4.5 Experiences and recommendations from the training course implemented in Athens

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4.5.1 Introduction

The training course implemented in Greece was held at the premises of the School of Pedagogical and Technological Education (ASPETE) in Athens, and was organized in 5 face-to-face meetings that each one lasted for 6 teaching periods of 45 minutes, during 3 Fridays/Saturdays afternoons.

20 of the 23 trainees participated in the final evaluation at the end of the training course. As to their specialization, there were 2 Mathematicians, 1 Physicist, 5 Engineers, 8 Informatics teachers and 4 Primary School teachers (10 males, 10 females). The trainees were volunteers in the course (some of them work as teacher trainers) and only 2 of them had a previous experience in educational robotics.

For the evaluation of the course, a series of tools were used. This section presents and discusses some of the evaluations made by the trainees themselves regarding the educational methodology applied in the course, as recorded in the diaries that they kept on the e-class right after the end of each meeting and their responses to the written questionnaire which was given to them at the end of the course.

4.5.2 The diaries

A selection of typical statements from the diaries of the groups of trainees concerning the course training methodology is shown in table 4.5.1.

Table 4.5.1. *Typical Statements from the Diaries of the Trainees written at the end of the meetings*

Group	*"What was the best thing that happened to you today?"*	*"What was the worst thing that happened to you today?"*
A	We experienced the joy of creation, we built it up and it proved operational. We managed to complete an exercise and to park the bus.	Very little practical application, quite a lot of writing on the *Word*.
B	The whole process of the robot construction and its ensuing programming was very pleasant and creative The construction process and that	We did not manage to make our robot move along a square … We ran out of time for experimentation with all the activities proposed in the work sheets. There should

	of experimentation with the scenario of coil.	have been more time available for experimentation and testing.
C	The creation of the robot and the implementation of the initial programs. When, ultimately, the robot moved along a square on the floor we rejoiced like young children! The activity where we tried to discover the function of the variables within a program … The fact that our group managed to propose a number of ideas for implementation in class.	The activity at the project's assembly stage "The bus running". The assembly stage was impossible to be implemented and we were compelled to talk theoretically.
D	The success with the cat robot which proved able to catch the mouse and turn tail at full speed… The exploration of the robot. It was great fun!... The collective effort (one section by each group) in constructing the bus. It was a very interesting and very well organized approach.	
E	The discussion of the construction ideas and the experiment with the power-speed. The result of the commands given to the cat robot to miaow The discussion about construction ideas.	Little time available for practical work … The hurried process regarding proposals for teaching strategies. The activity did not convince us as to its targets and what is looking for.

F	When we collectively constructed the NXT, set it in operation and carried out the activities Out contact with the NXT has begun to attract our attention and we are already anticipating the learning scenarios to be included in classes The use of robot construction based on projects (collective work – development stages) When we readily completed the program whereby the bus-robot stopped when it encountered any obstacle	When the lesson was over! Difficulty in the exploration and understanding of the variables. If there is not adequate time available for the completion of the activities, learning is senseless. The seminar should have lasted longer.

4.5.3 The questionnaire

The responses of the trainees to a selection of questions included in the questionnaire are presented in the following lines.

A. *What do you think of the participation / involvement of the trainees in the program's activities?*

The trainees, overall, describe their participation / involvement in the program as very or quite active. Their responses focus on their active involvement in the activities concerning robotic constructions and their programming, on team works, as well as on the debates that took place during the program in the classroom and via the e-class. The appraisal of their participation in the "theoretical" part of the program was, likewise, positive. ("*We took an active part even in the theoretical part, where our active involvement was encouraged*").

B. *What do you think of the proportion that existed between practical activities (by the trainees) and the presentations (by the trainers)?*

75 % think that there had been proper balance between practical activities (by the trainees) and presentations (by the trainers). They think that the presentations were necessary for the support of the practical activities ("*The presentations had appropriate duration at critical points in the progress of works and their completion*"; "*I think that there was a kind of concordance, where the trainers showed us certain basic things and we developed same through our activities*".).

