Experiences from ROBOESL project implementation in the 23rd Athens Junior High School

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Abstract. Robotics-based learning is considered as a way of providing better quality in education, improving technical and social skills. By designing, constructing and programming a robot, students have the opportunity to learn by playing. Robotic activities provide very strong stimuli, enabling enormous creativity and potential. With the present position paper the author makes a presentation of ERASMUS+ RoboESL European Program. The latter program involves organizing activities applicable to weak students that tend to fail or quit school (Early School Leaving). The aim is to motivate them by using Robotics and wake their interest to Science, Technology and School in general, therefore preventing School Failure and Early School Leaving.

Keywords: Robotics, Robotics-based learning, Early School Leaving, School Failure, educational robotics, RoboESL.

1 Introduction

Interest in robotics is increasingly growing, gaining more and more instructors, teachers, researchers, writers, psychologists etc. Through time and technological advances robotics is considered to provide a *high-quality education* and also to considerably improve both technical and social skills. Meanwhile, it motivates and encourages young students to learn science and technology. When children design, build and program robots, they have the opportunity to learn through playing.

From the past few years onwards, new methodologies, courses and competitions are increasingly created under the educational robotics general framework. Therefore, a variety of educational material is widely available, adapted according to the level, age and educational goals. All these activities provide very powerful stimuli, largely triggering students' potential and creativity [1].

In this paper we shall refer to the educational robotics program that took place during school year 2015-2016 in the 23rd Athens Junior High School (Gymnasium). This program, that is still in progress, is co-organized by the School Committee of Secondary Education of the 7th Municipal Community of the Municipality of Athens, the 6th SEK of Piraeus, the European Lab for Educational Technology EDUMOTIVA, in league with the European Project Erasmus+ RoboESL.

More specifically, this project is about organizing *learning activities* applicable to students prone to school failure and dropout, stimulating their interest in sciences, technology and school in general, through robotics. In the following chapters, apart from presenting the projects that were carried out, we shall emphasize on some details, as well as on the difficulties that came up. Finally, some educational and pedagogical perspectives will be discussed.

2 Pedagogical Perspectives

It is evident that working with robotics is inspired by the constructivist theories of J. Piaget and S. Papert. According to them, learning for humans is not a result of sharing knowledge, but an active process of constructing knowledge based on experience [2]. S. Papert adds that gaining new knowledge is achieved more effectively when the learners build products that have a personal meaning to them. The aim of constructivism is to provide children with the appropriate things to do in order to learn in practice and more effectively than before.

In this theoretical framework a social-constructivist approach is adopted where learning is not individualized but is treated as a social and socialized activity, in other words learning takes place within a social environment. In this framework, using educational robotics will have positive influence not only cognitively but also emotionally (self-esteem, self-confidence) and socially (socialization, debunking myths). When children design, build and program robots they have the opportunity to learn through playing and develop their technical/social skills.

Students can explore, experiment and enjoy the fruits of their labor immediately. Each and every activity – problem can be approached in multiple ways and so students discover or want to know alternative solutions. The teacher stands beside them guiding and encouraging, assisting them on *learning how to learn*. There are multiple possibilities that can offer versatility and adaptability at every student's level. For instance, the assigned linear movement of a robot can be achieved in ways of varying difficulty: altering power, rotation or rotation angle.

Working with activities on robotics fosters teaching various concepts of other Sciences and cognitive fields (Physics, Mathematics, Geometry, Technology, Mechanics etc.) as long as they can be a part of a well-designed curriculum.

3 From Design to Implementation

3.1 Informing School Community

The first step was to do a first briefing-presentation of the course to the fellow teachers whose co-operation would be necessary. This lasted a day in which the Teachers' Board was informed and finally approved the project. Then, the program was presented to all students and their parents-guardians, highlighting the advantages and benefits they would gain by their potential participation. Obviously, there was no reference about the relevance of the program with school failure and dropout. At the end everyone was ensured that student anonymity would be maintained throughout the course.

