Karypi, Sevasti

Educational robotics application in primary and secondary education. A challenge for the Greek teachers society

Journal of Contemporary Education, Theory & Research 2 (2018) 1, S. 9-14

Quellenangabe/ Reference:
Karypi, Sevasti: Educational robotics application in primary and secondary education. A challenge for the Greek teachers society - In: Journal of Contemporary Education, Theory & Research 2 (2018) 1, S. 9-14 - URN: urn:nbn:de:0111-pedocs-190946 - DOI: 10.25656/01:19094

https://nbn-resolving.org/urn:nbn:de:0111-pedocs-190946
https://doi.org/10.25656/01:19094

Educational robotics application in primary and secondary education: A challenge for the Greek teachers society

Sevasti Karypi
Hellenic Ministry of Education, Greece

Abstract: *This paper presents the results of a postgraduate study that was designed to investigate the attitudes and views of Greek teachers in primary and secondary education on the application of Educational Robotics (ER), towards the goal of drawing useful insights on how it can be further integrated in Greek schools. A total of 70 teachers participated in this study, currently working for primary and secondary schools in Greece and being involved in ER projects and ER-related activities. According to the research findings, ER has significant benefits for students and educators, as it fosters positive attitudes towards STEM education, encourages independent and active learning, facilitates teaching, and provides opportunities for the development of cognitive, social and communication skills. However, factors such as the lack of funding and physical infrastructure, the inadequate training of teachers and curriculum scheduling inflexibility, hinder its application. Thus, several structural and procedural actions should be taken in order to further integrate ER in Greek schools.*

Keywords: *Educational Robotics, schools, teachers, ER integration, Greek schools.*

JEL Classification: *I21, I29*

Biographical note: Sevasti Karypi is a primary school teacher working for the Greek Ministry of Education. Corresponding author: Sevasti Karypi (sevikkar1@gmail.com)

1 INTRODUCTION

Educational Robotics (ER) was developed over the past few decades as an innovative tool to promote STEM and aims to better prepare students for the knowledge and information society of the future. Initially, ER was developed according to the theory of constructivism (Mikropoulos & Bellou, 2013), according to which the mind responds to stimuli of the external environment and learning is a continuous process based on the student's synthetic ability and facilitated by the teacher (DeVries et al, 2002). Later on, Papert with his work (1980) influenced its evolution both by developing the Logo programming language and by advocating the theory of constructionism. According to this theory, knowledge acquisition is more effective when teachers engage in building of artifacts that the students can relate with. Other theories linked with ER are active learning, learning through making (maker movement) (Christou & Sigala, 2000, 2002; Goldman et al, 2004), and educational entertainment (edutainment) (Atmatzidou et al, 2008).
Recent research has demonstrated that the application of ER in various educational settings has many benefits for students in terms of cognitive, social and communication abilities' development, as well in forming positive attitudes towards STEM. As regards cognitive abilities, it has been found thatER fosters students' creative and critical thinking, independent and active learning, and decision making (Barak & Zadok, 2009; Khanlari, 2013), encourages cognitive problem solving, mental processing and logical sequencing (Lindh & Holgerson, 2007; Kazakoff et al, 2013), and supports intrinsic motivation and project management skills (Highfield, 2010; Hong et al, 2011). It also supports students in learning of abstract concepts (Whittier & Robinson, 2007), and second language acquisition (Chen et al, 2011). In addition, it has been documented that ER positively affects students attitudes towards STEM and school performance in related subjects (Barker &Ansorge, 2007; Bers et al, 2014), and other communication and social skills by encouraging teamwork and two-way communication (Ruiz & Aviles, 2004).
A limited number of researchers have also investigated teachers' attitudes towards ER. In particular, it has been found that teachers think that integrating ER in the educational process can bring significant benefits for students

ISSN: 2654-0274. UDC: 658.8+338.48+339.1+640(05)
http://doi.org/10.5281/zenodo.3598423
Published online: 27 April 2018

regarding their cognitive and social skills (Khanlari, 2016), as well for supporting in-class teaching (Fridin &Belokopytov, 2014), particularly in STEM (Reich-Stiebert & Eyssel, 2016). In Greece, Theodoropoulos et al (2017) found that teachers involved in ER projects consider that the latter are very beneficial for students, who are able to develop their creativity, innovative thinking, communication and project management skills, problem solving, self-confidence and self-discipline. In the same research it was found that the most important barriers for integrating ER in schools are the lack of time and insufficient financial resources available to schools for implementing such projects (Theodoropoulos et al, 2017).

