ºC > 5.5ºC. However, figures 3 and 6 show us that at the same minute the rate of temperature change was 0.314^{O}C/min in first case (initial temperature: 22.5ºC), whereas in the second case (initial temperature: 38^{O}C) the rate of temperature change was 0.9^{O}C/min >> 0.314ºC/min. So, the body of water in the second case, despite the fact that at 10th minute has 2-time higher temperature, comparing to the first case, it reached 0^{0}C first, since it was characterized by 3-times higher rate of temperature change at the same minute.

The previous mentioned data analysis methodology was applied to the remained initial temperatures in all four types of experiment.

4. Conclusion

After analyzing experimental measurements, we construct the graph in Figure 7. The x-axis shows the initial temperature of the water. The y –axis shows the time it took for the water to reach 0^{0}C

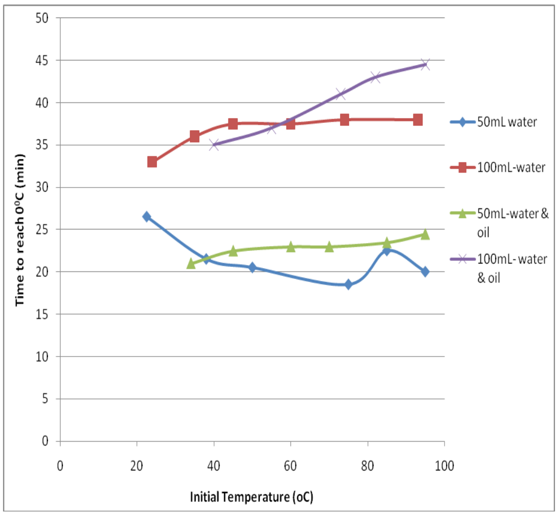


Figure 7

Based on the previous graph, we conclude that in the 1st experiment (50mL water in pyrex beaker) samples that were initially hotter reached 0ºC faster than samples that were initially cooler, confirming Mpemba's effect. In the 2nd experiment, where the only difference was the oil-layer on the top of the water, Mpemba's Effect has not been confirmed, showing how important evaporation is in order Mpemba's Effect to occur. 3rd and 4th experiments did not confirm the phenomenon we examine. Although, there have been stated many interpretations on Mpemba's Effect, there has not been developed any mathematical equation so as to describe time evolution of the temperature, such as Newton law of cooling. So, using our experimental measurements, we intent to give a quantitative approach to the effect we study. Finally, we can use this unusual phenomenon in order to give an alternative approach to "heat transfer" teaching at secondary education. In details, we created appropriate worksheets which are based on the "scientific / educational by inquiry model". The 5-steps which characterise our worksheets are the following:

1. Trigger of Interest
2. Hypothesizing expression
3. Experimenting- testing the hypothesis
4. Concluding
5. Application

Mpemba's Effect introduction to "heat transfer" teaching constitute an enriching activity of Greek secondary education curriculum.

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A prototype Physics Laboratory using only Renewable Energy Sources: The Case of a Low-Cost and Easy-to-Build Electricity Generator

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Abstract. *Physics Laboratories require the use of electricity in order to experiment in basic principles of physics. For example, a heat source is required when experimenting on Heat Transfer and an electric source for basic DC/AC study, Ohm's Laws e.t.c. Many laboratories use batteries for all those experiments, with well-known effects of their consumption to the environment, This study is based on the idea of discovering a way to produce the electricity that is required for all these experiments with the use of Renewable Energy Sources. We herein present one of the devices of that prototype Laboratory.*

Keywords. Easy-to-build Electricity Generator, Electromagnetism experiments, Renewable Energy Sources,

1. Introduction

A Renewable Energy Laboratory is distinguished by the extended use of renewable energy sources for the experimentation. The use of such kind of energy by the pupils in the process of experimentation leads to a positive view and understanding of environment friendly technologies.

In our study we present the construction of an easy-to-build device with low cost materials as a way to provide pupils with a hands-on exploration of generating electricity with water or human power. By constructing the model successfully, pupils learn and demonstrate the principles of generating electricity.

Figure 1 – Constructing the coils for the first device

Furthermore, they experiment on basic principles of Electromagnetism, Energy Conservation and Renewable Energy Production.

This is a thematic unit geared towards High School pupils and is suitable for teaching the courses of Physics, Technology and Environmental Sciences. By pursuing the objective to construct the model, pupils may develop complex cognitive and problem solving skills.

Pupils can also produce their own electricity necessary to reproduce fundamental electromagnetic experiments (which are mantandory in the curriculum of Hellenic Physics' Lab) like Ohm's Law, Electromagnetic induction, Alternative and Direct Current etc.

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Figure 2 – Building the stator

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2. Educational Methodology

Our goal in this study was for the pupils to approach the phenomenon of induction with relatively easy experiments. For this reason, the pupils are split in two groups and are given a worksheet which is based upon the aims and the objectives we describe in the next paragraph.

The worksheet includes the following steps of the scientific / educational by inquiry model [1][2]

- Trigger of interest
- Hypothesis expression
- Experiments
- Formulation of conclusions and proposals - recording
- Generalization - feedback – control.

2.1. Educational aims and objectives

Educational Aims

Pupils should:

- Acquire basic knowledge on phenomena that are related with magnets and electromagnetism.
- Practice on exporting conclusions via experimentation.
- Acquire a positive attitude concerning the use of renewable sources of energy.

Educational Objectives

Pupils should:

- Manufacture a Low-Cost and Easy-to-Build electricity generator.
- Describe the operation of an electricity generator and recognize the factors that play crucial role in the production of the electric current.
- Compare the produced electric current from the electricity generator with the one that we expected to get from the specifications of bibliography.
- Combine the operation of the manufactured electricity generator with the operation of major industrial electricity generators.
- Report alternative ways of operation of the manufactured electricity generator which are based on renewable sources of energy.

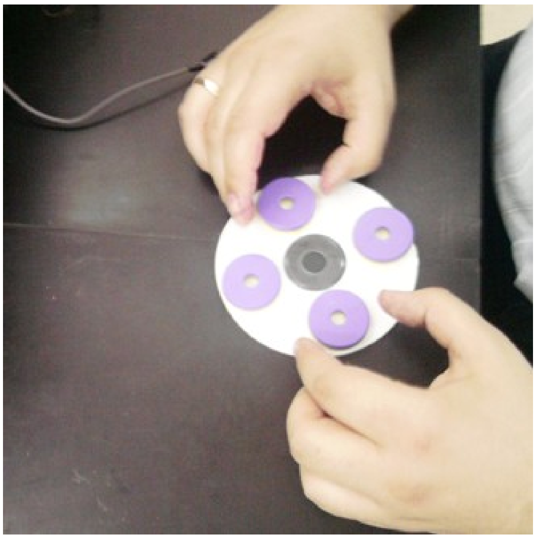

Figure 3 – Building the rotor

2.2. The Model in-depth

At the stage of Trigger of interest pictures and video of electricity generators are presented to the pupils Electricity generators that function with wind and water are selected to be presented in order to make more obvious the connection to renewable sources of energy.

In the stage of Hypothesis expression the pupils are left to formulate their opinions concerning the operation of an electric generator and the production of electric current.

In the stage of experimentation the two teams are requested to manufacture an electrical generator with simple and easy to find materials. Each team manufactures a different electrical generator so that in the end the pupils can compare them.

In the stage of Conclusions each team of pupils reports the final conclusions that are related with the operation of electrical generator and the production of electric current. The pupils are finally asked to choose one of the two generators based on criteria such as ease to built, lowest cost and production of current of higher tendency.

In the stage of Generalization the use of renewable sources of energy are presented to the pupils who are afterwards asked to find ways to replace the batteries in a renewable energy laboratory, especially those needed for the experiments of electricity (closed circuit, short-circuit, etc).

3. Building the devices

For our study we used materials such as: Plastic spoons, Magnets, Marking Pens, Wire connectors, Alligator Wire clips, a Multimeter etc. All of these materials are available in every school lab and easy to find for pupils, as well as the construction of the device is safe and the charge that the device produces is low.

The first team of pupils constructed an electric generator which was constituted of 4 coils adapted to a constant base (Stator) Fig. 2. [3] Each coil was made of 400 loops of copper wire (0,35 mm). In very small distance between the 4 coils pupils placed 4 magnets in a movable base (Rotor) Fig..3. In the utmost of the 4 coils pupils connected a LED light. As they rotated the magnets they observed that the LED light did not turn on, while the measurements of tendency that were recorded with a multimeter by the pupils never exceeded 0,2V.

Figure 4 – The coil for the second device

The second team of pupils constructed an electric generator which was constituted of a coil wrapped around a small paper box [4]. The coil consisted of 400 loops of copper wire (0,35 mm) Fig.4 and inside the box 2 magnets that had freedom of movement were adapted. In the utmost of the coil the pupils connected a LED light. Pupils turned the magnets with an axis adapted onto them and as they rotated the magnets they observed that the LED light turned on, while the measurements of tendency that were recorded with a multimeter oscillated from 0,8V(min) to 1,8V(max).

At the end of the experimentation phase the two teams concluded that the easiest to built generator with the best tendency measurements, was the second one. They also concluded that the way the magnets are moved towards coils is fundamental for the voltage measurements.

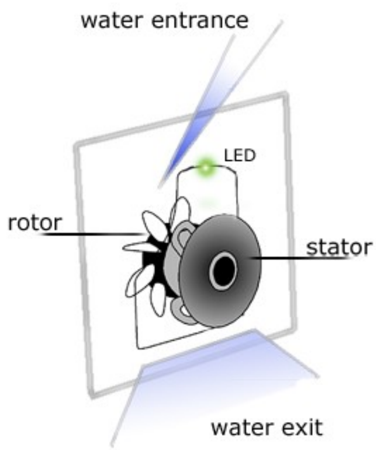

Figure 5 – The schematic of the final device

3. Renewable Energy Lab

After having constructed the two devices and finally having chosen the one which can produce higher voltage the pupils are requested to find a way to produce electricity using an alternative energy source like wind or water power instead of rotating the rotor by themselves. They chose to use water power and they created a construction shown in Fig.5

After their study in producing electricity pupils can use one of the devices they have already built for experiments on various physical phenomena, like: Ohm’s or Joule’s Law, Alternative and Direct Current Study and Safety related matters like short-circuit. The pupils had already experienced the difficulty of producing electricity and voltage over 1V so they will have the opportunity to choose experiments that can be accomplished with devices 1 or 2. For example they explain why they can lighten up two LED lights only when they connect them in parallel and not in serial circuit. They understand why they cannot heat up water with those volts and why we use special low voltage LEDs.

4. Conclusions

The construction of the device helps pupils to understand and apply scientific concepts and principles, conduct scientific inquiry, work in groups and communicate. Additionally they increase their conceptual understanding of energy production through construction of a model hydropower turbine and increase their mechanical and conceptual skills through construction and operation of the turbine. Finally they comprehend the basic electromagnetic principles that are necessary for the construction.

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Olympic School Science Fair: Playful and Explanatory Hands-on Experimentation for Elementary School Students

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Abstract. *Is it possible to involve all classes of the primary school in a science fair? What activities can be included in such a science fair and what results will be got? These are some questions we asked ourselves, as we planned to give a different direction to our school events, shortly before the end of the school year. We wished to devote our school festival to the presentation of students' educational activities, wich had been created during the school season. In this .presentation we report the main steps we followed, the scope of activities and a few results that surprised us.*

Keywords: Education, Hands-on experiments, Primary school, Science Fair

1. Introduction

Our school, the 26th Primary School of Acharnes, located in the Olympic Village in Athens is in its fourth year of operation The Olympic Village is a place, where in a short time span some ten thousand people of different origins were located, without there being any common vision or planning. The urban plan is modern, but there is lack of social infrastructure and activities that will give an outlet to the residents. Our school, that is co-located with the 29th Primary School of Acharnes, is attended by about 400 students aged between 6 and 12 years and has forty teachers of all disciplines The school building was constructed to serve about 250 students. The excess pupils are housed in metal prefabricated classrooms.

We believe that under these circumstances the role of our school should not be limited to the narrow framework of learning, but it should be a link to the whole community. The school's role is to highlight the particular skills of the students, to provide more learning opportunities, to encourage students to play a more active role, to involve the most possible members of the school community, in a climate of cooperation and mutual understanding.

Modern curricula emphasize the interdisciplinary approach of knowledge. Specifically, the science books, which have been introduced in recent years in primary education, promote the exploratory approach of knowledge with an emphasis on experimental procedures through teamwork learning.

One of the major problems reported in education [1] and especially in science teaching [2],[3] is lack of connection of school knowledge with everyday life. As a result students' knowledge is fragmentary and limited to the school subjects. Therefore, students and citizens later, accept interpretations of phenomena that are not based on scientific knowledge.

Today we believe that the tools of digital technology if available in schools are useful in the educational processes at all levels of education. Especially in our school, there is a fully equipped computer lab which helps students, with their teachers' guidance, to learn how to seek and process information. Thus, computers are tools for everyday use.

Our school participates in the activities of the Network of Educational Innovation [4]. This collaboration provides us the opportunity to have greater freedom in the choice of our educational activities and methodological approaches.

On the occasion of the end of the school year, we promoted the idea of organizing a festival that would allow all students and teachers to participate in a process of reflection, search, organization and presentation of what they have learned with relation to science.

2. Methodology - Planning

Science fairs in schools are not new in the international arena, while similar initiatives have been developed by the Hands-on Science Network. In most Greek schools, such events are infrequent, with a few exceptions [5] [6] and till today the Greek Schools' festivals at the end of the school year, usually include songs, dances and theatrical performances by students. When proposing to change this tradition there was concern about the realization and possible acceptance of a science festival.

The promotion of the idea and the interaction between teachers and students during the school year revealed new ideas, shaping and strengthening the spine of the event. It should be noted that we tried to involve all classes and teachers in the festival from their own perspective. Although the activities may have a different content for each classthere was a common method of approach according to the students' abilities and needs.

In all classes, the process began with students' questions, triggered either by issues arising from the textbooks, or by trying to understand and interpret natural phenomena, or environmental issues and technological applications.This approach is based on the inquiringly evolving educational model.

We urged students to express their own ideas/ hypotheses and they were asked to seek information, to participate in the activities, which took place inside and outside the classroom and to carry out experiments from the schoolbooks The idea of the science fair at the end of the school year was led to new ideas for different experiments or constructions out of simple materials.

The skills of observation, planning and organizing experimental procedures, control of apparatus, use of simple materials, interpreting experimental data, tracking and analyzing environmental issues and developing respective positions, were just some of the objectives we have set for our students.

In any case, we had no intension to impress with the presentation of the experimental procedures, but we aimed at participation and cooperation between the students, understanding and correlation between phenomena and concepts and our ultimate goal was development of attitudes based on addressing phenomena and situations of everyday life.

3. Description

The organization and choice of activities by so many classes, and students of different age and the participation of teachers with different interests, background knowledge and experience was not easy.

The spirit of collaboration, the need for renewed activity, the enthusiasm of the students in implementing these science related actions and their flexibility to adapt to whatever activity each class decided, allowed for the synthesis of a multifaceted image with common subject.

Specifically:

The younger pupils carried out environmental programs and actions related to marine species threatened with extinction.Specifically, they gathered information from the Internet, books and magazines. They created and presented material that included texts, poems written by themselves, photographs and paintings. They composed narrative videos, constructions, quizzes they played with their parents at school. The main focus of these actions was not only the environmental awareness, but the interdisciplinary approach of knowledge (fig.1, 2.)

Figure 1,2: Presentation of Environmental Programs

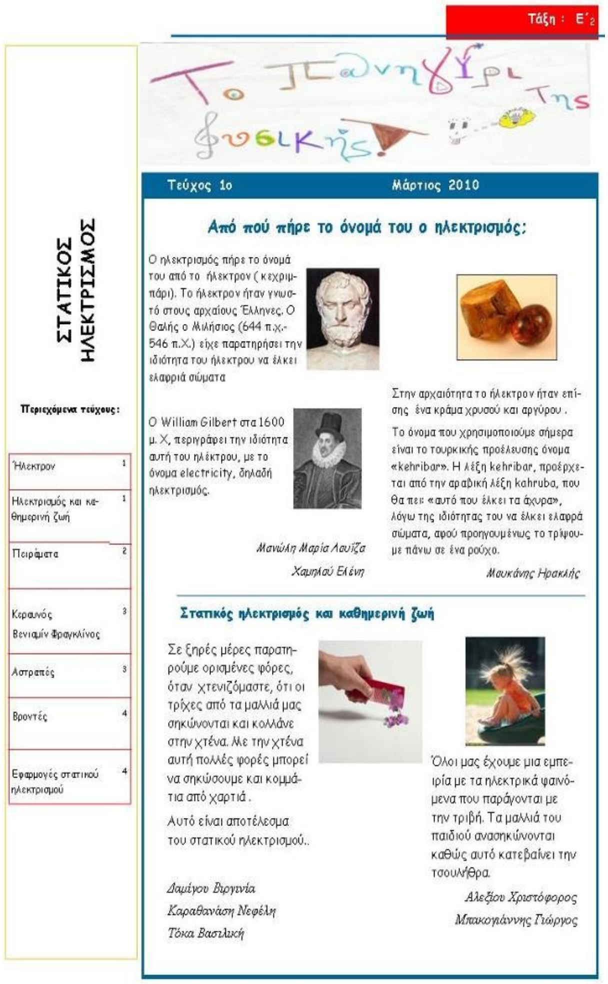
The students of the third grade collected utilities from the past that they compared with those of today. Furthermore, they distinguished the similarities and differences in their use, technological developments having occurred and changes in construction materials. Through this process, they discussed the changes that the technological development has brought into our lives, trying to move to the past in spirit and think of how their daily lives would be. Finally, they expressed their ideas about how they imagine the future. (Fig. 3)

Figure 3: Presentation of utilities from the past

The students of the forth grade dealt with the issue of recycling. Specifically, they explored the possibilities and benefits of reusing materials and they identified the problems of waste. In addition, they made musical instruments and utilities with simple materials (fig.4), they designed and presented the "fashion of recycling," and finally they wrote and played a puppet show on the Protection of the Mediterranean.

Figure 4: Construction of recyclable materials

The students of the two major classes were very interested in science during the school year as this lesson was very different from the others. In the science fair, they organized and presented experiments, using simple materials, by they own or with the help of digital technology that was available at the school. (Fig. 6)



Τάξη : Ε΄2

Το πανηγύρι της φυσικής!

Τεύχος 1ο | Μάρτιος 2010

ΣΤΑΤΙΚΟΣ ΗΛΕΚΤΡΙΣΜΟΣ

Περιεχόμενα τεύχους:

Ήλεκτρον	1
Ηλεκτρισμός και καθημερινή ζωή	1
Πειράματα	2
Κεραυνός Βενιαμίν Φραγκλίνος	3
Αστραπές	3
Βροντές	4
Εφαρμογές στατικού ηλεκτρισμού	4

Από πού πήρε το όνομά του ο ηλεκτρισμός;

Ο ηλεκτρισμός πήρε το όνομά του από το ήλεκτρον (κεχριμπάρι). Το ήλεκτρον ήταν γνωστό στους αρχαίους Έλληνες. Ο Θαλής ο Μιλήσιος (644 π.χ.-546 π.Χ.) είχε παρατηρήσει την ιδιότητα του ήλεκτρου να έλκει ελαφριά σώματα

Ο William Gilbert στα 1600 μ. Χ, περιγράφει την ιδιότητα αυτή του ηλέκτρου, με το όνομα electricity, δηλαδή ηλεκτρισμός.

Μανώλη Μαρία Λουίζα

Χαμηλού Ελένη

Στην αρχαιότητα το ήλεκτρον ήταν επίσης ένα κράμα χρυσού και αργύρου.

Το όνομα που χρησιμοποιούμε σήμερα είναι το τουρκικής προέλευσης όνομα «kehribar». Η λέξη kehribar, προέρχεται από την αραβική λέξη kahruba, που θα πει: «αυτό που έλκει τα άχυρα», λόγω της ιδιότητας του να έλκει ελαφρά σώματα, αφού προηγουμένως το τρίψουμε πάνω σε ένα ρούχο.

Μαυκάνης Ηρακλής

Στατικός ηλεκτρισμός και καθημερινή ζωή

Σε ξηρές μέρες παρατηρούμε ορισμένες φόρες, όταν χτενιζόμαστε, ότι οι τρίχες από τα μαλλιά μας σηκώνονται και κολλάνε στην χτένα. Με την χτένα αυτή πολλές φορές μπορεί να σηκώσουμε και κομμάτια από χαρτιά.

Αυτό είναι αποτέλεσμα του στατικού ηλεκτρισμού..

Δαμίγου Βιργινία

Καραθανάση Νεφέλη

Τόκα Βασιλική

Όλοι μας έχουμε μια εμπειρία με τα ηλεκτρικά φαινόμενα που παράγονται με την τριβή. Τα μαλλιά του παιδιού ανασηκώνονται καθώς αυτό κατεβαίνει την τσουλήθρα.

Αλεξίου Χριστόφορος

Μπακογιάννης Γιώργος

Figure 5: The first page of the newspaper

The experimental procedures included units of the curriculum such as density, solubility, air pressure, solids, production and dissemination of sound, static electricity, simple electrical circuits, conductors and insulators, contraction and expansion of solids, liquids and gases, acids, chemical reactions / bases and cellular structures. Also others were added, based on the interests and concerns of students e.g. transmission of waves, microscopic structures, planetary system, motion of missiles.

Figure 6: Observations with the digital microscope

Figure 7, 8: Pupils' experimental procedures, using apparatus and materials

The interaction between students was decisive for the development of our process. We have seen students cooperate even when disagreeing. Furthermore, common discoveries united them and gave them joy. (Fig 7-11)

Figure 9, 10,11: Highlights from the experimental procedure

4. Results

The process of organizing the festival of science at school, gave us some expected results and others that we were surprising.

The first point that impressed us, was that students with special learning or behavioral problems, participated in the activities. We were very pleased when we aw students that were diagnosed with learning difficulties, to take an active role. Not only had they gathered materials, but they also constructed experimental devices and experiments. They were active members of their team, they took responsibilities and finally they gained the acceptance of their peers.

The students moved quickly to self-organization processes and between teams rivalry developed, for the better presentation of their activities.

That the students undertook to present their activities to their peers and to their parents was a very important experience which helped them to develop self-awareness and present and support their opinions. Children who had difficulty to express their views and just reproduced the answers from the textbooks, managed to interact with the audience, explain and answer questions that they hadn't been prepared for.

The transportation and the expansion of the educational process out of the school environment, gave a different dimension to the subjects of the school programWe met children who spent break time or their spare time at home, trying experiments with simple materials and presenting them to their classmates.

Our students encouraged us to proceed by trying to find answers and explanations to phenomena that they were not interested in before.

Parents participated actively, in many of the activities. There were parents who did voluntary work for the preparation and construction of the experiments.

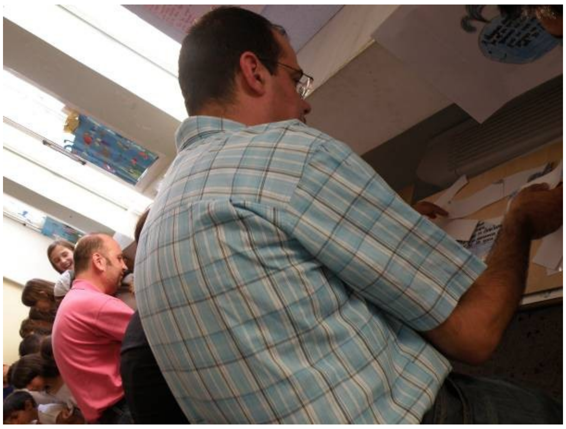


Figure 12. Parents participate in classroom activities

During the presentation, the parents took the role of learners and students took the role of instructors. The students set their parents thinking, encouraged them to express their hypothesis, implement experimental procedures or activities together and reach conclusions. (Fig. 12)

The whole process left excellent impressions to all of us. Our school opened up to the community, young and old people participated in the same path of learning and reflectionThe educational activities were not only confined to the classroom, but have been expanded into many areas of students' lives.

We believe that the science fair gave us the opportunity to promote and achieve objectives beyond the narrow framework of learning the lessons of science The two schools worked extremely well and the students with their teachers enjoyed their involvement during the preparation and presentation of the festival.

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Experiences from Long-Term Teaching Physics to In-Service Greek Teachers – Analysis and Proposals

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Abstract.
Teachers tend to teach as they were taught!
Do we have the right to insist on that "theory"?
Although the basic teaching style in too many (science) classes today remains essentially what it was two generations ago, the last years there is a growing body of research on how teachers (of science) will develop strategies to ensure that teaching is effective and matched with what is known about effective learning.
We believe that if the teachers are seriously trained and properly provided, they can be very effective.

Keywords Training in- service teachers, Problems, Aspects, Proposals

1. Introduction – Framework – Purpose

In-service training is considered to be an important component in the education of a teacher, helping to assure a high quality of performance in the classroom, from kindergarten to university level. With special regard to science, new developments and research results in different fields, new methods in didactics, new tools, either from the experimental side or with regard to computer utilization, demand a continuous effort to cope with these tasks. Another important aspect of in-service training concerns the exchange of experiences and materials between teachers. Whereas at the University level this part of further education lies in the sole responsibility of the individual, at the school level there exist some established programs for in-service training courses in many countries.
Seven years of ongoing experience, serving education as a school academic super indenter, we had the opportunity and the duty as well, to teach both subjects, Physics and Technology (training of trainers) to a great number of in-service teachers, The sample is about 500, especially teachers of fifth and sixth grade of primary school (10-12 years old).
Each teaching seminar lasts 120 min. and includes: introduction to the subject matter to be taught, the required methodology, some laboratory work and an educational intervention for the application of the microkosmos model.
The purpose is to discern their needs beyond the information provided by the teacher's and the student's book, to discover some good practices and propose some successful approaches.

2. Rationale – Research Questions

In this presentation we are going to analyze in brief:

- teachers' view about the scientific strategies and the common-sense reasoning,
- the appropriate (or not) use of the available means (teacher's instruction and lesson plan book, student's text /work sheet book, interdisciplinary student's book, materials for their experiments)
- the use of the proposed methodology, (by the curriculum)
- their skills in experimentation-as part of the methodology-
- the use of instructional technology (stimulations/visualization) - or otherwise, their ability to involve and explain the taught text/phenomenon using modeling process, supported by computer visualization.

3. Methodology

We follow the next steps:

- A short survey about their teaching preparation
- An exemplary teaching model based on the teacher's and student's books, following the proposed methodology (trigger, hypothesis, experimentation, theory, conclusions)

- Team - laboratory work on the teaching subject
- Approach of the microkosmos model
- Discussion on:

- Subject knowledge
- Methodological skills needed to translate their science knowledge into lesson plans
- Practical skills need by trainee teachers in order to design and set up experiments and investigations in school using standard equipment or design low-cost demonstrations using everyday materials
- Computer skills
- Curriculum statements translation into teaching routes
- Self evaluation

4. Results

After so many years and hours of training the trainers, we came to conclusions that refer to some main points (except of the necessity for continuing education):
-the need of a better preparation which concerns their involvement (practice) to the experiments
-the need to handle the microkosmos model (to support them), in order to make descriptions or give explanations
-the need of self evaluation
Better teaching is therefore grounded, first of all in improving the quality of teacher preparation and in making continuing professional education available for all teachers.

5. Conclusions – Proposals

We focus on the experimentation procedure, which involves the teachers themselves and propose the reference (occasionally -as part of their didactic approach) to a science education curriculum that is based on the microkosmos model as a unifying element, in order to describe and explain numerous natural phenomena appearing to be irrelevant between each other.
Finally as we all know that the way to interest children in science is through teachers who are not only enthusiastic about their subjects but who are also steeped in their disciplines and who have the professional training to teach the subjects as well.

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Hands-on Activities using Video Analysis of Motion with Low Cost Equipment - An Inquiring, Innovating and Utilitarian Proposal for the Hellenic Physics Curriculum

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Abstract. *The existent curriculum of Hellenic Physics' Lab has unfortunately been designed to run basically in a "Cookbook" style with a pre-specified course of actions for the pupils with the use of Microcomputer Based Labs (MBLs). Although MBL-effects upon student learning and conceptual development in undergraduate course of physics are un-doubtful, there are certain constraints in Hellenic schools, that eliminate those advantages.*

Our study aims to propose an innovative and utilitarian approach for the Hellenic Physics' Lab curriculum that will provide pupils with hands-on inquiring activities with the use of Video-Based Labs (VBLs).

