Journal of Modern Education Review, ISSN 2155-7993, USA
October 2016, Volume 6, No. 10, pp. 726-731
Doi: 10.15341/jmer(2155-7993)/10.06.2016/004

http://www.academicstar.us

Can Innovative Learning Applications Influence the Students' Attitudes towards Science: The Case of Educational Robotics

Batzogiannis Ilias, Hatzikraniotis Euripides
(Department, Aristotle University of Thessaloniki, Greece)

Abstract: This paper suggests the introduction and use of programmable robotic constructions in secondary school education aiming at changing students' attitude towards science. The theoretical background of the methodology is learning by inquiry and the tool that is going to be used is Lego Mindstorms EV3, which offers a great variety of constructing and programming potentials.

Key words: educational robotics, attitude towards science, teaching science

1. Introduction

It has been observed in recent years that students are drawn away from science. This is due to the difficulty of the subject, the non-connection of what they learn to real life and the fact that students do not "learn" science. The only thing that they do learn is solving "some equations" (Redish et al., 1999; Mc Dermott, 1991).

The investigation of students' attitudes towards studying science has been a substantive feature of the work of the science education research community for the past 50 years. The increasing attention to the topic is driven by recognition that all is not well with school science and far too many pupils are alienated by a discipline that has increasing significance in contemporary life, both at a personal and a societal level (Osborne, 2003). As Osborne states in his review article, "while it would be difficult to transform the nature of science offered in most curricula, at least in the short term, a better understanding of the attributes of science classroom activities that enhance 'task value' might make a significant contribution to how the quality of students' experience might be improved". Thus, innovative learning activities, such as the employment of educational robotics, may provide with the enhanced "task value" and therefore influence the students' attitudes towards science.

Educational robotics is the tool that we will use in our attempt to alter this situation. We believe that as students are designing, building and programming these robots, they will be motivated to learn math and science needed to achieve their goal (Frangou et al., 2008; Rusk et al., 2008; Church et al., 2010; Douglas et al., 2008), by exploring (Papert, 1980; Vosniadou, 2001; Bers M. U., Ponte I., Juelich C., Viera A. & Schenker J., 2002).

Nowadays, the teacher has the means to associate the theory of science with real life through educational robotics. The students realize that they really use what they learn. The tool which will help us to achieve this goal is the Lego Mindstorms EV3. The majority of students are already familiar with the Lego bricks and the Lego

Batzogiannis Ilias, Ph.D. Candidate, Physics Department, Aristotle University of Thessaloniki; research areas/interests: STEM teaching. E-mail: iliasbatzo@yahoo.gr.
Hatzikraniotis Euripides, Associate Professor, Physics Department, Aristotle University of Thessaloniki; research areas/interests: materials science & ICT-based teaching and learning in science. E-mail: evris@physics.auth.gr.

constructions. Programing the robot is not going to be a problem as the Lego software being used is quite easy to be understood (Lego site 2014). The versatility of the hardware and software allow a wide variety of possibilities in what students can build and program. Lego Mindstorms have been used by teachers all over the world in teaching STEM (Church W., Ford T., Perova N., & Rogers C., 2010).

The main educational method being used in this research is the inquiry method because we believe that children may reach higher levels of understanding science when they perform structured investigations (Edward F. Redish and Richard N. Steinberg). Other methods being used are the constructional method and constructivism. In this work, we examine how students' attitudes towards science are influenced by innovative learning applications, such as educational robotics.

2. Description of the Sequence

We are trying to change students' negative attitude towards science by using educational robotics. In our attempt, Lego Mindstorms are used as "friendlier" towards the students. Lego bricks, sensors and an "EV3 brick" (microcomputer) are used to construct the robot. In our research, the robot is constructed by the students easily by following some instructions given (Picture 1). The robot is a rover.

Picture 1 Rover

This study implements a ten-hour robotics program in the first grade of secondary school (12 year old students) in Platon School of Katerini, Greece. Questionnaires had been given to them to examine their attitude towards science before the program took place (pretest) and after the program ended (posttest). Students were divided into groups of five or four with clear, but different roles each time (coordinator, manufacturer, developer, etc.). The division was made by us in order to have, students with different grades in science, different attitudes towards science, different genders etc. in the same team.