25% ask for more practical activities: "*A greater involvement in activities and their exploration would have generated great interest*"; "*In general terms, there* *had been balance, but I would have liked more weight to have been given to the practical activities, since they are more attractive. Besides, we are "full" of theoretical presentations*".

C. *What do you think of the support provided by the trainers?*

The trainees describe the support provided by the trainers as very (95%) or quite (5%) satisfactory: "*They supported ideas, encouraged efforts, proposed solutions*". They describe their support as "discrete and when there was need for it". They describe, likewise, the support provided via the e-class as satisfactory.

D. *What do you think of the duration of the program?*

30% consider the program's duration as satisfactory, while 70% would have liked more hours spent on it. Some of them explain that it was their first contact with the programmable robotic constructions and needed more time to become more familiar with them ("*In quite a few of cases I felt that time was against me and I think that I needed more time available*"), others would have liked more time as they wanted to do more things ("*to swim in deeper water*", "*there were things we did not have time to do, although they were interesting, e.g. collection of data from the environment*"). Others think that they needed more time for the preparation of their assembly works and that through longer engagement in the subject matter in the classroom, they could have produced better projects.

E. *State any difficulties that you encountered during the program*

They mention difficulties in respect of programming activities ("*certain Switches seemed too heavy for me*", "*I would have liked more engagement and experimentation activity in the programming field for the development of the necessary skills*"), difficulties in respect of cooperation between teams outside seminar when dealing with the assembly side of their group project, difficulties with the material available: they would have liked more Lego blocks available and one set per each trainee.

F. *What do you think of the training materials (work sheets, software examples, presentations et al.)*

75% consider as very useful and 25% as quite useful the training material given to them. They explain that the material "*gave ideas and outlets regarding the pedagogical approach, as well as regarding the educational utilization…*"; "*with effective subject sequence…*"; "*it succeeded in involving us under normal conditions in the rationale and philosophy of both, Lego Mindstorms and the logic of robotics in education*". They considered as positive the fact that "*there had been presentation of a comprehensive work, which enabled them to study all its stages*". Some of them would have liked more material "*for additional stimuli…*" or for "*homework*".

G. *What in the program seemed interesting to you and worth-while using in class, as a teacher, with your pupils?*

They mention the teaching means used, such as the e-class and the work sheets, the training method and the teaching approach based on the cooperation of teams. Especially appreciated was the cooperation between teams in processing the theoretical texts, which took place at the first meeting; it was found useful for their own work in their capacity as trainers of other teachers.

H. *Evaluate each one of the parts of the program, stated in the table shown below, by marking them as follows:* ***6****= excellent,* ***5****= very good,* ***4****=satisfactory,* ***3****= moderate,* ***2****= inefficient* ***1****= very inefficient*

The average marking was as follows:

Table 4.5.2. *Evaluation marks for each one of the parts of the course*

	mark
Educational content	5.60
Educational method	5.45
Support by the trainers	5.80
Educational material	5.40
Educational results	5.25
Electronic class	5.00

4.5.3 The trainees' products

During the course, the trainees had to design their own projects based on the proposed methodology. Six of the seven groups of trainees developed and submitted interesting projects. All the groups worked with the Lego Mindstorms kit and programmed the robotic construction with the Lego Mindstorms Education NXT version 1.0. Below we provide brief presentations of the six projects.

Project 1: selector of recycled garbage

This group consisted of two mathematicians and two computer scientists. According to their project, school students are invited to construct a simulation of a selector of recycled garbage able to identify the colour of different objects - normally garbage bags come in special colours (see Fig. 4.5.1).

The selector decides if the object is to be recycled or not based on its colour, and accordingly puts the object in the appropriate bin. The robot is equipped with two belts and a light (or colour) sensor.

Fig. 4.5.1. *Selector of recycled garbage*

The sensor checks the colour of the objects and activates one of the two belts accordingly. Worksheets for school students were also produced by the trainees following the proposed project-based learning methodology. Students are supposed to work in groups in a laboratory equipped with computers and some Lego Mindstorms kits.

