RoboESL project at 56th Junior High School of Athens. Activities and experiences from our 1st implementation

Tassos Karampinis [1], Marianthi Zixnali [2]

[1] Computer Science teacher, 56th Junior High School of Athens, goa56tk@gmail.com
[2] Technology teacher, 56th Junior High School of Athens, mariazi12013@gmail.com

Abstract. The 56th Junior High School of Athens participates in the ROBOESL program. We use interdisciplinary educational robotics' projects trying to help pupils to improve their grades and change their attitude towards school; especially those who don't like school settings. Our first implementation took place during the last trimester of 2015-16 school year using three EV3 Lego Mindstorms. The time wasn't sufficient to discuss about grades improvement concerning the participants (this is anyhow a long term procedure) but enough to discuss our first results. Apart from our official team of 10 pupils we run two other teams consisting of: a) 12 pupils during ICT – Technology lessons and b) 5 pupils after school hours.

Keywords: RoboESL, EV3 Lego Mindstorms, Problem Based Learning

1 Introduction

In this report we will present our participation in the RoboESL project. This project aims at exploiting the potential of robotics for developing extra-curricular constructivist learning activities in schools that will help children at risk of failure or Early School Leaving (ESL) to practice and develop their creativity skills, raise their self-esteem, motivate their interest in schooling, and finally encourage them towards staying at school [1].

Robotics is a new unexploited area. As Alimisis said [2], it has attracted the high interest of teachers and researchers as a valuable tool to develop cognitive and social skills for pupils and support learning in science, mathematics, informatics, technology and other school subjects or interdisciplinary learning activities. To this framework we participate implementing general, exemplary and concrete projects using contemporary pedagogical theories and learning models to support our innovative projects.

We run this project during the last trimester of 2015-16 school year. Three teams were made. The official one consisted of 10 pupils of 2nd grade. The implementation of this intervention took place, after the appropriate arrangements, during school hours. The duration was 12 hours. Of the other two teams the first one, a whole 3rd grade class (G1a), worked for 3 hours during ICT-Technology lessons and the second after school hours, in a voluntary form. The duration was about 4 hours and 5 pupils participated. In this report we will present facts about our official team of 10 2nd grades pupils.

2 Choices and Pedagogical framework

2.1 Framework - Ages - Selection

The age of the pupils of 56th Junior High School of Athens is, normally, between 12-15 but we have pupils older than 15 because they failed to pass the class (low performance in lessons, absences etc). The ten pupils who participated in this program attended the 2nd grade and their ages were from 14 to 16 years old. Pupils chosen to participate in the program meet the conditions of the program and wanted to take part in this.

2.2 Hardware/ Software: EV3 Lego Mindstorms

We used our EV3 robots both as learning objects and learning tools giving more importance in their interdisciplinary and practical characteristics. In our RoboESL project we discussed both EV3 Lego Mindstorms and Arduino technologies. We decided to implement EV3 because, in our opinion, it is more convenient for the age of our pupils. It is a complete set that allows robots to be built in every way possible. In addition to that, using EV3, robust and interesting robots can be constructed. For our first projects EV3 was used as a versatile wheeled vehicle ("tripod" tangible object) that utilized sensors to navigate on our testing fields accomplishing the tasks discussed.

We didn't focus particularly on programming skills nor in an in depth approach. We tried to have joyful, playful and intriguing hands-on activities for the participants of the programs.

To program our EV3 robots we used EV3 Programmer. EV3 Programmer is a flowchart language, a graphical programming interface for developing robotic applications. The programming structure simulates a flowchart design structure almost icon by icon. It's free to download and install. Pay attention to the fact that some software blocks, like gyroscope, ultrasonic etc are missing in the typical installation. They have to be installed manually by the user.

2.3 Theories and learning models: Constructivism and Problem Based learning

The methodology proposed by the program is Problem based. Problem based learning models are designed to teach pupils how to pursue problems in a systematic way, develop as independent learners and acquire content in the process. They are based upon Dewey's views of meaningful learning, as well as sociocultural views of how language and interaction facilitate learning. There are different approaches about the steps and procedures proposed in a problem based learning model, such as those proposed here [3] [4] [5]. In our implementation we followed the six steps of Eggen & Kauchak model of learning. [6].