We mentioned earlier that this was a ten-hour program. In these ten hours, the teams had to accomplish some "missions". The scenario of the "missions" was that NASA has ordered you (the students) to build a rover that they need to send to a new planet that they have discovered. The rover must be fully programmed to act "by its own will" and can't be remote controlled. The "missions" guide the students to set the rover to fulfill its purpose, explore the planet. In order to do so, the rover must be capable of avoiding objects (using its sensors). During this

procedure the students learn things about physics (velocity, force, friction, reflection of light etc.), learn things about math (unit's conversion, angles etc.) and acquire scientific skills (carry out measurements, draw graphs, problem solving). These "missions" were assigned to each team through students' worksheets. The teams use the worksheets to follow some guidelines and keep some notes. Through this procedure they come across some problems that they have to overcome on their own. Of course these worksheets include some instructions given by us but as the program is progressing, less instruction is given. This is our way of making them inquire and not just follow instructions.

The programming of the robot is carried out by Lego Mindstorms software. The software is easy for the children to understand and use as it works with pictures. They don't need to know a programming language and so they can focus on understanding the nature of programming and not wasting time in trying to learn the language (Picture 2).

Picture 2 Lego Mindstorms Software

3. Description of the Method

In order to check if our method had any impact on students' attitude toward science, we constructed a questionnaire on a Likert scale, which was given to students before the program (pretest) and at the end of it (posttest). The scale was:

Never/Strongly disagree	Rarely/Disagree	Sometimes/Undecided	Usually/Agree	Always/Strongly agree

The questionnaire consists of 21 questions categorized in 5 categories which are:

(1) 7 questions about themselves (gender, age, grade in physics, etc.).

(2) 5 questions checking if the students are interested in physics and math (Q1: I observe natural phenomena and try to learn why they happen, Q2: I read science book and articles, Q3: I would like to have a job that has to

do with science, Q9: I like science, Q10: I like math).

(3) 4 questions checking how students feel or react during class (Q5: I care about science class, Q6: I participate during science class, Q7: I feel nervous during science class, Q8: I would like to experiment more during science class).

(4) 3 questions checking if the students consider physics important (Q4: it is important for someone to know physics, Q11: I use what I learn in physics class in everyday life, Q13: I don't need science).

(5) 2 questions checking if the students think that physics is easy (Q12: Science class is easy, Q14: Science is easy).

4. Results & Discussion

The data from the questionnaire is presented in Table 1. The statistical analysis was made using miniTab Statistical Software in two different groups, boys (11) and girls (16). We want to check if there is a significant difference on the pretest answers given by boys and girls, if there is a significant difference on the posttest answers given by boys and girls and what impact the sequence have on both groups. The scale used to assign the data was -2, -1, 0, 1, 2.

Table 1 Data Divided in Two Groups Boys (11) and Girls (16)

	Boys (11)					Girls (16)				
Questions	Mean (pre)	Mean (post)	Alteration of mean	Std. deviation (pre)	Std. deviation (post)	Mean (pre)	Mean (post)	Alteration of mean	Std. deviation (pre)	Std. deviation (post)
#1	-0.18	0.45	0.64	1.33	0.69	0.00	0.94	0.94	1.21	1.06
#2	-0.91	1.00	1.91	1.30	1.29	-1.00	0.13	1.13	1.15	0.96
#3	-0.91	-0.27	0.64	1.30	1.27	-0.56	-0.56	0.00	1.59	1.46
#4	1.00	0.82	-0.18	0.77	0.60	0.56	0.94	0.38	1.31	1.39
#5	1.18	1.18	0.00	0.98	1.25	0.44	1.75	1.31	1.55	0.58
#6	1.00	1.09	0.09	1.26	0.83	1.00	1.25	0.25	0.89	1.18
#7	-0.64	-0.91	-0.27	1.12	1.30	-0.63	-0.31	0.31	1.20	1.35
#8	1.09	1.27	0.18	1.04	0.90	1.06	1.13	0.06	1.34	1.26
#9	0.45	1.18	0.73	1.21	0.75	0.19	1.31	1.13	1.17	0.95
#10	1.09	1.27	0.18	1.38	0.79	1.44	1.56	0.13	1.03	1.03
#11	0.55	0.36	-0.18	1.04	0.81	0.38	0.75	0.38	1.20	1.00
#12	0.18	0.45	0.27	0.60	0.69	-0.13	0.38	0.50	1.36	1.15
#13	1.36	1.36	0.00	0.67	0.67	0.50	1.38	0.88	1.46	1.09
#14	-0.09	0.27	0.36	0.30	0.90	0.25	0.19	-0.06	0.77	1.38

