ADAPTATION OF A RESEARCH TOOL IN GREEK LANGUAGE WHICH MEASURES TEACHERS' PERSPECTIVES ABOUT INTEGRATING ROBOTICS IN PRIMARY EDUCATION TO ENHANCE STEM TEACHING AND LEARNING: EVALUATION OF VALIDITY AND RELIABILITY OF THE TOOL

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Abstract

The continuous technological explosion, forces the education policy makers reconsider curriculum, teaching methods and means in order to provide young learners a high-tech knowledge and skills. Considering that such skills can be developed through the fields of Science, Technology, Engineering and Mathematics (STEM), it's obvious that a high-tech teaching method must be adopted to enhance STEM learning. Robotics seems to be a very promising method. This work is about the adaptation of a research tool in the Greek language in order to measure teachers' perspective and attitude regarding the integration of robotics in primary education to enhance STEM teaching. Evaluation of the validity and reliability of all questions is conducted in order to finalize the questions that need to be kept or discarded from the questionnaire.

Keywords: STEM education, educational robotics, validity of a questionnaire

Introduction

Providing a high quality education to prepare children in a way that they could seamlessly respond to the needs of the contemporary life is an issue that has always been a priority for the educational systems all of the world. Obviously the rapid evolution of technology demands a change on both teaching methods and means, so that education can synchronize with society and can 'catch up' the continuous technological development. Educational robotics seems to be a very innovative teaching method and tool to make teaching a real challenge and help students meet the high-tech learning expectations (Goh H. & Mohamad B. A., 2014· Adolphson, 2002). Robotics has been used as a teaching method and tool in high schools the last few years with great success. Both teachers and students declare satisfaction whilst higher interest, commitment and efficient learning have been observed through researches about integrating robotics in schools (Altin, H. & Pedaste, M., 2013· Barker, B.S., Nugent, G., & Grandgenett, N., 2008· Mataric, M.J., Koenig, N. & Feil-Seifer, D., 2007). There is a strong opinion that the learning outcomes would be much better if kids could get earlier into courses of robotics and STEM education and particularly if this starts from their primary schooling (Goh H. & Mohamad B. A., 2014). Of course such an attempt is not an easy issue. It requires a series of actions that will prepare the ground properly for effective STEM teaching through robotics. Primary school teachers' attitude and

perspectives is one of important variables to be examined and definitely has to be taken into consideration. Since no other research has been found in the Cypriot context regarding teachers' attitude and perspectives regarding the integration of robotics in Cypriot primary education to enhance STEM learning, this work is believed that will highlight with important information regarding the readiness and the attitude of teachers to accept and adopt this innovative teaching method.

The main purpose of this work is to adapt a research tool in Greek language, so that the perceptions of primary school teachers regarding the integration of robotics in primary schools of Cyprus to be measured. Because of the absence of such a tool in the relevant literature, the integration of new technologies was considered very close to educational robotics and a research tool measuring teachers' perceptions about integrating Information Technologies for Communication (ICT) into primary education was chosen instead. The statements of that tool were formulated to fit the question of the integration of robotics into education, whereas those statements that did not fit with educational robotics were replaced by others. The questionnaire was proceeded to 150 teachers working in public primary schools in Cyprus. All collected data were analyzed through the statistical package SSPS 2.0. Suggestions for improving the questionnaire after evaluating the results of the reliability and validity tests are also provided in this paper.

Literature Review

The idea of integrating robotics into education era is based on the pedagogical principle of 'learning by doing' suggested by the philosopher and educator John Dewey as well as the constructivist theory firstly introduced by Jean Piaget, and later developed by Papert Seymour (1971). According to this theory the best way of teaching is through real objects. This method helps to engage actively students in the learning process (Stager, G.S., 2001). The more time kids have on task the better the learning outcomes suggests the research for school effectiveness (Creemers, B. & Reezigt, G. (1997). Understanding that kids learn better when they are actively involved in the learning procedure and much more when this procedure involves hands-on activities educational robotics seems to be an innovative teaching method that gives students the opportunity for a deep thinking about technology, especially when a robotic kit used in the class allows both the programming and constructing (Eguchi, 2014). Today kids are very interested in technology and spend a lot of their day time on using different kind of technology apparatuses. The fact that their life is surrounded by technology even before they are born has to be seriously taken into consideration for the development of school curriculum (Eguchi, 2014).