In many countries, ER has been a popular and well-organized extra-curricular activity often taking place after the end of the regular academic day (Valachis et al., 2008; Sullivan & Moriarty, 2009). As far as the subject concerned, ER is integrated in computer and technology education, as well as in non-technical education, such as languages. In the first case, the primary goal is to provide knowledge about robots and technology, by introducing students in learning objects related to computer science and programming. According to Balch et al (2008), such a lesson typically includes an initial introduction to robot programming and, subsequently, the practical training of this knowledge in robotics' construction, which results in building a sense of ownership and strengthening interest of the student (Mubin et al, 2012). In the case on non-technical education, ER is used as means of teaching various learning objects, such as mathematics and geometry (Highfield et al, 2008), as well as second languages (Kanda et al, 2004). In this case, the most frequent use of ER is STEM-related subjects, aimed at interdisciplinary science learning, enhancing student literacy and increasing the number of students wishing to pursue a professional or academic course in the relevant disciplines (Mataric et al, 2007).

However, it should be noted that ER does not apply exclusively to STEM fields but also to other subjects such as literature, history, social sciences, dance, music and arts, providing students the opportunity to find new ways of cooperation, expression, innovation and critical thinking. In history, for example, with the construction of a catapult robot, children had the opportunity to experience the development of the technology of that era and the work of Archimedes. An interdisciplinary approach, therefore, is best suited to exploiting the benefits of integrating ER in the educational process (Eguchi, 2014). Furthermore, the development of many ER commercial packages, with particularly improved and user-friendly design (eg. LEGO Mindstorms), have given the opportunity to organize specific projects in schools that have proven to be extremely effective in terms of enriching the learning process, motivating students and developing new skills (Detsikias & Alimisis, 2011). It should also be noted that ER integration in education has also been promoted by several robotics competitions organized at international or national level and aimed mainly at high school students, while offering significant opportunities for interaction, cognitive and social development, and improved learning in STEM-related fields (Nugent et al, 2012). At the same time, over the last few years, various actions, activities and events are taking place in Europe concerning ER development addressed to teachers, students and other specialists, including thematic workshops (eg. International Workshop "Teaching Robotics, Teaching with Robotics"), conferences (eg."Robotics in Education"), training seminars for teachers (eg.TERECoP, Roberta Teacher Training) and other local or regional networks (eg. RobotScuola in Italy and CENTREBOT in Austria).

However, in Greece, ER has been limited and often a result of the initiative of certain teachers and individuals. Indeed, although the application of ER in the lower educational grades of mainstream schools is primarily occasional, given the lack of information and training programs for teachers on this subject, there are several remarkable cases of autonomous projects with the initiative of individual teachers, which have successfully participated in international and domestic competitions. An extremely important role in the development of the field of ER in Greece is played by the nonprofit organization WRO Hellas, which organizes national ER competitions and aims to the development of STEM education in Greek schools.

Given that ER in Greece has been around for less than 10 years, little is known about its how it is used, its benefits, and how it is perceived by the educators in terms of ER integration in the educational process, including respective barriers. The purpose of this study is to fill this gap by presenting and analyzing data that were collected by surveying a random sample of 70 teachers from primary and secondary schools all over Greece. Though all these teachers had used ER in their teaching, the degree to which they did varied from teacher to teacher. The research was conducted using Google forms between 4-12 December 2017.