In the pre-test, the mean values are not significantly different for boys and girls ($P = 0.673$, $p > 0.1$), as shown by the 2-sample t-test. Similarly, the mean values in the post-test is not significantly different for boys and girls ($P = 0.730$, $p > 0.1$). In Figure 1, are shown the mean values for each of the 14 questions (gray points), along with the mean value of the distribution (red point) and the corresponding standard deviation. As can be seen, the mean values for the distributions in pre & post test for boys and girls fall very close, and within the standard deviation of each sample. However, both boys and girls show significant difference in the mean values for pre-post paired t-test comparison ($P = 0.028$ for boys and $P < 0.001$ for girls). Thus, both boys and girls have

changed their attitude towards science, to more positive values.

In order to explore more the change of attitude, we performed a 2-sample t-test for the difference post-pre for boys and girls. Results are shown in Figure 2. Though there is not enough evidence to conclude that the means differ even at the 0.1 level of significance (P = 0.288), the mean for girls is slightly higher than for boys (0.52 to 0.31) and the distribution for girls is narrower (standard deviation 0.46 to 0.56). Despite the low number of samples (11 boys, 16 girls), the distribution for girls is different from the one for boys. The skewness for girls is 0.46 (1.91 for boys) and the kurtosis is -1.27 (4.78 for boys). Skewness quantifies how symmetrical the distribution is. The higher value for boys indicates that the distribution is more asymmetrical, with longer tail to the right. Kurtosis quantifies whether the shape of the data distribution matches the Gaussian distribution. The negative value of kurtosis for the girls indicates a flatter distribution while the positive for boys indicates a more peaked than a Gaussian distribution.

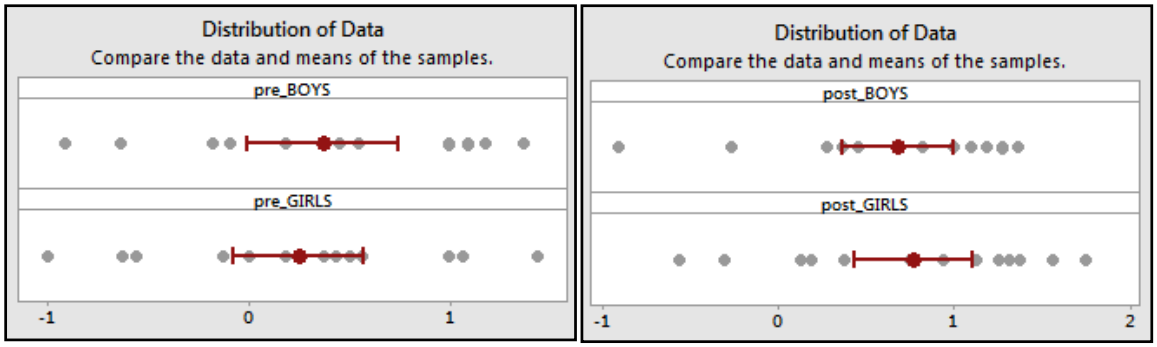

Figure 1 Distribution of Data for Pre (left) and Post (right) Tests for Boys and Girls