3.2 Designing, Preparing Educational Material and Logistical Infrastructure

The activities would take place in the school's Computer Lab, so the space was arranged as necessary.
Some of the arrangements made were:
-*placing school desks in a pattern* appropriate for building robotic structures in teams (2-4 desks joined together),
-*installing the programming environment* to the computers,
-*creating lanes* (improvised tracks) on the desks to carry out the projects e.t.c.
Likewise, worksheets, supporting material, instructions, questionnaires etc. were prepared.

The robotic equipment used would be LEGO Mindstorms. The educational course was designed to consist of two Projects involving Robotic activities. The time to accomplish this would be 12-14 hours. Lessons were to be carried out outside school curriculum, after the end of the school day.

3.3 Student selection

Student selection was carried out according to some criteria. Weaker students or students with a lot of absences or behavioral problems would be the most suitable, since they were more likely to fail or drop out of school.

Taking under consideration the opinion of fellow teachers proved to be useful since this helped to create more accurate student profiles. In the end, seven 2nd grade students were selected: available resources (3 robot kits and 1 teacher) limited the number of students to be involved.

4 Starting Day: First Meeting – Group Formation

In the first meeting, students were welcomed and introduced to the subject. A brief introductory video with robots in action triggered students' interest even more. But, honestly speaking, their attention and eyes were already laid on the half-opened LEGO boxes. Initially a Brainstorming activity about robotics was planned, but students' enthusiasm reduced the activity length down to 2-3 questions.

Group formation was to follow. Again, there was an activity aimed to do that but since the students already knew each other (they were all in the 2nd grade), 3 groups were easily formed without much teacher intervention. Good practices of group working would have to be maintained. Having that in mind, should there any team-related problem occur, the teams would have to be modified. But this did not happen throughout the course.

5 Project 1: The Automatic Train

5.1 Description

The activity is about building and programming a train-robot which will begin at the start line, stop automatically in every station, wait a while and continue untill the finishing line. In the finishing line, after waiting a little longer, it will reverse its route (going in reverse gear) returning to the start line where it will completely stop. It is assumed that there is equal distance between the stations and that the train moves with steady speed.

5.2 Briefing- Demonstration

Firstly the project goals were described and then a brief demonstration of the LEGO parts and sensors followed. Students got familiar with the environment and the method of robot programming on a basic level. Finally, the two main commands necessary for the project were explained: `MoveSteering, Wait.`

5.3 Building – Programming

Building stage went by very quickly since students showed a lot of interest and performed well. Programming phase followed up very smoothly leading to some trial runs in the improvised track (simple structure with duct tape, markers etc.). There, after lots of experimentation and tests, the appropriate parameter values for the command parameters were discovered and applied.

5.4 Final Result – Comments – Conclusions

In this first project students were exceptionally and unexpectedly enthusiastic and this encouraged them to finish within the planned time frame. All three groups did not just build the simple structure assigned to them (a simple vehicle with 4 wheels that would be the train's engine), but, without being asked to do so, they built more complex structures: they made caterpillar tracks, a 2nd wagon etc. In fact, one of the groups made a mobile phone holder in order to video record the train's route. Even more, when the train reached the finishing line and had to move backwards, a motor was rotating the mobile phone so it would video record towards the correct route direction. And that was purely conception and implementation of the students, without the instructor's intervention.

Moreover, some students experimented with the angle of the wheel rotation as a parameter to move the robot. Thus, they understood to an extent some Geometry and Physics principles.

6 Project 2: Automatic Car Parking

6.1 Description

The aim is to build and program a four-wheel robot (car) which will be able to detect an empty parking space and park automatically. It is assumed that the parking is fixed with parking spaces of specific width/length. The empty space tracing is performed by an ultrasound sensor (which measures the distance from an obstacle). The vehicle rotates initially in a 90° angle in front of the potential parking space. The sensor measures and, if there is an obstacle (the parking space is occupied), the car rotates back to its initial position and moves on to the next one space. When it finds an empty parking space, it parks and stops.

6.2 Sensors and Commands – Demonstration

There was an initial discussion with the students about the aims of the new project. With the ultrasound sensor being an incentive, principles of Physics were explained (as regards sound spectrum etc.). Afterwards, there was a brief demonstration of the ultrasound sensor, and the use of command `MoveTank` (that rotates the robot).