2 RESEARCH QUESTIONS

The aim of this study is to understand the current state of ER in Greece, by assessing the experiences of the teachers who participate in this development and evaluating their views and attitudes towards ER. In particular, this study aims to investigate teachers' views regarding: (a) the current state of ICT integration and implementation in Greek mainstream schools, (b) the benefits for students involved in ER projects, (c) the educational subjects that teachers consider more appropriate for the implementation of ER, (d)the most significant limitations and barriers observed while planning and organizing ER projects in schools, and (e) ER further implementation and potential in primary and secondary education in Greece.

3 RESEARCH SAMPLE

In this study, a convenience sampling method was used, so as to collect a representative set of teachers, given also the limited number of educators involved in ER projects in Greece. The sample of the survey consists of 70 primary and secondary education teachers from all over Greece, and collections of data was performed through the Google forms platform with a 64.5% response rate, which is considered to be satisfactory. The teachers involved in the research have applied ER in class and / or have taken part in robotics competitions. Teachers' e-mail addresses were searched through the school network, through social networking tools, and through personal contacts of the researcher during ER competitions, in which Greek primary and secondary schools took part or/and awarded. As regards the demographic profile of participants, it has been observed that the sample was evenly distributed concerning their gender. The 35,7% of participants were graduates of Technical Institutions or Universities, 57,1% were postgraduates and 7% were PhD holders. Also, the 65,7% were permanently appointed, 10,0% were temporarily transferred, 2,9% were replenishing, while 14,3% were in higher hierarchical positions (school principals / vice principals). Regarding their specialization, the 60% of the sample is specialized in Information Technology, 4,3% in Physics, 2,9% in Chemistry, 5,7% in Engineering, and 27,1% in various other fields (mainly primary education teachers). The percentage of those having been trained in ICTs was exceptionally high, coming up to 91,4%. Finally, the average sample age was 45+/-6,9 years and the average service time was 19,7+/-6,1 years.

4 DATA COLLECTION AND ANALYSIS

Data collection was performed via a questionnaire that was developed by the researcher according to the findings of the relevant research literature concerning ER. The questionnaire consists of 5 parts and close-ended questions. The first part of the questionnaire reflects the demographic and professional characteristics of the respondents such as gender, age, years of service, their level of education, their position and skills, and whether they have ICT training. The second part of the research tool consists of five Likert-scale questions regarding ICT integration in schools that respondents are currently working for, and the third part involves ten questions concerning ER benefits. In the fourth part of the questionnaire, the level of robotics implementation in schools is first determined through 9 Likert scale questions, and then multiple choice question marks the courses that are considered more appropriate by teachers for the use of ER. Finally, in the fifth part of the research tool assesses the experience of respondents in ER, as well as their views regarding its further potential. A pilot study was also performed in a sample of 5 teachers so as to identify potential problems and assess its reliability. Statistical processing was performed with the statistical package SPSS 20.0.

5 RESULTS

As regards ICT integration in the educational process, it turns out to be relatively high (A.S. =3,60, S.D.=82). It should be noted that teachers participating in this study highly incorporate ICTs in their teaching, and they extensively use digital technologies both in the classroom as well as in other extra-curriculum activities. This finding is quite expected, as teachers involved in this survey are also involved in ER projects and have been trained in ICT-related subjects. On the other hand, the technological infrastructure of schools for implementing ICTs is considered mostly moderate, providing evidence that technical and technological resources of Greek schools are not adequate for developing ER projects and further incorporating robotics in the educational process.