Keywords. Low cost Video Analysis, Inquiringly evolving educational model, MBL, VBL

1. Introduction

Teaching High School's course of Physics and especially Physics' Lab in Greece, means following specific instructions. Both teacher and pupils receive an instructions' manual and they are obliged to follow a step-by-step guide through their preparation/experimentation/ and conclusion. The already mentioned manual includes a lab-sheet with empty boxes, tables and diagrams ready to be filled in. Firstly there is an introduction with the necessary equations needed for the sheet. The instruments that are going to be used are pre-specified and helpful figures are available for pupils in order to comprehend the given instructions. The most common equipment that are utilised in the Hellenic Physics' Lab are: the tape with the time stamp (Fig.1), a basic MBL consisted by two motion sensors connected with a timer (Fig.2) and rarely a distance sensor.

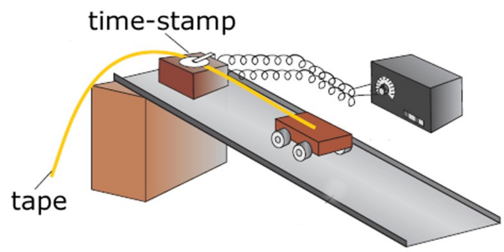

Figure 1

Unfortunately, most of the time there is only one pair of MBL's per lab which is usually broken. In most cases, due to malfunction, or even worse lack of equipment the teacher has no

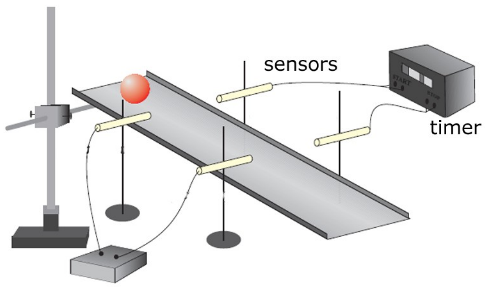

Figure 2

other option than to reproduce the experiment according to the given instructions and pupils can only take notes, as well as data and equations provided directly from the teacher that will afterwards use in order to fill in the Lab-sheet. All the above make the Physics' Lab boring for pupils as it deprives them from the feeling of discovering.

2. Our proposal

Although MBL-effects upon student learning and conceptual development in undergraduate course of physics are un-doubtful [1][2][3], as we already mentioned, certain constraints in

Hellenic schools, eliminate those advantages. Our team is currently focused on developing a different way of teaching Physics' Lab with low cost instruments, which would be easy to use and would give pupils the opportunity to practice their solving problem skills and finally make physics significantly more interesting for them. The solution to all the above is VBL.

VBLs can be a powerful tool with similar advantages to MBLs [4][5] in improving pupils' comprehension of difficult and significant issues in physic, like graphs. The most significant advantage of VBLs is that the above can be achieved without any specialized hardware or instruments like sensors etc, but only with a low cost web camera and a computer.

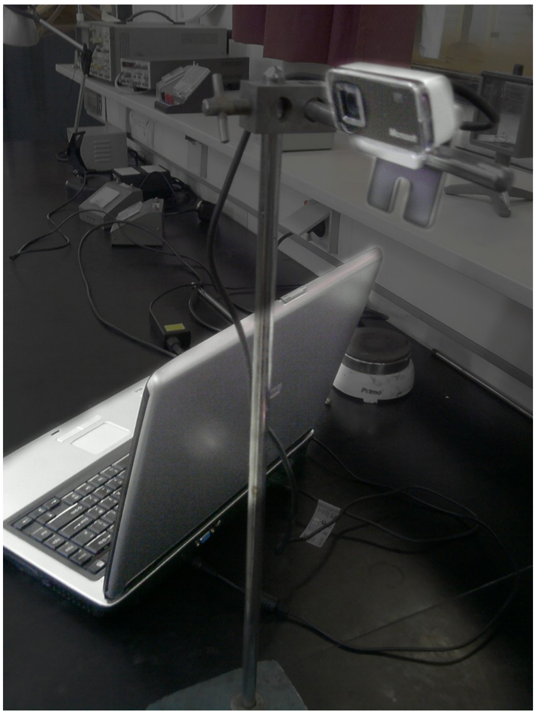

Figure 3 – Low cost equipment

The main advantages of video analysis are:

- Video analysis programs are very helpful for elimination of various barriers, which are faced during the incorporation of real-world investigation into math-studies. Also, they are considered to be an economical solution for enrichment of investigations and applications of graphical, mathematical, and numerical representations with real world problems and data. [6], [7], [8]
- Video analysis technology is one of the few easily accessible methods in order to achieve quantitative studies for a big variety of physical phenomena, which are not too fast to be recorded at 30 frames per second. [4], [6], [7]
- Computer-based video analysis is also considered an easy method for pupils. In addition, as the latter need to judge and understand the video analysis process in order to scale the video frames or choose interesting points frame-by-frame they need to deal with boring process of data recording and to concentrate more on the physical phenomena under study. [6]
- A very important advantage of video-analysis software is the very low uncertainty of the measurements, compared to other kinds of measurements made in laboratories. In a video, pixels (short of picture element) are used by the video-analysis software to measure the distances, which are afterwards scaled in meters with the use of an object of known length found in the video. Considering that the dimensions of a standard digital image are 320x240 pixels, the uncertainties in position measurements are only about 1%. [6],
- Another important advantage of video analysis suites is their versatility. This feature allows every object, wherever it is located, to be recorded during its motion and then to be analyzed by the video analysis software. In addition, modern computer technology makes easy and feasible the video analysis of every motion, which has been videotaped and of every video format which is available. [4], [5], [6], [7], [9]
- There is a huge variety of video material showing physical phenomena that take place outside the science laboratory. A student can video analyze this material obtaining any useful information about the position of an object frame-by-frame and can also extract informative graphs of position, velocity, acceleration, force, impulse, and energy with just a click of the mouse button. [1], [6], [7]
- The video motion programs are usually free or inexpensive and can be incorporated into homework assignments or distance learning. The video material can be recorded in many settings like residence halls, classrooms or even

outdoors using laptop computers and cameras. These videos are normally very short, but long enough to show a phenomenon fully and can be analyzed with low effort. [6]

- The video analysis software, based on assigned masses of system elements, can be configured for the calculation of the center of mass of a system of objects, or a non-rigid object. [6],
- Video-analysis technology allows pupils to study two-dimensional motion, like side shot or projectiles, unlike probes and sensors (basic tools in MBL), which don't provide this feature. [5], [6], [7], [9]
- By using video-analysis in science laboratory, pupils can analyze and collect data from motions of more than one objects, which as a result allows the study of multiple objects that are in the same system. [5], [6], [9]
- Video analysis is a data collection technique that doesn't require equipment like: cumbersome wires, probes and sensors associated with MBLs. [5], [6], [9]
- Video analysis technology provides an opportunity for pupils to observe graphs and video of the event at the same time. [8], [12]
- Using video analysis, pupils can record objects and analyze motions, which take place in distances well beyond range of most motion sensors. [5]
- Finally, the fact that any captured digitized video can be copied to any computer that has a playback board, allows the school science laboratories to posses only one and not multiple copies of the necessary video equipment. This feature makes video analysis technology more affordable for the classroom. [5]

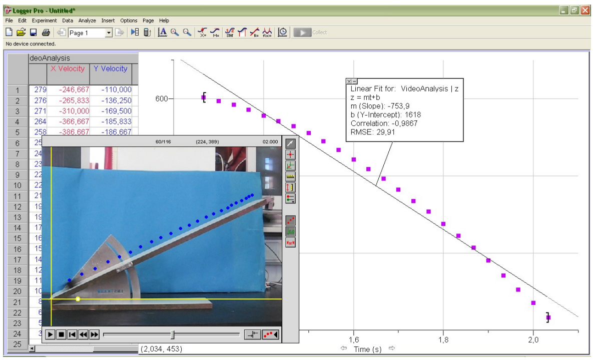

Figure 4 – Logger Pro's screenshot

For our study we used a five year old INTEL Celeron laptop and an external USB web-camera (MS Windows compatible) Fig.3. System requirements are not demanding of computational power. The software that was used consisted of two well-known suites for VBL: Logger Pro[10] Fig.4 which is a commercial packet and Tracker[11] Fig.5, a free cross-platform application. Both packets are user friendly and provide all the necessary tools for data analysis (graphs, equations e.t.c.)

3. Educational Model

Most physicists feel that lab courses are an essential part of teaching physics in school. Some have even gone as far as to state that all physics instructions should take place exclusively in the laboratory. Research conducted in order to determine the benefits of labs in teaching the course of physics, has consistently shown that labs which give pupils explicit instructions in a "cookbook" style have little value, particularly when it comes to addressing a problem-solving goal [12]. "Hands-on" experience is an efficient way in overcoming misconceptions. Solving a problem in the laboratory requires from pupils to make a chain of decisions based on their knowledge in physics. Wrong decisions based on wrong physics' understanding would lead to experimental problems that can be observed and corrected.

We herein present our view on how such experiments should be implemented in order to engage the pupils in the scientific process during lab-teaching, increase their ICT skills and provide all the advantages of Video Analysis with low cost equipment. Furthermore, as far as the educational approach is concerned, we suggest the scientific / educational by inquiry model [13][14], that includes the following steps:

- Trigger of interest

- Hypothesis expression
- Experiments
- Formulation of conclusions and proposals - recording
- Generalization - feedback – control.

3.1. The Model in-depth

Before the lab

The teacher imports the problem after having triggered his pupils' interest with an activity. (Step: Trigger of interest)

He describes the allocated equipment, and he assigns studies and a pre-lab test that needs to be answered by the pupils in order to allow them participation in the lab.

Studies are assigned to pupils split in groups and the latter need to cooperate with each other in order to collect information, formulate assumptions and design the experiment. (Step: Hypothesis expression)

At the lab

The teacher answers to questions and offers indications.

The pupils execute the experiment and collect data from measurements, (Step: Experiments)

The teacher answers to questions and offers indications once more.

The pupils analyze the measurements

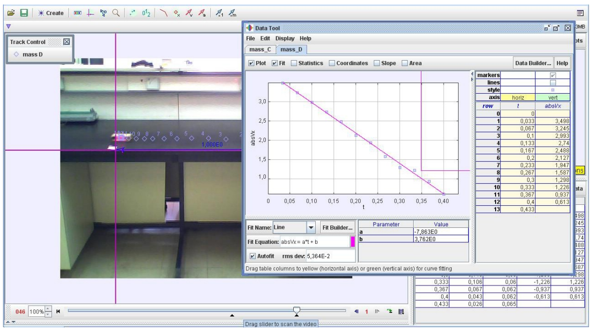

Figure 5 – Tracker's screenshot

After the lab

The pupils formulate conclusions. (Step: Formulation of conclusions and proposals - recording)

Finally, they publish the solution. (Step: Generalization - feedback – control.)

3.2. Video Analysis Procedure

Pupils, using a digital camera or a simple web camera videotape a physical phenomenon, which can not be too fast to be recorded. ~~(~~usually video with 30 fps is preferred, but for slow phenomena video with even smaller frame rate can be used~~)~~. After ~~the~~ recording, the digital camera must connect to a personal computer (desktop, laptop or netbook) with pre-installed a suitable video analysis software and the pupils after launching the software, insert the movie clip to the computer, for the process of analysis.

Pupils "mark" the location of the object in study in each frame of this movie clip by simply moving the mouse cursor over the object's location in the frame and "clicking." The program has the ability to advance (with every "click") the video clip automatically to the next frame, and even allows the pupils to predetermine whether they want to "mark" every single frame manually or every second, third etc skipping the rest of the frames to be automatically marked from the program itself, a feature which is particularly useful when analyzing lengthy video clips. As each frame is "marked," the vertical and horizontal positions of the object at that precise time are entered into a data table and are available to the pupils when needed. At the same time all the experimental data are automatically presented in suitable diagrams, visualizing the position and the velocity of the object horizontally and vertically, during the phenomenon.

After marking each of the desired video frames, pupils quickly and easily set as zero point (x=0, y=0) the lowest marked position of the object and use the meter stick in the video's background to convert coordinate~~s~~ values from pixels to meters. Since all the data and the graphs are scaled automatically according to the new measurement unit the pupils can now easily use the data, in order to calculate variables relevant to the physical phenomenon and its study. Fig.4,5

5. Results

This approach was followed in a set of four lab-exercises from the Hellenic Physics' Lab Curriculum. Those exercise were:

- Free fall
- Horizontal Projectile motion
- Measurement of kinetic friction coefficient
- Law of momentum conservation

In that first approach participants were students of Pedagogic Department P.E. and ~~the~~ pupils from the Greek team that will participate at the International Physics Olympiad – Croatia 2010. All those participants had similar characteristics to those of High School pupils.

Results from this process were the desired ones since pupils/students managed to practice their problem solving skills, learned how to design an experiment, gained an appreciation of the difficulty and joy of conducting and interpreting an experiment, learned how to use equipment, confronted their preconceptions about various phenomena and finally had fun by doing something more active than sitting back and listening. In other words pupils experienced what "real" scientists do.

Figure 6 – VBL Lab

5. Conclusions

Our study aims to propose an innovative and utilitarian approach for the Hellenic Physics' Lab curriculum that will provide pupils with hands-on inquiring activities with the use of Video-Based Labs (VBLs), in a way that pupils will find interesting that problem solving experience developing the same time their ICT abilities and revising their preconceptions about various physical phenomena.

The results of our work in the Science/Physics lab prove that VBL's can successfully replace the existent "cookbook" style-MBL Lab.

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Expanding the Horizons through Field Trips: Developing Global Action Plan For Saving Endangered Species and Threatened Environments

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Abstract: *The purpose of this study is to develop an action plan for protecting endangered species and threatened environment together with children from different countries. Out of 60 students, 41 students from Turkey, 13 students from Romania and 6 students from the USA have been involved in developing this action plan. At the beginning of the study, the students in each country formed a project team which was responsible for developing their part of action plan. Under the guidance of the coordinator teacher, each team was required to determine an endangered species specific to their region, and a study area nearby their school.*

Key Words. Endangered species, Threatened environment, Field trip, Water-soil experiments

1. INTRODUCTION

Outdoor activities give pupils to experience outdoor involving direct contact with the various aspects of natural environment [1]. Further, the outdoor activities, i.e. field trips, enable students to develop in-depth knowledge regarding the interaction among living and non-living organisms [2] and also affect (i.e. attitude, responsibility) and action skills (i.e. responsible behavior) as well as cognitive skills (i.e. observation, data collection) [1, 3]. Field trip is one of the examples of the outdoor activities. The professional literature and previous studies revealed that taking students to field trips help the students obtain first hand experiences through the use of scientific processes (i.e. observation, data collection and draw conclusion) [2, 4, 5]. In addition to, outdoor activities (field trips…etc) provide teachers and the students with opportunities [3] to study environmental issues first hand [6], and this approach has been effective in helping students develop an awareness of the environment [1,7]. By considering the importance of encouraging students to be involved in nature-related studies, Save Our Species Project (Project S.O.S.) was developed with the joint cooperation of primary schools from Turkey, Romania and America. The project was mainly grounded on nature studies which provided the students with not only hands-on but also minds-on experiences. The ultimate aim of this project is to develop environmental literacy and responsible behaviors of students for saving endangered species and threatened environment. Project S.O.S. is mainly based on the data and findings of the previous pilot project Unique and Universal which lasted three years [2, 5, 5, 12, 13]. For further details, please also read the article entitled "*A Unique Call for S.O.S.: Students around the World are Getting Together for the Project 'Saving Our Species"* within the conference proceeding book.

2. METHOD

During the 2009-2010 academic year, The Project S.O.S. was undertaken with primary school students (4^{th} to 8^{th} graders) from Turkey (five schools), Romania (one school), India (one school) and America (one school). Due to several reasons (illness, heavy school schedule), only three schools from Turkey, one school from Romania and one school from America sent the completed data collection instrument to the project coordinator on time. Only the data obtained from these schools were analyzed.

2.1. Participants

The participants of the study were 4th to 8th grades students from three countries; Turkey (n=41), Romania (n=13), and the USA (n=6). Twenty-two of the students were boys while 38 were girls. 21 students enrolled in 4th-5th grades while the remaining students enrolled in 6th-8th grades. The distribution of the demographic characteristics of the participants is given in Table 1 below.

Table 1. Students' gender and grades versus country

	Turkey	Romania	USA
Gender			
Girls	23	9	6
Boys	18	4	-
Grades			
4th-5th	21	-	-
6th-8th	20	13	6

2.2. Study areas and species

Each participating school assigned a project teacher who established a project team from that school. Project coordinator prepared a guideline which would help the project teacher coordinate the project activities within and out-of school. Project teachers were quided by the instructions given in the handbook *'Nature Education in 22 Steps'* during the project period. [11] They had meetings with the project team (within the school) and decided on the study area and endangered species that they worked throughout the 2009*2010 Academic year. The study areas and endangered species selected are given in Table 2.

Table 2. Study area and species by school and country

	School	Study Area	Study Species
Turkey	School A (Ankara)	Beynam Forests	Imperial Eagle (*Aquila heliaca*)
	School B (Ankara)	Atatürk Forest Farm	Angora Rabbit Oryctolagus cuniculus
	School C (Diyarbakır)	Dicle-Fırat Rivershed	Euphrates Soft- shelled Turtle (*Rafetus euphraticus*)
Romania	School D (Satu Mare)	Satu Mare RiverTur Valley	Noctule Bat (*Nyctalus noctula*)
USA	School E (Baltimore)	Maryland Cheseapeake Bay	Monarch Butterfly (*Danaus plexippus*)

2.3. Data Collection Instruments

Developed by the first two authors [1], three data collection instruments were utilized to assess students' knowledge, attitude and behavior regarding endangered species and threatened environments and two instruments to assess students' ability to collect and analyze the data, and then conclude the results.

Knowledge Test (with behavior items); This test included both open-ended and closed-ended items. The items were associated with students' knowledge regarding endangered species, threatened regions and water quality parameters (pH, heat, dissolved oxygen, turbidity), and their source of knowledge, and also types of action needed to be taken on these topics.

The Attitude Questionnaire; This test was used to investigate primary school children's attitudes toward endangered species and threatened regions. The instrument consisted of 13 closed-ended items on a 4 point Likert-type scale (1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree). For each item, the students were required to explain the reasons behind their tendencies and responses.

The picture form; This form was used to determine to what extent the students know the characteristics of the endangered species they focused. The students were asked to draw a picture of the species. They were also required to indicate the characteristics of this species.

Field trip tests; Two field trip tests were used (1) to determine students' knowledge about the scientific experiments (identifying problem(s), determining variable(s), collecting data, interpreting data and presenting the results/findings) carried out during the field trips; and (2) to determine the students' knowledge of the endangered species upon which they focused.

2.4. Data Collection

During academic year, the students were taken to the study area more than once for close examination. In the field studies, the students took water and soil samples for investigating the effects of water and soil quality not only on flora and fauna of the study area but also on selected endangered species. At the beginning and at the end of the field trips, field trip tests were administered. Other data collection instruments (knowledge test, attitude questionnaire and picture form) were given to the students during regular meetings at the end of the spring semester.

2.4. Data Analysis

Open-ended results from the data collection instruments were subjected to content analysis. On the other hand, quantitative data were assessed by making use of SPSS 11.5.

3. RESULTS

3.1. Students' knowledge

Turkish students believed that the species are being endangered due to excessive and uncontrolled hunting, water and air pollution, people ignorance of the natural environment and other species, loss of natural habitats, lack of protection measures, global warming, urban sprawl, over-population and damaging the forests. Ignorance, lack of awareness, lack of protection measures and uncontrolled hunting were seen to be more effective reasons causing the species to be endangered. On the other hand, the students believed that natural regions are threatened due to unawareness, lack of environmental policy, factory wastes and discharges, water and air pollution, chapping-down, uncontrolled usage of natural sources, littering, droughts, global warming, uncontrolled pesticide usage, urban sprawl and uncontrolled industrialization. Unawareness, uncontrolled usage of natural resources and littering were indicated to be more influential reasons.

To Romanian students, species are being threatened due to water and air pollution, littering in the natural habitats, uncontrolled constructions, usage of chemicals, lack of food and loss of habitats and excessive and uncontrolled hunting. Pollution and loss of habitat were the most important ones influencing the species to be endangered. They believed that natural regions are threatened due to cutting down trees, destroying parks, excessive constructions, littering, pollution, lack of interest in the environment, ignorance and chemical usage in the land. Excessive constructions, littering and ignoring the environment were indicated to be more negative impact on the natural regions.

American students indicated that hunting, loss of habitat and food, and littering were main reasons causing the species (Monarch Butterfly) to be endangered. Loss of habitat was cited to be most influential one. Over population, over-use, invasive species, littering and chopping down the forest were the main reasons of being threatened of natural regions. Invasive species and over population were seen as more negative impact on the natural regions.

School (including curriculum and science teachers), media (TV, internet and magazines) and the project they were involved (S.O.S.) were the main information sources regarding endangered species and threatened regions for the students in three countries. Even though the school was rated as one of the information sources, nearly all of the students within the project reported that course textbooks, class activities and subject taught in the classroom were very limited and not sufficient to be knowledgeable about the species and natural regions. The students in all countries reported the importance of field trips activities and out-of school activities to do more observation and more practice in the natural regions.

Students' knowledge regarding the species selected for the study (see Table 2) was also assessed by using picture forms. In the picture form, students drew the species on which they focused and wrote the characteristics of the species. Their pictures and identifications of the species revealed that some of the students knew very well the characteristics of the species whereas the others indicated very limited identification. Examples from the students' drawings are presented in picture 1 to picture 5.

Picture 1. A picture of Imperial Eagle (*Aquila heliaca*) drawn by a student in School A

Picture 2. A picture of Angora Rabbit (Oryctolagus cuniculus*)* drawn by a student in School B

Picture 3. A picture of Euphrates Soft- shelled Turtle (*Rafetus euphraticus*) drawn by a student in School C

Picture 4. A picture of Noctule Bat (*Nyctalus noctula*) drawn by a student in School D

Picture 5. A picture of Monarch Butterfly (*Danaus plexippus*) drawn by a student in School E

Students' responses to the questions assessing their knowledge on field trip experiments indicated their lack of knowledge on water and soil quality parameters. However, the field trip test administered after field trip activities revealed students increased knowledge on these parameters (physical, and chemical parameters such as pH, dissolved oxygen, heat…etc).

3.2. Students' attitudes

Turkish students strongly supported that the endangered plants and animals should be protected (95% Turkish students, %83 Romanian students, 100% American students), pesticides should only be used under the control of agriculture engineering (88% Turkish students, %50 Romanian students, 100% American students), natural resources should be very carefully used (88% Turkish students, 75% Romanian students, 100% American students), each individual in the society should do something for protecting species (85% Turkish students, 58% Romanian Students, 88% American students). The students were excited when doing search about the endangered species (80% Turkish students, 100% Romanian students, 100% American students). They thought that unplanned industry and urban sprawl had negative impact on endangered species (68% Turkish students, 33% Romanian students, 67% American students). They become unhappy when they saw people doing nothing for endangered species and threatened natural regions (83% Turkish students, 83% Romanian students, 100% American students). They felt happy when they thought of solution for preserving endangered species and threatened regions (83% Turkish students, 92% Romanian students, 100% American students) and when they came up with solutions for saving them (88% Turkish students, 92% Romanian students, 100% American students). They were observed not to approve the construction of new building over the natural regions (54% Turkish students, 58% Romanian students, 100% American students). Almost all of the students from three countries reported that wild animals should not be killed because they are a part of ecological cycle and they have right to get by within the nature. Despite few, the students thought that the projects aiming to protect endangered species and threatened natural areas in the World and in their own country were adequate.

3.3. Students' suggestions and actions

Students from all countries were appeared to be very motivated to take action for protecting species and natural regions. They indicated several action strategies for taking protection measures.

Turkish students were more concerned about informing and warning people about the species and natural regions through campaigns, posters, e-mail groups, forums and projects. Even though some participated already, some indicated that they had not yet done anything, but volunteer to participate in environmental protection studies and projects. Some prepared posters for increasing the awareness of other people on the species and natural regions. They believed that giving fines, putting new laws, creating special areas for the plants and animals located in those threatened areas, putting much more information about these topics in the textbooks, holding conferences and seminars, and warning people who are polluting the natural areas were very significant precautions for helping protect endangered species and threatened regions.

To Romanian students, three actions should initially be taken for helping protect endangered species and threatened regions; (1) Putting much more information about these topics in the text-books, (2) creating special areas for the plants and animals located in those threatened areas and (3) sharing the findings of the project with other students and teachers in the school. They all so motivated to take part in the environmental-related projects aiming to save species and natural regions. Many of them appeared to be involved in waste management activities (i.e. recycling).

American students indicated the importance of raising the awareness of people about endangered species and natural regions through conferences, seminars and school curriculum. They also believed that people should not be allowed to enter the threatened regions.

4. CONCLUSION

This study was, one more time, indicated the significance of field trip activities to realize the ultimate aims of environmental education; developing students' environmental literacy and thus environmentally responsible behaviors [8, 9, 10].

Students reported low level of knowledge on the endangered species and threatened environment at the beginning of the study. Also, they had limited knowledge on different varieties of species. However, during the academic year, they developed their knowledge on this topic through internet search, series of field trips nearby their school, and interaction with other students in the project. The picture they drew showed to what extend they were familiar with the species they focused. The project they were involved provided opportunities them to go through for the possible reasons that have negative impact on the species and the natural habitats regions. The information sources they used were reported as school environment, media and the project S.O.S.

The study further revealed that most of the students were observed to be highly concerned about the endangered species and threatened habitats. They reported high level of motivation and willingness to take action for saving the species and natural habitats. They strongly believed in their strengths to take part in protection studies.

As reported by the students, the classroom activities and text-books were seen insufficient in terms of their content regarding endangered species and threatened habitats. In this regard, the teachers are suggested to include more field-trip activities in school curriculum.

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A Unique Call for S.O.S.: Students Around the World are Getting Together for the Project '*Saving Our Species*'

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Abstract. *Project S.O.S. (Save Our Species) is an environmental project involving primary school students around the world. The project aims to develop a unique action plan whose main goal is to demonstrate the significance of encouraging students to take the initiative for saving endangered species and threatened areas throughout the world. In this Project, students also develop new ways of gaining knowledge that can only be developed through field work in the 'outdoor classrooms' within the heart of nature. The schools involved in Project S.O.S. have flexible activity plans whose contents have been continuously shared and discussed by the collaboration of the partner schools in the project website.*
The aim of this paper is to present data obtained from the implementations of the labwork, artwork and fieldwork by sharing and discussing the steps followed, the activity sheets and the data collection tools used by the students, the reports based on students' records and the letters sent to the partner schools within the context of Project S.O.S.

Keywords. Environmental project, Endangered species, Threatened areas, Outdoor classrooms.

1. Introduction

When students are given an opportunity to study in a natural setting, they are able to gather data directly using their own senses and careful examination. They observe the interactions between living and non-living components of the ecosystem and also interactions among various life forms. By being directly involved, the students develop not only a cognitive understanding of the environment, but also affective and action skills. When they are encouraged to design investigations in a natural setting they develop a sense of responsibility for that habitat and those who live in that habitat. They can use scientific process skills making use of observation, in-depth questions and experiments to answer the questions. Through working in a natural setting, students develop a sense of stewardship for the natural world and find their own place within the environment they are studying.

Project S.O.S. has mainly concentrated on the endangered species and their habitats worldwide. The core subjects have been studied by primary school volunteer students from different parts of the world.

Based on the data and findings of the previous pilot project *'Unique and Universal'*, which lasted three years, Project S.O.S. aims to develop an action plan by gathering the students around the theme of scientifically studying endangered species and their habitats, sharing the data among partner schools and thus drawing global attention to the significance of taking responsible action towards these species. [1,2,3,4,5,6,7]

The project was initiated in Turkey in 2009 with the participation of 122 students from nine primary schools located in Turkey (n=98), the USA (n=6), India (n=5) and Romania (n=13).

Initially, schools were asked to volunteer for the project through the National Eco Schools Meeting held in Muğla, Turkey; the 6th International Hands-on Science Conference held in Ahmedabad, India and the Teacher Training Seminar held at Akdeniz University in Antalya, Turkey in 2009.

With the participation of the nine primary schools and their co-ordinating teachers from Turkey, the USA, Romania and India, a website where all the participants have been able to share their labwork, artwork and fieldwork data has been constructed; initial instructions were given by the first author at the beginning of the educational year 2009. This website has served as a motivating platform on which innovative ideas and unique practices have been constantly shared and 'brain stormed' by the teachers and students involved in the project.

Activity plans were developed to be shared by the schools and ideas were exchanged. Due to the differences between physical settings, flexibility remained a key feature of the implementations realised both at school and also during field work, amongst the participating schools.

During the year, the students were taken on field work trips to make observations according to their activity plans. They formed model water ecosystems and researched the effects of pollutants in still waters, by using scientific methods at the laboratories. In the field, the students took water and soil samples to conduct water quality tests and recorded their findings. They were mainly guided throughout the whole process by the instructions given in the project handbook, *'Nature Education in 22 Steps'* [7].