STEM Education

STEM teachings refer to the interdisciplinary approach of teaching the cognitive subjects of Science, Technology, Engineering, and Mathematics (Chew, Noraini Idris and Leong, 2014· Francis Poscente and Davis, 2013). According to the literature, robotics can be effective for teaching STEM courses. (Alimisis, D., 2013) as it allows practical application of concepts of

engineering and technology and contributes to the clarification of abstract concepts of physics and mathematics (Nugent et al., 2010).

Educational Robotics

Robotics as a concept is directly related to the programming of a machine in order to follow specific instructions. The pedagogical approach and exploitation of robotics technology in education provides opportunities for practical applications and interdisciplinary teaching of lessons coming from the field of STEM courses. The positive contribution of educational robotics in teaching and learning STEM courses has being extensively referred in literature (Altin, H. & Pedaste, M., 2013· Barker, B.S., Nugent, G., & Grandgenett, N., 2008· Mataric, M.J., Koenig, N. & Feil-Seifer, D., 2007). This is explained by the fact that educational robotics allows the practical application of concepts coming out of Engineering and Technology and assists in understanding abstract concepts from the subjects of Mathematics and Physics (ChanMin K., Dongho, K., Jiangmei, Y., Roger, B.H., Prashant, D. Chi, N. Th., 2015· Nugent et al., 2010). Besides, other experimental researches conducted to measure students' performance in mathematics when using robotics in both primary and high school classes have shown improvement in the learning outcome and particularly for intermediate level students (Lindh, J. & Holgersson, T., 2007). Similarly, there were positive learning outcomes recorded when investigating the performance of primary and secondary school students in Physics (Karahoca, D., Karahoca, A., & Uzunboylub, H., 2011).

In the curriculum of Design and Technology course in Cyprus control systems and technology are consisted one of the main chapters of the syllabus for this course that students are being taught from the age of six up to eighteen in a spiral learning approach. Different kind of simple robotic systems like Egg box, Probot and Engino Robotic Platform are introduced to kids in primary schools in order to give young learners the experience of building and programming of a robot. Through these lessons, students are required to learn and assess the various technological products or constructions, as well as the modern developments in the areas of robotics, entrepreneurship, nanotechnology and biotechnology in a way that they learn to be creative, innovators and able to transform their ideas through collaboration, into products and procedures. (Mistry of Education of Cyprus, 2012). Additionally, educational robotics becomes more and more popular especially in the afternoon lessons that are provided by private institutes mostly to young children who belong in the age group of 9-15 years old. Furthermore, in the island of Cyprus an internationally recognized Cypriot company which designs and manufactures its own patented construction system under the brand name Engino, provides an innovative robotic kit also suitable for the ages 9-15 years old, which is accompanied by a set thirty-two fully designed lesson plans to enhance STEM teaching through robotics.

Methodology

Because of lack on local and international surveys examining teachers' perspectives about integrating robotics in primary education to enhance STEM teaching and learning, the research on integrating new technologies was considered very close to educational robotics and a questionnaire on that topic

was adapted and translated into the Greek language for the purposes of this work. A quantitative methodology was used to collect data for the validation of the tool. Some demographic information about the participants were asked in the first page of the questionnaire (i.e. gender, age, years of working experience, lessons that usually teach and studies). The rest of the questionnaire was divided into three sections asking teachers' opinion about a) the integration of robotics in primary education for STEM teaching, b) difficulties to integrate robotics in primary education and c) the benefits to students' learning when using robotics in class. Teachers had to answer twenty-nine questions in total based on a five point Likert scale, where 1 means totally disagree and 5 totally agree. The face validity of the questionnaire was ensured by the opinion of an expert in the field. A pilot research was conducted with 5 primary school teachers in order to refine the questions and estimate the average time required to complete the questionnaire. The time needed in any case did not exceed the 10 minutes. The sample of the research was consisted of 150 primary school teachers, working in public primary schools in Cyprus. An introduction letter was attached to the questionnaire where a brief explanation of the purpose of the research, a short definition of educational robotics and an assurance of protecting the anonymity was given to the respondents.

