Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 8, Issue 4, October 2017: 428-445
DOI: 10.17569/tojqi.343218

Research Article

Education on Programming with Robots: Examining Students' Experiences and Views[1]

Serkan Çankaya [2], Gürhan Durak [3], Eyup Yünkül [4]

Abstract

The present study aimed to determine the success and views of students receiving education on programming with robots. In the study, which was carried out with the mixed research method, the data were collected via a creative problem-solving test, applied performance evaluation test for programming with robots, a semi-structured interview form. The creative problem-solving skills test was taken from PISA 2012 conducted by OECD. The study was carried out with 9 secondary school students. In the application process, first, the students were asked to fill in the creative problem-solving test. The creative problem-solving test included interactive simulations in online environment and questions regarding these simulations. Following this, the students were given education on programming with robots for one week. At the end of this education, a performance evaluation test regarding this education was given. Lastly, an interview form was used to determine the students' views about the activity carried out.

[1] This study was supported by Scientific Research Projects of Balıkesir University.

[2] Res.Assist.Dr., Balıkesir University, Necatibey Faculty of Education, Department of Computer Education and Instructional Technology, serkancankaya@balikesir.edu.tr.edu.tr, http://orcid.org/0000-0002-3951-9809

[3] Assist.Prof.Dr., Balıkesir Üniversitesi, Necatibey Faculty of Education, Department of Computer Education and Instructional Technology, gurhandurak@balikesir.edu.tr.edu.tr, http://orcid.org/0000-0003-2944-3713

[4] Res.Assist.Dr., Balıkesir Üniversitesi, Necatibey Faculty of Education, Department of Computer Education and Instructional Technology, eyunkul@balikesir.edu.tr.edu.tr, http://orcid.org/0000-0002-6177-3766

Received: 13.10.2017, Accepted: 30.10.2017

Consequently, depending on the results of the applied performance evaluation test, the education could be said to be beneficial. As a result of the correlation test conducted, a moderate level of positive significant relationship was found between the students' creative problem-solving skills and their performance scores. When the students' responses to the interview questions were examined, it was revealed that the students generally had positive attitudes and that the education given was motivating and entertaining and contributed to their learning of programming.

Keywords*: Pisa 2012, education on programming, robots, creative problem-solving skills*

Introduction

The number of information companies in the list of biggest companies in the world is gradually increasing (Witherspoon, Schunn, Higashi, & Baehr, 2016). The US Bureau of Labor Statistics (2014) predicts that the labor based on the computer science will keep growing with a rate of 11% until 2022. The importance of computer programming is emphasized with the Hour of Code activity carried out for millions of students in more than 180 countries every year, and countries support this activity to a great extent. As a consequence, in a number of countries, various attempts are made to include the course of computer programming in related curricula as a compulsory course. Obviously, computer programming is increasingly considered to be among the basic skills that students are expected to acquire (Passey, 2017; Wong, Cheung, Ching, & Huen, 2016).

Computer programming requires students to solve problems by making use of their imagination and creativity. Programming and coding are similar concepts in meaning. In the present study, the word 'programming' was adopted. In studies reported in related literature, it is pointed out that programming with a programming language can help develop students' problem-solving and cognitive skills (Czerkawski & Lyman, 2015; Lau & Yuen, 2011; Wang, Li, Feng, Jiang, & Liu, 2012).

Creative problem-solving, which is closely related with programming, refers to a mental process of findings solutions to a complex problem which requires creative thinking. In their daily lives, people encounter with complicated problems. It is important for people to have the ability to find creative solutions to complex problems at the end of a structured process of solving such problems so that they can become successful in life. Organization for Economic Cooperation and Development (OECD) regards creative problem-solving skills as one of the key skills necessary for people to become successful in their future jobs. Parallel to this, with the Program for International Student Assessment (PISA) conducted by OECD, the problem-solving skills of students in member countries have been being measured at regular intervals since 2003.

Traditional programming languages are likely to be found too complex and hard to learn by K12 students (elementary school, secondary school and high school students) (Álvarez &

Larrañaga, 2015; Kelleher & Pausch, 2005; Kurebayashi, Kamada, & Kanemune, 2009; Major, Kyriacou, & Brereton, 2012). This situation causes students to end up with failure in courses of introduction to traditional programming and thus to develop negative attitudes towards courses of programming (Ala-Mutka, 2004; Korkmaz, 2016; Robins, Rountree, & Rountree, 2003).