It is hoped that the students involved in Project S.O.S. will continue to collaborate with their partners in the project. The scientific methods used, together with the close observations they made, should promote their sense of curiosity and their understanding and interpretation of environmental cause-and-effect relationships in nature. As a result of all these practices, in which they view themselves as an intrinsic part, they develop a sense of caring for the natural world, followed by the wish to protect and enhance. Meanwhile, the students' awareness of natural phenomena increases. Thus they develop positive attitudes towards endangered species and their habitats, by contributing to the project. At the beginning and the end of each semester, pre- and post participation assessment tests are given to the students in order to assess the outcomes of the project on their development.

1.1 Summary of Study Species and Sites

The endangered species, together with their threatened habitats, as selected by the nine volunteer schools located in Turkey, the USA, Romania and India involved in S.O.S. Project are summarized in Table 1.

2. Methodology

2.1 Participants

122 students from nine primary schools located in Turkey, the USA, India and Romania have been voluntarily involved in Project S.O.S.

Country	School	Study Area	Study Species
Turkey Coordinator country	Göktürk	Ankara Beynam Forests	Imperial Eagle *Aquila heliaca*
	Kavaklıdere	Ankara Atatürk Forest Farm	Angora Rabbit *Oryctolagus cuniculus*
	Şehit Öğretmen Nuriye Ak Primary School	Diyarbakır Dicle-Fırat Rivershed	Euphrates Soft-shelled Turtle *Rafetus euphraticus*
	Uzunmustafa Primary School	Düzce Efteni Lake	Caucasian Festoon *Zerynthia caucasica*
	İnci Narin Yerlici Pimary School	Orhaniye Çetibeli Sığla Forest	Anatolian Sweetgum Tree *Liquidambar orientalis*
	İ Private Ekin College	Seyrek Menemen Gediz Delta	White Stork *Ciconia ciconia*
USA	Roland Park Country School	Baltimore Butterfly Meadows in Cheseapeake Bay Watershed	Monarch Butterfly *Danaus plexippus*
Romania	School Number 5 Satu Mare	Satu Mare River Tur Valley	Noctule Bat *Nyctalus noctula*
India	Panchayat Union School	Cuddalore Kundiyamallur La	Bird species at Kundiyamallur Lake

Table 1. Selected species and their habitats

2.1.1 Turkish Sample

The total number of students joining the project from Turkey was 98, from six schools located in Ankara, İzmir, Orhaniye, Diyarbakır and Düzce. The students ranged in age from 9 to 15 years.

The Table 2 shows the number of students involved in the project from different locations in Turkey.

Table2. Number of Students joining the project in Turkey

School and Location	# Stu.
Göktürk Primary / Ankara	20
Kavaklıdere Primary / Ankara	15
Uzunmustafa Primary / Düzce	22
Şehit Öğretmen Primary/ Diyarbakır	6
İnci Narin Primary / Orhaniye	15
Ekin College/ İzmir	20
Total number	98

2.1.2 The USA Sample

The number of students varies throughout the year. In the months of September to November the Butterfly Club, which is the alternative name of Project S.O.S., is large because that is when the Monarch butterflies are in the area. In the spring (February to May) there are only about six students - that is when they are mainly working in the garden. They ranged in age from 10 to 13 years.

2.1.3 Romanian Sample

Thirteen students from School Number 5 in Satu Mare, Romania took part in the project. Some of the students had previous experience in outdoor fieldwork. The students ranged in age from 13 to 14 years.

2.1.4 Indian Sample

Five students from Kundiyamallur in Cuddalore district, India took part in the project. The students ranged in age from 13 to 15 years.

3. Summaries of Project Activities Performed by Partner Schools

A sample of one semester action plan that was created by the first author was shared by the partner schools on the website at the beginning of the educational year, in order for the partner schools to be generally informed. Following this step, each school was expected to create their own unique action plan that is most appropriate for their physical settings, curriculum agenda and their surrounding environment.

3.1. Göktürk Primary School, Ankara, Turkey

In Göktürk Primary School, following a preparatory period, the project had a prompt start in December 2009. The students were already studying the Eco Schools Project and they were very excited by the idea of a new environmental project to action. A series of meetings followed.

They researched local endangered species generally and decided to study the Imperial Eagle. Their activity plan was constructed by exchanging ideas through brain storming. At the beginning of the study, the students were set assessment tests. They prepared Power Point presentations and a poster. The poster was presented on their Project S.O.S. Bulletin Board.

While drawing Imperial Eagle figures on the picture forms, they realized that they could distinguish significant differences between Imperial Eagles and the other eagle species.

Poetry and drawing competitions were organized at the school. First, second and third prize winning ceremonies followed these competitions. From these drawings, a calendar was created by the students. Each week on Wednesdays, a seminar whose topic was the question of ‘What can we do to protect the Imperial Eagles?’ was delivered by the students in the classes. The stories about Imperial Eagles written by the students were shared by the students in classes. Through all these activities the students’ mutual interest towards Imperial Eagles was awakened.

Figure 1. Birdwatching around Mogan Lake

Following the field work, photographs were placed on the bulletin board. Other students at school became more interested in and concerned about the project practices and many students at school wanted to get involved in the project.

The students corresponded with their Romanian and American counterparts.

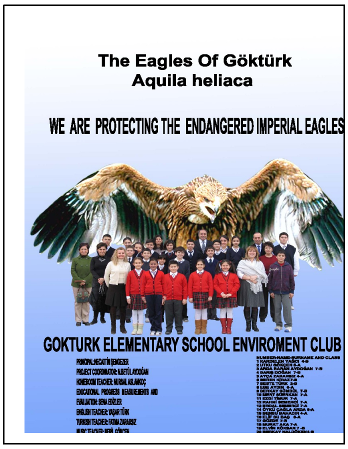

Figure 2. Poster designed by students at Göktürk Primary School

The first field trip with students took place in May 2009 to Eymir Lake in order to search for the habitat of the species. This visit was accompanied by the Middle Eastern Technical University *'METU' Birdwatching Society.*

The second trip was in June 2009 to Mogan Lake. The S.O.S. Team in Göktürk Primary had support from the METU Birdwatching Society on their second trip also.

3.2 Kavaklıdere Primary School, Ankara, Turkey

In Kavaklıdere Primary School, following the choice of Angora Rabbit as their study subject, the students' increasing interest in rabbits resulted in them researching a wide variety of this species. The students adopted rabbits and brought them to the school.

Pre-tests were administered to the students. They prepared bulletin boards, carried out research and recorded their findings. In May 2009, a field trip was made with students to Atatürk Forest Farm. The students were informed about the fact that it was not possible to see a pure Angora Rabbit around anymore and those ones that could be seen were hybrids. With the hope of being able to observe at least a few Angora Rabbits, they contacted the Ministry of Agriculture and Forestry.

Figure 3. Caring for rabbits at Kavaklıdere Primary School

The research about the Angora Rabbit was reinforced by creative techniques. The students wrote many poems, stories, composed songs and prepared power point presentations. They also created posters and brochures for their presentations. After the post-project tests were administered, their certificates were given and a closing party organized.

Figure 4. Poster created by the students at Kavaklıdere Primary School

3.3 Şehit Öğretmen Nuriye Ak Primary School, Diyarbakır, Turkey

Five volunteer students accompanied by five teachers were involved in Project S.O.S. at Şehit Öğretmen Nuriye Ak Primary School. The *Nature Help Team* was formed and activity plan was constructed. The first creative work achieved was designing the poster and logos.

Figure 5. S.O.S. Poster designed at Şehit Öğretmen Nuriye Ak Primary School

Pre-project assessment tools were administered to the students at the beginning of the study. In these tests it was clearly observed that the students' knowledge about endangered species and the causes of extinction were limited.

The first outdoor work was achieved in the school garden by observing the soil components and the living beings on it. They enclosed four different areas of one square meter on the ground and called them *stations.* These *station observations* helped them to realize the fact that there was a great variety of creatures on a place even as small as one square meter. During the outdoor work, they were enthralled and astonished by observing the abundance of nature, about which, as they themselves emphasized, they had previously been unaware.

Great interest in Project S.O.S. was reflected by the students after the work was presented on Bulletin Boards in the school hall in May 2010.

Figure 6. Observing soil at Şehit Öğretmen Nuriye Ak Primary School

Students did not know about the scientific terminology of water quality tests such as pH, ppm and dissolved oxygen, prior to the field trips. While conducting the tests on water quality at the laboratory, they became familiar with these terms. Field trips followed the laboratory implementations.

A field trip was organised to the Fırat Riverside. The students took water samples from the river, observed and tested two types of parameters in order to get qualitative and quantitative data during the field work. These were: *Physical parameters* of water quality, such as temperature, depth, and turbidity. *Chemical parameters* of water quality, such as DO (dissolved oxygen) and pH.

Colorimetric tests were conducted to analyze water samples. During the testing activities and observations, La Motte test kits were used.

In April 2009, the third outdoor study was undertaken by the project team students in the school garden, for a second observation and comparison on soil quality. They were very surprised when they observed that worms were replaced by the ants on spring.

A presentation on soil characteristics, flora, fauna and the causes of soil pollution was delivered to the students. Thus, the students started to answer for themselves the question, *Why does a species become endangered?* Additional information, concerning the extreme rarity of this turtle, which is nearly extinct in the wild, reinforced the students' keenness to prevent such tragedies in future.

In the laboratory, a basic experiment was set up using four jars filled with sample from the Fırat River; river water with detergent added; plain tap water; and tap water with detergent added, in order to test *'The effects of detergent on water environments'*.

The students observed the colour changes in the water samples. They recorded and compared their findings.

As far as the students' observations were concerned, there had been a slight change in the colour of the plain river water sample. There had been no significant colour change in either jar of tap water. They also reported the fact that there had been a vivid green colour change in the jar containing river water with detergent added to it. As a result of all this observations made by the students, they could understand and highlight the human impact on the destruction of nature, for the first time throughout the project period.

The students wrote impressive poems, compositions and letters filled with nature protection messages. The post-project tests were administered to the students in June 2010 and their certificates were presented at the closing ceremony.

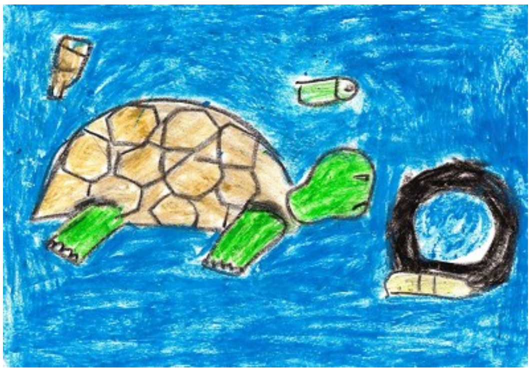

Figure 7. Euphrates Soft-shelled Turtle surrounded by rubbish, as seen through the eyes of a student at Şehit Öğretmen Nuriye Ak School

3.4 Uzunmustafa Primary School, Düzce, Turkey

The project started with the participation of twenty-two volunteer students on 18th January 2010 at Uzunmustafa Primary School in Düzce. The butterfly *Zerynthia caucasica* was the species studied, together with its threatened habitat, Efteni Lake. The students researched the properties of this species and its habitat.

The meetings for the team members were planned twice a week, each of which lasted two hours. Pre-project assessment tests were administered to the students before the project work was started. Themes such as: *'Protecting nature, the endangered species, Zerynthia caucasica, Efteni Lake and their significance'* featured on the bulletin board, which was prepared by the students themselves.

In the laboratory, the students prepared natural pH indicators by using red cabbage and instant coffee filter papers. As a further step, they also prepared separate solutions in water of lemon juice; vinegar; toothpaste; flour; orange juice; fertilizer; aspirin; and coca cola. By testing the pH of these different solutions and painting the colour change observed on indicator papers onto a separate box, they developed a pH observation kit. They then took this kit into the field to make comparisons when conducting water tests.

They took water samples from Efteni Lake to set up model aquatic environments in the laboratory. In this lab experiment, five jars were filled with plain tap water. Then, original water samples taken from Efteni Lake were added to improve the quality of model. The jars were placed by the window in direct sunlight kept at ambient room temperature.

The students were told that these model aquatic environments were used to test *effects of fertilizer and other pollutants that came from homes.*

The students brought in samples of household products to use in the experiments. It was explained that they would be conducting pollutant tests with the models that were set up before.

One jar was used as the '***control***'. Three of the jars were used as ***'the students' household product samples'*** and the last one was used as the '***excessive fertilizer***' sample.

Two tablespoons of selected detergent; enough motor oil to cover the surface; ¼ to ½ cup of vinegar; two teaspoons of plant fertilizer were added to each jar and the carefully labeled jars were left in the sunlight as before.

The students were asked to observe the jars every other day and record their observations.

Figure 8. Testing effects of pollutants

Artwork creations based on the theme *Zerynthia caucasia* followed the labwork implementations. Students created puzzles out of posters and prepared a drama about the species and the lake.

The presentations and drama work were delivered to all primary classes and 1st graders at school by the Project S.O.S. team.

The Forestry Faculty of University of Düzce was visited by the students in order to learn about the special plants that *Zerynthia caucasia* prefers.

From this visit, the idea of forming a plant bank by drying, pressing and laminating the plant species living in the adjacent area was developed by the students, for the very first time.

The importance of meadows and green fields for ecological life was emphasized during the visit to the National Office for Agriculture. The project students undertook interviews with the elderly people living in built-up town areas, which had once been green pastures. The sorrow of these elderly people because their grandchildren could not find a suitable green area to play anymore was witnessed by the team students during the interviews.

Before the field visits took place, the students' observatory skills were improved through games. The significance of making careful observations were discussed with the students and the games were occasionally played at the beginning of meetings to test their observation skills.

A field trip took place in the nearby surroundings of the River Asar around the school. The students recorded their observations on to the observation sheets during the outdoor work. Water quality tests were conducted to measure pH; dissolved oxygen; temperature; and turbidity. The observed and measured parameters from the River Asar by the Project S.O.S. Team on 13th May, 2010 were as follows:

Efteni Lake (a wetland area) was the main study site for Project S.O.S. by Uzunmustafa Primary School in 2009-2010. The number of birds living around this wetland area has been estimated as approximately 150. The students bird-watched and searched for the Caucasian Festoon Butterfly's favourite milkweed plant *(Aristolochia Iberica)* during this visit. Unfortunately, they were not able to find any signs of this plant species in the area.

Figure 9. Testing water quality parameters during field work.

During the second visit to the same area, the students mostly concentrated on using their five senses and thus improving their natural observation skills. They were instructed to perform a silent '*Five-Minutes-Notice'* when they arrived at the area. They were then asked to write down what they sensed in the wetland during the five minutes of peace and quiet. At the end of the period, they described their observations.

At the second field trip organized to Efteni Lake, water quality parameters were observed and measured, and the findings were recorded by the team students.

Before and after the field trips, the students answered the questions on the field work tests in order for their pre- and post-project knowledge to be assessed and compared. High levels of eutrophication (the invasion of lakes and ponds by plant material) on the water surface were observed by the students. Table 4 indicates the measured parameters from Efteni Lake.

At the end of semester, it was observed that the students' motivation for sustaining this project work was rapidly accelerated and they decided to collaborate with NGOs next year. The presentation of their stewardship certificates took place at the closing party.

3.5 İnci Narin Yerlici Primary School, Orhaniye, Turkey

For the students, adapting to the studies concerning Project S.O.S. was an easy process because they already had been involved in the Eco Schools Projects for a number of years. The team had support from a NGO throughout the whole project period. After the species to be studied and its study area were determined, the project was started with fairly easy and interesting spontaneous activities such as drawing pictures of *Liquidambar orientalis* and creating songs. The initial number of volunteer students in the project was seven and as the project progressed, this number went up to fifteen. Amongst them there were students who had not been involved in any environmental project before. The meetings with the team were organized as often as twice a week and in most lunch breaks.

The assessment tests were administered to the students both at the beginning and at the end of project year and it can clearly be seen that there is a statistically meaningful difference in the end of project answers given by the students to identical test questions. Moreover, when the picture forms which were administered for the second time to the team members are observed, it is obvious that the drawings of study species are far more detailed in the students' later efforts.

A model of an Anatolian Sweetgum Tree was produced by the team students and mounted onto the wall in the school hall. The method of making the model by cutting each leaf and seed from paper ensured that students learned the properties of the tree very well. The students also prepared a poster identifying the provinces in which the Sweetgum Tree was most abundant.

Figure 10. Preparing model of Anatolian Sweetgum Tree

The students decided to prepare a metal plaque with the project name on it and composed a song. They emphasized that because of this song they had learned the Latin name of Anatolian Sweetgum Tree, *Liquidambar orientalis* very well. The name of Anatolian Sweetgum Tree was mounted on the door of one of the classrooms. The bulletin boards prepared with messages and news about the Project S.O.S., featuring team members conducting experiments holding test tubes and other scientific equipment, attracted attention from many of the other school students.

The students planted young Anatolian Sweetgum Trees in Hisarönü village within the framework of Forestry Week activities on 25th of March, 2010.

Figure 11. Planting young Anatolian Sweetgum Trees in Hisarönü Village

Two field trips were organized to Çetibeli Forest, Marmaris. Prior to the experiments, the students performed a *'Five-Minutes-Notice'* whilst they were standing quietly, listening to the sounds and smelling the scents of the forest. After the experiments had been carried out, they photographed the trees and played some appropriate games to reinforce the experience.

According to their own reports, going on a field trip and conducting scientific tests was an unforgettable experience for all of the students who participated in Project S.O.S. at İnci Narin Yerlici School. They were even excited when testing the temperature of water.

Three sub-teams were formed to perform field tests. Their observations and ideas were exchanged and their findings were interpreted by these groups. As far as the tests were concerned, there was no significant difference in their findings.

3.6 Ekin College, İzmir, Turkey

Project S.O.S. was begun in December 2009 at the privately-funded Ekin College, with twenty volunteer students and one teacher. After the study subject and study area were determined as the White Stork and the Gediz Delta, the students researched the species and the area, produced posters and exhibited their works on the school Bulletin Board.

Figure 12. Posters of the White Stork produced by the team members at Ekin College

At the beginning of the project period, the students were assessed with attitude tests, knowledge tests and picture forms.

The school intends to continue the project in the year following the initial study.

3.7 Roland Park Country School, USA

The *'Save Our Species Club'* at Roland Park Country School had a special name, *'The Butterfly Club'*. In September 2009, when the students returned from summer break, they went straight into action because this is the season when Monarch Butterflies migrate through their area. Students learned to identify the caterpillars, the chrysalis and the butterfly and quickly learned what milkweed looks like.

Then they started to look for the caterpillars, to catch them for rearing in captivity. The Monarch butterfly changes from an egg into a caterpillar and then into a chrysalis. The adult butterfly emerges from the chrysalis about thirty days after the egg is laid. By bringing the caterpillars inside during their metamorphosis, this resulted in a high survival rate. The students brought in fresh milkweed leaves every day for the caterpillars, until they changed into the chrysalis stage. The caterpillars ate a great deal of milkweed and grew tremendously.

Butterfly chrysalis attaches to a leaf of milkweed and hang in the air suspended by a thin strand of silk. The students watched this process closely in the small containers where they raised the Monarch butterflies. Once the butterflies hatched, the students tagged them and released them, hoping that they would survive the 3500 mile journey to Mexico, where they spend the winter.

In the spring, Monarch butterflies begin the return journey north to spend the summer in areas where milkweed grows wild. They reproduce several times during the summer. Students were very interested in following the Monarch's life and also connected, through the internet, with their migration on the 'Journey North' website.

To encourage the Monarchs, the club created a butterfly garden in the school grounds to grow several kinds of milkweed, as well as various nectar plants to attract the adult butterflies. The students planted several different kinds of plants in the butterfly garden and learned to identify them. They had over twenty-five different plants, including five species of milkweed for the caterpillars.

The opinions of the teacher partner for Project S.O.S. is given below:

'The garden has been growing for five years and is now quite mature. Next year the students will begin to "split" some of the plants and sell samples to families of the school who want to establish a butterfly garden. All of the plants are perennials, which means they return to growth each spring and thus do not have to be replanted every year. Their seeds are saved in the autumn and used to breed new plants in order to fill any gaps in the garden.

Figure 13. Monarch Butterfly at Roland Park Country School

Soon, the students will also sell these young seedlings to interested people. In this way the S.O.S. Club is able to help the Monarchs, which are endangered, by both rearing the young caterpillars to increase the survival rate and also by expanding their habitat, by increasing the garden supply of nectar and larval plants essential to their survival'

3.8 School Number 5, Satu Mare, Romania

The 8th graders began their involvement in an environmental project a few years ago, with their participation in the pioneer project *'Unique and Universal'*.[1,2,3,4,6] They enriched their knowledge about the world and endangered species, raising their awareness that the Earth is not ours to abuse, but to protect - nowadays more than ever!

At the beginning of the 2009-2010 educational year, together with their volunteer teacher, they became involved in Project S.O.S. They selected as their study species and study areas the Noctule Bat, with the River Tur Valley as its endangered habitat.

Within the framework of the project, they completed questionnaires; listened to experts telling them about the endangered species; and absorbed, processed and internalised the information received, thereby making it their own to pass on, because theirs are the voices that will be heard in future generations.

Figure 14. Drawing the Noctule Bat at School Number 5, Satu Mare

The opinions of the partner teacher of Project S.O.S. are given below:

‘*They left the school this year to fulfill their destiny to high school and, later on, at college and university. All of them will choose different paths in life but there are things that will keep them together in their fight to protect the environment.*
Wherever they may go, they will always remember endangered species like the Grey Stork, the White Headed Duck, the Pool Frog, the Golden Eagle, the Monarch Butterfly or the Noctule Bat. [1,2,3,4,6]
They will tell their children about endangered species and protected areas, making our work worthwhile’.

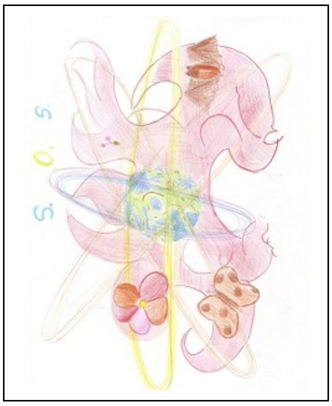

Figure 15. A logo for S.O.S Project designed by a student at School number 5

3.9 Panchayat Union School

Five Students from Panchayat Union School, Kundiyamallur, India, together with their volunteer teacher, were involved in Project S.O.S. in December 2009.

The selected study area by the school was Kundiyamallur Lake. Selected species have not been reported as yet. At the beginning of the project, the first field trip took place at Kundiyamallur Lake in Cuddalore district. Since then, no further data has been reported.

It is hoped that the school will continue to collaborate with its project partners in following years.

Figure 16. Field trip at Kundiyamallur Lake with Panchayat Union School

4. Conclusions

Project S.O.S. was carried out in the 2009/2010 Educational Year with 98 students from six schools in Turkey, 13 students from one school in Romania, 6 students from one school in the USA, and 5 students from one school in India. Within the frame of Project S.O.S: (1) A unique study species and its habitat were selected by each partner school, (2) A website was constructed as a common data sharing platform; (3) An activity plan that was flexible but based on shared practices was scheduled; (4) Field trips were organized by each school. The number of field trips remained flexible, depending upon the different physical conditions of the partner schools; (5) Concerning the activities, Science and Art were two closely related disciplines applied; (6) The findings and letters were shared among all schools throughout the project period; and finally, (7) The partner schools confirmed that they wished to continue the project in the subsequent years.

Throughout the year, the students were encouraged to participate in field trips (organized near their school), where they could observe the cause-effect relationships among living and non-living organisms. Furthermore, under the guidance of the project teacher, the students carried out their own experiments with the soil and water samples taken from study areas. Their observations and experiments helped them collect data which contributes to understanding possible effects (physical, chemical or biological) on endangered species and threatened habitats. In each school (see above pictures), they created a Project Corner to share their findings with their peers and used internet connections and emails to share their findings with their colleagues in other countries. Finally, they developed shared ideas into action plans for protecting endangered species and threatened habitats.

Project S.O.S. showed the vital importance of taking students on field trips in order to develop their motivation to take action to protect the natural environment. During the project, easily accessible materials were used for the experiments. We, the authors, recommend that other teachers follow similar strategies to encourage and develop responsible behaviour amongst students towards the environment in general, and, in particular, species and natural regions.

ACKNOWLEDGEMENTS

To these dedicated partners of the project, we extend heartfelt thanks for their great contributions to our project:-

Martha Barss, Teacher at Roland Park Country School, Baltimore, MD, USA

Ancuta Nechita, Teacher in School Number 5 Satu Mare, Romania

Dr. Kumarasamy Sampath, Teacher in School, Panchayat Union, Kundiyamallur, India

Betül Aydoğan, Teacher in Göktürk Primary School, Ankara, Turkey

Mehmet Salih Çelik, Teacher in Şehit Öğretmen Nuriye Ak Primary School, Diyarbakır, Turkey

Ümit Çakır, Teacher in Kavaklıdere Primary School, Ankara, Turkey

Dilek Balaban Teacher in Uzunmustafa Primary School, Düzce, Turkey

Senem Şahin, Teacher in Private Ekin College, İzmir, Turkey

Cihan Şen, Teacher in İnci Narin Yerlici Primary School, Orhaniye, Turkey

Thanks to La Motte Company for their technical support with water monitoring test kits and also to Jill Aslan for her editorial and proof-reading assistance.

And finally special thanks to all dedicated students and their parents in partner schools, who have been volunteers in Project S.O.S.

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Bridging the gap through Hands-on Science & Technology

Science & Technology Entrepreneurship Development Programme (STED) Project, Bharuch, Gujarat, India (Case studies)

Project supported by: NSTEDB, DST, Government of India, New Delhi

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Abstract. *About STED Project: Waking up to the routine course of the daily life, managing home, children and abusive alcoholic husband is the story of almost every woman in many villages in tribal areas of Bharuch, South Gujarat, India.*
The region is characterised by low agricultural productivity and very low economic activity.
My organisation, Manthan is working in this area on Science and Technology Entrepreneurship Development (STED) project supported by National S&T Entrepreneurship Development Board of Department of Science and Technology, Government of India. During this project Manthan has empowered several women to setup their own micro enterprises through S&T intervention.

Keywords. STED Project, Development, Manthan

1. Introduction

Manthan has been working on this project since four years. For STED Bharuch project Manthan formed the core-planning group to develop methodologies for implementation of this programme. The group comprised of EDP trainers, marketing experts and rural technologies' specialists, bankers, training material developers, communicators, social scientists, field workers and government functionaries. The planning for developing methodologies was done through interaction, consultations, seminars, and workshops.

The activities were categorised into three segments:

a) Survey and preparations for training (Pre training)

b) Launching of Science & Technology Training Programme (Training)

c) Launching the Micro enterprise & Follow up action (Post Training)

Outcome of the project:

Unit Established by women entrepreneurs in last 3 years by S&T Interventions

Sr. No	Year	Units by female	Employment Generated
1	2005 - 2006	31	209
2	2006 - 2007	36	231
3	2007 - 2008	24	190

Case Studies:

Case Study – 1

<u>Need for Hands-on Science & Technology</u>

Village: Koop, Bharuch District, Gujarat

Problem: During the survey we found that the village couples were provided fishing nets through a Govt. Scheme. But many times the nets were torn off over a period of time, so suddenly their economic activity was suffered.

Fig. 1. Women SHG members repairing fishing nets

When we had survey meeting with the women of Koop village, a woman namely Jamnaben stood up and told about this problem to us. Our motivator thought of organising a Hands-on Science & Technology training of repairing these torn off fishing nets under the leadership of Jamnaben. A small indigenous gadget normally used in coastal area was introduce to the beneficiaries of jungle area. The group of woman were taught to make the gadget by themselves and were also taught to repair the fishing nets. A woman group formed a SHG and started saving some money. Today these women are economically independent. Now, they have better social status.

Case Study – 2
Concept of Technology

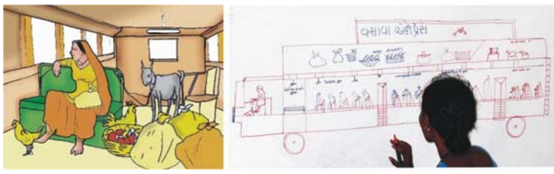

Fig. 2. Vasava Tribal SHG member designing concept of her own bus (Vasava Express)

Village: Nivalda, Narmada, Gujarat

In a workshop in Nivalda, a woman participant had observed:
"Technology to me means a cotton cloth, which I can put to different uses, to cover my baby, to make a cradle for my baby, to tie up seeds collected and even to tie up the fodder/fire wood which I bring back home".