Project 2: autonomous irrigation system for water management

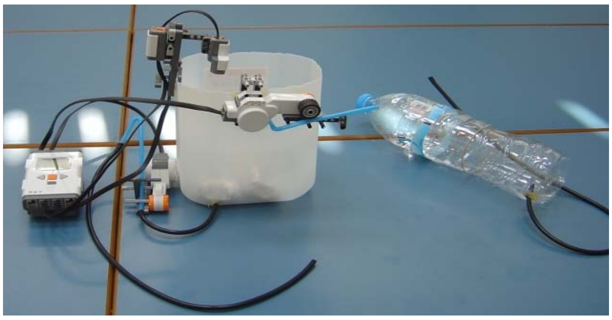

Fig. 4.5.2 *Autonomous irrigation system for water management*

This group consisted of a mechanical engineer and a computer scientist. Through this project school students are invited to design and construct an autonomous irrigation system for water management. The basic functions of this system are: (a) filling up a tank and control of the water level, (b) control of watering from the tank during the night.

The main challenges set by this project concern (a) avoiding water loss while filling up a tank, i.e. the tank must not be overflowed and (b) automatic provision of water from the tank when it is getting dark and the climate conditions favour watering. The characteristics of the system can be changed or enriched by students' ideas. Lego Mindstorms NXT kit, a plastic tank and watering pipes are used for the construction of the system (see Fig.4.5.2). Its behaviour is being arranged through sensors controlling the behaviour of motors. The project is organized in 5 stages following the proposed project–based learning methodology and aims, in addition to other objectives, to sensitise students about the ecological management of water resources.

Project 3: Organizing seats in a theatre

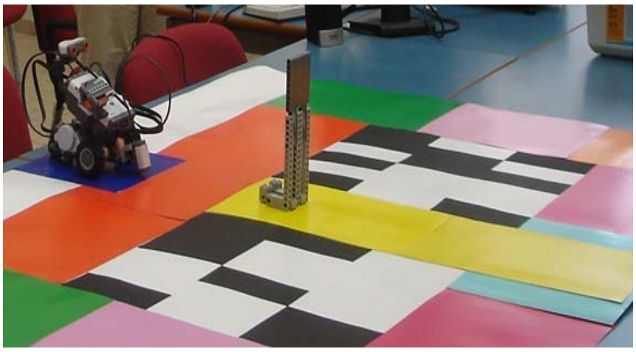

Fig. 4.5.3 *Organizing seats in a theatre*

This group consisted of a computer scientist and two physics teachers. In this project, school students are invited to construct and program a robot able to follow a predefined route in order to count the free seats in a theatre or cinema or ground or class etc., and inform the person in charge about the free seats of the whole place or a specific section (see Fig. 4.5.3). Extending the project, this robotic construction might also place audience in appropriate places according to their ticket.

Project 4: Easy parking

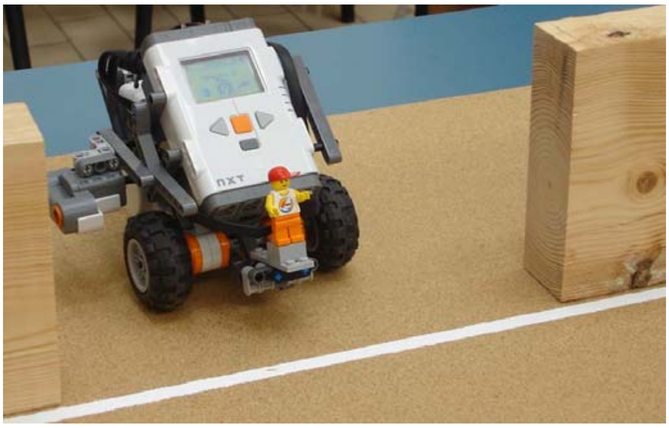

Fig. 4.5.4 eas*y parking*

This group consisted of a computer scientist and an architect. In this project students are invited to construct a car-robot able to perform 'easy parking' on a mock up having several obstacles (see Fig. 4.5.4). The robot has to identify the blank spaces, to avoid obstacles by turning left or right, to stop, and finally to park at free car parking places.