Table 1: ICTs use and integration in schools

	None		A little		Moderate		A lot		Very Much			
	N	%	N	%	N	%	N	%	N	%	A.S.	S.D.
How adequate is technological infrastructure/ technological means at school curriculum (PC, software, technical support)?	3	4,3%	9	12,9%	23	32,9%	20	28,6%	15	21,4%	3,50	1,10
Up to what extent do you integrate ICTs in teaching process?	2	2,9%	4	5,7%	8	11,4%	25	35,7%	31	44,3%	4,13	1,02
To what degree have you been using digital technologies in classroom?	4	5,7%	3	4,3%	7	10,0%	29	41,4%	27	38,6%	4,03	1,09
How often do you use ICTs for other curricular activities outside the classroom?	1	1,4%	5	7,1%	10	14,3%	32	45,7%	22	31,4%	3,99	0,94
To what extent do you use robotics in the process of teaching?	26	37,1%	16	22,9%	11	15,7%	12	17,1%	5	7,1%	2,34	1,33
Use and integration of ICTs											**3,60**	**0,82**

Table 2: ER benefits

	None		A little		Moderate		A lot		Very much			
	N	%	N	%	N	%	N	%	N	%	A.S.	S.D.
Robotics makes teaching easier.	3	4,3%	8	11,4%	17	24,3%	37	52,9%	5	7,1%	3,47	0,94
Robotics facilitates gaining of knowledge in various learning objects.	1	1,4%	8	11,4%	14	20,0%	35	50,0%	12	17,1%	3,70	0,94
Robotics creates positive attitudes for students towards positive sciences courses.	1	1,4%	2	2,9%	6	8,6%	37	52,9%	24	34,3%	4,16	0,81
Robotics creates positive attitudes for students towards theoretical sciences.	8	11,4%	17	24,3%	19	27,1%	15	21,4%	11	15,7%	3,06	1,25
Robotics encourages communication and teamwork learning.	2	2,9%	4	5,7%	8	11,4%	26	37,1%	30	42,9%	4,11	1,02
Robotics encourages creativity and self-expression.	2	2,9%	2	2,9%	9	12,9%	27	38,6%	30	42,9%	4,16	0,96
Robotics has a positive effect on problem solving and task management skills.	2	2,9%	2	2,9%	12	17,1%	31	44,3%	23	32,9%	4,01	0,94
Robotics has a positive effect on communication skills.	3	4,3%	1	1,4%	19	27,1%	34	48,6%	13	18,6%	3,76	0,92
Robotics has a positive effect on mental skills.	1	1,4%	4	5,7%	9	12,9%	36	51,4%	20	28,6%	4,00	0,88
Robotics favours the development of research interest.	1	1,4%	1	1,4%	8	11,4%	29	41,4%	31	44,3%	4,26	0,83
Robotics benefits											**3,87**	**0,75**

In addition, it is found that, according to teachers' views, the most appropriate subjects of the school curriculum where ER can be used are technology (80,0%), physics (62,9%), engineering (57,1%), mathematics, and geometry (52,9%). The application of robotics is also suggested to be used in independent projects as extra-curriculum activities (68,6%). On the other hand, history is a subject of limited potential for ER application.

Table 3: Most appropriate subjects for the use of robotics applications

	N	%
Physics	44	62,9%
Mathematics and Geometry	37	52,9%

Technology	56	80,0%
Engineering	40	57,1%
History	12	17,1%
Intermedia	6	8,6%
Independent project	48	68,6%
Other	10	14,3%

Furthermore, the 59,9% of teachers participated in this study have applied an ER project and/or have participated in domestic and international ER competitions, including Etwinning, the WRO Hellas Panhellenic Competition for primary school students, the Panhellenic Teaching Robotics competition, the First Lego League, the Informatives Students Convention, The Robotics Olympiad competition and the Digital Creativity Festival. Furthermore, the educational platforms used are LEGO EV3 MINDSTORMS, ANDRUINO, SCRATCH, WEDO 2,0, RASPBERRY and E-TWINNING. As such, it can be suggested that ER implementation by teachers is facilitated by a relatively wide variety of commercial ER packages, which now provide enhanced opportunities for the development of robotics in Greek schools.