Another woman participant had said:
"Technology to me means a bus designed without seats in such a way that I could carry vegetable baskets, goats, hens, etc. for sale in the city markets where they fetch a better price. It is very inconvenient in a sari to climb and keep the produce on the bus roof. I do not mind not having seats as I can easily stand or sit on the floor of the bus".

Case Study – 3
New perception of role of Women

Fig. 3. Young SHG members illustrating role of 'today's women using technology' during work shop

Some SHG members illustrated role of 'Today's Women' in the development of the society. They were also aware of the existence of stereotyped attitudes towards women and importance of technology in their work.

Case Study – 4
Smarter Spouse of Rajasthan… but…..

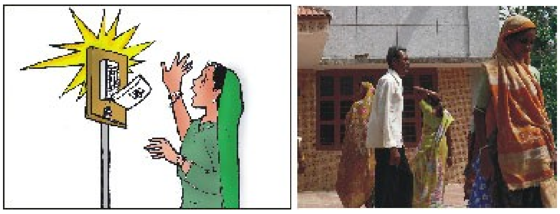

Fig. 4. This case study is role played by STED members during the training workshops (Adopted from Gender & Technology Manual, Developed & Designed by Manthan, Project supported by Science & Society Division of DST, Govt. of India)

Importance of Involving Spouses during Hands-on Science & Technology Training Programmes

A women's training programme for fabrication of solar photovoltaic lamps was underway in rural Rajasthan. On a visit expert were interacting with these women trying to know how this new skill gained was benefiting them both in terms of enhanced incomes as well as enhanced self image. One young woman frankly told the experts that though she has benefited in terms of enhanced income she experienced domestic violence at home when she rectified a fuse which had blown. Her husband frightened of electricity thought she had become a little too smart since she could now do things which he could not do. This was too much for his male ego. On being asked the wise among women gave two suggestions. The first was not to show how much you know in the home rather to behave in a docile and ignorant manner to keep gender equations intact the other was that the male folk also to be included in the programme so that they know and understand what the women are learning. The second suggestion that worked, was, though the programme was only for women, informally men were also involved.

Learning science while playing

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Abstract. *Science plays an important role in the development of the society. While walking through the small villages in India, we found that science exists everywhere. All the activities the people do have some or the other scientific principles involved in them, but the only lack was, they were not aware of them. Going to several schools and talking to several students, we learnt that the science education system was more theory based which was becoming difficult for children to remember. The science education system need to be given a new approach and had to be made more hands-on for the school kids. Science should become an integral part of day to day learning. Like a kid reads a comic book, he/she should also play with science more often. Scientific knowledge has to be made more accessible to all the segment of the society for all the ages. Manthan has been working in the field of informal science communication since past decade. In the Hands-on science forum I would like to discuss about few of the outreach projects carried out by Manthan and their impacts at different segments of the society.*

Keywords. Manhan, Science, Playing

Project 1:
Toys a great tool for science learning

In every different village or a town every kid plays with a toy. A toy either made by themselves or bought from the market. While surveying few of the toys from the Western Part of India, we found several locally made and available toys. Many of the toys worked on interesting scientific principles. Manthan came up with an innovative idea of teaching science to students through the toys. So there were few workshops organized for making the toys and educating the students with the same toys. Also an innovative traveling exhibition was developed which traveled at few small villages in India and also Internationally. The participatory nature of the exhibition helped the children learn the scientific concepts much faster. The children also related their toys to their surroundings bringing them close to their society.

Project 2:
Astronomy on Camel Cart

Year 2009was the International Year of Astronomy and there are several activities been conducted all around the world related to astronomy. We wanted to give the benefit of the astronomical knowledge to all segments of the society in a fun manner. For this we decided to reach maximum people in an inexpensive and innovative way during 100 Hours of Astronomy. Thus after thorough brainstorming we decided to have a Mobile Camel Cart Exhibition on Astronomy along with hands-on activities which would move along the entire city and outskirt villages (25 villages) in radius of 35 km around Ahmedabad. The viewer group was very diverse and more than 2,50,000 members directly were benefited by this event. The project was designed in such a way that the camel cart would stop at any required place and the people could see the exhibition and the volunteers would conduct several astronomical activities. Several times the children would walk along with the camel cart and also join in explaining concepts of astronomy to other people from different villages. The camel cart gave them a sense of belongingness. This project was rated the Most Innovative Outreach Project in the world. This entire project was carried out as an experiment and received an amazing success. People were quite amazed and we got really great feedback from different audiences.

Project 3:
Hands-on activity kits

Manthan has been developing several hand-on material for science awareness projects, scientific events and also several scientific subjects. The main aim of developing hands-on science kits for special science events and awareness events like Solar eclipse, astronomy year, biodiversity year, earthquake, etc. is to educate the children and common people in a low cost and play way manner. Every activity kit consists of 25 – 30 activities. These kits reach to the doorsteps of the registered members and also to several school and science clubs all round the country. All the material is made in vernacular languages. The students/members can learn about several concepts of science just by folding, cutting and pasting the pieces of paper given in the kits. While learning the children make their own toys related to similar subjects. The information gained of such projects is not only gained by the registered student but rather its shared in the entire families and also several friends. In the case of science clubs, one kit is used by several students and that knowledge is spreaded to all the family members and friends of the beneficiary students. Thus this multiplying knowledge helps the entire society to develop and generate scientific awareness.

Several similar projects have been carried out by Manthan in the field of Science and Society for the development in the grassroot levels.

Biochemical Characterization of *Nostoc muscorum* under Multiple Stress

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Abstract. *Cyanobacteria are Gram –ve prokaryotes and are the first organisms to evolve on the earth. They are diazotrophic nitrogen fixers and perform oxygenic phoyosynthesis like higher plants. They are important in increasing the fertility of paddy and sugarcane fields. The unrestricted developmental activities such as industrialization and urbanization carried out during the past few years have given rise to serious problems of environmental contamination. Cyanobacterial response to heavy metals renders them to be a suitable model to study such responses that are comparable to higher plants.*

The organism used for the present study was filamentous, hetrocystous cyanobacterium, Nostoc muscorum. Axenic cultures were maintained in the culture room at a temperature of 25 ± 1°C, illuminated by white cool fluorescent tubes to receive a light intensity of 4000 – 5000 lux. The cultures were kept in 14 hours light period and 10 hours dark period. The culture was maintained on BG 11. The medium was buffered to pH 7.5 with 10mM NaOH. The strain was grown in multiple stress of salt (100mM) and heavy metals (2uM). The strain was grown in heavy metal stress, namely, Zn, Mn, Mg, Hg, Co, Cd & Pb as chlorides. All manipulations involving transfer of culture was done under aseptic conditions Growth of the salt and/or heavy metal tolerant strains was measured in terms of protein and chlorophyll a content. Whole cell absorption spectra for comparative analyses of the pigment system (Chl a, carotenoids, phycocyanin & phycoerythrin) was recorded.

In the present study, the overall result shows that there is inhibition in growth under multiple stress of NaCl and heavy metals as compared to heavy metal stress alone. Magnesium and zinc are not showing significant inhibition in growth whereas Pb and Hg showed maximum inhibition.

Key words: Cyanobacteria, Multiple stress, Pigments, Absorption spectra.

1. Introduction

Salinization is predicted to result in 30% of farmable land loss globally within the next 25 years, and up to 50% by the year 2050 [1]. If water-logged conditions prevail for lengthy durations salinization of the soil occurs and, in India, this is commonly known as the formation of Usar land [2]. Cyanobacteria, are the dominant microbial inhabitants of rice fields. Members of the orders Nostocales and Stigonematales assume a special significance in this environment [3]. Salinity adversely affects photosynthesis and therefore productivity [4], the functioning of plasma membranes [5], ionic balance in the cells [6] and protein profiles [7,8] of some phototrophs including cyanobacteria.

In the present study, growth response of *Nostoc muscorum* was studied in terms of protein and chlorophyll a content. The effect of stress was seen on the pigment system upon exposure to multi stress i.e. chloride salts of heavy metal and salt stress.

2. Materials and methods

Cyanobacterial strain and growth conditions

Nostoc muscorum was used in all experiments. It was grown with continuous aeration in liquid BG-11 medium [9].The medium was buffered to pH 7.5 with 10mM NaOH. The cultures were maintained at a temperature of 25 ± 1°C, illuminated by white cool fluorescent tubes to receive a light intensity of approximately 100 µE/m^2/s. Culture density for all studies was approximately 0.8 A680.

Salt and metal ion stress

In one set of experiment, the cells were subjected to the divalent cations by adding a single dose of Co^{2+}, Cd^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}, Pb^{2+} and Hg^{2+} as chlorides to give final concentrations each of 5µM. In another experimental set the cells were exposed to double stress of salt (100mM) and heavy metals.

Estimation of protein and pigments

The protein and chlorophyll a content was measured after every two days.Total protein was estimated according to Lowry *et al*., 1951 [10]. Chlorophyll *a* was estimated using the extinction coefficients given by Jeffery and Humphrey[11]. Phycobilipigments were estimated from the extinction coefficients given by Bennett and Bogorad, 1971 [12]. Extraction and estimation of carotenoids were performed according to the method of Shaish *et al*., 1992 [13].

Measurement of absorption spectra

4ml aliquots of the cyanobacterial cultures were withdrawn and analyzed in terms of absorption spectra of Chl a, carotenoids, phycoerythrin and phycocyanin at room temperature by UV-Vis spectrophotometer (Ultrospec 4000).

3. Results and discussions

Effect of stress on growth of test organism

When *Nostoc muscorum* was cultured with different divalent metal ions and salt stress, varying effects were observed on the pigment system. There was a regular increase in cell density under single stress showing adaptation of cell under stress, highest growth was shown by Zn. The order of toxicity shown by different test metals wasHg>Cd>Pb>Mg>Mn>Co>Zn when compared with untreated culture. Growth in multiple stress show gradual increase in some culture showing very slow adaptation such as in the presence Cd^{2+}, in some case the growth showed a decline initially then there was a gradual increase showing that cell revived slowly as in case of Mn^{2+}, Hg^{2+} and Zn^{2+}. Some cells showed adaptation initially then a decline in growth was observed as in case of Co^{2+} and Mg^{2+}.

Effect of stress on the pigment system

Table 1. Concentration of chlorophyll a (mg/ml) in *Nostoc muscorum* under stress ofheavy metals and salt.

"+" Heavy metal and NaCl stress
"-" Heavy metal stress
"+*" 10^{th} Day

Heavy metal	+*	-*	+**	-**	+***	-***
Control	.0061	.0272	.0074	.0281	.0130	.0330
Pb	.0057	.0310	.0060	.0150	.0090	.0190
Co	.0058	.019	.0040	.013	.0240	.038
Mn	.0062	.0360	.0070	.0140	.0210	.0200
Cd	.0055	.0190	.0170	.0740	.0110	.0190
Hg	.0051	.0050	.0050	.0050	.0060	.0040
Zn	.0025	.0270	.0740	.0120	.0270	.0270
Mg	.0054	.0272	.0060	.0110	.0290	.0280

"+**" 12^{th} Day
"+***" 14^{th}Day

There was a regular increase in chlorophyll a concentration under single stress in the presence of Co^{2+} and Mg^{2+} whereas a decrease was observed in the presence of all other metal ions. Under double stress the increase in chl a content was observed in the presence of Pb^{2+}, Co^{2+}, Mn^{2+} and Mg^{2+} whereas a decline was seen in the presence of Cd^{2+} and Zn^{2+}. In case of Hg^{2+} the concentration remain constant (Table 1).

Table 2. Concentration of phycocyanin (mg/ml) in *Nostoc muscorum* under stress of heavy metals and salt.

Heavy metal	+*	-*	+**	-**	+***	-***
Control	.0015	.0049	.0120	.0010	.0690	.0010
Pb	.0032	.0028	.0020	.0020	.0025	.0210
Co	.0016	.0046	.0098	.0020	.0110	.0190
Mn	.0020	.0045	.0010	.0010	.0010	.3600
Cd	.0008	.0100	.0020	.0020	.0010	.0020
Hg	.0009	.0010	.0010	.0010	.0070	.0008
Zn	.0031	.0122	.0010	.0001	.0020	.0010
Mg	.0013	.0021	.0030	.0010	.0010	.0350

"+" Heavy metal and NaCl stress
"-" Heavy metal stress
"+*" 10^{th} Day
"+**" 12^{th} Day
"+***" 14^{th}Day

An increase was seen in phycocyanin concentration under single stress in the presence of Pb^{2+}, Co^{2+}, Mn^{2+}, Hg^{2+} and Mg^{2+} whereas a decrease was reported in the presence of other metal ions. Under double stress the increase in phycocyanin content was observed in the presence of Co whereas a decline was seen in the presence of Pb^{2+}, Mn^{2+}, Cd^{2+}, Hg^{2+}, Zn^{2+} and Mg^{2+} (Table 2).

Table 3. Concentration of phycoerythrin (mg/ml) in *Nostoc muscorum* under stress of heavy metals and salt.

Heavy metal	+*	-*	+**	-**	+***	-***
Control	.1720	.7990	.0510	.7480	.0970	.8070
Pb	.2210	1.027	.1680	.5000	.0280	.3780
Co	.2010	.5700	.0590	.6190	.5800	.8610
Mn	.1950	.1220	.1930	.5460	.5710	.8370
Cd	.1810	.8530	.0960	.5360	.2060	.9110
Hg	.2460	.2940	.1930	.1620	.1320	.1180
Zn	.0790	.0160	.1280	.4000	.2060	.8490
Mg	.1470	.8960	.2060	.4210	.3430	.7440

"+" Heavy metal and NaCl stress
"-" Heavy metal stress
"+*" 10th Day
"+**" 12th Day
"+***" 14thDay

There was a regular increase in phycoerythrin content under single stress in the presence of Co^{2+}, Mn^{2+}, Cd^{2+} and Zn^{2+} whereas a decrease was seen in the presence of Pb^{2+}, Hg^{2+} and Mg^{2+}. Under double stress the increase in phycoerythrin content was observed in the presence of all metal ions except Pb^{2+} and Hg^{2+} (Table 3).

Table 4. Concentration of carotenoids (mg/ml) in *Nostoc muscorum* under stress of heavy metal and salt.

.

Heavy metal	+*	-*	+**	-**	+***	-***
Control	2.196	2.240	2.016	2.976	.4200	6.504
Pb	1.632	12.480	3.276	6.024	3.552	5.304
Co	1.464	7.728	1.680	7.620	6.156	7.956
Mn	1.356	9.288	4.200	6.000	4.824	7.716
Cd	1.212	5.268	2.016	7.390	1.368	5.724
Hg	.4920	1.104	1.260	1.68 0	2.946	4.956
Zn	.7440	7.272	2.780	4.908	6.504	8.064
Mg	1.176	6.144	4.500	5.496	5.940	6.204

"+" Heavy metal and NaCl stress
"-" Heavy metal stress
"+*" 10th Day
"+**" 12th Day
"+***" 14thDay

A regular increase in carotenoid concentration was reported under single stress in the presence of Co^{2+}, Hg^{2+}, Zn^{2+} and Mg^{2+} whereas a decrease was observed in the presence of Pb^{2+}, Mn^{2+} and Cd^{2+}. Under double stress the increase in carotenoid content was observed in the presence of all metal ions except Cd^{2+} (Table 4).

Whole cell absorption spectra

Different peaks were observed of photosynthetic pigments by scanning whole cell in UV-Vis spectrophotometer. An increase in chl a peak (at 665nm) was observed under single stress of heavy metal. In double stress of heavy metals and salt, initially some peaks were observed later on the peak disappear showing decline in growth. Similarly carotenoid pigment showed regular peak increment indicating regular photosynthetic pigment growth in the culture under single stress. Under double stress the same pattern was observed as in case of chl a pigment. Phycocyanin pigment peak (at 545nm) was observed initially only in Hg^{2+} stress containing culture in single stress and under double stress no peak was observed in Cd^{2+} and Hg^{2+}. A distinct peak was not present in the cultures grown under double stress Phycoerythrin peak (at 618nm) was observed in the cultures of metal stress alone and a regular increase in peak was seen but under double stress peaks decreased gradually and disappeared.

Absorbance spectra of cells were measured in the presence of single and double stress of heavy metals and salt. Metals inhibit the synthesis of different pigments due to substitution of the Mg^{2+} ion from the pyrrole ring. The synthesis of pigments was suppressed highly under heavy metal and salt stress with maximum suppression in mercury with respect to control. In some cases (Mg^{2+} and Zn^{2+}), an enhancement in the synthesis of pigments was also recorded till 14th day after which there was a decrease.

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Alteration in the Activity of Antioxidant Enzymes in *Nigella sativa* Seed during Different Phases of Germination

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Abstract. *Nigella sativa (black cumin; Kalonji is an annual herbaceous plant growing in Western Asia and the Mediterranean region for its seeds which is used as an important spice and condiment. Seed germination is a complex process that involves the activation of specific enzymes at the appropriate times and regulation of their activity. It has been shown that seed germination percentage might be related to the efficiency of free radical scavenging in dry seeds because this scavenging can affect merely seed storage and vigor. Some authors have shown that production of ROS during seed germination may be a beneficial biological reaction, one that is linked with germination capacity, seedling development, and protection against parasitic organisms during germination. For these reason there is a growing interest in the functional role of ROS and corresponding scavenging enzymic systems in seed germination. Antioxidative enzymes such as superoxide dismutase (SOD), POD, and catalase (CAT) are considered to be the main protective enzymes engaged in the removal of free radicals and activated oxygen species. The present study was undertaken to study the morphological changes during germination phases and to assay antioxidant enzymes (SOD and CAT) in each germination stage.*

The seeds were procured from the local market. Seed lots used for the different experiments showed germination capacities ranging from 80 to 98%. For germination studies, seeds were placed on four layers of damp filter paper at 25°C and incubated in dark till the initiation of sprouting after which they were placed at a light intensity of 100 µmol m^{-2} s^{-1} and a 14/10 h (day/night) photoperiod till the complete plantlet with two leaves were obtained. Germination, defined as 1 mm radicle emergence, was followed for 11d; no contamination by microorganisms was observed during this time.

The level of antioxidant enzymes, SOD and CAT decreased gradually in the samples up to 4th day after the start of sprouting there is a rise in enzyme activity as germination proceeds. The activity of SOD and CAT was significantly higher in seed sample as compared to first four days after the start of imbibition. The activity of these two enzymes was seen to increase from fifth day to tenth day. It can be concluded that SOD activity is not correlated with the changes during seed germination. However, its presence in all samples suggests that this enzyme may participate in protection against free superoxide radicals.

Key words: Germination, Free radicals, Antioxidant, SOD, Catalase

1. Introduction

The seeds of *Nigella sativa* have been reported to possess a number of medicinal properties [1, 2]. Seed germination is characterized by imbibition, after which seeds rapidly increase oxygen uptake and oxidative phosphorylation, processes required to meet the high energy cost of germination [3].
Also it has been shown that seed germination percentage might be related to the efficiency of free radical scavenging in dry seeds because this scavenging can affect merely seed storage and vigor [4,5]). Some authors have shown that production of ROS during seed germination may be a beneficial biological reaction, one that is linked with germination capacity, seedling development, and protection against parasitic organisms during germination [6]. For these reason there is a growing interest in the functional role of ROS and corresponding scavenging enzymic systems in seed germination [7, 8]. Antioxidative enzymes such as superoxide dismutase (SOD), POD, and catalase (CAT) are considered to be the main protective enzymes engaged in the removal of free radicals and activated oxygen species [9]. Catalase and SOD

are the most efficient antioxidative enzymes [10). On the other hand, PODs also have a role in very important physiological processes like control of growth by lignification, cross-linking of pectins and structural proteins in the cell wall, and catabolism of auxins [11]. Despite the importance of PODs in plant development, their exact relationship to developmental events is often obscured by their extensive polymorphism in a single plant species. It is therefore very important to select POD associated with plant development for purification and further studies [12]. Studies of antioxidative enzymes during germination of coniferous trees are rather rare. One such study treated enzymes involved in cycling of ascorbic acid and glutathione in *Pinus pinea* seeds during the first stages of germination [3]. This work is the first study of the activities and isoenzyme pattern of the antioxidative enzymes CAT, POD, and SOD during germination of *P. omorika* seeds. Our aim was to follow the expression of particular parts of antioxidative systems during the early stages of germination of two genetically different lines and compare them with the activities in the needles of Serbian spruce. We also sought to find out if there is a correlation between activities of these antioxidative enzymes and seed germination in these two lines.

2. Materials and methods

Collection of N*igella sativa* seeds

Seeds of *N. sativa* were procured in December, 2009 from a local grocery store in Lucknow, India and surface sterilized with 1% $HgCl_2$ for 30 minutes.

Germination of seeds

The seeds were procured from the local market. Seed lots used for the different experiments showed germination capacities ranging from 80 to 98%. For germination studies, seeds were placed on four layers of damp filter paper at 25°C and incubated in dark till the initiation of sprouting after which they were placed at a light intensity of 100 µmol m^{-2} $s^{-1}$and a 14/10 h (day/night) photoperiod till the complete plantlet with two leaves were obtained. Germination, defined as 1 mm radicle emergence, was followed for 11d; no contamination by microorganisms was observed during this time.

Antioxidant enzyme assays

Biochemical evaluations were performed to determine the activity of superoxide dismutase (SOD) and catalase (CAT).

Preparation of enzyme extracts

Different enzymes were assayed in each germinating stage of the seed. For preparation of crude extract, 0.25 gram of plant material was homogenized in chilled mortar and pestle with ice cold 5 ml of 50mM phosphate buffer (pH-7.8). Homogenates were centrifuged for 10 min at 10,000 rpm at 4°C and supernatant was collected which was used for the assays. Enzyme activities were referred in terms of fresh weight.

SOD activity was determined by measurement of inhibition of photochemical reduction of nitro blue tetrazolium (NBT) at 560 nm [13]. The 3 mL reaction mixture contained 50 mmol/L phosphate buffer (pH=7.8), 0.1 mmolg/L ethylenediaminetetra-acetic-acid (EDTA), 13 mmol/L methionine, 75 umol/L NBT, 16.7 umol/L riboflavin and enzyme extract. Riboflavin was added at last and the reaction was initiated by placing the tubes under two 9 W fluorescent lamps. The reaction was determined after 15 min by removal from the light source. An illuminated blank without protein gave the maximum reduction of NBT, therefore, the maximum absorbance at 560 nm. SOD activity is present as absorbance of sample divided by absorbance for blank, giving the percentage of inhibition. One unit of SOD activity was defined as the amount of enzyme required for the inhibition of the photochemical reduction of NBT by 50%.

Catalase activity was assayed in a reaction solution (3 ml) containing 50 mM phosphate buffer (pH 7.0), 30% (w/v) H_2O_2 and 0.5 ml of enzyme extract [14]. The reaction was started by the addition of enzyme extract. The activity of catalase was estimated by the decrease of absorbance at 240 nm for 1 minute as a consequence of H_2O_2 consumption. The extinction coefficient for H_2O_2 was 4.32 cm^2/µmol.

Statistical Analysis

Every experiment was repeated thrice and all the results were expressed as mean value ±SD for three replications. For each replication plant material was taken by weight from different stages of germination.

2. Results and discussions

The decrease in catalase enzyme activity was detected in *N. sativa* seeds up to 4th day after the start of sprouting there is a rise in enzyme activity as germination proceeds. Activity of SOD did not change significantly during germination, It can be concluded that SOD activity is not correlated with the changes during seed germination. However, its presence in all samples suggests that this enzyme may participate in protection against free superoxide radicals. Under Cadmium stress, the pattern of antioxidant enzyme activity was similar to that of normal germination but the level of enzymes was reduced during earlier stages of germination which increased from 9th day till the formation of plantlet.

Table 1. Activities of antioxidant enzymes in terms of unit per mg of fresh weight.

DAY	SOD	CAT
0	453.0±0.81	3715.10±0.70
1	446.2±0.48	3302.45±0.49
2	423.3±0.25	2064.65±0.63
3	365.5±0.32	1650.80±0.84
4	351.4±0.59	2890.30±0.42
5	359.6±0.42	3715.75±0.21
6	395.7±0.27	4541.55±0.49
7	407.2±0.65	5779.75±0.35
8	416.6±0.63	6605.30±0.42
9	407.5±0.79	7431.55±0.49
10	497.4±0.70	8669.40±0.56
11	474±0.28	8256.70±0.14

The level of antioxidant enzymes, SOD and CAT decreased gradually in the samples from first day to fourth day. The activity of SOD and CAT was significantly higher in seed sample as compared to first four days after the start of imbibition. The activity of these two enzymes was seen to increase from fifth day to tenth day. The complete seedling was formed on eleventh day of germination and the activities of SOD and CAT was lesser in seedling as compared to tenth day of germination (Table 1). This result is in compliance with the research of scientists and published data. The level of the antioxidants, SOD and CAT decreased gradually in all the seeds during the first five days of germination. The activity of SOD and CAT in fenugreek was significantly higher in the seeds treated with 0.05% carbendazim than in the control seeds ($p>0.01$). The decrease in the levels of SOD and CAT in the presence of 0.1% and 0.3% carbendazim could be attributed to the increased utilization of these antioxidants to combat the reactive oxygen species produced excessively during the oxidative stress [15].

Another research which supports the above result is shown by another group of researchers in *P. omorika seeds*. As no changes in enzyme activity were detected in *P. omorika* seeds up to 4th day after the start of imbibition, we here present specific activity of the enzymes catalase, superoxide dismutase, and peroxidase from the 4th day, when most of the seeds germinated [16].

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An experience of teaching biology classification and evolution in e-learning environment

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Abstract. *This work describes the experience of teaching a university course "Biological Classification and Evolution", in an e-learning environment, over two years. The pedagogical model adopted by our university and the platform used is Moodle. The course was divided into several units, each with written texts, films of YouTube and a forum to discuss the contents. This experience gave very positive feedback.*

Keywords. e-learning, Teaching Methodology, Biology teaching

1. Introduction

e-learning presents a real challenge and sharing personal experiences is important in furthering the development of best practices [1].
This paper describes an experience of e-learning of Biological Classification and Evolution, a discipline (semester) that integrates a 3-year course in Environmental Sciences. This discipline (second year of the course - second semester) using e-learning methodology started in the academic year 2008-2009. Thus the experience described in this paper is from the last two academic years.
In 2008-2009 14 students were registered and in 2009-2010 41 students, though 5 subsequently dropped out. This study therefore involved 50 students.
The methodology used generally followed the pedagogical model adopted by Universidade Aberta [2]. This is based on e-learning and on the intensive use of new tools for on-line communication (the Moodle Platform).

2. Methodology

2.1. Discipline

The discipline has an item of news where teacher puts the news, but students are not allowed to post.
Help Forum has final explanation, doubts about access to contents and questions related to continuous assessment and final exam, but there doubts about subjects are not permitted.
The course is divided into the following units:

1 – Theories of evolution and basic principles of classification
2 – Domain Bacteria, Archae and Eucarya
3 – Plant classification
4 – Phylum Porifera, Cnidaria, Platyhellminthes, Rotifera and Nematoda
5 – Phylum Mollusca
6 – Phylum Annelida
7 – Phylum Arthropoda
8 – Phylum Echinodermata
9 – Phylum Hemichordata
10 – Phylum Chordata

An example of a unit can be seen in Figure 1.

Fig. 1 – Unit 8.

The students, at the end of the third week, must choose their assessment mode: final exam or continuous assessment. If the options are continuous assessment, students must produce two works as a small digital document, called e-folio A and e-folio B, that contribute 40 % of the final grade and a compulsory written test, face-to-face, at the end of the semester, called p-folio, which contributes 60% of final grade (it is necessary to obtain at least 50%). e-folio A and e-folio B consists of work of research about a subject or question/s assigned by the teacher. The students do the work and send it to teacher using the platform e-folio A is during 5th week, and e-folio B is during 12th week of the semester. The aim of these two e-folios is to assess the development of competences in subject teaching [3,4].
If students opt for a final exam, at the end of the semester there is an exam assessment, consisting of a 2 hours plus 30 minutes exam face-to-face. Their final grade is based on the results of that final exam.
The students can do face-to-face examinations in our centres, in several parts of the world, depending on their address/location.

2.2. Analyse data

To study the interaction of students, the days when those interaction occurred were analysed. The week was divided into working days (Monday to Friday afternoon) and weekend (Friday evening to Sunday inclusive).
To study period of day the hours of intervention were divided into morning (8 am to 13 pm), afternoon (13 pm to 19 pm), evening (19 pm to 22 pm) and night (22 pm to following 8 am).

3. Results

3.1. Assessment mode decision

The students chose their assessment mode. The results of this decision, in both academic years, can be seen in Fig. 2.

