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Affordable and Efficient Science Teacher In-Service Training(*)

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

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

1. Introduction

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

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

The focus of this scheme is on the promotion of the collaboration and cooperation between teachers, schools and institutions involved in the Science teaching and in Science Teaching education. The fundamental philosophy is that learning can be developed and enhanced through the sharing of knowledge and best field practice

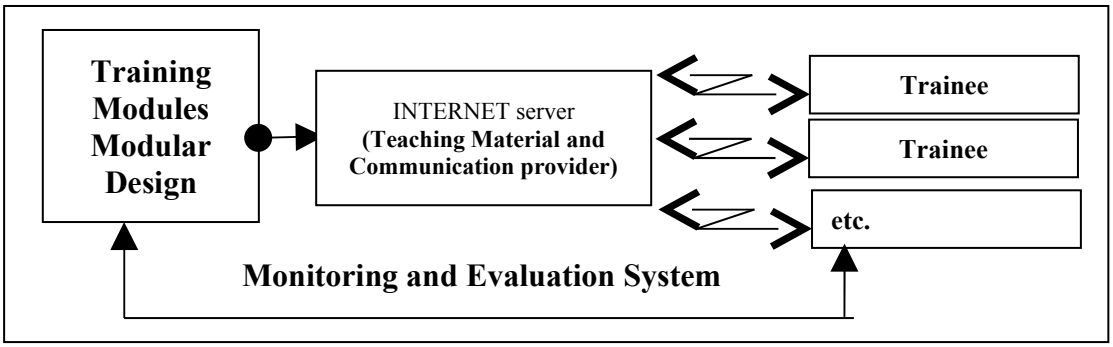

Figure 1: The e-learning system

experience of different groups involved in such activities. A further objective is the establishment of a network of people including scientists, school-teachers and researchers to promote Science and Technology education. In this aspect membership consortium is intended to be open to any colleague wishing to participate.

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

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

The activities of this project are organized in three phases

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

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

2. Implementation

1. One traditional face-to-face seminar was delivered four times during the period from March to May 2006 in the form of an intensive training course. The 1st was delivered in Nicosia Cyprus, to (secondary education) Science teachers as part of their pre-service training (3 training hours). The 2nd was in Heraklio Crete, to secondary education Science teachers (6 training hours in two consecutive days). The 3rd was also to secondary education Science teachers in Rethimno Crete (6 training hours in two consecutive days). The 4th was to primary school teachers in Rethimno Crete (6 training hours in a whole afternoon). In all 4 seminars the same two persons (P. G. Michaelides and M. Tsigris) were used as trainers. In the 4th seminar (to the primary school teachers) another person (N. Tsagliotis) presented also the basics of the reformed primary school Science books. In all seminars there was also an observer (A. Margetousaki of the authors).
2. The contents of the seminar were a selection of topics from different areas of the school curriculum, mainly from Physics and (to a lesser extent) from Chemistry. The seminar was mostly focused on the didactics adopting a teaching approach within a Hands on Science Teaching context [12]. More specifically, examples of relating Science to everyday life observations [13], [14] and experimentation with self made equipment

[15] were discussed. The seminar was organized as follows:

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

3. It must be noted that:
   - Science in primary school is a common course. In the first 4 classes it is within a 'Study of the Environment' school subject with topics from the natural and the human environment. In the 5th and 6th classes there is the school subject 'Science' with topics from Physics, Chemistry and Biology. There is also the school subject 'Geography'. In this, topics from natural Geography, especially of the Greek and the European area, form most of the syllabus but there are also topics from anthropography and from the solar system and its neighbourhood.
   - Teachers in primary school do not have a specialist education or initial training in Science. They teach all school subjects one teacher to one class or, sometimes in small villages, to two or more classes... This is true for schools with less than 6 teachers who have to teach the 6 classes (grades) of the primary school. In primary schools with a large number of students and 6 or more teachers an informal allocation (sharing of teaching responsibilities) is usually made with two teachers teaching the upper two (5th and 6th) classes (grades) one responsible for Mathematics, Science, and Technology (usually a male teacher) and one responsible for Humanities [11].
   - Secondary education schools in Greece include the middle school (Gymnasium, grades 7th to 10th) and the upper school, Lyceum or Technical Vocational Lyceum (or, previously, Technical Vocational school, a middle school). Science in secondary education schools is taught as separate subjects (Physics, Chemistry, Biology, etc).
   - Science Teachers in secondary school have a (University) degree in a Science subject (Physics, Chemistry, Biology, Geology, etc) and they are entitled to teach any of the Science subjects in secondary education schools, as needs arise. In practice they are assigned to teach Science subjects according to their own Science specialty. There is also an informal tendency [11] for male teachers to be assigned the responsibility of the higher grades and of Physics and Chemistry.
   - Students' attitude to Science subjects (along with every other school subject) in the upper secondary school (general Lyceum) is oriented towards the written entrance to higher education general examinations. This means that learning activities like experimentation are not within the students' priorities or within the tasks undertaken by the teachers (in these conditions, it seems to be loss of time).
4. Upon the completion of each seminar the (teachers) trainees were asked to fill anonymously a written questionnaire. The aim was to check on the trainees' impression to the teaching approaches adopted and to trace (possibly) their training needs.

3. Analysis of the questionnaire.

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

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

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

Table1. Participants

	Frequency	Percent
Heraklio	47	43,9
Rethymno (s)	39	36,4
Rethymno (p)	14	13,1
Cyprus	7	6,5
Total	107	100,0

Table 2. Sex

	Frequency	Percent
Female	48	44,9
Male	59	55,1
Total	107	100,0

The figures above are consistent with the corresponding percentages of teachers in the Greek schools. From these 107 participants we got 72 (67%) questionnaires as is depicted in the following Table 3. Questionnaires from the seminars and Table 4. Sex. Of the 8 primary school teachers who filled the questionnaire 4 were males (50%) and 4 were females (50%). Their degree qualification is depicted in Table 5. Degree where the 8 primary school teachers are classified as 'Other'.

Table 3. Questionnaires from the seminars

	Frequency	Percent
Cyprus	7	9,7
Heraklio	29	40,3
Rethymno (s)	28	38,9
Rethymno (p)	8	11,1
Total	72	100,0

Table 4. Sex

	Frequency	Percent
Female	27	37,5
Male	45	62,5
Total	72	100,0

Table 5. Degree

	Frequency	Percent
Other	32	44,4
Physicist	40	55,6
Total	72	100,0

A (significantly) lower response rate is observed for the female participants, likely even more for the female primary school teacher participants. On this observation, it is evident that a detailed analysis should rather differentiate between male - female participants and between primary – secondary school teachers participants. Because of the as yet small sample we examine the rest of the questionnaire as a whole restricting the results to the general trends only.

The participants were asked:

5. If the topics presented were useful with choices to answer; extremely useful, useful, just a little, not at all. The answers are presented in Table 6. Usefulness.

Table 6. Usefulness

	Frequency	Percent
Extremely useful	32	44,4
Useful	39	54,2
Least useful	1	1,4
Total	72	100,0

6. If the topics discussed were related to the school curricula with possible choices to answer; much related, a little relate, not at all related. The answers are presented in Table 7. Relation with the Curriculum.

Table 7. Relation with the Curriculum

	Frequency	Percent	Valid Percent
Very much	32	44,4	50,8
Little	29	40,3	46,0
Not at all	2	2,8	3,2
Total	63	87,5	100,0
Missing	9	12,5	
Total	72	100,0	

7. If the seminar presented another teaching perspective with possible choices to answer; Yes, No. The answers are presented in Table 8. Different teaching perspective.