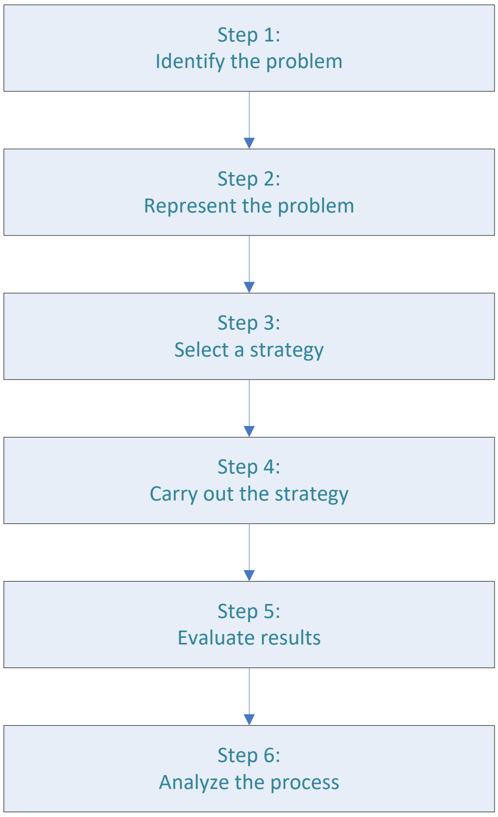

Fig. 1: The six steps of Problem Solving Model of learning according to Eggen & Kauchak

We used meaningful problems as a focal point and our pupils involved actively solving them. First, we identified the problems, discussing them with our pupils. In this step our purpose was to motivate them and to dissolve any ambiguities both in terms of goals and strategies. The representation of the problem is a very important step because it bridges the conceptual gap between the definition of a problem and the selection of a strategy. To help our pupils we had asked for their help when we were making our “tracks”, our testing fields, one week before the beginning of our intervention. The creation of the testing field helped them have a firsthand experience with the problem but also direct them towards the appropriate strategies selection.

After that step, pupils selected their strategies to solve the problems. We encouraged them to be more reflective and avoid selecting the first thing they thought of. Representation of the problem done previously helped them a lot.

Next, they tried out their strategy, observing the results and making changes as needed. Scaffolding and supporting questioning is very important at that stage in order for the pupils to be able to come up with a better solution to the problem and fully implement the solution in the computer, predicting the actual outcome, prior to testing it out with the robot itself. In any case, they had an accurate conception about the problem.

Evaluating the results is the fifth step of the learning model. We discussed the validity of the solutions produced by our pupils. All solutions in hands-on experience made sense and engender lots of discussions. Selecting, carrying out and evaluating a strategy steps were often repeated so as the pupils came up with a most accurate solution.

Finally, pupils presented their final work to the plenary (which they liked a lot) and analyzed their problem solving procedure. This is the most important long term goal using this model; it helps them be more systematic, more analytical problem solvers and more aware of their own thinking.

Learning through problem is based on two conceptual and theoretical foundations. On the work of philosopher John Dewey, who emphasized the importance of learning through experience [7][8] and on the social cultural learning theory - based on the Lev Vygotsky project [9] - a cognitive view of learning that emphasizes participation of learners with activities that make sense for them [10]. Technology itself, even if it is very attractive, cannot positively influence pupils, as mentioned in the 'Evaluation and critical analysis of Greek Language teachers training results in ICT use and exploitation in the educational teaching process in the Attica region' [11]

Pupils in a problem based approach explored real time, authentic, problems working in groups. They had to solve the problems discussed. They worked in groups but they had the possibility to discuss their difficulties with pupils from the other teams. Their final work was presented in plenary. When needed probing key questions asked to pupils helped them overcome their difficulties.

The role of teachers was to support the previous constructivist framework, to create the appropriate working environment for the participant pupils, to organize the interventions, to coordinate the whole process and to facilitate the pupils in their attempts to solve the problems imposed. The experimental, practical and explorative characteristics of educational robotics hands-on activities fit and support such constructivist and constructionist approaches to learning.

3 Implementation

The first two weeks of our project the teachers responsible of this intervention in school discussed about how we could improve the environment of the Information Technology (IT) lab to accommodate the robots and parts and discussed about the creation of mock-ups testing fields. Based on these ideas we altered the IT lab by adding appropriate desks, designing and redesigning the testing fields we later used.