Factor analysis performed regarding teachers' satisfaction from their experience while participating in ER projects revealed two factors, i.e. their satisfaction with students' involvement and their satisfaction with schools response. In particular, as demonstrated by the average rating of these factors, students' response to the project development procedure in terms of participation, co-operation, expression of ideas and development of skills and positive attitudes is remarkably high (A.S.=4,20, S.D.=0,56). On the contrary, the response of school in terms of logistics infrastructure sufficiency and teaching staff support is low (A.S. =3,08, S.D. =0,94). Accordingly, it can be argued that teachers participating in ER projects in Greece consider students as highly involved in the related activities, while schools are not ready yet for implementing such projects, a finding that should be well considered by educators, school administrators and educational policy-makers. A remarkable finding concern also the moderate support provided by other teachers not involved in ER activities. Thus, the interdisciplinary approach suggested for ER integration in schools is not facilitated in the Greek educational setting due to both schools inadequate infrastructure and other organizational and human-related factors.

Table 4
Satisfaction of teachers from their overall experience in ER projects

	None		A little		Moderate		A lot		Very much			
	N	%	N	%	N	%	N	%	N	%	A.S.	S.D.
The students participated actively during the project.	0	0,0%	2	4,5%	6	13,6%	19	43,2%	17	38,6%	4,16	0,83
The students co-operated harmoniously.	0	0,0%	1	2,4%	4	9,8%	23	56,1%	13	31,7%	4,17	0,70
The students were able to express their ideas and be creative.	0	0,0%	0	0,0%	3	6,8%	27	61,4%	14	31,8%	4,25	0,58
The students developed remarkable mental and communicational skills through the project.	0	0,0%	0	0,0%	7	15,2%	28	60,9%	11	23,9%	4,09	0,63
The students developed positive attitudes towards learning objects.	0	0,0%	0	0,0%	8	17,4%	23	50,0%	15	32,6%	4,15	0,70
Students' response											**4,20**	**0,56**
School logistics infrastructure was adequate for the development of the project.	8	16,3%	8	16,3%	22	44,9%	5	10,2%	6	12,2%	2,86	1,19
The school administration provided proper support.	1	2,0%	9	18,4%	12	24,5%	10	20,4%	17	34,7%	3,67	1,20
The remainder of teachers provided support and help.	5	10,4%	15	31,2%	19	39,6%	9	18,8%	0	0,0%	2,67	0,91
Response of school											**3,08**	**0,94**
Overall experience											**3,70**	**0,57**

Finally, the factor analysis revealed two factors regarding ER potential for further integration in schools and its application in Greek educational settings, i.e. structural and procedural actions. In particular, the need of structural action for further integration of robotics is schools is particularly stressed by teachers participating in this study (A.S.=4,37, S.D.=0,57), and secondly, the need of procedural actions is also pointed out (A.S.=3,73, S.D.=0,74). In addition, further integration of ER in Greek schools is also considered as necessary (A.S.=4,05, S.D.=0,54).

Table 5: ER potential for further integration in schools

	None		A little		Moderate		A lot		Very much			
	N	%	N	%	N	%	N	%	N	%	A.S.	S.D.
There is a need for further school funding for the development of equivalent projects.	1	1,4%	0	0,0%	5	7,1%	15	21,4%	49	70,0%	4,59	0,75
There is a need for further information of students and parents	1	1,4%	2	2,9%	9	12,9%	32	45,7%	26	37,1%	4,14	0,86
Seminars for teachers are required for the integration of robotics	0	0,0%	0	0,0%	5	7,1%	25	35,7%	40	57,1%	4,50	0,63
There is a need for updating school logistics infrastructure	1	1,4%	4	5,7%	6	8,6%	24	34,3%	35	50,0%	4,26	0,94
Structural actions											**4,37**	**0,57**
There is a need for integration of robotics to curriculum	2	2,9%	3	4,3%	18	25,7%	18	25,7%	29	41,4%	3,99	1,06
Robotics can be integrated to most scheduled courses	2	2,9%	12	17,1%	28	40,0%	23	32,9%	5	7,1%	3,24	0,92
There is a need for integration of robotics to curriculum	1	1,4%	2	2,9%	19	27,1%	25	35,7%	23	32,9%	3,96	0,92
Procedural actions											**3,73**	**0,74**
Potential of robotics integration											**4,05**	**0,54**