Project 5: A moving car

This is an introductory project developed for primary education. In this project pupils are gradually guided to cultivate basic construction and programming skills. They have to construct a car robot and make it move forward, backward and turn left or right. Then a challenge is set e.g. to move the car through a specific route and then move it freely in any path. This project can be expanded to a game with many challenges.

Project 6: The catapult

Fig. 4.5.5. *The catapult*

This group consisted of a mechanical engineer and two computer scientists. The project was designed for students of 15 and 16 years old. Students are invited to construct a robotic arm with one motor by following simple instructions (see Fig. 4.5.5). Then they should program it to throw small balls in a basket (projectiles). In order to make it work effectively, students should conduct experiments with the parameters involved like the length of the robotic arm, the motor power, the projection angle, the horizontal distance etc. Experimental data are collected and represented in graphs using appropriate software. Detailed examination of these graphs can help students to investigate relationships among the parameters involved. Finally students may continue playing a basketball game!

4.5.4 Conclusions and recommendations

In the training course a balanced whole of collaborative, learning- and teaching-focused approaches was adopted. The course evaluation was based on the trainees' products through the course and mainly on the projects they developed, on the questionnaires filled by the trainees and on semi-structured interviews at the enfd of the course. The preliminary results prove the potential of the training approach.

From the diaries kept by the trainees it appears that their statements as to "the best thing that happened to them" during the meeting involved focus on the practical activities, the creation of their own engineering structures and their programming. ("*We experienced the joy of creation, we built it up and it was operational*", Group A). It appears, indeed, that they enjoyed their work ("*When, ultimately, the robot moved along a square on the laboratory floor we rejoiced like young children*" Group C). Already from the initial activities some of them started thinking of scenarios for inclusion of similar activities in their own school class (Group F).

Conversely, among "*the worst things that happened to them*" they mention cases of "*very little practical work and quite a lot of writing*» (Group A), and, in some cases, lack of time required for the completion of their work. Their preference for practical work and their negative attitude towards "*theoretical presentations*" is also clear from the fact that they recorded among their negative experiences the case (assembly stage "*Bus Route*") where, because of lack of adequate time, their practical work was substituted for theoretical discussion (Group C).

Their positive experiences include the project-based learning method that they followed in their work and the exploration, experimentation and creation features included in that method, although some of the groups found that the proposal formulation process in respect of teaching strategies, which the trainees were asked for, was "*hurried*" and non-convincing (Group E) and that the implementation of the project "*bus route*" stage was not feasible (Group C).

From the questionnaire responses it appears that the training methodology of the course ensured their active participation, there was fair balance between practical activities on the part of trainees and presentations on the part of the trainers although some of them request even more activities and fewer presentations. They seem happy with the support and encouragement given to them by the trainers, while most of them asked for longer duration of the course. The difficulties mentioned by them are focused on robot programming elements (switches, variables) and the cooperation beyond the course, given that each group had only one Lego Mindstorms set at their disposal.

They evaluate the teaching materials used in the course as very useful. They state that the above materials as well as the training methodology followed in the course are worth applying either in their school classes with their pupils or in training fellow teachers (some of them work as trainers of teachers). The quantitative evaluations for the course range between very good to excellent (table 4.5.2) regarding all the aspects of the course that were evaluated.

Lastly, for the course improvement they propose even more emphasis to the construction work, additional and more complex examples of robotics activities, greater activation of the groups, increased sharing of ideas and projects between trainees via the internet and expansion of that communication to reach teachers of other European countries cooperating in the TERECoP project.

The above evaluations made by the trainees were confirmed by the group interview that took place at the end of the course (Papanikolaou et al. 2008).

The trainees' projects that were presented and discussed in the final session of the course followed the 5-stages methodology for designing robotics-enhanced projects that had been worked out during the training course. The presentation of the projects and the relevant materials (worksheets etc.) produced by the trainees indicate that the trainees efficiently adopted the proposed methodology. The projects address authentic problems from real life ('recycling garbage', 'saving water resources', etc.) and engage students in problem solving through exploration and investigation activities that exploit sufficiently the potential of the robotics technology.