One of the testing fields had to be further changed due to a small difference of the reflective light index between black and grey. Our pupils participated in this stage by helping in the creation of some of the testing fields. We wanted and encouraged that so as to form an idea concerning their "forthcoming" robotic activities.

In this very first stage we tried to establish the appropriate "physical" learning environment. During our meeting we dealt with encouraging them to participate and contribute to our project. We had 3 meetings of 4 hours each. Each team of pupils made five programs which addressed objectives of Science, Technology, Mathematics and Computer Science.

3.1 1st meeting

We started with the student/teacher meeting, in the IT laboratory, where the group would put into practice the project. We discussed why they chose to follow this program (they found it interesting, modern, a different experience; they wanted to create robots and learn something new and interesting were some of their answers). Later on, we informed them about the program as well as about the responsibilities that came with it. They filled their answers in a Google form created for this purpose. Thereafter they started to construct their robots, putting parts of their EV3 educational core packages together, following concrete guidelines. Every team (red, yellow and black) chose to construct one of three possible robots, whose instructions were given to them. In this way, three different in appearance robots were built. Color and ultrasonic sensors were then added on the robots by the pupils. Two groups of three and one group of four pupils built the robots. The yellow team had problems with the robot they chose to built and ended up building another (the robot from the leaflet). It seemed that going through the leaflet made the process of construction easier for them and they finished building it as fast as the other two teams. Nevertheless building the robots was not as easy as we first thought. Although our pupils have played and experimented with Lego before, they found building a robot more challenging.

During the last hour of our first meeting we tried to create and execute the program “following the black line”. The pupils found it hard to understand how the blocks were to be put together. In addition, they tried different blocks (“move steering”, “move tank”, “large motor”). In the end, two teams (the red and yellow ones) used “move steering” and one team (the black one) used “large motor”. Furthermore, when they did understand the optimal way of putting those together and tried to move the files (download them on their programmable-bricks), they were asked to update the software. Two of the p-bricks got stuck while the third one stopped working. Although we tried resetting the hardware, time went by and pupils had to leave. On the morning of the next day and after talking to the company’s responsible technician, we managed to get them to work again, updated them and generally got ready for the next steps of our program.

3.2 2nd meeting

The second day was moving on smoothly. All robots were ready and functional. We ran the programs and saw the results. To begin with, we checked our “follow the black line” programs. Pupils liked it very much. They saw the results of their hands on activities. They used different blocks in their implementations.

Moving on, we started discussing about trains, cars, movement and sensors. The student teams made tests and figured different ways to move their robots for a distance of 25 centimeters. We stuck a tape measure in front of their computers so that they could do the initial tests without wasting any extra time. After they experimented with the proposed “steering” block, they were asked to retry it 5 more times. One of the teams (the black one) immediately used the repetition block, while the other two used copy/paste. They were asked to alter the program by adding both time delay and sound. In the end the robot/train had to return back. All three teams correctly used «-» in the “power” block. During the last hour we asked them to start adapting their programs to work on a canvas testing field we had designed. The robots had to start and stop. Distances on this layout were different from the ones they used before. Teams made the appropriate adaptations easily and run their programs. We informed them that on the next day we would create the parking program. We discussed what robots should do in order for them to think of some solutions for the next day.

3.3 3rd meeting

During the first hour pupils started making the parking program. They did tests and needed about 2 school hours to succeed. Finally, they tried the hexagon. We had pre-designed two hexagon-shapes, one on wood and the other one on canvas. Pupils were enthusiastic with trying the program for the creation of the hexagons. On this last meeting they moved around the laboratory as busy as bees. The results, unfortunately, were not as expected and they could not succeed in having the robot do the exact movements that would create a normal hexagon during our meeting. Two out of three teams made one of the two “hexagon programs”. The yellow team had made the program for the small hexagon, on canvas, while the black team had made the program for the large hexagon, on wood.

Fortunately, teams didn’t give up. They tried to find solutions to the “hexagon program”. The fact that our school participated at the Athens Science Festival motivated members of the teams to solve all the problems. They succeeded in completing their tasks. Each team made two programs, one for each hexagon. The next day, pupils met in the lab voluntarily and discussed their difficulties trying to solve their last “create a hexagon” program, operating as a small learning community. They tried and achieved in making their programs ready for the Festival. In the Festival pupils ran part of the programs they had made and were very much satisfied because they showed their work to visitors and to their teachers that came to the exhibition and gave explanations to those that came at our kiosk in Greek, English and Filipino!