6 DISCUSSION

ER is a remarkably innovative teaching and educational application that provides the means for modernizing teaching and learning, having great benefits in terms of ICT integration in schools and curriculums. However, it is well known that up to now, there has not been a full alignment between the technological progress that has been achieved in the global society of knowledge and the respective school reality. Thus, the implementation of ER, though very promising, is still at a very primary level. The findings of this research suggest that, while ICTs are rapidly integrated in the Greek school setting, robotics still remain a relatively unexploited field, as it is also observed at an international level (Mataric et al, 2007;Alimisis, 2013). However, it should be also noted that the finding that ICTs seem to be well incorporated in Greek schools, as documented in this research, can be attributed to the fact that teachers participated in this study have been activated in the field of teaching robotics and therefore are familiar with modern technologies.

Regarding the benefits of teaching robotics, this study revealed that ER has significant advantages both for students and educators, as it facilitates teaching in class and especially STEM-related subjects. More precisely, it was found that ER has a positive impact on improving students' mental and cognitive skills, while it also fosters self-expression, research interest, creativity, project management skills, communication and collaboration, problem-solving and self-confidence. Findings in international studies confirm that the applications of robotics in various educational settings contribute to the development of mental skills and the acquisition of science-related knowledge (Lindh & Holgerson, 2007;Barak & Zadok, 2009; Highfield, 2010; Hong et al, 2011; Kazakoff et al, 2013; Khanlari, 2013), while providing upgraded opportunities for team work, communication and collaboration (Ruiz & Aviles, 2004), and enhancing positive attitudes towards STEM (Barker &Ansorge, 2007; Bers et al, 2014). It was also found that teachers have positive attitudes towards ER integration in the educational process, as it has been suggested in other related studies internationally (Fridin & Belokopytov, 2014; Khanlari, 2016; Reich-Stiebert&Eyssel, 2016), and in Greece (Theodoropoulos et al, 2017). Of course, several barriers exist, especially as regards schools technological infrastructure and financial resources available for ER projects (Theodoropoulos et al, 2017), as also shown in this research.

The findings of this research are of significant importance regarding ER integration in Greek schools. In particular, students' positive attitudes towards ER projects and applications imply that ER is of great potential for fostering STEM education in Greece. The systematic involvement of students in ER applications contributes to the enhancement of their interest in science and the increases of levels of intrinsic motivation for STEM. In addition, the teachers who participated in this study confirmed that robotics facilitates teaching, although it is worth noting that the views on whether the relevant applications lead to more positive attitudes towards theoretical subjects (eg. history) are mixed. This finding, of course, is expected if one considers the inherent link between robotics and STEM and the fact that the majority of applications are implemented in the corresponding lessons. Despite the above mentioned benefits, this study revealed that ER integration in Greek schools has many barriers, especially as regards the lack of sufficient time for designing such projects, the limited availability of technological resources, inadequate access to appropriate software / hardware, and the limited flexibility of the curriculum. At the same time, moderate seems to be the support of school administration for the integration of ER while the issue of insufficient digital literacy of teachers for the use of robotics is also significant. Indeed, schools' responsiveness to ER integration is not high, as documented in this research, implying that ER is a challenge for the Modern Greek teaching society.

In this respect, there is a need to take action, both centrally and at school level, in order to remove obstacles and make it possible to integrate ER more effectively into the school reality. A particularly important variable that can work in this direction is the organization of training seminars at a central level so that teachers are able to use relevant applications. At a school level, schools and their administrations should take advantage of the training opportunities offered by the private sector, which has been actively involved in this field over the last period, with the example of WRO Hellas. In this context, partnerships between schools and private bodies should be welcomed by school administrations. Besides, a specific plan for informing teachers themselves could also bear fruit for them to be informed about the possibilities offered by ER and to take autonomous action. Finally, at central level, a dialogue should be opened on the possible integration of robotics into the curriculum, notably through cross-thematic approaches, by adopting the best practices currently being developed in other countries.