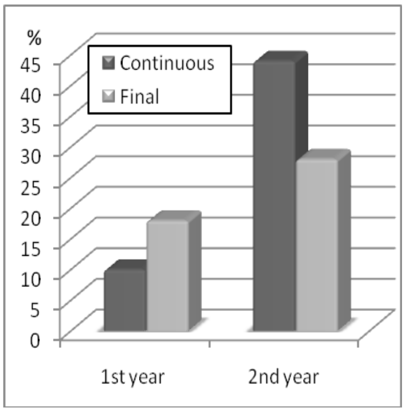


Fig. 2 – Percentage of students in continuous assessment and final exam, in both years

3.2. Help Forum

In this were 27 posts, 16 by students and 11 by teacher. The posts about problems with platform correspond to 41% and about evaluation corresponded to 59% of total.

The period of interventions was represented in Fig. 3

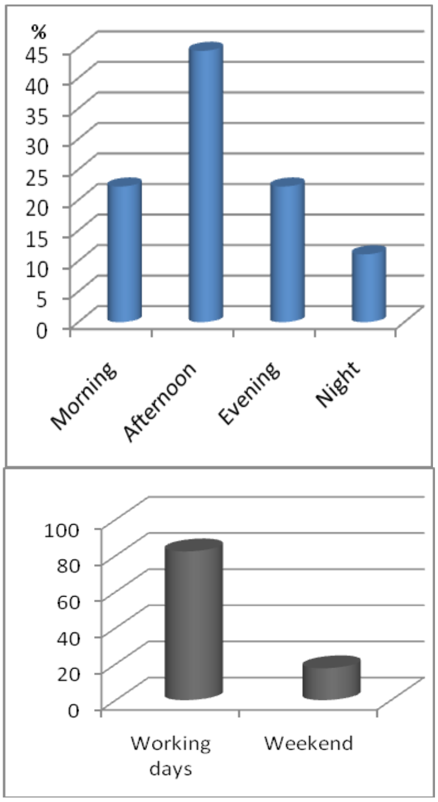


Fig. 3 - The hours of posts in helping forum (above) and the days of these posts (below).

3.3. Subjects forum

In this forum was discussed the contents of the discipline and sometimes students put an image of an animal in order to get help in identifying.

In this forum students participated more at the beginning of the semester, when there are no e-folios to be done in all disciplines. After work on e-folios started, the activity in the forum decreased (Fig. 4).

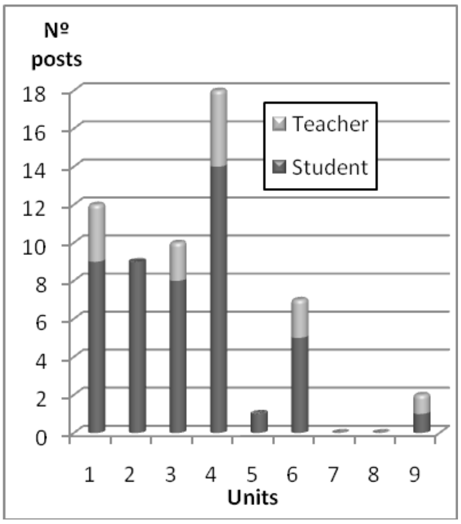
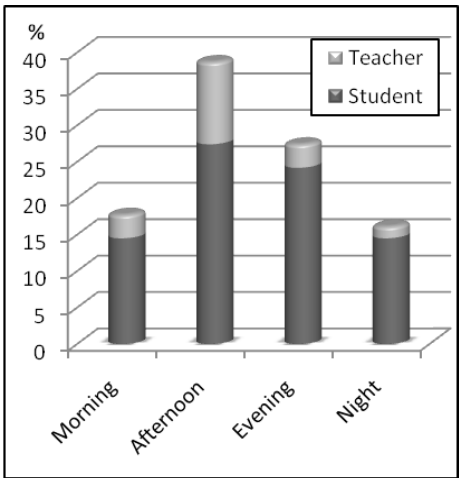


Fig. 4 – Number of posts, in each unit.

The numbers of participation were 67. Posts of students were 50 and of teacher were 17.

The time of day and days of week that these posts were made can be seen in Figure 5.



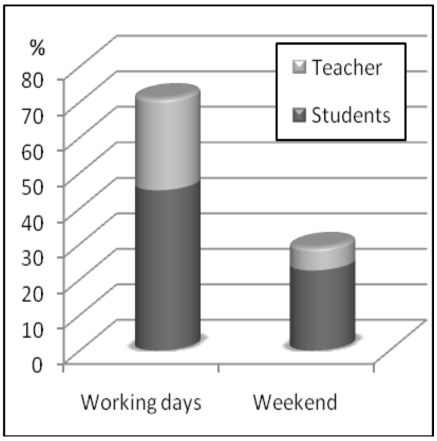


Fig. 5 - The hours of posts in subject forum (above) and the days of these posts (below).

3.4. e-folios

The participation in e-folios forum can be seen in figure 6.

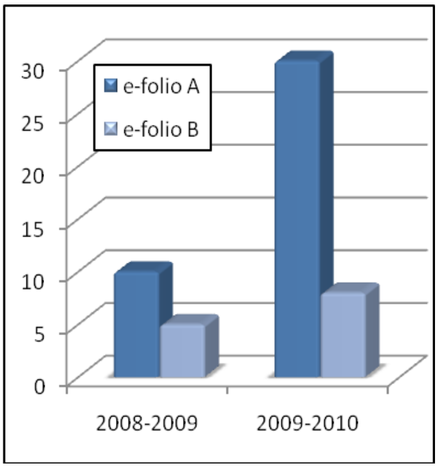


Fig. 6 – Number of participations, in forum of e-folio A and B, in each year.

This time of day and of the week these interactions occurred can be seen in Figure 6.

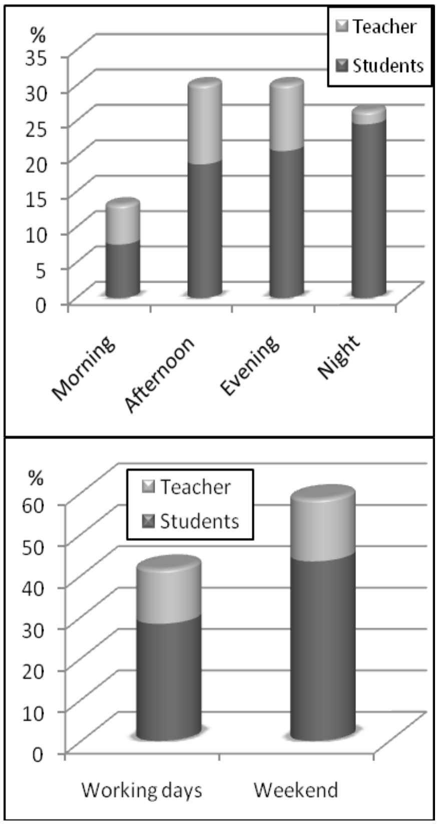


Fig. 7 - The hours of posts in e-folio's forum (above) and the days of these posts (below).

The grades obtain by students can be seen in figure 8.

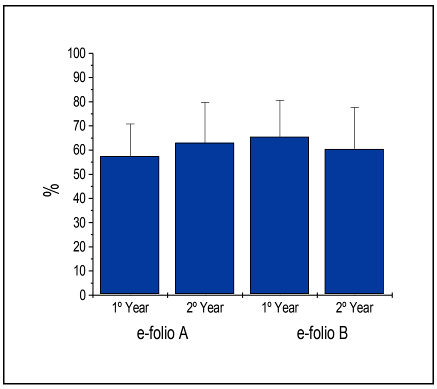


Fig. 8 – Percentage obtain by students in e-folios in both years.

3.5. Revision forum

For students in all units, a final unit was created called Revisions where every day the teacher put two questions to be discussed by students. The students of the previous year asked to be given all the questions and to be given some days to start discussion. This suggestion was accepted.

This time of day and of the week that interactions occurred, in Revision forum, can be seen in Figure 9.

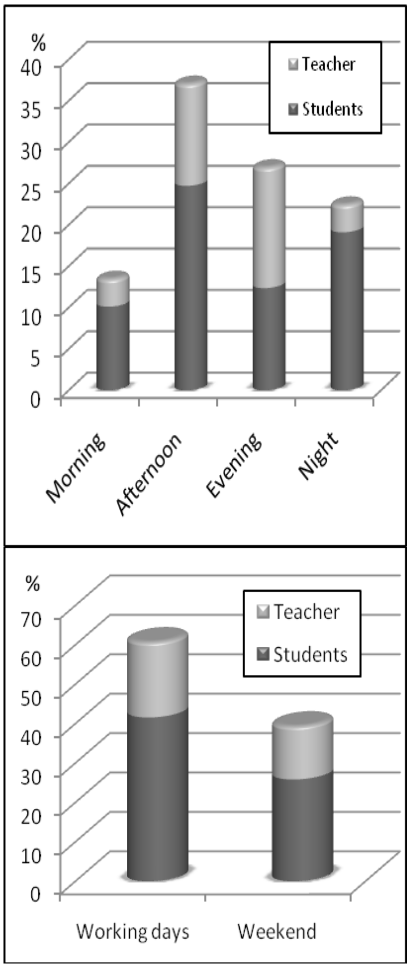


Fig. 9 - The hours of posts in revision forum (above) and the days of these posts (below).

The number of interventions in revision forum is higher than interventions in all subjects forum (Fig. 10).

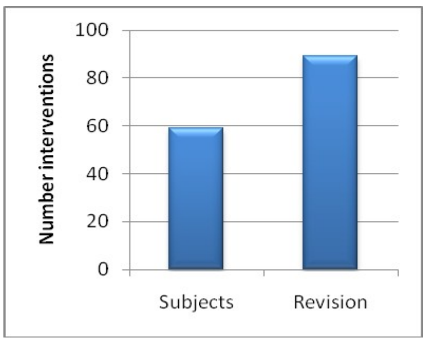


Fig.10 – Number of interventions in subjects forum and Revision forum.

4. Discussion and conclusions

In first year students chose preferentially assessment by final exam but in second year the opposite occurred. This was because of the advice given by 1st year students to the new students. In fact the competences of students in continuous assessment, in general, are better than the competences of students in final exam.
The e-folio work was carried out mainly in the evening and at the weekend. This was expected because our students work at their jobs during the day.
The participation during the weeks of subjects units were below our expectation, but the reason given by students was that they also had to work on e-folios of other disciplines.
The idea of creating a discussion unit at the end is not part of the pedagogical model of Universidade Aberta, but it was shown to be very important, as can be seen by student participation.
The problem of e-learning is that teacher has to read the forum everyday (if it's possible) and if necessary come in and respond to students, including weekends, which is very time-consuming.
The students' opinions about the skills acquired are very favorable, and this allows us to conclude that teaching this subject by e-learning and with methodology used is a good practice.

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The VALLA Tool: an application for the design of Lifelong learning courses

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Abstract. *The major aim of the VALLA Project was to develop tools and methods which could describe and evaluate unaccredited sectoral training using the Learning Outcome format. The project partners developed and tested an online tool, the results from which have been very encouraging, earning a high approval rate from course designers. A case study where it was applied is presented.*

Keywords: Courses design, Life Long Learning

1. Introduction

An important area in need of innovatory ideas leading to the improvement of science education at the vocational level lies in the present need to define units of work/short courses in a format acceptable to awarding bodies/national qualifications frameworks. This task can impose a heavy burden on the staff involved, and the VALLA (Validation of Lifelong Learning in Aquaculture) project has developed a methodology which can provide an excellent solution in this situation.

Some training provided in the vocational training sector falls outside current formal qualification systems, making it difficult to prove that any individual worker has indeed gained the requisite knowledge, skills and competences acquired through specialized training. To remedy this situation, the European Qualification Framework (EQF) was introduced throughout the EU in 2008. The EQF has been described as a translation device which will make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning. One knock-on effect is that National Qualifications Frameworks (NQFs) need to be related to the EQF system. But using the EQF system, divided into 8 levels, each described in terms of specific knowledge, skills and competence, requires that the course provider must know, and know how to use, learning outcomes for course descriptions.

How far the inclusion of the EQF system and learning outcomes have reached varies a lot in Europe; though some countries are well on the way, others have not yet begun the process. It looks as if so far the EQF system seems to work quite well in the formal education context. However the European aquaculture sector, an innovative industry which has grown rapidly from a cottage industry in the 1960s into a diverse industrial sector, is reliant for much of its success on a joint practical and theoretical knowledge base. People working in the sector may require specialized vocational training which falls outside current formal qualification systems. To improve this situation was the basis of the VALLA project, (Validation of Lifelong Learning in Aquaculture).

2. Valla Project

A major aim of the VALLA project was therefore to develop tools and methods which could describe and evaluate unaccredited sectoral training using the Learning Outcome format.

The VALLA online Tool is able to create descriptions of sectoral training in terms of Learning Outcomes, taking users step by step through a process which generates a template covering the following areas:

- Identification of the Learning Outcomes covered by the subject areas of a specific unit or course
- Information as to how the Learning Outcomes can be acquired
- Information as to how these Learning Outcomes are assessed.

The VALLA initiative has developed a methodological solution and guidance tools at the national, European and sectoral levels, which will implement and further the learning outcomes approach and will develop flexible pathways between general education and VET, possibly even leading to the provision of ECVET credits. For though the online tool was developed for the aquaculture sector, it is already in use by other sectors such as history.

The VALLA project is coordinated by **AquaTT**, the European network for training and technology transfer in aquaculture. The partnership consists of:

- FEAP - Federation of European Aquaculture Producers
- Ghent University, Belgium
- KEK Diastasi, Greece
- UMB - Norwegian University of Life sciences, Norway
- SQA - Scottish Qualifications Authority, UK

3. Case Studies

The choice of case studies (mobility placements, short term training, workshops/conferences, on the job training) was made in consultation with industry, educational and awarding body representatives, taking into consideration the range of job roles of differing levels of complexity and are at the heart of the project and its most important justification. They show that it has been possible to establish common reference points across a sector and the generated course descriptions should enable qualifications authorities to use the reference grid of the EQF as intended. The process has been tested through an extremely valuable consultation process with the Greek, Irish, Norwegian and Scottish qualifications bodies which authenticated both the VALLA process and its products.

The case study presented here concerns a blended learning course designed for people already working in aquaculture or for people who want to be involved and need more competences in that area. The course itself is part of a series designed to run in Portugal. Using the VALLA tool made it quite simple to design the course in such a way as to allow the easy recognition of the course when the proposed course is up and running. This type of course structure also enables people from different countries to understand both the structure of the course and the learning outcomes covered.

Influence of Learning Science in Outdoor Settings on 5th Grade Students' Understanding of the Nature of Science

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Abstract. *The purpose of this study is to find out the effect of learning science in outdoor settings on 5th grade students understanding of the nature of science (NOS). The sample of the study consists of 5th grade students(n:50) in a primary school. The experimental group (n:27) was taught science in outdoor settings whereas the control group (n:23) was taught science in a classroom environment. VNOS-E (views of nature of science for primary students) questionnaire were employed to the students as pre and post test. Additionally, semi-structured interviews were conducted with 10 students from only the experimental group. According to the results the experimental group developed their understanding of the nature of science better than the control group.*

Keywords. Science learning in outdoor settings, Nature of science, Primary science

1. Introduction

Tal and Morag (2007) believed that students have limited opportunities to interact and share their knowledge with each other, on the other hand learning activities in museums, in zoos, in science and nature centers and in any other informal settings the interaction between individuals become active and effective. Having opportunities to be experienced science concepts outside classrooms develops students' scientific literacy and their social interaction (Bybee, 1993, 2001). That is why outdoor learning is suggested all around the world.John Dewey also supports the idea that instead of limiting science learning just in classroom environment science knowledge should be a part of our life. Knowledge can be learned only it is used in the real life (Bender, 2005; Bal, 1993).

Recent curriculum frameworks around the world have reflected science as more than a body of facts (Duschl et al., 2006; Ekiz, 2006; Ministry of National Education (MEB), 2005; Qualifications and Curriculum Authority, 2006; Western Australia Curriculum Council, 1998). It has been argued (Gott and Mashiter 1991) that solving problems in science requires, inter alia, an understanding of both the substantive ideas of science (e.g. force, chemical change, photosynthesis etc.) and ideas associated with the procedural understanding which let the students use scientific processes and construct their own knowledge. Certainly this is easier in a natural environment since students engage with real materials. MEB (2005:9) describes the learning science in outside the classroom as follows: "It helps students to ask questions, to observe natural environment, to develop creative thinking abilities, to investigate, to discover and making conclusions like a scientist". Actually, the emphasis is on using hands on activities and developing students' understanding of the "nature of science (NOS)".

The nature of science is referred as scientific epistemology, and describes science as a teaching method and states the values and beliefs of the nature of scientific knowledge (Lederman, 1992). Bell et al. (1998) expressed that the nature of science is epistemology of science and science as a way of knowing. At the same time McComas et al. (1998) describe the nature of science as an intersection of the history of science, sociology of science, psychology of science and philosophy of science. “What is science?”, “How does science work?”, “What is a scientific knowledge?” “How do scientists work?”, “What are the effects of social and cultural issues on science?” are the questions that needs to be answered with the nature of science.

Scientific literacy is also an aspect of the nature of science. It is obvious that without teaching about the nature of science students could understand science as a list of factual knowledge (Akerson, Morrison and McDuffie, 2006). Many research findings have shown that the way of science teaching affects students' understanding of the nature of science (Lucas and Roth, 1996; Shapira, 1989; Songer and Linn, 1991). It is suggested that the nature of science should be taught directly and reflectively (Abd-El-Khalick and Lederman, 2000). According to the indirect teaching approach students can learn automatically by joining research activities. Instead of this some researchers (Khishfe and Lederman, 2006; Kucuk (2006) Abd-El-Khalick and Lederman, 2000) have found out that using direct teaching methods was more effective.

In Turkey, lately this research subject was studied by the researches. It is found that direct teaching method is affective (Macaroglu-Akgul and Aksoy, 2002; Kucuk, 2006; Bagci-Kilic et al., 2007, Can and Sahin-Pekmez, 2008). Bagci-Kilic et al. (2007) worked with primary students in a science camp and found a great effect of the work on students' understanding of nature of science. Because of the outcomes of outdoor learning and teaching nature of science stated elsewhere in this paper and since Turkey has many possibilities to use nature, in this study it was aimed to find out the influence of learning science in natural environment on 5th grade students' understanding of nature of science. The activities used with students and findings of this research will show alternative ways to teachers.

2. Method

The data collected in 2008-2009 academic year (March-May). The sample of the study consists of 50 5th grade students in a primary school located in a small village which is surrounded by nature. One group of students were choosen as an experimental group (n:27) and another group of students were choosen as control group (n:23). The experimental group was treated with some teaching materials (19 working sheets used from the literature) in outdoor settings, on the other hand control group was taught science in classroom with more traditional methods. In the curriculum it is suggested to teach this module in outdoor settings. However, from our experiences and from some informal talk with the teachers in the school it is for sure that they never go out for teaching science. The teaching materials chosen for the experimental group were for developing the students' understanding of nature of science. They were all suitable for the research purposes (they were all checked by the academicians working in that area). When the research was carried out it was the time to teach the concept of Living Organisms. The students in the experimental group followed the working sheets; they were instructed for collecting data by making observations, and make poster presentations about their research. The study time took eight weeks. Before and after the learning process VNOS-E (views of nature of science for primary students) questionnaire (Lederman, and Ko, 2004) was employed to the students in both groups as pre and post questionnaire. Additionally, semi-structured interviews were conducted with 10 students only from the experimental group.

2.1 VNOS-E

VNOS-E (Views of Nature of Science Elementary Level) questionnaire was used in this research which was developed by Lederman and Ko (2004). It consists of seven open ended questions. The questionnaire was translated into Turkish from English. After that the questionnaire was compared with the Turkish version of VNOS-D (almost the same questionnaire with VNOS-E) which is adapted into Turkish by other researchers in their study (Kilic et al., 2007). Additionally it was applied to 82, 5th grade students in the same district. By doing this piloting the questions are reorganized according to students' understanding. Although some more questionnaires (Lederman and O'Malley, 1990, VNOS-A; Abd-El-Khalick, Bell, and Lederman, 1998, VNOS-B; Abd-El-Khalick and Lederman, 2000, VNOS-C; Lederman and Khishfe, 2002; VNOS-D) were developed, VNOS-E was chosen since it was developed for elementary level students.

The questions are asking about the definition of science, scientific knowledge, scientific method and scientists.

2.2 Interviewing

Lederman et al. (2002) suggested that after using VNOS interview technique should be used with all of the students or 15-20% of students who are employed the questionnaire. In order to have deeper understanding of the nature of science and to have their feelings about the learning activities 10 interview questions were prepared. Five questions were to learn their feelings about the activities; the other five questions were about the nature of science. 10 students in the experimental group were chosen by using stratified sampling method.

The questions, like in the VNOS-E, are asking about the definition of science, scientific knowledge, scientific method and scientists. Of course the interview questions were probing, for instance "what do you understand from the meaning of science?", "How would you describe science?", "What is the aim of science?", "What does science do?".

2.3 Students' Working Sheets

Nineteen working sheets, which had two purposes, were chosen. One of the purposes is to teach conceptual knowledge. In the first section of the working sheets there are some explanation and questions for engaging, motivating and also making students to realize their understanding of the subject. The second purpose is to make students to acquire the understanding of the nature of science. Students were encouraged to work like a scientist. The all names and the content of the 3 working sheets are given below.

Natural living areas: It introduces the living areas and living species. Students construct their own knowledge by observing and making classification in a zoo.

Variety of living things: Outside of the classroom they collect data scientifically about the variety of living things. They discuss if scientific knowledge is definite or not.

I am introducing with plants: Students examine different plants and find out the differences between them. They observe, collect data, and make conclusion.

The others are types of roots, the function of the plants body, my plants are growing, my magic cards, I am discovering animals, my leaf, interview with an animal, worm farm, life story, my tree, are mushrooms different from plants?, why is dough rising?, mold garden, why do not I see?, have you ever made yoghurt?, nourishment pyramid, my story.

4. Results

According to the pre- and post-test (VNOS-E) results the students in the experimental group developed their understanding of the nature of science in all aspects. About the meaning of science most of the students told that "it is to invent something" in the pre-test whereas according to the post test 70% of students said that "science is finding evidence by working as a scientist. At the beginning they all believed that scientific knowledge has no chance to change, after the instruction they all said that it is not definite. Pre-test results showed that 15 students said that scientific knowledge can be reached by making research, this number increased to 22 in the post-test. According to both pre- and post test they did not decide if scientific knowledge is subjective or not. They all saw a scientist a person who makes invention; most of the students did not talk about scientific method a scientist uses before the instruction. The results of the post tests showed that students' attitudes towards scientists increased and most of them believed that being a scientist is a very hard work. About the scientific method students' previous ideas were about collecting data this changed to the importance of the data collection, and the way of collecting data. The students reported that they were not sure if scientists use their imagination or creativity but after the activities they believed that scientists use their imagination and creativity in each stage of their work.

On the other hand, the responses of the students in the control group showed that they do not have adequate knowledge and understanding of nature of science before or after the instruction.

The interview findings supported the results of VNOS-E. Additionally, during the interview the students stated that the activities were very useful and enjoyable and they wished all science classes were like that.

5. Conclusion

As a summary, the results showed that the students in the experimental group developed their understanding of nature of science whereas the control group showed no difference in their understanding.

In the experimental group the number of the students who believed that scientific knowledge can change, increased. Some researches also found that result (Akerson and Abd-El Khalick, 2005; Akerson and Volrich, 2006). About scientists using imagination the similar findings were found by Akerson and Abd-El Khalick (2005). Their sample (4^{th} grade) and this research sample (5^{th} grade) believed that if scientists used their imagination what they found would not be real. (This was found before the instruction)

Learning science outside the classroom increased students' attitudes toward science and scientists. They all found the activities enjoyable this means that it would be easy to motivate students with outdoor activities. Since we believe that students need to have the understanding of NOS we definitely suggest to find ways of acquiring different methods. Learning outside is one of them. Most of the teachers prefer doing experimental work rather than going outside. The next work will definitely will be again working outside both control and experimental group by using different approaches to teach the nature of science.

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Hands-on Science in Prison!

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Abstract. *Is it possible to introduce hands-on science in a prison? Yes, it is! In this presentation an annual hands-on educational programme of Astronomy will be described which has been conducted during 2008-2009 scholar year, once a week, in the Second Chance School of Korydallos Prison of Athens. The programme was aimed at adults prisoner-learners aged 20 to 65 years. The methodology was based on "project method" and a variety of didactic approaches has been experimented such as workshops of Astronomy using New Technologies, hands-on experiments, constructions, laboratories of art theater, painting and body expression. The enrichment of the educational programme with hands-on activities and interactive workshops helped a lot to make prisoner-students more social, creative and active and to increase the self-estimation of their abilities & capacities.*

Keywords: Adult Education, Astronomy, Hands-on Science, Museum Education, Prison Education, Science and Society.

Introduction

During 2008-2009 scholar year an educational programme of Astronomy has been organized in the Second Chance School of Korydallos Prison of Athens in Greece by Hellenic Physical Society, a scientific association with an intensive action in the field of education that represents the Greek scientists of Physics. The project, has been realized in occasion of the International Year of Astronomy 2009 and it has been approved by the National Academy of Athens as a greek national action of the Astronomical International Year. The astronomy project, titled *"Touching the stars…!"*, was an educational activity of the European Programme Exploring *"Science as Culture through the European Science Museums*", a Grundtvig Lifelong Learning partnership (numbered 07-GRCO1-GR04-00025-1), conducted from October 2007 to July 2009, that connected Science Museum with Adult Education. The European Lifelong Grundtvig Project (www.anakalypto.eu) aimed to the creation of teaching procedures of distance learning with the use of New Technologies as didactic tools and to the promotion of innovative pedagogical lifelong procedures of informal and non formal forms of Science and Museum Education. It was addressed to museum visitors and museum educators, to adult school students and teachers involved in adult education, to financially and socially inferior groups, such as prisoners. The programme *"Touching the stars…!"* was aimed at men adults prisoner-learners aged 20 to 65 years and it was conducted, once a week, in the Second Chance School of Korydallos Prison in collaboration with the teachers of the school. The basic group of work was composed of 10 students, but a lot of activities have been proposed to all 75 prisoner-students of the school.

Educational scenario

The pedagogical action was based on an interdisciplinary approach of study and it was composed of a variety of didactic approaches [1], such as research on Scientific Museology, use of New Technologies, laboratories, lectures, interactive workshops, constructions and performances. The educational scenario covered an extended range of astronomical issues: history of Astronomy, differences between satellites, stars and planets, basic constellations of northern hemisphere with specific references to the constellations of Hunter and Scorpion, orientation using the Polar Star, comprehension of astronomical maps, study of the Planet Earth, the moon, the sun, the solar system and of our galaxy.

<u>Use of New Technologies and hands-on experiments</u>

During the project elements of Science Museum Education have been introduced and prisoner-students had the opportunity to realize the importance of hands-on exhibits and interactive exhibitions [8]. Because of the impossibilty of the learners to visit museums the most important European Science Museums and Planetariums have been visited virtually. The educational material was based on the use of New Technologies [9]: special softwares such as *Crazy Talk* and *Crocodile Physics* have been utilized. Using *Crazy Talk,* a computer program for generating talking characters from an image or photo and facial animation for video, the participants created an artefact 'talk' of the solar system lending their voices to each celestial body. Using *Crocodile Physics*, a simulator that lets model a range of physics experiments, they practiced physics simulations. An *interactive board,* a whiteboard capable of interacting with a computer and projecting images in a screen, has been used constantly and students learned how to use it. 3D films of astronomy have been also watched using *special 3D glasses*.

Figure 1. Experiments on waves

For a better comprehension of the astronomical issues, lessons on physics notions have been activated and physics experiments have been realized. A small laboratory of physics has been created for the first time inside the prison school, in order to promote the scientific knowledge of the students in combination with hands-on activities. All 75 students of the school practiced experiments on motion, forces, optics and waves. All spaces of the school have been used, even the corridors were converted to laboratories for the realization of experiments with very long springs.

Lectures, workshops of art and body expression, theater performance, creation of an exhibition of astronomy

Lectures related to the theme of the project have been also organized for all 75 prisoner-students. The basic issues of the lectures were on Museum Education, on the use of New Technologies, on Astronomy and Cosmology. Our efforts have been supported by European experts and University Professors of Physics who came inside the prison to explain complicated scientific notions in a simple way.

Figure 2. Construction of the solar system using newspapers and glue

The educational programme has been enriched not only with hands-on experiments but also with a variety of interactive workshops. The movements of celestial bodies in the solar system, such as the rotation and the revolution of the earth and the rotation and revolution of the moon, were understood through specific workshops of body expression.