Finally, the trainees' answers and comments to the questionnaires and during the interviews offered evidence about the potential of the training course including the training methodology, the educational content, the use of e-class, the learning experiences and the integration of robotics in the school reality.

Training methodology: Trainees recognised their active participation in all the sessions of the course and their creative involvement even in the theoretical parts that introduced constructivist and constructionist principles and the methodology for designing robotics-enhanced projects. Several trainees emphasised that the educator's axiom '*teachers teach as they are taught, not as they are told to teach*' was really followed in the course. They admitted that they had a real experience of constructivism ("*It was for me a lesson of knowledge construction*", "*Constructivism was present all the time in the course*", "*this course was substantially different from the courses I had attended in the past*").

Some comments focused on the synthesis of the groups, doubting about the efficiency of the criterion of personal relations for group formation purposes. Especially the group of the primary school teachers noted that "if a teacher of Informatics participated in our group, s/he would have helped us a lot…" Other trainees emphasised that the cooperation of teachers coming from different disciplines (maths, science, informatics etc.) is necessary for the successful implementation of the projects in school settings given that the projects are normally interdisciplinary.

The communication and cooperation between trainees and trainers was appreciated by the trainees as very supportive and helpful ("*we achieved a common language*…") However, they suggest that the duration of the course should be extended and the development of their own project –or most of it- should take place during the course.

Concerning the *educational content* they very much liked the activity-orientation. They also liked that they had a real case of a project ('*The Bus Route*') to analyse the different stages of the methodology. They suggested that more examples and activities for homework would be also useful.

Concerning the use of *e-class,* most of the trainees evaluated the central role of the e-class during the face-to-face meetings and beyond them in enhancing social interaction and promoting a positive sense of community. They found the use of the web-based class as an interesting and useful experience that they wish to exploit in their work as teachers or trainers, although they think that its administration is a quite time consuming task. They acknowledged the timely provision of information, course content, and support when necessary. They mentioned that the discussion forum was mainly used for posting messages and not for real discussions since most discussions took place through face to face communication.

Learning experiences and integration of robotics in the school reality: Trainees appreciated the potential of educational robotics as a teaching tool but also as a subject in different disciplines such as technology, informatics, and engineering. A critical issue for integrating robotics-enhanced projects in the schools was how an interdisciplinary project may fit to the current school curriculum and schedule. Interesting ideas were proposed for integrating educational robotics in schools such as working interdisciplinary projects or research programs running out of the school schedule involving students from different levels e.g. engineers from technological education working with high school students. Trainees seem also to worry about the management of big classes during the implementation of robotics-enhanced activities in school settings ("*It will be difficult for one teacher to manage a school class of 30 students…*") and the cost of the necessary equipment.

Finally, trainees highly appreciated the opportunity to create their own project ("*a serious gap would have been left, if I had not worked on a new project within my group*"). They recognised that at the end of the course, they felt capable to implement the robotics technology in their school class ("*I understood how to exploit these new ideas and technologies in my school class*").

As an epilogue, we shall use the following very pointed statement made by one of the trainees, as, in our view, it describes in a concise manner the success of the methodology we applied: "*What I enjoyed most of all in the seminar was its planning. I liked the fact that we initially functioned as learners in the activities proposed, so that we crossed over to the other side, as a start, and, subsequently, we undertook the role of a teacher and came to the level of activity planning. I think that this kind of planning provided a quite comprehensive image of the usefulness and utilization possibilities of robotics in education*".

References

K. Papanikolaou, S. Frangou, D. Alimisis, (2008). *Teachers as designers of robotics-enhanced projects: the TERECoP course in Greece,* In proceedings of the SIMPAR 2008 conference/Workshop "Teaching with robotics: didactic approaches and experiences", University of Padova, 2008. Available at http://www.simpar-conference.org/