This study has a number of limitations that need to be mentioned. The most important limitation is the relatively small sample of teachers participating in this research, although teachers involved in relevant projects and applications in Greece is quite limited. A further limitation concerns the fact that no attempt was made to investigate the specific characteristics of the ER projects in which the teachers are involved, so as to examine any links between these projects and teachers' respective views on benefits and possibilities for further implementation. Given this research limitations and the fact that ER is a growing and promising field in Greece, future research should further explore teachers' attitudes towards ER, including educators of non-STEM subjects who are not currently involved in ER projects. Furthermore, future research is needed as regards students' views on ER, in order to better understand ER benefits and limitations. Lastly, a matter of future research interest is the examination of the causal link between systematic child engagement with ER and STEM school performance, as well as the investigation of ER involvement impact on the academic and professional path of students in their latter adult life.

REFERENCES

Alimisis, D. (2013). Educational robotics: New challenges and trends. Themes in Science and Technology Education, 6, pp. 63-71.

Atmatzidou, S., Markelis, H. & Dimitriadis, S. (2008). LEGO Mindstorms application in Elementary and High School.Game as a learning trigger. Proceedings of the 4th Pan-Hellenic Conference in Computer Science Teaching.Patra, Greece (In Greek).

Balch, T., Summet, J., Blank, D., Kumar, D., Guzdial, M., O'hara, K., & Jackson, J. (2008). Designing personal robots for education: Hardware, software, and curriculum.IEEE Pervasive Computing, 7(2), pp. 5-9.

Barak, M. &Zadok, Y. (2009).Robotics projects and learning concepts in science, technology and problem solving.International Journal Technology & Design Education, 19(3), pp. 289-307.

Barker, B. S.&Ansorge, J. (2007).Robotics as means to increase achievement scores in an informal learning environment. Journal Research on Technology in Education, 39(3), pp. 229-243.

Bers, M. U., Flannery, L., Kazakoff, E. R. & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. Computers & Education, 72(1), pp. 145–157.

Chen, N. S., Quadir, B. &Teng, D. C. (2011).A Novel approach of learning English with robot for elementary school students (pp. 309-316). In M. Chang (Eds.), Edutainment 2011, Heidelberg, Germany: Springer-Verlag Berlin Heidelberg.

Christou, E. & Sigala, M. (2000). Issues that Influence the Use of Multimedia in Hospitality Education in Europe: An Empirical Approach. EuroCHRIE Spring Conference 2000, Dublin Institute of Technology, Dublin, Ireland, 18–19 May.

Christou, E. and Sigala, M. (2002). Innovation in hospitality and tourism education. International Journal of Tourism Research, 4(1), 65-67.

Detsikas, N.&Alimisis, D. (2011).Status and trends in educational robotics worldwide with special consideration of educational experiences from Greek schools. Proceedings of the International Conference on Informatics in Schools: Situation, Evolution and Perspectives. Bratislava, Slovakia.

DeVries, R., Zan, B., Hildebrandt, C., Edmiaston, R.& Sales, C. (2002).Developing Constructivist Early Childhood Curriculum: Practical Principles and Activities. New Jersey: Teachers College Press.

Eguchi, A. (2014). Educational robotics for promoting 21st century skills.Journal of Automation, Mobile Robotics & Intelligent Systems, 8(1), pp. 5-11.

Fridin, M.& Belokopytov, M. (2014).Acceptance of socially assistive humanoid robot by preschool and elementary school teachers.Computers in Human Behavior, 33, pp. 23-31.

Goldman, R., Eguchi, A. &Sklar, E. (2004).Using educational robotics to engage inner-city students with technology.Proceedings of the 6th International Conference on Learning sciences.Santa Monica, California.

Highfield, K. (2010). Robotic toys as a catalyst for mathematical problem solving. Australian Primary Mathematics Classroom, 15(2), pp. 22-27.