Figure 3. Painting of the Universe

Art theater workshops have been also organized and a theater performance, an abstract of the book of Brecht's "Life of Galileo", has been presented to public. At the same time prisoner-students attended labs of painting and created constructions of the solar system from different kinds of materials, such as alfa-block, newspapers, glue and even bread crumbs and sugar! The painting and construction creations implemented an art exhibition of astronomy which took part to the Art & Science Symposium "Meeting in the Early Universe" that Hellenic Physical Society organized at Harokopeio University in October 2009. Thanks to the exhibition of astronomy the prison school partecipated also and won an award to the Panhellenic Competition of Astronomy 2009.

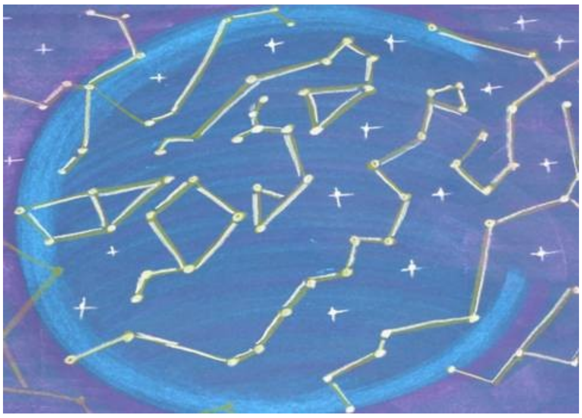

Figure 4. Painting of the sky and constellations

Methodology

The methodology used was based on "project method", that means in-depth and indisciplinary study of a subject [7] in which ideas, questions and interests of students direct the course of research and shape the experiences among learners [2]. The project has prompted us to develop applications of «interactive experience model» according to Falk and Dierking [4]. In addition, we focused on activities of «discovering learning» following the didactic approach of Freeman [5] that includes: i) guided discovery, ii) resolution of the problematic, iii) student action.

Particular emphasis was placed on assessing students' ideas. The educational programme focused in a particular way on the correction of misconceptions and on the reconstruction of previous knowledge, for a right understanding of scientific concepts [3]. The encouragement of curiosity and motivation, a systematic non-passive attitude of students and their active involvement through observation and partecipation in hands-on activities were main objectives of the educational process [6]. The encouragement of group discussion was also an important methodological key in order to facilitate the socialization of students [10].

Results

The results of the project were very encouraging:

- All students were strongly motivated and they would like to repeat this experience.
- The variety of interactive cross-curricular teaching activities from the area of non-formal education has led to the sharp increase of interest for astronomy and physics science and improved the apparent astronomical knowledge of learners.
- The encouraged student action and the enrichment of the educational programme with parallel interactive workshops contributed to make prisoner-learners more social and creative.
- The integration of non formal and hands-on activities in a formal environment promoted the group work and the interaction among students.
- The use of New Technologies as teaching tools is very useful to the the creation of innovative learning teaching procedures.
- The long duration educational programmes offer substantial and specialized pedagogical results.
- Prisoners are often depressed and have low self-esteem. Such educational actions provoke the augmentation of the self-estimation of their abilities & capacities.

Conclusions

These extremely encouraging results demonstrate that:

- The interdisciplinary teaching methods incorporating actions of non formal learning and hands-on activities "refresh" the formal educational system and contribute to science and society approach.
- Scientists and teachers of science should be governed by the philosophy that the relationship between science and society must be interactive.

- Hands-on science can be introduced even in socially disadvantaged environments such as prisons.

Acknowledgements

The author wish to thank Mr. Panagiotis Fildisis, A' Vice-President of Hellenic Physical Society, for his contribution to the realization of the European Grundtvig Project *Exploring "Science as Culture" through the European Science Museums.* Also Mr. Georgios Zouganelis, Director of the Second Chance School of Korydallos Prison of Athens, for his permanent psychological and practical support in implementing the Astronomy Project *"Touching the stars…!"* conducted inside the prison school.

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A Robotic Chemical Analyzer

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Abstract. *Educational robotics seems to be an important field for the development of the energetic attendance and self-activity of students. The combination of software development with the mechanic construction gives an opportunity to connect the robotics with science applications. The direct connection of science applications with robotics opens a dialogue's window of the students, with cross-thematic approaches, and groupwork applications. The present work, tries a connection between applied chemistry with robotics. It includes the construction of a robotic chemical analyzer (titrator), able to measure automatically, a chemical parameter in a group of samples. The upgradability of the construction, gives an opportunity of a continuous improvement. This improvement, of the software, the automatism, the variety of applications, the technical characteristics and the additional construction of support units, maintains a diachronic interest of the students for the robotic chemical analyzer.*

Keywords. Educational robotics, Science teaching, Self made apparatuses.

1. Introduction

Educational robotics [1] seems to be an appreciable area for the growth of self-activity, spontaneous energetic attendance of students and groupwork study. The majority of the students are familiar with computers. It allows us to focus all our effort in the organization of the construction through a well determined project. This project starts from the point "what I want to manufacture", it then examines ways that given software may be used to serve the needs of the construction, continues with the description of the technical materialization of the construction, and is completed with the matching of the hardware with the software to have the required result.

This is a multilevel planning which, combined with the fact that the majority of educational robotics is a team work, will result that the particular action from each member of team, begins as individual action but is fulfilled through the team, and produces a collective result, in which the autonomy of the individual action is obvious. The personal inspiration and the individual planning should be presented in an appropriate form in order to be negotiable with the team. A project like this includes all the important elements of self-activity of energetic attendance of groupwork study, imposing an essential internal treatment for each member of the team [2]. For the schoolteacher of natural sciences, it appears that initially, educational robotics can be a carrier of all desirable training attributes that we would appreciate to be available in natural science students [3] [4].

Hence, the challenge for a connection of educational robotics with the natural sciences is present. For a robotic application of a creative game type, that is comprehensible from the student, it translates to "what should I do". The construction in educational robotics based on the science application does not cause itself the interest but it is stimulated by the usefulness of application and the challenge to manufacture "exotic" robotics appliances of trade. The sense of control of the total construction, as well as each of its individual department, the analysis of total in the parts and the composition of total from the parts, are an unusual experience for the students. From the side of science such a construction requires a interdisciplinary approach of the application, which meets a fertile ground as science is not end in itself, but is used in order to it attributes to us a measurable and useful result. We believe therefore that the enlargement of application of the educational robotics in spaces of utilitarian applications of the science opens a new field of experimental applications.

2. Methodology.

A project for the materialization of the above mentioned didactic proposal is the construction of a robotic chemical analyzer according to the following methodology.

A common measurement method in the chemistry is the titration. Titration is a method in which a known volume of an unknown concentration solution reacts with known concentration reaction agent. The end of reaction becomes obvious with a variety of ways, usually with chromatic change. Follows calculation, for the determination of the unknown concentration. On the manual method of titration, we use a probe for the progressive addition of the reagent up to the chromatic change. The above process can be automated with a robotic construction. A typical application, which can constitute the initial challenge for the students, for such analyzer, it is the measurement of acids in the wine. The application for the students will start from an initial search for the wine and its history, the factors affecting the tasty and smell characteristics of the wine and the importance of acids for these characteristics. What type of acids exists in the wine, how these are associated with the local and weather particularities how we measure their quantity. Follows a short laboratorial experience of acids measurement manually with the use of a probe, reagent of sodium hydroxide and phenolphthalein as an indicator.

The experience that will be acquired constitutes the needed spark for the construction of a robotic chemical analyzer.

3. The Application.

In this particular project, we used the system Mindstorm of LEGO. It was an effort to construct the titrator with the parts of one single set.

The construction is based on logic of substitution of human manual work by the robot. The system is constituted by the following departments (see **Figure 1**).

1. Sampler: It is circular sample carrier. For its construction, they have been used parts from a common home blender. The sample carrier has at the first place the blank sample, at the second the standard following by the unknown samples. A step motor, controlled by the computer unit, moves the carrier to the proportional sample.

2. Syringe for the Reagent's Volume Measurement: It is a common syringe, the piston of which is connected with a screw, controlled by step motor of LEGO. In each complete rotation of the motor, the piston moves at an equal to the step of the screw distance. This corresponds in a concrete reagent volume that is added and the computer in each measurement enumerates the number of turns of the motor that was spent up to the end of reaction.

3. The Valve: The syringe after each measurement will be supposed to fill with reagent for the next measurement. This become through a 2-way valve, which is controlled by a step motor via the computer. In the first position, it adds the reagent for the measurement and in the second it reabsorbs the used reagent, in order to be ready for the next measurement.

4. Optical Detector: The optical color detector determines the end of the reaction (equivalent point) from the change of color.

5. Magnetic stirrer:

It is independent exterior unit which stirs the sample during of reaction time.

6. Unit of computer: In this unit are connected the motors and the detector. Also it is loaded and executed the software.

7. Software: The structure of the program.

Figure 1

The first sample is blank; it contains all reagents and water instead of sample. Reagent is added until the detector realizes change of color. The turns of the syringe motor are measured. The valve changes position reabsorbs the spent reagent that it had been add in the measurement. The valve comes back in the position of reagent's addition. The motor of the sampler moves the second sample for measurement, which is the standard (known concentration sample). The number of syringe motor turns are measured as already described. The sampler motor moves to the first unknown sample. Number of turns are measured as already has described.

For the calculation of the unknown concentration, we use the formula:

CS=(RS-RB)CST/RST-RB where:

Cs: the concentration of the unknown sample

RS: the number of turns of the syringe motor at the measurement of the unknown sample

RB: the number of turns of the syringe motor at the measurement of blank sample

CST: the concentration of standard sample

RST: the number of turns of the syringe motor at the measurement of standard.

According to the above calculation the system gives the result. It continues with the next samples.

4. Upgradability

The upgradability of the system concerns the software, the hardware and the applications. The upgradability gives in this project a diachronic development and a continuous improvement. Each extension, acts also as a critical regard of already existing system,

4.1. Program upgradability

The upgradability of the program, concerns important points of his structure, which influence the faculty of system to be friendly in the user, to be able to invite new applications, to optimize the conditions of speed and effectiveness, to avoid interruptions of the operation caused by program's weaknesses.

4.2. Applications upgradability

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The system with suitable changes of the reagent, the program, and probably with the use of auxiliary systems, could extend its operation, in other interesting applications. Such an application is the measurement of acids in the olive oil, which has some additional difficulties on the sample treatment.

4.3. Hardware upgradability

We constructed the parts of the system, by using common materials, without special laboratory equipment, constitute a source of inspiration for the students is a challenge to improve and to supplement their constructions as individual units, as well as for the composition of new appliances in combination with additional ideas. This is the objective of such an application, to have the student a challenge of autonomous interest in science. For example, we can in order to upgrade the system, to add one unit for the preparation of the sample, which adds a second reagent, phenolphthalein or the dilution reagent for the measurement for the olive oil.

5. Connection with other sciences.

This type of applications, are able to connect directly a number of sciences. Local tradition that concern special care for the production of qualitative foods, for example wine, olive oil, and the connection of their quality with measurable chemical parameters. Students can study also hoe the collection time, the morphology of the area, and the illnesses of the plants that affect the quality of the foods. It can be connected with nutritional value of the food. However the most important connection is with the mathematics. The significances of precision, reputability and resolution of the measurements are clearly statistical significances. The calculation of the concentrations use mathematic formula, via which, we can comprehend the significance of measurement's unit and its use. On the other hand, the use of a pHmetric detector constitutes an important application for Lyceum students, because the calculation of equivalent point requires the use of derivatives on the curve of pH- volume of reagent.

6. Epilogue

Our laboratory has already a long experience on the application of self-made experimental apparatuses using simple materials, focusing especially on polymorphic [6] quantitative measurements [7]. We have also an equivalent experience on the educational robotics [8], [9]. With the proposed type of robotics application, we effort on the combination of our two fields of activity. A limited initial application on the students our laboratory and science teachers of secondary education shows that exists an important interest. A future extension of our applications will allow us to enounce more intergrated conclusions.

7. References (and Notes)

[1] 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.

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[6] 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).

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A Proposal for an Experimental Approach of Vectors

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Abstract. *In this work, we promote a proposal for a laboratory exercise, for the familiarization of students with vectors. This exercise is based on the composition of forces and the calculation of the resultant, but also on the analysis of forces in their components, depending on the level of application.*

The exercise asks students or teams of students to find the unknown weight (mass) of a body, with the use of a line of known weights (masses), threads and pulleys. It is assembled as a construction of balancing three forces of which only two are known. The forces are portrayed in a piece of paper as directions and then are drawn under scale. Then the third force is calculated as the resultant of two known forces. The corresponding application with analysis of forces uses, besides a protractor for the measurement of the angles, trigonometric numbers for the calculation of components.

Keywords. Vectors, Science teaching, Self made experimental apparatuses.

1. Introduction

In previous articles [1], [2] we have reported on the value of laboratory applications, based on self made experimental apparatuses, made of simple materials, for quantitative measurements using polymorphic experiments [3]. The present work is an experimental application with mentioned characteristics, in the comprehension of a difficult concept for the students, the vectors. A number of references [4] [5], confirms that a concept like the concept of *vector* has two components. The mathematical concept (algebraic and geometric) of the *vector* and a physical concept (representation) that connects vectors with science applications. For the second component, absence of simple experiments connecting directly the concept of *vector* with the measurement on a natural phenomenon is observed). For the natural phenomena that require the use of vectors, the mathematization is done without the participation of the student and without any direct connection to natural experience.

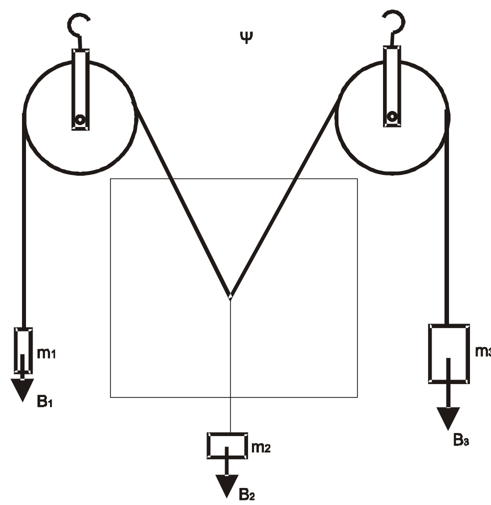
The experiment we propose, prepare the student for the connection between the mathematic and physical representation of vectors. Also the students are trained to discover the sources of the errors through the knowledge of the physical phenomenon. At the same time it constitutes an exercise for the significance of unit of measurement, the use of proportions and the use of trigonometric numbers in practice. From the application of the experiment, they may acquire a series of psyhomotive skills, the fineness of handlings that require the experimental provision, the drawing of parallels and the accurate measurement of lengths. The results on each step, constitutes an important experience of self-assessment for the students.

2. Methodology

The experimental application is based on a common exercise that the students are called to solve. To calculate the resultant of two forces, using either the rule of parallelogram or with the rule of triangle. This particular exercise can function on a very simple way as a laboratory experiment. The experiment consists on the question "what is the weight (or mass) of a body" with the use of threads and pulleys and known weights (masses). The students have to construct an experimental apparatus as in **Scheme A**. With the use of two pulleys and threads and two known weights, conditions of balance of three weights are created with the unknown weight as one of the three. With a piece of paper behind the threads they make an imprinting of the directions of the threads with special attention to not disturb the balance of the system.

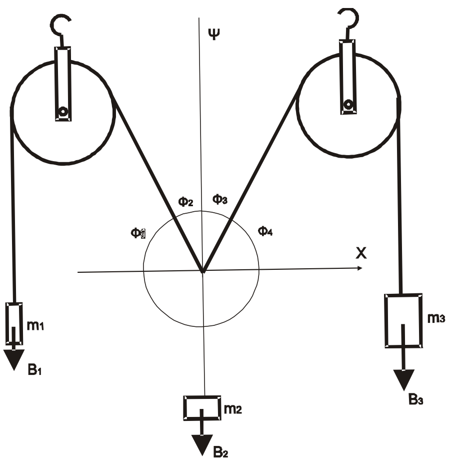
Based on this imprinting, they can start the process of calculation. The first control that the students can run in order to evaluate the precision of imprinting, is to produce the directions of the three lines up to meet each other at the same point. In case where the divergence is big, it will be supposed they have to repeat the imprinting. The effort of a precise imprinting requires accurate handling and develops psyhomotive skills to the students. Then they have to design in scale the two known forces. At this point the significance and the use of unitary vector become perceptible. Then with the use of a parallelogram or triangular they design the resultant of the two forces. The design of a parallel helps in the acquisition of kinetic skills of the students and the understanding of geometrical terms. At this point, we have a second self-assessment, while the resultant of the two forces should be on the same rule line with the third force. Whoever, divergence shows a fault either on the design of the parallel, or in the imprinting of forces with base the unitary vector. Finally, based on the unitary vector, they calculate the third force.

Such an experiment is appropriate for students of the second and third class of the High School. According to the analytical program, the students in Greece meet for the first time the mathematical and physical concept of vectors. The experiment is also useful for the students of the pedagogic departments in combination with the next experiment, as it works as a polymorphic experiment.



Scheme A

A version of the above experiment, that is appropriate for Lyceum and Pedagogical department students, is to place at the centre of threads, a protractor or its photocopy. With the system balanced, we turn the protractor suitably to fix a system of axes, with axis X horizontal and axis Y vertical, in order to overlap with the thread of B2 (**Scheme B**). This helps the students, to become familiar with the usefulness of the freedom on the choice of axes. Then we can follow two ways. On the first way, they imprint the directions of the forces, based on the measurable angles on a piece of paper and develop the experiment as it was described above. On the second way, they are analyzing the forces in horizontal and vertical components, so students practice themselves on the balance of the components of the forces in every axis. In this application we have to mark two fundamental points; a/the weight of protractor has to be added on the B2 weight and b/we decrease the psyhomotive activity of the students and some stages of self-monitoring of the application (but it gives the opportunity to exercise with the trigonometric numbers and the analysis of vectors in components).



Scheme B

3.Epilogue

We applied the above described experiments on students of Department for Primary Education of the University of Crete and on students of second class of high school. The students of high school worked pleasantly in small teams. They had a better comprehension of the concept of vectors. The second version was faced pleasantly by the students of our laboratory and showed to help to the physical application of a mathematical concept. The self-assessment that is also included in both experiments is pleasant for the students and they assist in the effort of a spontaneous self motivation. The analysis of the errors helps on the comprehension of individual effects caused by the parts of system as pulleys friction or what affect the precision. They were able to locate both, the systematic errors but also their handlings errors, the random errors.

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[3] 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).

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Modular Mobile Training: Developing a Program on Science and Technology Experiments

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Abstract. *In this study, a professional training program has been developed in accordance with the experimental professional training needs of science and technology teachers who work in the rural areas with limited laboratory sources. This program, named as Mobile Training Program, has been based on system approach, and it is easily discernible among all the programs since it has a mobile laboratory as the application field. Questionnaires and interviews conducted in order to identify the needs were taken into account during preparing the content of the program, and the application of the program was limited to four days. The program was administered to 223 science and technology teachers who work in the province of Yozgat. Strategies, methods, and techniques that would actively involve teachers into teaching and learning process were utilized. Mobile Training Program has been evaluated through questionnaires, and the results show that the program is highly successful.*

Keywords. Science education, Training program, Teachers in rural areas, Laboratory studies.

Summer on Campus - Learning Robotics with fun

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Abstract. *After the academic year, summer comes and students spend some time at home without anything to do. It is time to rest but summer is long. In order to prepare youngsters for the future, the University of Minho organizes short courses (one week long) called "Summer on Campus", on which students can work on the university laboratories, feeling the excitement of working in such places, tutored by a Professor, in small groups of 10-20 people. On these courses, they spent the mornings on the labs and the afternoons on cultural or sportive activities. They meet new friends, they learn new things and they have some fun at a University.*
One of those courses is called "Robotics for Juniors – come and build your own" and teaches how to build a robot.
In this course the students are first introduced to the most basic electronics components, then they are taught the basics for programming. They are given a robotic Kit Bot'n Roll which they have to assemble, soldering the electronic components, program it and they participate on small contests with the robots. The experience is well appreciated by all. This paper described this robotics course in detail and the results obtained.

Keywords. Mobile and Autonomous Robotics, Events, Learning experience, Science, Youngster, Hands-on, Science

1. Introduction

It is important to keep the youngsters active and busy during their spare time, like the summer holidays. Even though they also deserve some rest from the academic year, the 3 months holiday is a long lasting resource in time, which they can use to enrich their knowledge. Apart from keeping them busy, they learn and enjoy themselves, when well orientated for science crash courses.
There are many events on which they can participate in many universities, so that they start discovering what a university is and also how it works in general.
There are many options on which they can spend their time and one of them is to learn how to build mobile autonomous robots.
Nowadays, Robotics field is seen as a field of the future. Youngsters like robotics because they see it as a very futuristic area and also because they can see it has a bright future. It is a very appealing area of science and they enjoy building robotics since they can apply and test some of their knowledge and skills.
Building a mobile robot is a multidisciplinary hands-on project which at early stages can enrich their skills and allow them to feel and experience the difficulties of a real challenge.
With a robotics project, students acquire knowledge in various areas such as electronics, programming, communications, mechanics, etc., Above all they can experience many things like working in group, developing a real physical prototype built by themselves, and having the possibility of participating in robotics competitions with other teams and getting the possibility of comparing their work and discussing it with other people. Above all, this is easily become in the end, a rewarding learning experience.
This paper describes the original experience of learning how to build a mobile autonomous robot in a week crash course.

2. Motivation

It is very simple for a youngster to start a robotics project. In fact it is easier for a student rather than for a teacher. They see many videos on the web of robots carrying out some tasks and they get so involved that they do not realise the complexity of those projects. To convince a teacher is much more difficult, since they are aware of the difficulties and of the multidisciplinary areas involved.
There are many robotics competitions on which they can start participating and some of them are described by Fernando Ribeiro on [1]. This paper

describes the basic competitions and respective requirements.
There are also many books which they can read but the hands-on experiences are much more rewarding than just the reading. There are also some robotics events which are not competitive but just tutorials for a robot build up, like RoboParty [2] held at University of Minho [3] in Portugal, described by Fernando Ribeiro on [4].
The budget is becoming less a problem since the actual robotic kits are becoming extremely cheap and also simple to build.
Also, even though there are many robotics events for youngsters, they need some support from an adult and therefore we should encourage, motivate and accompany them. The expenses will be very much rewarding in the future when we realise how much the youngster knows about robotics.
It is also important to point out that participating in competitions dignifies not just the team but above all the school which they belong too. When a team has the robot built, they can participate in competitions and the name of the school will be used.

3. The week Robotics Crash course

Following the experience of organizing the RoboParty (www.roboparty.org) and since many students decided to participate on summer activities at University of Minho, it was decided to create a crash course on robotics during the summer holidays. This is held in July, it is called "Summer on Campus – Learn how top build a robot" and lasts one complete week. The students spend the mornings on the robotics laboratory and the afternoons on leisure/cultural activities on the cities of Guimarães and Braga (where the two university campus re are located).

3.1 Advantages

This way, the students can enjoy a campus experience, can discover how a research centre laboratory works, they learn how to do research and how to work in group, they learn how to build a robot with hands on, learn how to assemble a robotic kit and how to program it and above all with lots of fun and accompanied by adults which can guide them on the learning side and on the leisure side.
Another major advantage is that the students come to this activity to learn and not to compete. While in a robotics event the students have to build the robot in school or at home and bring the already built robot to the event, in this case they do not have the stress of the competition itself. They learn how to build a robot in a relaxed environment, with people guiding them all the time, without any kind of stress.

3.2 Modus operandi

This crash course is carried out with only 20 students maximum, in 5 groups of 4 students each. These students don't know each other and this is a good experience to meet new people and to learn how to work in group.

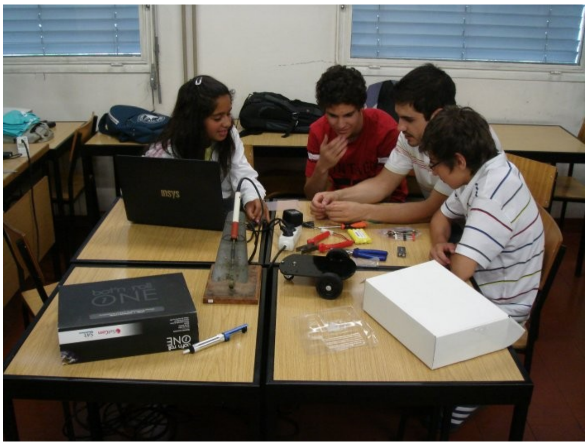

Figure 1. Each group has four participants

Each group is guided by a robotics experienced tutor, normally an industrial electronics university student belonging to the robotics group and with practical experience. This guaranties the participants proper guidance, even though academic staff is present at all time.

Figure 2. One Tutor on each group

To each group is given a robotic kit called Bot'n Roll [5], developed by the University of Minho and the SAR – Soluções de Automação e

Robotica [6], which is a spin-off company of the university of Minho. This kit comes with all the mechanical and electronic components, with a manual and software for its programming, and a DVD with instructions how to assemble and program the robot.

Figure 4. Bot’n Roll

There are other robotic kits [7] [8] [9] [10] [11] [12] [13] [14], but Bot’n Roll was the preferred one.

Figure 1. LEGO robot - RCX controller

Figure 5 LEGO robot - NXT controller

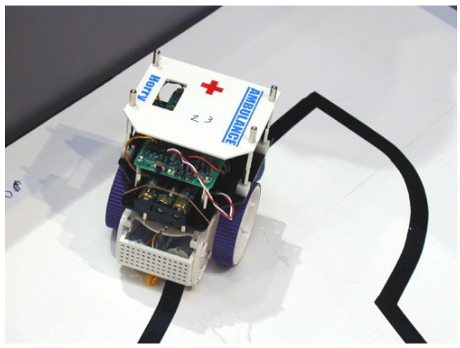

Figure 6. Soccer robot 915 from ELEKIT

3.3 Learning Robotics

The course is lectured by two academic staff and 4 industrial electronics students to guide them during the build up, programming and competitions tasks. The students are never left alone so that whenever they have any doubts they are immediately assisted.

On the first day the students are taught about robotics history, their practical applications and the Bot’n Roll kit is introduced. Then they have to solder the electronic components on the main board and assemble the mechanical parts. On the third day they learn how to program the robot and on the fourth day they start some indoor competitions and on the last day they complete the competitions and have a time to ask some more complex or they can ask for help on some other projects they might be developing in school or at home.

Since youngsters from 11 years old participate on this activity, the lectures have to be very

accessible to every one. Therefore, lectures were specially prepared for people who do not know anything about robotics and even their knowledge on programming or electronics is very reduced.
As an example, cartoons are used to teach robotics programming, and some other simple techniques are used to teach electronics, for example the similarities between electricity and water were used to teach what each electronic component is used for.

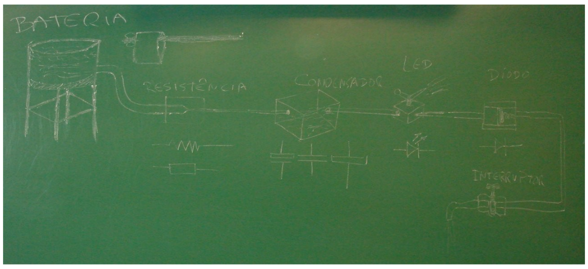

Figure 7. Electronic components explained

The electronic switch is compared to a water tap, the resister is compared to a thinner pipe, a battery compared to a water reservoir, a capacitor to a bi-level water container, etc… This way the students get an idea of how things work.
After teaching them the basic principles of electronic soldering, they have to solder the supplied robot components on the main board of the robot and some tutors guide them during this process. They take one morning to complete the board but they get good hands-on experience on soldering.
The mechanical assembling of motors and wheel on the main chassis is also carried out but them but always guided by the tutors.
The next step is to teach them the basic programming commands. Since the robot brain of the Bot'n Roll is the PICAXE, the programming language used is BASIC. First the students learn the concept of the main programming instructions like cycles, conditions, reading, writing, mathematical operations, etc… Animated cartoons are used to explain that clearly. Only then, they are taught the respective commands in BASIC language.
At first, some examples are given to them so that they can edit existing code, as first task, but soon they want to create their own programs.
In order to write code, we ask the students to make the robot to perform some pre-known tasks, like avoiding obstacles, following a certain target, running as fast as possible, etc. They have some time to write those commands and afterwards, they can download the code created to the robots and then they can test in practice what the robots really do.
This practical testing is the part they like the most because that is when they start understanding the meaning of each command. They have to fix the code according to the behaviour of the robot.
In the last day, a few challenging tasks are given to the participants such as:
a) Proximity challenge – where the robot has to be programmed to go as close as possible to a wall but without touching (otherwise it is out). In this task the participants have to calibrate properly the infra-red sensors.