Table 8. Different teaching perspective

	Frequency	Percent	Valid Percent
No	8	11,1	11,4
Yes	62	86,1	88,6

Total	70	97,2	100,0
Missing	2	2,8	
Total	72	100,0	

8. If they would attend again a similar seminar with possible choices to answer; Yes, No. The answers are presented in Table 9. Attain again.

Table 9. Attain again

	Frequency	Percent
No	1	1,4
Yes	71	98,6
Total	72	100,0

9. If they think that this seminar would be interesting to their fellow teachers with possible choices to answer; Yes, No. The answers are presented in Table 10. Are other teachers interesting?

Table 10. Are other teachers interesting?

	Frequency	Percent	Valid Percent
No	3	4,2	4,5
Yes	64	88,9	95,5
Total	67	93,1	100,0
Missing	5	6,9	
Total	72	100,0	

On the two (open) questions about the positive and about the negative aspects of the seminar the responses are presented in 'Table 11. Positive points of the seminar' and in 'Table 12. Negative points of the seminar' respectively. Of the participants (refer to 'Table 11. Positive points of the seminar'):

- 31% found the simplicity of the constructions very positive,
- 18% mentioned that they found very prototypal the experiments,
- 43% mentioned as very positive the teaching method proposed during the seminar,
- 8% think that the seminar was a chance for further speculation on the teaching of Science.
- There was a percentage 29% who did not answer this question.

Table 11. Positive points of the seminar

	Frequency	Percent	Valid Percent
Simple constructions	16	22,2	31,4
Prototypal	9	12,5	17,6
Teaching approach	22	30,6	43,1
Speculation	4	5,6	7,8
Total	51	70,8	100,0
Missing	21	29,2	
Total	72	100,0	

Correspondingly as negative points of the seminar were mentioned**:**

- The time spent was not enough to cover the subjects by 44% other participants.
- The organization was not appropriate (24%). This category covers a wide variety of statements including: 'the subjects should be related to the curriculum', 'teachers (i.e. the trainees) should participate at the procedure' or 'I would prefer to participate myself at the experiments'.
- Almost 20% of the respondents mentioned as a negative point that there was too much theory in the seminar.
- 12% of the respondents mentioned as a negative point that the topics discussed were mainly from Physics.
- A significant 43% did not answer this question.

Table 12. Negative points of the seminar

	Frequency	Percent	Valid Percent
Little Time	18	25,0	43,9
Subject	5	6,9	12,2
Organization	10	13,9	24,4
Theory	8	11,1	19,5
Total	41	56,9	100,0
Missing	31	43,1	
Total	72	100,0	

On the question if they would participate in a similar seminar organized with Distant Education methods the results are depicted in Table 13. Distance learning seminar.

Table 13. Distance learning seminar

	Frequency	Percent	Valid Percent
No	22	30,6	32,4
Yes	46	63,9	67,6
Total	68	94,4	100,0
Missing	4	5,6	
Total	72	100,0	

Interesting is the respondents' answer to the question 'Can you apply the topics discussed/ the knowledge acquired to your classroom?' which is depicted in Table 14. Application. The vast majority (more than 84%) answer 'yes'. However a (small) number of these positive

answers continue that this may be done on the prerequisite that they would have the time and the infrastructure.

Table 14. Application

	Frequency	Percent	Valid Percent
No	6	8,3	9,0
Yes	61	84,7	91,0
Total	67	93,1	100,0
Missing	5	6,9	
Total	72	100,0	

4. Commentary

The data presented earlier show that the seminars were accepted by the teachers – trainees in a very positive way. However, a detailed analysis, especially on the criticism performed is appropriate and on going. However we would like to add a few comments based on the (informal) discussions the authors had with the trainees.