Highfield, K., Mulligan, J.&Hedberg, J. (2008).Early mathematics learning through exploration with programmable toys.Proceedings of the Joint Conference in Psychology and Mathematics.Morelia, Mexico.

Hong, J. C., Yu, K. C.& Chen, M. Y. (2011).Collaborative learning in technological project design.International Journal Technology & Design Education, 21(3), 335-347.

Kanda, T., Hirano, T., Eaton, D.& Ishiguro, H. (2004). Interactive robots as social partners and peer tutors for children: A field trial. Human-computer Interaction, 19(1), pp. 61-84.

Kazakoff, E., Sullivan, A.&Bers, M. (2013).The effect of a classroom-based intensive robotics and programming workshop on sequencing ability in early childhood. Early Childhood Education Journal, 41(4), pp. 245–255.

Khanlari, A. (2013). Effects of robotics on 21st century skills.European Scientific Journal, 9(27), pp. 26-36.

Khanlari, A. (2016). Teachers' perceptions of the benefits and the challenges of integrating educational robots into primary/elementary curricula. European Journal of Engineering Education, 41(3), pp. 320-330.

Lindh, J.& Holgerson, T. (2007). Does Lego training stimulate pupils' ability to solve logical problems? Computers & Education, 49(4), pp. 1097–1111.

Mataric, M. J., Koenig, N. P., &Feil-Seifer, D. (2007).Materials for Enabling Hands-On Robotics and STEM Education.AAAI spring symposium: Semantic scientific knowledge integration. Stanford, California.

Mikropoulos, T. A.&Bellou, I. (2013).Educational robotics as mind tools. Themes in Science and Technology Education, 6(1), pp. 5-14.

Mubin, O., Bartneck, C., Feijs, L., Hooft van Huysduynen, H., Hu, J.& Muelver, J. (2012).Improving speech recognition with the robot interaction language.Disruptive Science and Technology, 1(2), pp. 79-88.

Nugent, G., Barker, B.& Grandgenett, N. (2012). The Impact of Educational Robotics on Student STEM Learning, Attitudes, and Workplace Skills (pp. 186-203). In B. Barker, G. Nugent, N. Grandgenett, & V. Adamchuk (Eds.), Robots in K-12 Education: A new technology for learning, Hershey, PA: IGI Global.

Papert, S. (1980).Mindstorms: children, computers, and powerful ideas. New York: Basic Books.

Reich-Stiebert, N.&Eyssel, F. (2016). Robots in the classroom: What teachers think about teaching and learning with education robots.International Conference on Social Robotics. Kansas City, USA.

Sullivan, F. R. & Moriarty, M. A. (2009). Robotics and discovery learning: pedagogical beliefs, teacher practice, and technology integration. Journal of Technology and Teacher Education, 17(1), pp. 109-142.

Sigala, M. & Christou, E. (2007). Exploiting Web 2.0 in open and distance education: Developing personalised and collaborative learning environments. In A. Lionarakis (ed.), Proceedings of the 4th International Conference on Open and Distance Learning-ICODL 2007 (pp.181-195). Athens: Propombos.

Theodoropoulos, A., Antoniou, A.&Lepouras, G. (2017). Teacher and student views on educational robotics: The Pan-Hellenic competition case. Application and Theory of Computer Technology, 2(4), pp. 1-23.

Valachis, I., Christou, E., Maroudas, L., & Sigala, M. (2008). Assessment of training quality in hospitality industry: an exploratory model. In 26th EUROCHRIE Congress "Building a Legacy, Living the Dream".

Whittier, L. E. & Robinson, M. (2007).Teaching evolution to non-English proficient students by using LEGO robotics. American Secondary Education, 35(3), pp. 19-28.

SUBMITTED: DECEMBER 2017
REVISION SUBMITTED: FEBRUARY 2018
ACCEPTED: MARCH 2018
REFEREED ANONYMOUSLY

PUBLISHED ONLINE: 27 APRIL 2018