3.4 Representative example

The Parking program is the third program the three teams had to make. Until then our teams had already been in contact with notions from different learning areas. They had familiarized with the basic characteristics of EV3, designing and constructing their tangible model (Technology), they made their programs using EV3 Programmer and the appropriate programming structures to perform their tasks (Computer Science); they calculated physical quantities adapting the programs of their robots (Physics and Mathematics). The parking program can be completed in about 3 teaching periods (of 45min each). According to our model described above the learning sequence was the following.

Identify the problem: Pupils are introduced to their task. They saw cars to park by themselves. We discussed about it, triggering their interest. They told us their experiences with their family cars in the region and in supermarket parking areas. Our scenario was to park their tribot (three-wheeled robot) in a mock up testing field.

Representation of the problem: Pupils measure the distances of the parking slots of our mock up. Some of them put their tribot and “made” the movements their vehicles had to do by hand.

Selecting a strategy: Pupils discussed their algorithms in groups. We gave them support and urged them to think about the result of their strategy before trying it out.

Carry out the strategy: This step is the natural extension of the previous three and provides opportunities for them to implement and experiment their ideas.

Evaluating the results: Teams observed and discussed the validity of their solutions. If the results didn’t meet their goals, we discussed it and gave them feedback. They made new predictions and changes in their programs until they were satisfied by the final results. Pupils in this step made lots of calibrations, changing the parameters of power, seconds etc exploiting the experimental, practical and explorative characteristics of EV3 hands-on activities. Analyze problem solving procedure: Teams presented their programs in the plenary. They talked about their way of thinking, their difficulties, questions remaining, things they liked/ disliked…