Statistical techniques used to test validity and reliability of the questionnaire. Validity and reliability tests of the research tool were conducted through the analysis of the survey data. The statistical package SPSS 20 was used for this purpose. In order to verify the validity of the tool, a check on the regularity of the values of the variables was performed first. As almost all the variables showed a normal distribution, then the correlation of the variables was checked with Pearson's method. The data from all variables that had shown a statistically very significant correlation and their Skewness asymmetry was within the allowable limits (-1 <Skewness <1) were then inserted into a Factor Analysis after the Preliminary tests KMO and Bartlett's test of Sphericity. A rectangular rotation test of the variables loaded on each factor was performed to examine the charges of each variable to the factors created. In addition, the Principal Component Analysis was used to investigate the variance among the variables charged to each factor. The reliability of the tool was checked using the Cronbach's alpha method for each set of variables found after the factorial analysis to load into a factor. All the statistics finding relating to the validity and reliability test of this questionnaire are presented and analyzed in the "Results" section.

Results

The descriptive analysis of the demographic characteristics of the data had shown that 21 were men, representing the 21% of the respondents and 129 were women which represents the 86% of the sample. The proportions of male and female teacher education respond to the proportion that exists in all primary school teachers in Cyprus. According to data, 44 teachers (29.3%) are in the age range 25-35 years old, 89 teachers (59.3%) in the range of 36-45 years and 17 teachers (11.3%) in the age range of 46-55 years. Both the age group "under 25" and the "55+" does not appear at all in the sample. Regarding the working experience of the teachers in the sample, only one

teacher (0.7%) has experience less than one year, five teachers (3.3%) have 1-4 years of experience, twenty-eight teachers (18.7%) have experience of 5-10 years, seventy-one teachers (47.3%) have experience of 10-20 years and forty-five teachers (30%) have experienced more than 20 years. Fifty-four teachers (36%) have a Bachelor degree in Education, 87 teachers (58%) have Masters and 9 teachers (6.0%) have PhD. Very high seems to be the percentage of teachers who teach at least one course of STEM (87%) subjects, a fact which confirms the need for evaluation of their attitudes and perceptions when it comes to introduce an innovation in teaching courses like the integration of educational robotics.

The findings of the descriptive analysis on the variables of the first section of the questionnaire, have shown that most of the teachers believe that using robotics helps students to concentrate more in a STEM lessons (mean=3.65). It is also strongly believed by teachers (mean=3.95) that students have a better understanding when working with robotics because they work in a more practical way. Moreover, teachers believe (mean=3.97) that students develop a stronger memory of what they learn when educational robotics is integrated in the lesson, because of the hands-on activities included. They also have the strong belief (mean=3.91) that educational robotics facilitates the differentiation of teaching during a lesson and that encourages the interdisciplinary approach of teaching (mean=3.74). A statistically significant correlation among these five variables was derived after a conduction of Pearson's correlation coefficient check. The regularity of the values, the satisfactory correlation of the variables ($r>0.400$) and the fact that the Skewness value of each one of these variables was in the acceptable range of -1 up to 1, allowed the factor analysis of the variables, through which one main factor was extracted. These variables were found to have a statistically significant correlation with the variables of the third section. A descriptive analysis was also conducted on the data related to the fifteen statements measuring the teachers' opinion about the difficulties in integrating educational robotics in primary education. Moreover, all variables of the second section had showed a normal distribution and skewness in the accepted range of values ($-1<skewness<1$). Missing values were taken into consideration and they were not included in the analysis. Though the value of skewness of four questions was out of the limits all questions were considered important and they were submitted for a factorial analysis. From the correlation test that was conducted on the fifteen variables of the second section, it was found a statistically significant correlation index ($r>0.400$). The gender and study variables do not appear to have any correlation with other variables. The examination of the correlation coefficient among the variables is considered to be necessary for the assessment of the validity of the variables. All variables that had a significant correlation coefficient index were considered to have high validity and they were submitted for factorial analysis. Table 1 shows the factors extracted after the factor analysis of the fifteen variables of the second section of the questionnaire.