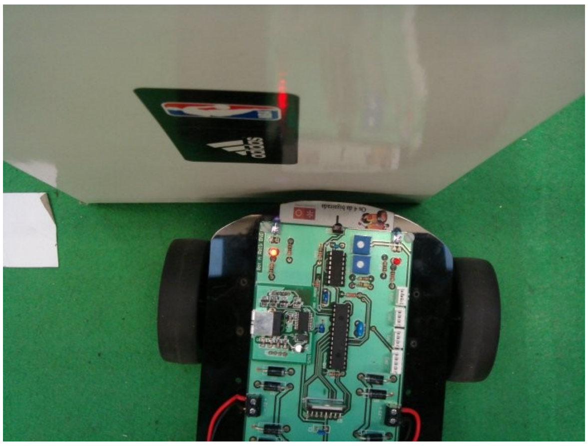

Figure 8. Proximity challenge

b) Race with obstacles avoidance - all the robots are placed on the track at the same time. Each robot is supposed to reach the arrival line in first place overcoming all the other robots. The track is a few meters long and it has bends and obstacles. The other robots also work as obstacles, which make the task even more complex.

Figure9. Race challenge

This is one of the most expected challenges by all participants.

c) Maze – this is a very simple maze which the robots have to come out. They need to use the infra-red sensors and to overcome a few obstacles to make the task more difficult. In order to avoid that the participants pre program the robots, some toothpick are placed on the track as well as some straws. This makes the traction more complex and the software cannot be pre-programmed.

Figure 10. Final Maze

After the challenging tasks, the participants are taken to the robotics laboratory [15] and the academic staff makes a demo of all the robots built. The participants like very much this demo because they can see real and large robots carrying out some real tasks.

Figure 11. Participation certificates and awards handed in

Also, in that appealing environment, the participants receive the participation diplomas, an award from their results on the competitions they just participated on and a souvenir from the robotics lab.

4. Building the Bot’n Roll robot

Each team is given a Bot’n Roll robotic Kit, which comes with all the electronic components, mechanical parts, batteries and charger, a DVD with software, drivers and a video of a robot build assembled.

Figure 12. RoboParty Box

The required tools are supplied by the robotics group, like screw drivers, soldering guns, etc.

The robot assembly has three major steps: mechanics build up, electronics soldering and robot programming. All the necessary parts are in the box.

4.1. Mechanics

The participants start assembling the mechanical components which consist of a base where all the components attach to.

They start screwing one motor to an L shape motor holder, and attaching it to the base.

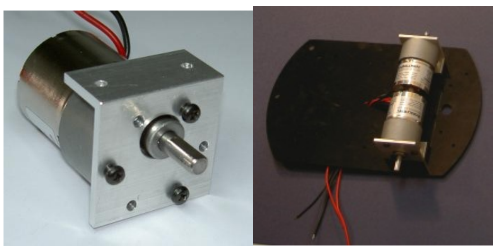

Figure 13. L shape Motor support (left) and robot base with two motors on (right)

Then the wheel is attached to the motor vein. This is repeated to both right and left motors/wheels.

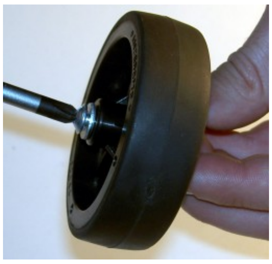

Figure 14. Robot Wheel

The third support of the robot (caster wheel) is also assembled and attached to base and the back side.

Figure 15. Caster wheel

Other components have to be assembled but that task will be carried out after the electronic board has been assembled.

4.2. Soldering electronic board

The second step is then to solder the electronic components on the electronic board. This board was developed on purpose with large electronic components to make it easy for the participants the soldering task.

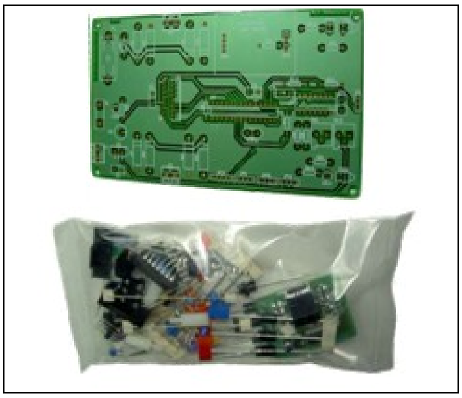

Figure 16. Electronic board (top) and electronic components (bottom)

The components are well and easily identifiable with colours or asymmetries and their location on the board is also easy to find because the board has the names written on it.

Before soldering the components a lecture on "how to solder" is given for those inexperienced. Another lecture is given to explain the participants what is a resistor, a capacitor, a battery, and LED, etc. These very basic instructions make them aware of the functionality of each component. The components soldering proved to be one of the most desired task by the youngsters.

Figure 17. Soldering task

Even though there is a manual to follow, a CD is distributed on the box with videos on how to assemble the electronic board and all the volunteer are around the teams to guided and help the participants.

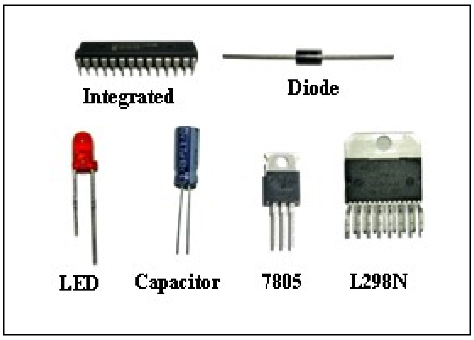

Figure 18. Major components

Once all the components are soldered, the board should look like the following picture.

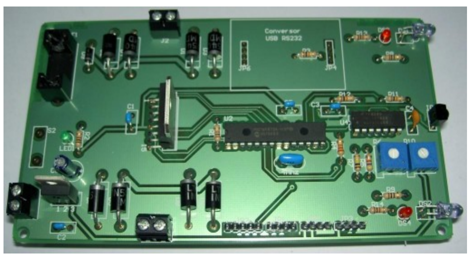

Figure 19. Board with components soldered

To make it easy for the teams to program the board, a USB-Serial converter is used on the board, but since this uses SMD's (very small components), this is given already assembled as a small secondary board and they just have to plug it on the main board.

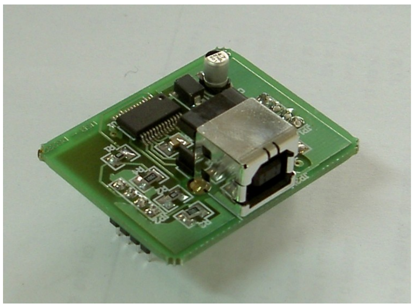

Figure 20. USB to serial converter

The board is then tested and placed on the robot (initial base where motor and wheel are attached.) with plastic supports.

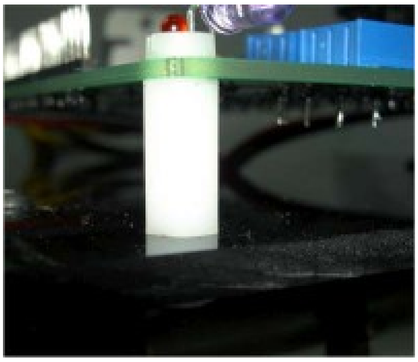

Figure 21. Board supports

The wires are then plugged in. Again, all the wires given have specific colours so that the participants do not mixed them. The main switch is mounted into place and the wires plugged.

Then the battery is placed under the robot and it gets stuck with Velcro, so that they can remove and replace it whenever they need without screws or any other mechanical device.

There are two optional extras for those teams who required it: a line follower and an LCD display. Those come already assembled and they just have to plug them on the robot.

The final aspect of the robot is pictured next.

Figure 22. Fully assembled Bot'n Roll ONE

All the cables, CDs and chargers are supplied in the BOX so that the robot can start working immediately.

4.3. Robot Programming

The third step is the robot programming. The software has to be installed on the laptop computer the teams brought with them, and a manual is given to all participants with instructions on how to install it. The software also comes on the DVD within the robot box. A PICAXE is used as the brain of the robot and therefore the software to use is a compiler from the PICAXE itself.

The language is BASIC style and several examples built by the development team are given to the participants so that they get easily familiar with the main instructions. One lecture is given to participants on how to program a robot and teaching the main BASIC instructions.

Taking into account their age and their short programming knowledge, this lecture was specially created with cartoons and several examples in order to make it easy to understand. It describes the most basic instructions and real examples are given and followed step by step so that they don't get afraid of learning the rest of the commands. In a few minutes the participants can experience their small projects and see the robot moving.

They get excited because the learning rate is fast. Besides, they can share their experiences and suggestions within the group making the learning process much easier and fast.

As bottom line the participants learn and build robots, learn many areas of knowledge, met new people, get souvenirs, met the facilities at the University of Minho (including cultural and sport facilities), and take a robot home with them. Some of these robotic platforms are used in national and international robotic competitions (like RoboCup and Robótica) which means that the students continued developing the robots and improving the software to their needs.

5. Conclusions

It is important for young students to start working with science and robotics due to its multidisciplinary. Areas like mechanics, computer science and electronics are the most essential to build a robot and they are necessary to any technological challenge.
Mobile robotic competitions are important because students get very much involved on the subject, they work in group, they compare their work with other teams, etc. A competition is a good work form as it provides students a specific and stimulation goal. The projects are fun and stimulating so that the motivation and desire to make an effort in the course is high.
The main advantages in short term are that they participate in educational projects, students get more motivated to continue learning and they get competences in different scientific areas.
In long term, probably more students decide to continue their studies (at University level), there will be more chances of blossoming technological companies, new technological solutions in civil areas, etc.
Participation on this kind of events is relevant not only for students but also for teachers. It is also important to point out that motivated students are easier to teach.
This activity is already on its second edition.

Acknowledgements

The authors would like to thank everyone in the Robotics Laboratory at University of Minho for all the support given in the organization of many events. A special thanks for all the staff at the SAR – Soluções de Automação e Robótica.
All the organising committee and volunteers deserve the recognition of their work.

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HelOP – Heliostatic Ornamental Panel

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Abstract. *Nowadays we all agree that population and economic growth put an enormous pressure on the exploitation of natural resources, mainly fossil fuels. The search for higher patterns of quality of life led Man to an unrestrained race for energy whether it is used to extract the same natural resources, food production or simply to ensure its own comfort.*
The HelOP project intends to reduce the consumption of fossil energy and consequent reduction on CO_2 emission and keep the comfort levels that Man has been used to [1]. By resorting to a renewable energy source [2] (the Sun) and to materials originating from abundant natural resources (slate, black schist and sand among others of less significance), without a great consumption of energy on its preparation, ornamental panels can be produced so as to allow the exploitation of solar energy on its four valences: natural light, thermal inertia, thermal collector and photovoltaic generator. The HelOP pieces have been created on the basis of an innovative design and can be applied in any building or architectural work to fully integrate its construction, thus accommodating the new concept of sustainable urban design.
The project has been entirely developed at Secondary School and based upon a Hands-on learning strategy. It is a technological approach to assist the construction of bridges that we need to shorten the distances between science and society.

Keywords. Solar Energy, Sustainable Architecture, Teaching, Urban Design.

1. Introduction

Throughout human history energy has always been a highly "desired" study object by all of those who have contributed to the construction of scientific knowledge. In our days, the installation and setting of equipments for the use of solar energy in public and private buildings often end up being aesthetically aggressive, thus causing a visual/environmental impact which depreciates the architectonic framing of the constructions.

Catch, store and convert the energy made available by the sun in a sustainable design perspective became for us the big challenge that allowed the conception, development and implementation of this project.

The option of turning to the use of raw materials natural resources (slate, black schist), or even other transformed, like for example the glass (sand), well demonstrates our intention of valuing endogenous natural resources abundant in our country. This way we have combined piece design, and all together, the noble purpose of energetic use of solar radiation.

The application of this project results in an increase of energetic efficiency of the buildings with environmental effects in the corresponding reduction of CO_2 emission and natural saving of fossil fuels.

2. Project Methodology Applied

We can describe the methodology used based on the tasks that were followed in every step.

- Bibliographic research into solar radiation and its annual course; thermal characteristics of the materials used in the production of the pieces; energy equivalents; etc.
- Study, conception and production of a piece model for laboratory tests.
- Study and conception of the standard piece with real dimensions.
- Preparation and setting of each type of piece according to its functionality: natural light, thermal inertia, thermal collector and photovoltaic generator.
- Study into the integration of the pieces in panels and other components of urban design.

- Setting of panels in the exterior for tests and gathering of experimental data.
- Conclusions and future perspectives.

This Project was developed with secondary school students attending the Scientific-Technological Courses of Chemistry, Environment and Quality and Arts and Graphic Industries from Colégio Internato dos Carvalhos in an extracurricular school atmosphere.

3. The HelOP Project

The first and most important studies produced on optical physics focused on the course of radiation through blades with parallel faces (Figure 1.). These allow demonstrating the deflection of light and the possibility that part of that radiation is retained, producing the greenhouse effect [3].

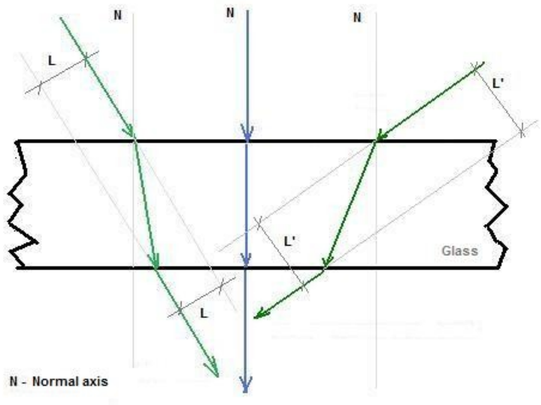


Figure 1. Deflection of Light

Some of the physical characteristics (Table 1.) of the used materials [4], as well as of the solar light were analysed so as to come to a conclusion on the possibility of using the greenhouse effect in the interior of the piece combined with the dark bodies' theory (Stefan-Boltzmann) (Figure 2.). Out of this symbiosis would emerge cooperation for the use of solar energy [5].

Material	ρ/g.cm^{-3}	C/KJ.kg^{-1}. °C^{-1}	α/m. °C^{-1}
Slate	2,70	0,837	8,0 x 10^{-6}
Marble	2,70	0,837	8,0 x 10^{-6}
Black Schist	2,70	0,837	8,4 x 10^{-6}
Glass	2,57	0,836	9,0 x 10^{-6}

Table 1. Characteristics of the Materials

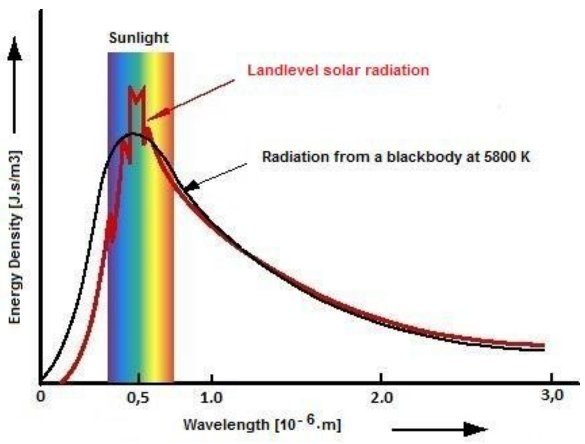


Figure 2. Radiation Overlapping

3.1. Experimental Model

The experimental model was conceived and built in the shape of an equilateral triangular prism with a 60 cm face and 15 cm high. On the exterior face was put glass and on the basis of the box was put a 2 cm thick slate plate (Figure 3.). This model was used to perform the first laboratory tests and allowed to infer the high potentiality of a piece with identical characteristics and the same purposes, allowing a step further on its application.

The tests with the model piece were conducted in the laboratory next to a window directed to the south and during January and February 2010.

Figure 3. Assembling the experimental Model

Acknowledging that the laboratory temperatures were not the same as the exterior, the valid tests presented appreciable data in the slate temperature capable of encouraging us to continue the project. Table 2. and the Graphic 1.

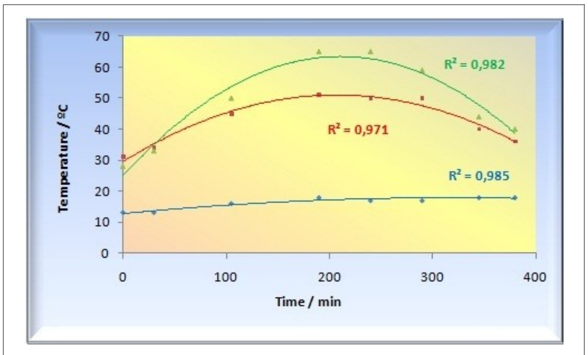
that follow result from data obtained experimentally on the 28th January 2010.

t – Time / Minutes
T1 – Room Temperature / ºC
T2 – Inside HelOP Temperature / ºC
T3 – Slate Temperature / ºC
U – 3 Photovoltaic Cells / V
E – Light Intensity / Lux

HelOP - Study on 28 January 2010 (Clear Sky)

Time	t / min	T1 / ºC	T2 / ºC	T3 / ºC	U / V	E / Lux
10h30m	0	13	31	28	3,95	2400
11h00m	30	13	34	33	3,95	2450
12h15m	105	16	45	50	3,89	2400
13h40m	190	18	51	65	3,87	2300
14h30m	240	17	50	65	3,86	2350
15h20m	290	17	50	59	3,85	2250
16h15m	345	18	40	44	3,23	2400
16h50m	380	18	36	40	2,19	2400

Table 2. Laboratory Tests



Graphic 1. Temperature Curves

3.2. Original HelOP Element

From the study conducted on the experimental model of higher dimension was conceived the original piece of HelOP {Figure 4. a), b), c) and d)}, built in the shape of an equilateral triangular prism with a 30 cm face and 8 cm high to be applied in different outdoor areas, preferably directed to the south or adapted to the design and/or functions [6].

The already mentioned materials were cut, worked and handled in the construction of four different piece models [7]. One piece [4.a)] – glass/slate – or – glass/black schist – that was created with the goal of retaining heat (thermal inertia). Another piece [4.b)] – glass/ copper pipe/slate – that was created as thermal collector used in water heating. A third piece [4.c)] – glass/photovoltaic [8] cell/marble – to the production of electric energy and finally a fourth piece [4.d)] – glass/glass – to natural light.

4. a) Thermal Inertia

4. b) Thermal Collector

4. c) Photovoltaic Cells

4. d) Natural Light

Figure 4. Different HelOP Elements

Of all the created pieces the ones that presented higher difficulties were those that required the fitting of a twisting copper pipe later painted black in the slate basis. These are meant to lower the slate face to fit the pipe (Figure 5.)

Figure 5. Lowering the Slate

The pieces dedicated to the photovoltaic present a white marble in which two small 1V e 500 mA cells were fixed. The future intention is to cover the entire surface basis with photovoltaic material to obtain maximum output. The six units were linked in series so as to allow the charging of a 12 Volts battery. The position of these pieces in panel must be done to avoid the direct exposure to the sun since the cells lose output when they heat.

Of the four different pieces only the one used to natural light, entirely made in glass, offers less construction work. All the pieces were glued using silicon. The faces were covered with a thin skin of white sponge, simulating concrete, to protect its panel union [9].

After building 6 elements for each described function the HelOP pieces were fixed on a support structure for exterior tests (Figure 6.).

Figure 6. HelOP – Exterior Testing Panel

4. Sustainable Urban Design

4.1. Introduction

In the last years many questions have been made regarding environmental conditions, ecological balance and implicitly life quality. Ecological concerns, consumerism and the feeling of economical vulnerability have an impact on the options of design and architecture so as to make them more sustainable [10]. This notion of sustainability in Design [11] (being Design a planed and creative activity that aims to contribute to the improvement and enrichment of the human life) intends to find a balance between the functional, aesthetical, economic, social and cultural dimensions of global development [12].

The growing rises on energy costs and weather changes have been "awakening" people and institutions to the importance of the environmental impact of the anthropogenic activities. Sustainability is no longer seen as an "interesting" option and has become the main goal of any activity [13].

The relation between the principle of planetary sustainability and the concept of eco-efficiency of a product is the main conditioning item on Design of products to the XXI century [14]. So it has become more and more important and urgent that Design may give answers to these new needs and act in a socially responsible way [15].

The design study of the presented panels, in its whole, will be used as the example for a possible application of the studied pieces without neglecting other bolder proposals (Figure 7.).

Imagination is the conducting wire that links creativity and innovation together!

Figure 7. Design Panel Sample

4.2. Applied Design Methodology.

The methodology used with students is part of the contents taught in the school subject Theory of Design – Project Methodology and was seen under the following steps:

1 – Problem definition (identification of aspects and functions).
2 – Synchronic Analysis (competition analysis) and Diachronic Analysis (analysis of the historical evolution of the product).
3 – Development of Ideas (Creative Synthesis).
4 – Evaluation/Discussion of alternatives and ideas presented.
5 – Project Development.
6 – Prototype/Model Development.

4.3. Application in Industrial and Architectural Design Projects

This innovative project is a Redesign based on a covering material – glass brick – that contains aesthetical/ornamental functions and the capacity to let light get through. The HelOP has a major ecologic concern in the creation of panels that present different functions and that promote the sustainability of public or private spaces.

The students presented the study of 3 different applications for the developed materials:

1 – Project of a Multifunctional school sports area. (HelOP application of all valences – Figure 8.)

Figure 8. Multifunctional school sports area

2 – Project of a private house/cottage. (HelOP application of all valences – Figure 9.)

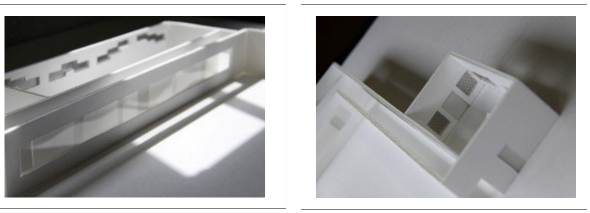


Figure 9. Private house or cottage

3 – Project of a bus stop. (HelOP application of 3 valences – Figure 10.)

Figure 10. Bus Stop

The use of each panel in the spaces will always take into consideration its synergic potential demonstrated by its higher functionality and profitability together with its aesthetic and ornamental aspects. Being able to combine sustainability of area and its visual shape/impact, both interior and exterior, has been a constant concern regarding the HelOP objectives.

5. Acknowledgements

I thank all students that attend the 11th form of the Chemistry, Environment and Quality (QAQ) course and the 12th form of Arts and Graphics Industry in Colégio Internato dos Carvalhos), who were deeply involved in this experiment. We also thank Luis Leites, our English Teacher.

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Science Education and E- Learning and Teaching for Secondary Education

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Abstract. *The main purpose of this paper is the practical implementation of on line learning in the area of secondary education, in particular for the teaching of Science. Moodle 1.9.5 is used for the creation of the virtual classroom. Strategies against students' erroneous perceptions of electrical circuit's matters are put into practice. Synchronous and a-synchronous communication is tried especially among the students as well as between students and the instructor aiming at cooperative learning. The analysis of the worksheets and the meta-cognitive questionnaires results shows a small improvement in the performance of students and a relative conceptual change. The positive attitude that is observed towards the model of blended learning and the LMS Moodle, do not appear to have high cross-correlation with the use and intention of use. This fact is also verified by the system's log files of students' participation in the attendance of internet courses and by the final acceptance questionnaire.*

Keywords. Science Education, Students' perceptions, Learning management system, Moodle, e-learning, TAM.

Introduction

Contemporary studies in Natural Sciences didactics have focused largely on the examination of students' ideas/perceptions on concepts and phenomena within the field of Natural Sciences, generating an important international bibliography on the subject. This paper examines students' perceptions on the subjects relating to electric circuits. We shall identify the models which continue to obstruct the comprehension of concepts and functions on the learning subject of electric circuits, in the age group of students in the second year of secondary education (lyceum). The aim of this paper is to get students acquainted with the model of mixed learning as well as the use of Moodle environment. We shall study the levels of improvement in students' performance, their view towards the introduction of a computer system in Natural Sciences education and also the levels of participation in interactive classes. We shall explore the relation between the perceived usability and the actual ease of use of such system, as well as the views towards a virtual learning environment, the model of mixed learning and the use and availability of interactive classes in other subjects.

Theoretical background

Information and Communication Technologies (ICT) and Natural Sciences (NS)

Information and Communication Technologies (ICT) are considered to be largely applicable on Natural Sciences (NS) because they enable representation of phenomena, they foster experimental study and they enable the creation of models and problem solving applications. There is a large number of ICT developed for NS didactics, such as spreadsheets, presentation software, microcomputer-based laboratories (MBL), multimedia, simulation models, research and interactive learning environments. All of the above aim to actively engage the student into the research process and offer the teachers the opportunity to work in such conditions which would not be viable or possible in a traditional learning environment.

Despite the general findings in what we expect from ICT in education [9], [3], as deriving from everyday practice and studies, we can observe a relative improvement on learning performance, on one hand, but still the conceptual transformation is not largely benefited, on the other hand. The introduction of

ICT in Didactics and Education as applied now is not yet as effective as we have initially expected.

Students' perceptions

Recorded students’ perceptions on electric circuits are as follows: When subjects relating to electricity in simple circuits are studied, there are five models in use: a) unipolar, b) "clashing currents", c) attenuation, d) partitive (cases c and d are consuming models) and e) scientific [10]

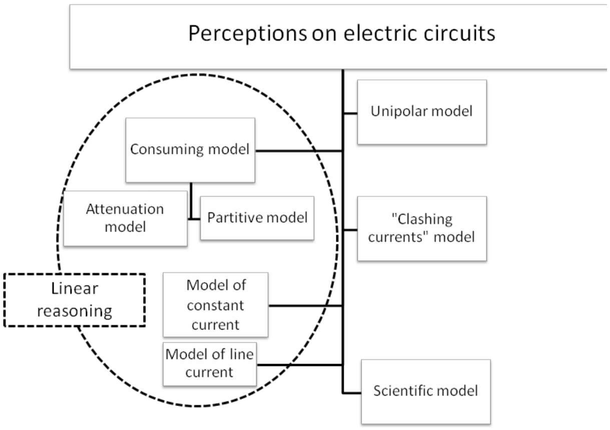

Figure 1. Mental models on electric circuits

Behind these models lies a common perception: electricity starts from the battery and following a linear flow, meets the cables, the resistors, the lamps and other parts of the circuit as it passes through, thus resulting in another mental model, especially when more complex circuits are involved [8].

According to studies, as age and didactics proceed gradually, there is a transfer from unipolar to scientific model. Shipstone[10] found that 50% of 12-year-old students in elementary school adopt consuming electricity models, the same percentage growing to 60% for 14-year-old students and falling below 40% for 17-year-olds. The scientific model involved less than 10% of 12-year-old students, less 40% of students of 15 years and just 60% of 17-year-olds. 50% of 15-year-olds have adopted a consuming electricity model. Nevertheless, even after graduating from secondary education, students in their majority support the consuming model or electricity maintenance [8].

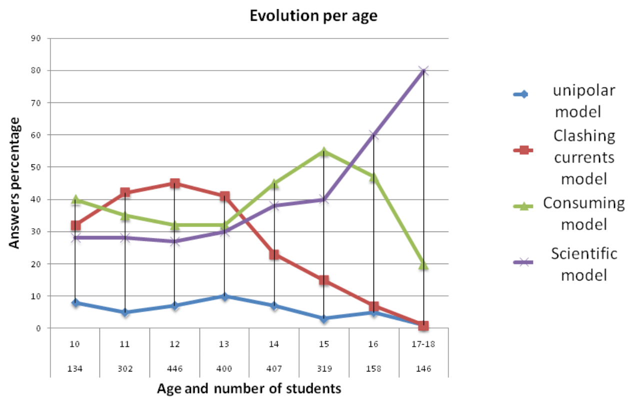

Figure 2. The evolution in model adoption for electric circuits per students' age [8]

The difficulties students are faced up with cannot be dealt with by means of traditional didactics, which is based on quantitive approach of electric phenomena and thus students learn mainly to solve mathematical equations. In the framework of general education, students should develop model building skills and a comprehension of their nature, using PCs and the appropriate model building software. ICT use for problem solving requires the application of Computer Science principles according to the following scheme: Problem ↔ theory ↔ model ↔ simulation method ↔ effectuation (using programming languages or software) ↔ evaluation (comparison to actual data) [7]. The objective in the above scheme is transforming the phenomena from the abstract level to a scientific model, which shall in continuance be tested with regard to its evaluation and validity [7].