1. Many of the participants believe that the theoretical framework was extremely extended and in many cases was characterized as useless (see also Table 12).
2. There was a vivid interest on the experiments and the constructions (see also Table 11).
3. Straightforward or indirectly many of the participants admitted that they have not experience at all with this kind of application or teaching approaches in the classroom. Comments made are 'There are no books' 'It is not anticipated by the ministry'.
4. Schools in secondary education are equipped with labs and the necessary tools for the experiments. Although there is equipment in schools, the main negative point mentioned was that there is no need for this kind of experiments because they are not useful for the entrance examinations to higher education.
5. Many of the participants mentioned the simplicity and the prototypic nature of the constructions (see also Table 11).
6. It was understood that through this kind of applications it is possible for the teacher to be a collaborator or partner of the children through the learning process in the laboratory.
7. In the end of the seminar many expressed the desire to be capable of performing these experiments presented during the seminar, and bypassed the point that these experiments were part of a broader context applying in a certain teaching methodology. They seemed to focus on the certain cases, instead of the teaching method proposed with those cases as starting points.
8. Another thing that came out from the discussions is the need expressed from the teachers to work on the constructions and try to perform the experiments themselves, a point mentioned also in the questionnaires too.

5. Epilogue

The results show that there is great interest for the teaching model of Science proposed during the seminars. Teachers seem to be interested in the idea of quantification of the experiments and the involvement of the pupils to the experimental process. Teachers are willing to have further training in this field and are also ready to use the online training method of Science teaching. It is also obvious that there is an extended training gap concerning the science teaching as shown from the fact that teachers are willing to participate in a training seminar of this kind again and from the fact that they think that other teachers would also be eager to participate too. The main negative point of the seminar mentioned from the participants was the lack of time, which seemed to be very short in comparison with the subjects inquired. Maybe there is a need for a more extensive seminar where there will be provision for teachers' active participation to the construction of the equipment - instruments and the development of the experiments. This way they will have a direct experience and they will be able to work on the idea of self-made apparatus.

8. Acknowledgements

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9. References

[1] see for example a synopsis for the case of England in Susan Barker and Pilar Reyes, 'Why be a Science Teacher?', pp.57-68 of Vol. II of the proceedings of the University of Cyprus, '1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens', Paralimni-Cyprus 29/4-2/5 2001.

[2] Institute for Science Education and Science Communication' related to the teaching of Science and Technology to students of a non Science related career, b/for England and Wales, 'Science: The National Curriculum for England', c/for a more general review, Karidas A and Koumaras P. 'Scientific (and Technological) Literacy for All: Presentation of a Research Model and an Attempt to Constructing a Relevant Proposal', pp.89-97 of Vol. I of the proceedings of the University of Cyprus, '1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens', Paralimni-Cyprus 29/4-2/5 2001.

[3] Krystallia Halkia, 'Difficulties in Transforming the Knowledge of Science into School Knowledge', pp. 76-82, of Vol. II of the proceedings of the University of Cyprus, '1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens', Paralimni-Cyprus 29/4-2/5 2001.

[4] As may be inferred from the fact that, in human history, they appear and advance earlier than other sciences.

[5] For example their subjects of study are easily perceptible through the senses, an irrefutable advantage for most of the compulsory education students who, in a Piagetian context, have not as yet reached the formal logic stage.

[6] The necessity on the modernisation of the Science curriculum has been pointed out in: George Kalkanis 'Which (and How) Science and Technology Education for Future Citizens?', pp. 199-214 of Vol. II of the proceedings of the University of Cyprus, '1st IOSTE Symposium in Southern Europe – Science and Technology Education: Preparing Future Citizens', Paralimni-Cyprus 29/4-2/5 2001.

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[10] Project AESTIT, Contract 226381-CP-1-2005-1-GR-COMENIUS-C21. A web site (http://www.clab.edc.uoc.gr/AESTIT/) is also being developed.

[11] Private own data within the context of an on going project on school practice.

[12] Learning Science requires the involvement of the student in activities of observing, experimenting, making hypotheses to explain the data observed, planning and realizing experiments to discriminate between different hypotheses, making generalizations in the form of models and communicating the results of their study. Hands on Science includes all these activities but places an emphasis on the (usually neglected) phases of observation, experimentation and the (subsequent) collection of relevant data.

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