Table 1

Table of Factorial Structure for Difficulties of Embedding Robotics in Didactic Practice

	Component				
	1	2	3	4	5
QB3 / Teachers, parents and students are not sufficiently informed about the educational value of robotics	0.868			0.129	
QB1 / STEM teaching with robotics is not included in the Cyprus Curricula.	0.848				
QB4 / The use of robotics in teaching is not the goal of my own school or educational system in Cyprus	0.831		0.137	-0.109	
QB2 / The stakeholders involved in educational policy are not aware of educational robotics.	0.781			0.167	0.164
QB11 / Not enough PCs connected to the Internet to access free programming software		0.893			0.149
QB10 / There is not a sufficient number of PCs in each school to support programming programming	0.122	0.86			
QB12 / There are technical difficulties and problems with school computers.		0.816		0.145	
QB13 / There is a lack of teaching material (robotics set, course plans, software) for teaching STEM with robotics.	0.195	0.443	0.199	0.428	-0.12
QB5 / The school timetable is very strict and robotics will add extra school activities	0.267		0.761	-0.125	
QB6 / For teaching through robotics, the syllabus needs to be reduced.			0.735	0.386	0.138
QB8 /Teaching of basic computer skills is not included in the Cypriot curricula which is required for learning programming.	0.125	0.34	0.589	0.148	-0.19
QB9 / The price of many robotics sets available on the market is too high.	0.185	0.133	0.396	0.37	0.37
QB14 / Teachers need training to use robotics to teach STEM.	0.138			0.86	
QB7 / Teachers will need the support of specialists to incorporate robotics into STEM teaching.		0.162	0.375	0.659	
QB15 / The organization of the school space as it is today in the schools of Cyprus is suitable for teaching Robotics with robotics					0.915

The descriptive analysis of the questions of the third section of the questionnaire had shown that the teachers strongly agree to the statement that educational robotics allow the teaching of problem solving skills in STEM education through the modeling method (mean=4.08). Teachers also agree that through educational robotics students learn to write simple programs by using special software, and that coding contributes to the development of children's critical, analytical and synthetic thinking (mean=4.10). They also seem to strongly believe that students understand better how digital devices work when they learn to program their own robots (mean=4.29) and that the development of students' logical thinking through error detection and correction processes is achieved (4.19). Additionally, they very strongly agree that students have more motivation to learn as they remain committed waiting to see the outcome of their work (mean=4.29) and that through educational robotics there is a targeted use of technology to create, organize, store, manage and retrieve digital material (mean=4.10). They also have the very strong belief that students recognize the value of robotics and programming beyond school (mean=4.24). In final, teachers agree that the educational robotics will allow the school curriculum to get synchronized with the new trends and needs of the labor market (mean=3.83). As all nine variables of the

third section had shown normal distribution and they appear to have a statistically significant correlation, they were used for factor analysis.