6.3 Building – Programming

Building stage was brief since it merely involved placing the sensor onto the previous constructed vehicle. What proved to be time-consuming was experimenting with `MoveTank` command, so that the vehicle should rotate with relative precision.

6.4 Final Result – Comments – Conclusions

The second project obviously proved to be more challenging, however students were persistent and completed it successfully. It is worth to mention some *difficulties* that came up:
-In the basic LEGO programming environment the ultrasound sensor block was not pre-installed. This took some time to be detected as the ultrasound block was initially confused with the installed infrared block. Once this was detected, downloading and installing the correct block to every PC was a matter of time.
-One of the groups built a vehicle with the following peculiarity: Its clockwise rotation was precise whereas its anti-clockwise rotation was largely divergent even though the same parameters were applied in both cases. After repeated tests and value changes the problem remained. A careful check of the structure was necessary to realize that the ball caster was not placed in the center, causing the rotation axis to vary between right and left turn. When the problem was fixed the robot rotated properly.

7 Overall Conclusions

7.1 Effect on students

The vast majority of the students were particularly interested and eager on robotics from the very first moment. They felt more free and spontaneous in class – without crossing the line or becoming undisciplined. Feelings of team-spirit, collaboration and mutual aid were cultivated, without undermining individuality, self-motivation and, in the case of charismatic students, innovation.

It is true that the nature of robotics played a major role in everything: they treated it much more as a group game which, however, enabled them to gain new knowledge and skills. Building a construction that can move and execute commands in the real world, a construction that was just designed and built a few moments ago, provides a very powerful stimulus.

When one of the groups was the first to complete an activity, the others raised their speed to catch up with them or even further develop the construction, promoting fair play and a spirit of competition.

7.2 Teacher – Students Relationship

From the first day on there was a positive feeling and a sense of creativity in class, with the teacher assuming a more consultative and guiding role, as a coordinator of the educational process, rather than a teacher who merely lectures. Students' interest and opinion sometimes changed -in a pleasant way- the flow of the activity, without altering the educational goals. The relationship between teacher and students was strengthened even more with the school's participation in the Athens Science Festival. There the students were asked to present and explain their robots operation to the visitors. This activity strengthened their sense of responsibility since they had to play the role of mature adults who present their work to strangers and answer their questions.

8 Results - Conclusion

Throughout the course measurement and evaluation tools were used. These tools (such as questionnaires, forms, observation protocols, etc) could measure students' tendency to drop out of their school education. According to the results, as regards students' interest and performance in robotics, the messages were very encouraging. All students wanted to participate again to similar classes or workshops, even though it took up much of their free time.

However, to draw more solid conclusions for further generalization (such as to correlate the *Robotics in Education* with *Early School Leaving Prevention*), more Robotic activities need to take place along with monitoring performance, absences and behavior in other classes. Besides, RoboESL program is still ongoing and in progress.

To conclude, Robotics is a very useful tool that pleasantly enriches the learning process. It triggers students' interest and offers them great satisfaction. It encourages them to research, experiment, learn and possibly invent. The teacher will have to decide whether he will use robotics for education or robotics in education. If Robotics is going to be an important factor in reducing School Failure and dropout remains to be seen.

References

1. Bredenfeld, A., Hofmann, A., Steinbauer, G.: Robotics in Education Initiatives in Europe - Status, Shortcomings and Open Questions. Proceedings of SIMPAR 2010 Workshops, International Conference on SIMULATION, MODELING and PROGRAMMING for AUTONOMOUS ROBOTS (2010)
2. Piaget J.: Psychology and Epistemology: Towards a Theory of Knowledge, Harmondsworth: Penguin (1972)
3. Wadsworth, Barry J.: Piaget's theory of cognitive and affective development: Foundations of constructivism, 5th ed. Pearson (2003)
4. Papert, S.: Mindstorms. Children, Computers and Powerful Ideas. Basic books. New York (1980)
5. Robotics Laboratory, http://tiny.cc/xbahey
6. Educational Robotics, http://tiny.cc/daahey