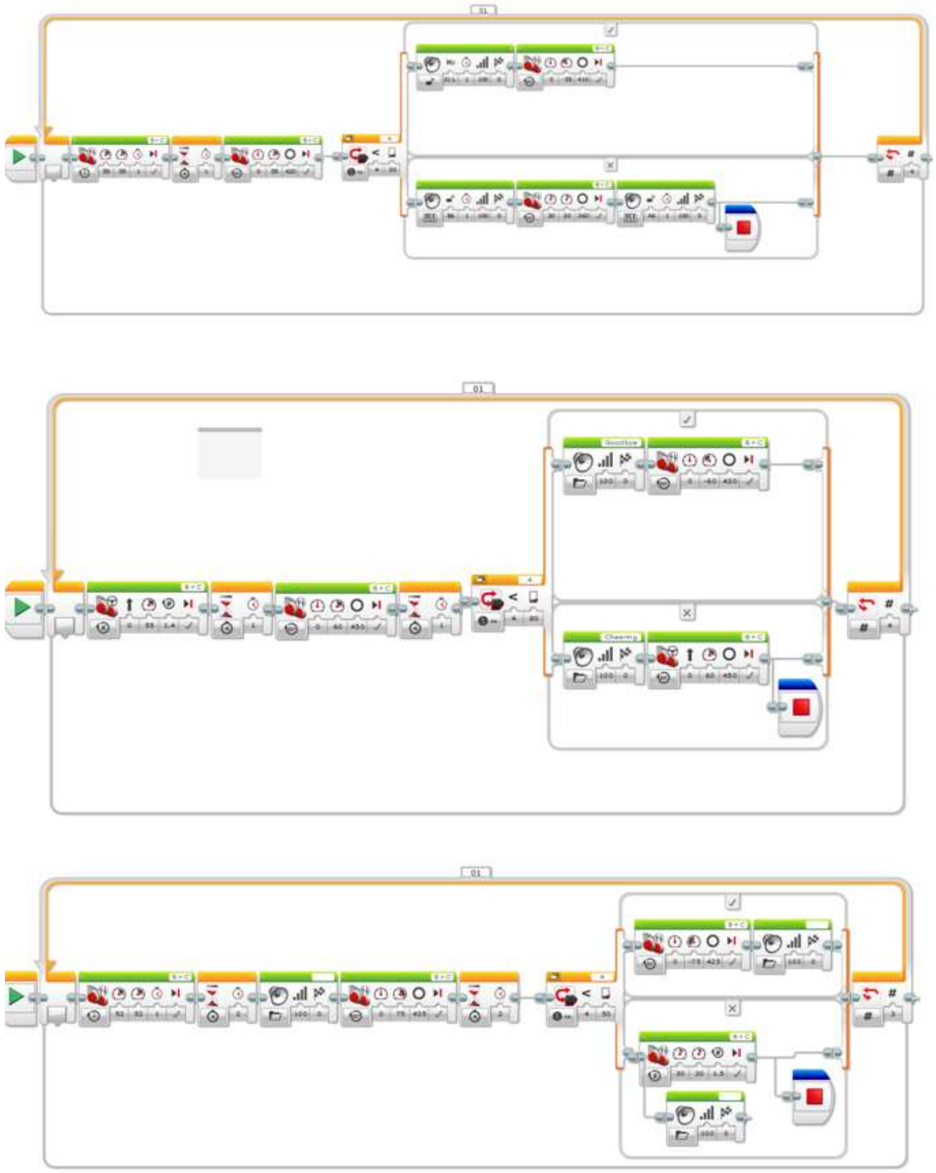

Fig. 2: Parking programs from our teams "red", "yellow" and "black"

4 Results - Discussion

In this paper we present our first activities in the framework of RoboESL program. In our implementation we observed an active participation/ involvement of pupils. They cooperate and collaborate both in their own team and with other teams as well. The direct feedback of their tries provided them with opportunities for reflections and self assessment cultivating their metacognitive skills and helping them understanding what they had to change through trials and errors. They liked this immediate response. The applied activities triggered not only their interest but also their curiosity. We don't know how and whether participating in this project will improve their attitude towards school but they definitely liked it and spent more hours than what was scheduled in the original plan in order to present their work at the Athens Science Festival 2016. It seems that robotics at school is causing pupils to be active and energetic. They discussed their difficulties trying to solve their problems, ex. after the completion of the program and before our participation at the Athens Science Festival they operated as a small learning community. They tried to make their programs ready for the Festival. This school year we will continue our activities with the pupils who had already participated in the program the year before. They will be learning our new activities and teaching other pupils in our school and in our neighboring primary school. We will also introduce Moodle e-learning to our project. Moodle potentially can support any learning model [13]. In our e-learning platform (http://e-mathisi.mysch.gr/) they could find all relative information they need in one place accessing it from everywhere (repository use) but they could also ask/ answer questions participating in forums increasing the learning experience in various ways.

References

1. RoboESL– Robotics-based learning interventions for preventing school failure and Early School Leaving, http://roboesl.eu/?page_id=11
2. Alimisis, D. Educational robotics: Open questions and new challenges. In: Themes in Science & Technology Education, 6(1) pp. 63--71 (2013)
3. Joyce, B., Weil, M., & Calhoun, E. Models of teaching. Allyn and Bacon, Boston (2000).
4. Trilianos, T.. Methodology of modern teaching. Trilianos, Athens (1998β) (in Greek)
5. Papanilolaou K., Fraggou S., & Alimisis D.. Developing a design framework and application activities planned robotic construction: the TERECoP work, http://hermes.di.uoa.gr/frangou/papers/papers_PFA-Syros2007.pdf (2007)
6. Eggen, P. Kauchak, D.. Strategies for teachers: teaching content and thinking skills. Allyn and Bacon, Boston (2001)
7. Dewey, J.: How we think. http://www.brocku.ca/MeadProject/Dewey/Dewey_1910a/Dewey_1910_toc.html (1910).
8. Dewey, J.: Democracy and education. http://www.ilt.columbia.edu/digital-text-projects/john-dewey-democracy-and-education/ (1916),
9. Vygotsky, L.S.. Mind in society: The development of higher mental processes. Gutenberg, Athens (1997) (in Greek)
10. Koliadi, E.. Theories of learning and educational practice. Greek Letters, Athens (2007 c) (in Greek)
11. Karampinis, A.. Evaluation and critical analysis of Philologists training results in ICT use and exploit the educational teaching process in the Attica schools (2010), https://www.slideshare.net/secret/bKEFNYWIU9QuhB (in Greek)
12. Karampinis, A.. Employment of a Moodle environment in school education (2010), http://dione.lib.unipi.gr/xmlui/bitstream/handle/unipi/3814/Karampinis.pdf?sequence=2 (in Greek)