A reliability test on the variables of the six factors derived out of the factor analysis of the three sections of the questionnaire was conducted so that their internal consistency to be determined. The value of Cronbach's Alpha for each group of variables that were loading into these factors was estimated by submitting data into the SPSS 2.0 statistical package. Cronbach's Alpha value for a>0.7 was considered as a satisfactory reliability index. According to the Table 2 Cronbach's Alpha value for the first factor (factor a includes variables QA1 - QA5) was .821 which proves a high level of consistency amongst these variables. Similarly, the results from the reliability test on the variables of the second factor (variables QB1, QB2, QB3, QB4) have given a satisfactory level of consistency (a=0.875) as well as the Cronbach's Alpha and the third factor (variable QB10, QB11, QB12, QB13) where a=0.817. The factor which was consisted of the four variables QB5, QB6, QB8, QB9 had a slightly low level of consistency (a=0.642), whilst the consistency of the fifth factor (variables QB7, QB14) seems to be even lower. Very high level of consistency seems to be amongst the nine variables of the third section of the questionnaire (a=0.911)

Table 2

Reliability Test

Cronbach's Alpha	N of Items	VARIABLES
0.821	5	QA1 - QA5
0.875	4	QB1, QB2, QB3, QB4
0.817	4	QB10,QB11,QB12,QB13
0.642	4	QB5, QB6, QB8, QB9
0.564	2	QB7,QB14
0.911	9	QG1 - QG9

Conclusions

Following the validity and reliability tests carried out in the research tool that is examined in this study, it appeared that almost all variables had a high validity and reliability index. This reasonably leads to the conclusion that all the variables are measuring the perceptions and attitudes of the teachers about the integration of robotics in elementary schools for teaching STEM. Only the case of the two questions in section two (QB7 and QB14) need to be reviewed if they will remain in the questionnaire. The writer considers both these two statements which are referring to teachers' training and support by specialist as important issues that will cause difficulties during the procedure of the integration of robotics to enhance STEM teaching if not anticipated with professionalism by education policy makers.

Validity tests conducted to the questionnaire through factor analysis on the variables of the three different sections, had shown one main factor coming

out of the first section, five factors out of the second section and one main factor out of the third section. The validity of the variables of this questions was ensured by satisfying all tests, (Normality, correlations, KMO B Bartlett's Test of Sphericity). A high reliability index was observed when Cronbach's Alpha method was used. Specifically, for the variables concerning the first question of the questionnaire 'What is your opinion regarding the integration of robotics in elementary school for STEM teaching', the factorial analysis carried out showed only one strong statistical factor.

From the factor analysis of the variables of the second section of the questionnaire five factors were extracted. After a careful study of the factorial structure it seems that the first factor refers to the awareness of teachers about the existence of educational robotics in the curricula. Teachers seem to have no awareness about the introduction of robotics in Cypriot context. Apparently, this is happening because only very recently educational robotics was included in the curricula and not sufficient time was given to teachers to get familiar to this new teaching tool or get introduced to some teaching ideas (lesson plans). Another thought regarding this finding is that usually only one teacher from each school is teaching the Design and Technology subject so they were very few teachers in the sample of this research that knew about robotics in the educational system of Cyprus. The four variables loading to the second factor are related to the proper materials and technical support that are needed for the seamless integration of robotics in education. Sufficient numbers of computers to support the teaching of programming, a high speed connection to internet for free access to programming software, robotic kits, teaching materials and sufficient technical support are relatively high costing issues. It is important so bigger budgets to be allocated in education by the Cypriot government if we really want to have a contemporary educational system. The third factor involves all changes needed to be done in the structure of the existing curriculum in order to integrate robotics into primary education like a reduction of the curriculum, and introduction of computer science lesson which is prerequisite for teaching programming in robotics. The question QB9 which refers to the price of many robotic kits was not expected to load on this factor. It looks as a problematic statement and must be discarded from the questionnaire. As very few questions are loading to the fourth and fifth factors of section two, it seems that the questionnaire needs to be enriched with few more statements that would refer to teachers' professional development and the form that classes must have to enhance teaching through robotics. In last, the findings of the analysis of all variables in the third section have high validity and reliability and can remain as they are in the questionnaire. The findings regarding the correlations had shown that the variables this section were highly correlated to the variables of the first section which was also referring to the educational benefits on student's learning when using robotics in class. This finding leads to the idea of merging these two sections of the questionnaire under one statement and naming it 'the educational benefits on student's learning when using robotics in class'.

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