Certain difficulties in applying the above are: time restrictions in school educational programs, schools' infrastructure in our country, practical difficulties in computer and internet access concerning natural phenomena simulation when children are in school and the established teacher-centered model. Space and time restrictions and also the issues relating to the difficulty of applying an alternative pedagogical framework within the natural school space, may be overcome by means of distance learning, through a particular learning management system. This paper examines among other questions the extent to which such an interactive platform can be used to eliminate such restrictions.

e-learning

The development of distance learning systems along with technological advancements enable the creation of a new dynamic technology in e-learning. This new technology aims to exploit ICT and the internet for improving the quality of education offered. We are in the 5th generation of e-learning and according to Taylor (2001) [11] «…the only constant in our era is change». In the current era of technology, information transfer cannot be restrained by obstacles such as distance or time. Offering education from distance in the era of e-learning is not either a simple or easy task. According to Karakirios, Kekkeris, Paliokas, Reppa-Athanassoula, & Psycharis (2009) [5], in order to establish an educational activity, irrespective of the media used and the distance (in time as well as in geographic terms), there are three prerequisites: the people (educators, pupils, administrators) who take part in any way, the procedures or techniques which are followed and the learning material, i.e. the educational media in any form. The combination of the above factors can lead up to offering quality distance learning.

LMS - Moodle

LMS (Learning Management System) is a software platform for managing a coherent educational electronic system. In particular, through LMS the management of electronic classes and the educational material in general is made possible, such as developing classes through the platform authoring tools, introducing predesigned classes, and modifying, enriching or deleting their content. Users registration can thus be automated and access to classes can be controlled. Users' actions can be monitored from the moment they enter the platform to the moment the exit the system. Monitor data are available to platform administrators and the teachers of the classes.

Moodle (Modular Object Oriented Dynamic Learning Environment) is an electronic learning environment (Learning Management System, LMS) which came to attention in the 1990s by Dr. Martin Dugiamas, specializing in Computer Assisted Education. The development of Moodle was based on a learning philosophy known as «social constructive learning» Social constractionist pedagogy includes the concepts of Constructivism, Constructionism, Social Constructionism.

The present paper was based on the use of Moodle environment. The platform was installed in the web server www.hostgator.com, and the page under the domain name: www.e-sxoleio.net, which was created for the needs of the present paper, under the following characteristics: Apache 2 (version 2,2,11), Mysql5 (version 5.1.35), Php5 (version 5.3.0), Moodle (version 1.9.5), PhpAdmin (version 3.1.2).

TAM

The Technology Acceptance Model (TAM) is a commonly used model which provides for and explains the use of computer systems. It is a model which explains the adoption behavior of computer systems by the users and calculates the level of acceptance. TAM by Fred D. Davis is a computer system theory which examines how the users receive and thus how they make use of a certain technology. According to this model, the adoption and use of computer technology lies upon two major factors, the Perceived Ease at Use and the Perceived Usability. Davis' model (1993) [2] is completed by the following concepts:

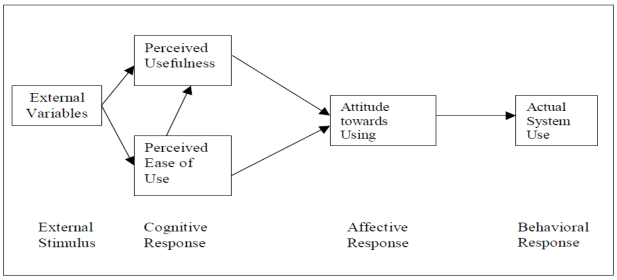

Figure 3. The three phases in TAM: cognitive, affective, behavioral

This paper makes use of TAM declarations for evaluating the Moodle platform in the framework of NS classes.

Methodology of the study

Aims of the study

The aim of the study can be divided into two major sub-domains, as hereby described below:

A. *The domain of Natural Sciences Didactics:*

A1. Applying strategies for correcting the wrong perceptions of students in the field of electric circuits, by introducing the appropriate educational activities which shall lead to conceptual transformation.

A2. Evaluating the efficiency of educational tools with regard to learning objectives.

B. *The domain of ICT in education:*

B1. Creating, developing and applying an interactive *learning* environment at school level by use of the distance learning platform Moodle.

B2. Exploring the response model of Learning Management *System*, its use and intention of use.

Sample – Procedure of the Study

The sample of the students in the study were 25 students, 12 boys and 13 girls in the second year of Sidirokastro General Lyceum in the school year 2009-2010. The learning level of the participants is characterized good to excellent, based on the students' grades. Each group consisted of students who had grades of between 14 and 19,9 from all routes available.

The criterion for the school selection was the fact that it is a typical, district school. As far as the social status of the students is concerned, the majority of them come from agricultural or labour backgrounds (children of workmen or employers in private or public organizations), which corresponds to the vast majority of economically active population in Greece.

One motivation for the students' participation was the awarding for participation in terms of grade, to a percentage of 40% in the final grade of the participants (60% from class performance and 40% from participation and performance in the computer environment).

In the first phase, the implementation and application of a scaled weekly plan of classes and activities was studied, based on the following bibliographical references: distance learning principles, classes organization models, material and distance learning development, the guidelines of the Comprehensive Programme of Studies, the selected pedagogical framework, the theory on students; perceptions of electric circuits.

In this phase,the installation and organization of Moodle platform was planned, the requirements with regard to hardware and software material were also determined and finally, the server for the webpage hosting the educational and learning environment, including a computer system for direct and indirect distance learning, was selected.

In the second phase, the efficiency of educators' interference was applied and evaluated, based on results from spreadsheets. In addition, the use and response to the educational and learning environment was evaluated by means of the system's log files and the respective response questionnaire.

The strategy base on case study was used. The study conducted is in the form of a review. This review consists of data collected by different sources (questionnaires, Moodle participation registration, Quiz tools in spreadsheets) in the given time period. Data collected either describe the existing conditions or determine the relations between the facts [1].

The conduction of the study was based on the quantitative approach. The spreadsheets and questionnaire on meta-learning experience consist of closed questions, in true-false and yes-no format. The final response questionnaire consists of closed questions, under the Likert evaluation format and includes five possible answers to each question. The system's log files include numerical data, picturing the participation (for example, entries to the system per student).

The process of the data is based on descriptional, statistical methodology (data presentation in tables and figures). For performance examination in spreadsheets, on the first level, there is the normality test Kolmogorov-Smirnov and the t-test evaluation on dependent samples (performance before and after teaching). In addition, the criterion Wilcoxon signed rank was used to make the comparison (between performance before and after), in cases where there is a variation in the normality test.

The final questionnaire is examined in terms of validity and reliability. In order to establish the conceptual construct validity of the questionnaire, the factual structure is examined, using the principal components analysis method.

The evaluation of reliability is based on the internal effect with criteria method, the Cronbach "α" method, the item-item correlation testing and the corrected item-total correlations, in order to evaluate each question under this scale. Data processing is performed using the SPSS program, version 17.

Results

Transformation of perceptions (A)

As far as the exploration of alternative ideas on electric circuits are concerned, it has been found that, according to the questionnaire on students' perceptions, the current bibliography is confirmed and it is further shown that in the age group examined the wrong ideas are eliminated to concrete obstructions in the linear reasoning. The repetition of ideas' exploration 20 days after the conclusion of the classes and the completion of the spreadsheets has shown that the percentages of adopting wrong perceptions are reduced in comparison to the former ones. This fact further confirms the studies claiming that the reduction in the levels of model adoption is related to the strategies for correcting such perceptions. Nevertheless, there are certain perceptions which tend to persist, even after such interference on the part of the educators.

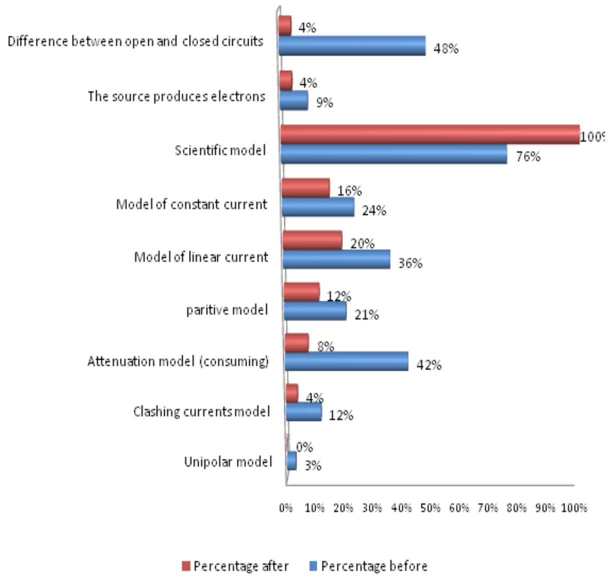

Figure 4. Students' perceptions

The improvement in students' performance, as shown in the completed spreadsheets, is quite significant statistically, in two of the three spreadsheets.

		N	Mean Rank	Sum of Ranks
fe1_ana - fe1_pro	Negative Ranks	2a	5,50	11,00
	Positive Ranks	6b	4,17	25,00
	Ties	17c		
	Total	25		
fe2_ana - fe2_pro	Negative Ranks	3d	5,67	17,00
	Positive Ranks	10e	7,40	74,00
	Ties	12f		
	Total	25		
fe3_ana - fe3_pro	Negative Ranks	2g	11,00	22,00
	Positive Ranks	12h	6,92	83,00
	Ties	11i		
	Total	25		

Table 1. Spreadsheets results

The constructive approach through Moodle platform ,within the framework of the present case study, is considered relatively satisfactory. The views of the students towards this mode of education were rather positive. Similar papers on NS teaching, such as Crippen & Earl's (2007) [6], have found that the results from the educators' interference do not generally depict a statistically significant variation in terms of average grades in the subject of Physics on the internet. However, there has been an improvement on homework assigned. Furthermore, the views of the students towards studying at home based on the internet appear to be of positive nature [6].

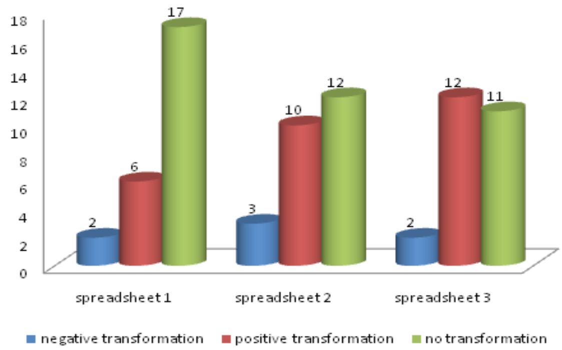

Figure 5. Performance improvement in spreadsheets

The collaboration among the students working in groups has had an effect on 1/3 of the students' sample, who changed their decisions towards the correct answer, as shown in the study of the answers to the questionnaires of meta-learning experience. This can be due to various factors, such as: the nature of the activities, the limited familiarization with this particular mode of learning, the lack of intention to collaborate, the common way of thinking among students who are well acquainted with one another (which also consists a restriction in this particular study). Besides, the mode of teaching NS and other subjects in schools is not oriented towards team-working learning activities and as a result the students' levels of collaboration are low, since never before had they participated in such an experience.

Development and Application, and response to the LMS (B)

As far as the development, application and function of an interactive environment is concerned, it has been found that the educator who shall attempt such a task shall be faced with difficulties of technical nature and functionality, from the start. As a consequence, issues such as hosting, platform installation to a large or smaller extent, can be considered as an "adventurous" and demanding attempt. The knowledge required has not yet been available to educators today by means of any educational programme.

The participation rates have shown that in the initial, pilot application of the system there has been an increased rate of participation, probably due to the curiosity involving something new taking place in school, but as far as participation during the experimental application is concerned the rates were decreasing, as resulting from the examination of the relevant log files.

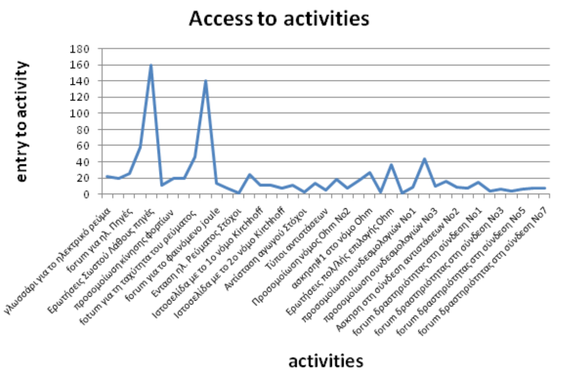

Figure 6. Participation chart in terms of time per activity

The students' outside school preoccupations (such as educational activities, sport, etc.) result in diminishing free time, which acts as a preventive factor to consistent participation. The students claimed they prefer to surf the internet without particular purpose, including social networking webpages such as www.facebook.com, rather than get involved in or spent extra time on the subject of Physics on the internet. The grade (a percentage of 40% of total grade) as a means of motivation and awarding for participation did not appear to play a significant part. This is clearly due to the recently noted indifference of the students towards subjects of general education and their concentration on route subjects. The examination system for entering Higher Education has, therefore, formed particular tendencies and results in similar views and behaviours on the part of the students, same as far as ICT are concerned.

The creation of the questionnaire was based on a study of relevant to the research questionnaires, bibliography and online websites. Additionaly, Moodle environment is included in COLLES questionnaire, the examination of which has been helpful in forming some of the questions in this particular questionnaire.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,571
Bartlett's Test of Sphericity	Approx. Chi-Square	262,168
	df	136
	Sig.	,000

Table 2. Sample Efficiency

Reliability Statistics

Cronbach's Alpha	N of Items
,552	17

Table 4. Scale Reliability

Factual correlations in the questionnaire, as answered by the students, show that: The Perceived Usability (PU) of the System relates loosely to the positive view towards the system (EA), whereas it does not relate at all to the behaviour towards the use or the actual use (AS). In addition, the perceived ease at use (PE) does not relate to the positive view towards the system (EA) and its relation to the intention of use (AS) is limited. Finally, there has been found no relation between the positive view towards the system (EA) and the intention of use (AS). The conclusions as set above have been taken into consideration and have been confirmed in the system's log files (course view).

Factor Loandings for Measures o Constructs

	PU	PE	EA	CTA	AS
Perceived Usefulness PU (Cognitive response) Factor 1	,800 ,933 ,902 ,735				
Perceived ease PE (Cognitive response) factor 4		,953 ,818 ,860			
Environment Attitudes EA (Affective response) factor 5			,530 ,878 ,688		
Collaboration and teaching attitudes CTA (Affective response) factor 3				,788 ,928 ,919	
Actual system use AS (Behavioral response) factor 2					,805 ,834 ,355 ,859

Table 4. Varimax rotation

Component Correlation Matrix

Component	1 (PU)	2 (AS)	3 (CTA)	4 (PE)	5 (EA)
1 (PU)	1,000				
2 (AS)	-,062	1,000			
3 (CTA)	**-,269**	-,082	1,000		
4 (PE)	**,217**	**-,240**	-,189	1,000	
5 (EA)	**,328**	-,024	-,125	,005	1,000

Table 5. Matrix of factual correlations p<0,01

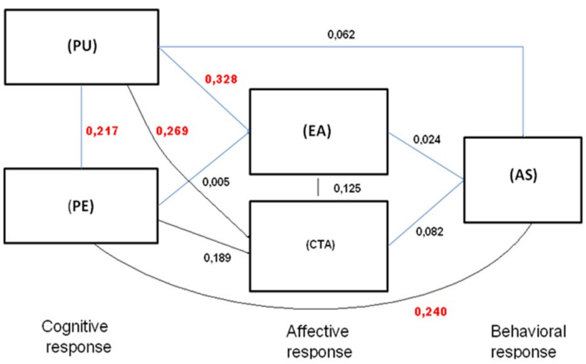

Figure 7: Factual correlation of response questionnaire

Conclusions

The students, being in their majority acquainted with PC use and the internet, can generally learn and use easily an interactive environment, such as Moodle. They can also perceive its usability in terms of the opportunities it can offer. However, the relation between the positive views towards the System, its use and the intention of use with the perception of its usability and ease at use, is affected on a large scale, by other factors. The need for free time, the general views towards school reality and learning in school, the way of life (role-models, values, behaviours) depicted in mass media, the mentality and practices of most educators (but for limited exceptions), the lack of team-working experience, are all such conditions which require examination in order to establish how much they relate to the success or failure of e-learning.

It should be possible for the use of interactive educational platforms to achieve the aims set, if the students are activated towards the educational procedure and take full advantage of the possibilities that technology offers to direct and indirect effects within the society. Naturally, this is also related to the Comprehensive Programme of Studies, which should be modified and oriented towards ICT [4]. The above is further confirmed by the fall in participation in the duration of time.

The development and exploitation of an effective Educational Software is not a new issue. However, has it ever been student-centered and constructive enough? In most cases Teaching - Learning stereotypes are reproduced, wrapped up in a New Technology "packaging".

We shall not always consider anything new as something innovative and something to be adopted without control and consideration of other factors.

The conclusions of data processing of the programme PISA 2003 underline the negative and limited relation between new technologies use (PC, internet) and the learning and students' performance [9]. The same fact is confirmed in the study of performance spreadsheets.

The choice of an appropriate pedagogic framework, the development, structuring and planning of learning through LMS require that educators who undertake such a project are familiar with ICT as well as well trained in pedagogic issues as well as in ICT, in order to support the achievement of teaching aims. Apart from careful planning and determination of aims, it is vital that certain factors are considered: educational staff, material and procedures [5].

Finally, there is the need to specify the framework for the «Rules of Operation and Exploitation of ICT in Education». The educator who desires to take part should not only be eager and attentive, but he/she should be quite certain for «what is to be used, how to use it, where to publish it, who have the right or the obligation to access it, who controls it.

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Science education for pupils with special needs in a non formal environment

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Abstract. *Apart from what critical literature says about the importance of a science education for pupils' development, one of the points of departure of this communication was done by collecting information at Aveiro (Portugal) schools in which it was noticed that the curriculum of the pupils with educative special necessities (nee) does not include, generally, any sciences discipline. We will describe a project that tries to promote science education for pupils with nee in a context of teaching not formally.*

Keywords. Non-formal environment, Pupils with special needs, Science education.

1. Introduction

The development of the different scientific disciplines, the growing specialization, as well as the notion of applicability of his knowledge, made science apprenticeship a subject of basic importance for the functioning of the society.
Science education seeks to provide situations of learning that promote the understanding of the natural world, and it's (inter)relations with the social world. It will also contribute for the development of the pupils' skills and attitudes that allows them to act in the future like explained consumers and able citizens, of intervening, in a responsible form, in the resolution of day by day problems.

Martins [10] defends that science education must pass with a social framing so that all the pupils can realize science contribution for the citizenship.

A recommendation of the *Declaration on Science and the Use of Scientific Knowledge* of written at *World Conference on Science for the Twenty-first Century: A New Commitment* carried out in the day 1 of July of 1999, reinforces these convictions:
"Governments should accord the highest priority to improving science education at all levels, with particular attention to the elimination of the effects of gender bias and bias against disadvantaged groups, raising public awareness of science and fostering its popularization." (UNESCO and ICSU, 1999).

2. Legal framework of students with special needs in Portugal

In Portugal the education system is compulsory for all children and young people, for 9 years, corresponding to basic education, according to Table 1:

		Average of ages
1st cycle	4 years	6-9
2nd cycle	2 years	10-11
3rd cycle	3 years	12-14

Table 1. Portugal education system

Over those years of schooling, science education is presented at Table 2:

	Physical and Natural Sciences
1st cycle	(generalist)
2nd cycle	Sciences of the Nature
3rd cycle	Natural Sciences Physics and Chemistry

Table 2. Science education at compulsory education.

To promote a democratic and inclusive school, looking for responding to the diversity of characteristics of all students, including children and young people with special educational needs, there is legislation which sets out to provide specialist support and educational measures to be applied, updated in Law 3/2008. The most restrictive is the Individual Specific Curriculum (previous Alternative Curriculum, according to Law 319/91). This replaces the skills defined for each level of education and training. This curriculum is designed from the identification of strengths and weaknesses of each student.

3. Science in individual specific curriculum

Was done a collecting information at Aveiro (Portugal) schools, between May and June 2007, that showed that the pupils, of the 2nd and 3rd cycle of basic education with special needs with an Alternative Curriculum, do not have Physics and Chemistry and only 34.7% have Natural Science.

The data collected by interview to the teachers responsible for the construction of curricula for students, allow concluding that the reasons why students do not have the science disciplines were:
- characteristics of the content (complexity, abstraction ...);
- characteristics of students (cognitive difficulties, ...);
- other (lack of appropriate materials, lack of preparation of teachers, ...).

However, all the teachers interviewed believed that is important or very important to include science in pupil’s curricula.

4. Science education in a non formal environment

The concept of education supported by the "World Declaration on Education for All" (UNESCO, 1990) beyond the limits of formal education and includes non-formal environments. As above, "Supplementary alternative programmes can help meet the basic learning needs of children with limited or no access to formal schooling ...." It also says that "Other needs can be served by: skills training, apprenticeships, and formal and non-formal education programmes in health, nutrition, population, agricultural techniques, the environment, science, technology, family life (…) and other societal issues.”

Seeks to clarify the meaning of these names we can say that formal education is developing in its own institutions (schools) and is characterized by being highly structured, following pre-defined programs. The non-formal education is an organized and systematic educational activity that happens outside the formal system (Hamadache, 1993; Bianconi and Caruso, 2005; Gadotti, 2005) and is conveyed in the museums, science centres, media or other counterparts.

According to Gadotti [6] the non-formal education should not be seen as opposed to formal education, arguing for the complementarity and coordination between the two. Know their potential bring them to the benefit of all. To Ávila [2] we can not conceive education isolated from society or accept that the formal school is the sole locus of expression of educational intentional processes.

Non-formal education characteristics, such as flexibility concerning time and space, reinforcing the relevance of the role that a less formal environment - outside school - can have on education for pupils with special needs that have a particular rhythm and development. It permits to respect differences and capacities of each one. According to Gadotti [6], non-formal education programs don’t need a sequential and hierarchical progression. Gohn [7] states that non-formal education gives conditions for individuals to develop feelings of self-recovery, the rejection of prejudice that they are addressed, the desire to be recognized as equals in their differences which reinforces the idea behind this project, increasing the environmental non-formal education in science for students with special needs. The environments of non-formal learning enabled by museums and science centres, according Chagas [4], are very rich and diverse that approximates the natural environments where the child spontaneously, creates its own knowledge. Some studies (Rodrigues, 2005; Bianconi and Caruso, 2005) emphasize the role of a non-formal environmental education in science. They believe that it have a huge potential to be exploited, especially to motivate pupils, to develop their creativity and, above of awakening the interest of the young in science.

The current movement of museums and centres that are dedicated to the spread and communication of science and technology is highlighted by his enormous public acceptance. Such acceptance is due, fundamentally to the appellative form as they show up, as well as the dynamic ones of exploration that stimulate the participation and interactivity, not forgetting the scientific correction. His structure invites the visitor to explore and to lift questions to all the public. According to Chagas [4] science centres assume so a clearly educative function using interactive techniques of exhibition and it stimulate curiosity and pupils participation.

In this sense, in Portugal, the program Ciência Viva, was created like one unity of the Ministry of the Science and Technology (Law 6/MCT/96), with the principal objective to produce spaces for the spread of science and technology, corresponding to new social practices, like non-formal interactive institutions.

Visit interactive science exhibitions is one of the processes that can be used in the science education that has been showing sign of quite elevated levels of implication and apprenticeship. That happens, because in these visits the experimental situations are of essentially playful nature, where the pupils explore / observe, not having certainly or wrong and where the rhythm is established by owns them. So, all the pupils, even that have learning problems, have possibility to develop several competences and capacities such as attention, cooperation, critical spirit or creativity.

So, the development of interactions between science centres and schools must not be restricted to punctual situations but be translated to a deeper collaboration.

5. Proposed project

Considering the previously presented (3.), we can note that we were before a population that in spite of frequenting the school will be illiterate scientifically.

Assuming the relevance of science education for all, it has to be put in a multidisciplinary and multidimensional perspective, with community implication. To Ferreira [5], pupils with special needs problems must not be discussed or solved like an isolated reality.

It is necessary to think about a cooperative proposal, looking for new methodologies that provide pupils development, in the society, in a process of autonomy and inclusion. This idea is reinforced by Latas (1990 quoted by Sousa [15]), what suggests the use of alternative resources to provide experiences of apprenticeship that are adapted to the different necessities of the individual pupils.

Only an included education in a social context will allow enjoying the full right of citizenship. So, the true inclusion implicates to understand the concept of education as a whole, implicating a school restructuring, passing by a fusion between the formal and non-formal education.

In this sense a proposal project was developed, in a partnership between Fábrica Centro Ciência Viva of Aveiro (a science centre), the Department of Education and Educative Technology of the University of Aveiro and the schools that were making part. The great mark of this project was to develop competences (capacities and attitudes), through science education, contributing to the educative inclusion of pupils with specific individual curriculum.

The implementation of this project implicated to include in the curriculum of the pupils, a science area, with a weekly periodicity (during 90 minutes), what was happening in Fábrica Centro Ciência Viva.

6. Why Fábrica Centro Ciência viva

Fábrica Centro Ciência Viva is a non-formal science education environment, in constant growth, which gives him a set of own characteristics that potentiate it and allow pupils a rich, diversified and differentiated experience.

Is a centre with a multiple offer capacity, making possible the exploration of different spaces with opportunity to carry out activities of different levels (interactive, thoughtful, reflexive, …) and with different communication ways (sound, light, image, writing, …). This plurality stimulates the curiosity and interest of the pupils, allowing them to explore, to question, to manipulate, to try,…, while they interact with other visitors.

7. The implementation of the project

7.1. Participants

There were wrapped 18 pupils of two Aveiro schools, divided in three groups (Tuesday group: 6 pupils of the 3rd cycle of the basic teaching; Thursday group: 6 pupils of the 2nd cycle of the basic teaching; Friday group: 6 pupils of the 2nd and 3rd cycle).

Besides the investigator himself, that had an active paper, they were also implicated Special Education teachers, responsible for the pupils, who supplied information on the pupils and of the impact of the implemented dynamic ones in them development. This information were also supplied for persons in charge of education of the pupils and of elements of the Executive Councils of the Schools.

7.2. Dynamic

During the academic year 2007/08, the pupils wrapped in the project carried out, once weekly, several activities proposed in the Fábrica Centro Ciência Viva. The pupils of the School João Afonso were moving accompanied by an educative assistant, and stay there alone. Those of School Aradas were accompanied by the respective teacher of Special Education.

For the School EB João Afonso, the project had beginning in the 1st period, being extended up to end of the academic year:

• Group of the 3rd cycle (Tuesday) – total of 31 sessions:
  - first session: 02 / October / 2007
  - last session: 17 / June / 2008

• Group of the 2nd cycle (Thursday) – total of 29 sessions:
  - first session: 04 of October of 2007
  - last session: 19 of June of 2008

For School Aradas, for reasons foreign to the persons in charge and project promoters, like the late placing of the teacher of Special Education in the School and pupils dislocation, project had beginning only in the 2nd period, being extended up to end of the academic year, to Friday, having carried out a total of 16 sessions:

- first session: 11 / January / 2008;
- last the session: 20 / June / 2008.

Each group developed sessions of activities, organized at three moments:

- 1st moment (orientated by the investigator): preparation / motivation of the pupils for the activity to develop, where different strategies were used, such as the placing of a question problem, resolution of an enigma, …;
- 2nd moment: realization of the activity. When the activity was belonging to one of Fábrica it orientated by his monitors. Before the session to happen there was always a prior approach to monitors, by the investigator, of how to potentiate the session dynamic, attending to pupil's characteristics. The sessions boarded quite diversified themes, trying to attend to pupil's ages, development, interests and motivations. Someone sessions were prepared and / or adapted for the effect.
- 3rd moment (orientated by investigator): systematization of the activity; reflection; resolution of the question problem...

7.3. Gathering information

The instruments of gathering of data of the observation were: notes, photos, registers of the meetings carried out with the schools and wrapped teachers, materials produced for and on the pupils, such as graphic different registers of descriptive and reflexive character.

They were done interviews to the different intervenient in the study (pupils, teachers, parents).

7.4. Articulation with the schools

Along the whole academic year straight contact was maintained between the investigator and pupils Special Education teachers. In the end of each period there were formal moments, when interviews were carried out. Of these contacts agreements were born to the implementation of the project, such as:

- the development of activities in the School, continuing sessions carried out in the Fábrica;
- the presentation by pupils of the activities developed in the Fábrica, in their own schools.

In the end of each period there was carried out, by the investigator, a global evaluation of each pupil who consists of his school registers.

8. Conclusions

On basis of the collected data, we can say that pupils benefited, with pleasure, the proportionate activities. Besides to go out from the routine of the school, the sessions corresponded to his curiosity and interest, surpassing expectations. There was a global development, in all the pupils, at several levels, such as: social behaviour, relation with others, language. Besides these aspects highlights still the knowledge built through the individual discovery. Along the academic year there were carried out several activities that provided to the pupils different experiences, the contact with " things " what they would never have access if it was not this project, which led to the development of general competences and of capacities and attitudes.

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