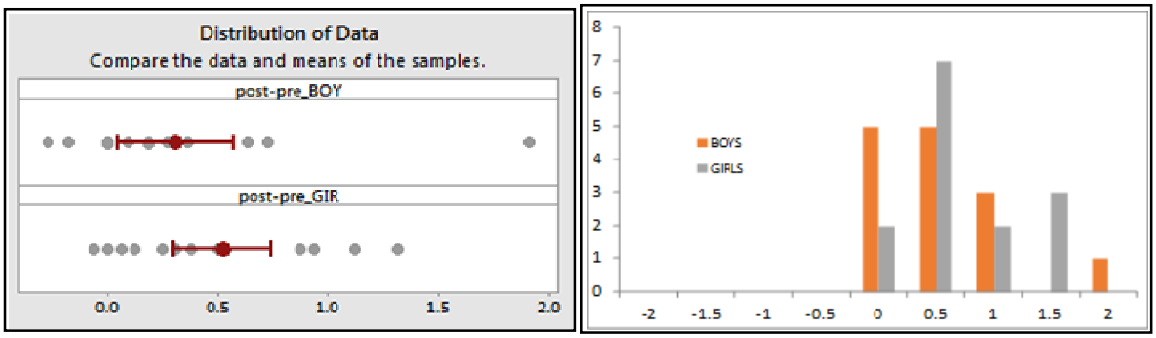

Figure 2 Distribution of Data for the Change of Attitude (Post-pre) for Boys and Girls

5. Conclusion

As an overall conclusion, there is a positive change in the children's attitude toward science. They have started to observe natural phenomena and try to learn why they happen more often than before, they think that science class is easier than they thought etc. The other science teachers from the school where the program took place also mentioned that they have seen some change in the children's behavior in the class. Some of them said: "They ask more questions", "They try to explain natural phenomena in a scientific way" and "They want more experiments".

Comparing boys' and girls' attitudes, there is not enough evidence to conclude that the means differ significantly. However, it seems that girls achieve a slightly better change in their attitudes than boys; the

distribution for girls is narrower and more Gaussian-like.

It seems like innovative learning applications, in this case educational robotics, can influence the students' attitudes towards science. Although, we should consider that the number of students that took the program (27) is not adequate for us to draw concrete conclusions but it encourages us to continue the research.

References

Bers M. U., Ponte I., Juelich C., Viera A. and Schenker J. (2002). "Teachers as designers: Integrating robotics in early childhood education", *Information Technology in Childhood Education Annual*, No. 1, pp. 123–145.

Church W., Ford T., Perova N. and Rogers C. (2010). *AAAI Spring Symposium Series*, last visited 14/12/2014, available online at: https://www.aaai.org/ocs/index.php/SSS/SSS10/paper/view/1062.

Edward F. Redish and Richard N. Steinberg (January 1999). "Teaching physics: Figuring out what works", *Physics Today*, Vol. 52, pp. 24-30.

Frangou S., Papanikolaou K., Aravecchia L., Montel L., Ionita S., Arlegui J., Pina A., Menegatti E., Moro M., Fava N., Monfalcon S. and Pagello I. (2008). "Representative examples of implementing educational robotics in school based on the constructivist approach", in: *Workshop Proceedings of SIMPAR 2008*, pp. 54–65.

McDermott L. C. (1991). "What we teach and what is learned — Closing the gap", *American Journal of Physics*, Vol. 59, No. 4, pp. 301–315.

Osborne Jonathan, Simon Shirley and Collins Sue (2003). "Attitudes towards science: A review of the literature and its implications", *International Journal of Science Education*, Vol. 25, No. 9, pp. 1049–1079.

Papert S. (1980). *Mind Storms: Children, Computers, and Powerful Ideas*, Basic Books.

Resnick M. and Ocko S. (1991). "Lego/logo learning through and about design", in: Papert S., & Harel I. (Eds.), *Constructionism*, Ablex Publishing Corporation, pp. 141–150.

Vosniadou (2001). "How do children learn", *International Academy of Education.*

Williams D. C., Ma Y., Prejean L., Ford M. J. and Lai G. (2008). "Acquisition of physics content knowledge and scientific inquiry skills in a robotics summer camp", *Journal of Research on Technology in Education*, Vol. 40, No. 2, pp. 201–216.

Available online at: http://www.lego.com/en-us/mindstorms/downloads/download-software, last visit 16/12/2014.