Several tools such as scratch and code.org have been developed to do programming with the use of code blocks, which does not require any programming by writing and to teach a simple algorithm of programming to students. This type of tools allows students to learn in a more entertaining environment by removing the complexity of the authoring language. Another alternative in programming education is programming with robots. Similar to programming with robots, the softwares developed in a scratch-like programming environment can run on a robot. In this way, students can program the robots they have developed themselves, and they have the opportunity to witness the results of the program they have developed.

In related literature, there are several studies demonstrating that programming with robots is a more effective and entertaining method when compared to traditional programming education (Kurebayashi et al., 2009; Liu, Newsom, Schunn, & Shoop, 2013; Major et al., 2012). Patterson (2011), who examined 19 studies in literature, and found that use of robots in 14 of these studies had positive influence on programming education. It is reported that education on programming with robots is engaging and motivating and that robots could sometimes be dreadful as they require mechanical installation (Liang, Fleming, Man, & Tillo, 2013; Lykke, Coto, Mora, Vandel, & Jantzen, 2014). Therefore, it is important to provide students with guidance in the process of mechanical installation of robots.

Teaching computer programming to K12 students is thought to develop their thinking skills involving information processing and to improve the learning outcomes at university level (Mayer, 2013; Wong et al., 2016). Similarly, it is pointed out that robotic programming plays a very important role in the development of students' thinking skills involving information processing and that it is increasingly regarded as one of the basic skills at K12 level (Alimisis, 2013; Barr & Stephenson, 2011; Eguchi, 2015; Grover & Pea, 2013; Witherspoon et al., 2016).

In related market, there are a number of tools for robot use in programming education. Among these tools, the most popular one is MindStorms developed by Lego company. Lego produced its first programmable MindStorm robots with MIT in 1998. These first robots were called MindStorms RCX. In 2006, MindStorms NXT was developed, which was followed by MindStorms NXT 2.0 in 2009 and lastly by MindStorms EV3 in 2013 (Patterson, 2011). In the present study, the Lego MindStorms EV3 basic education set was used. In Lego MindStorms EV3 robots, there is one programmable brick. On this brick, four ports are found to connect the engines and sensors. In addition, in the basic education set, there are two big and one small engines, a color sensor, a touch sensor, gyro sensor, an infrared sensor and various plastic parts to produce simple robots. It is possible to produce a wide variety of robots by using these parts. It is necessary to develop a different programming logic for each robot produced (Koç & Böyük, 2013). Figure 1 presents a MindStorms robot designed in a way to move on two wheels. In order for this robot to stay in balance on two wheels, the Gyro sensor should be programmed.

Figure 1. Lego MindStorms robot able to move on two wheels

In order to program MindStorms robots, code blocks are used in a visual environment which does not require code writing. These blocks allow doing such basic programming functions as defining the variables, doing calculations, making decisions and establishing cycles. Also, specific to EV3, blocks are found for use of engine and sensors. Figure 2 illustrates a sample program written for EV3.

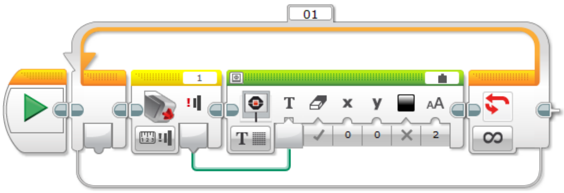

Figure 2. Sample program for MindStorms EV3

In an experimental study carried out by Korkmaz (2016) with a pretest and posttest control group, Lego MindStorms EV3 robots were used in the course of C++ programming in the department of Computer Engineering. The results of the study demonstrated that the students in the experimental group who used the Lego MindStorms EV3 robots had significantly higher levels of academic achievement when compared to those in the control group. In addition, the study also revealed that the Lego MindStorms EV3 robots had positive influence on the students' attitudes towards computer programming.

In another experimental study which lasted two years and which was conducted within the scope of Basic Programming Course in the department of Computer Engineering at Bask University in Spain, the influence of Lego MindStorms robots on programming education was investigated. In the study, a significant increase was observed in the students' motivations and in their perceptions of their own learning, and a decrease was found in their drop-outs of the course. On the other hand, in the same study, no significant difference was found between the experimental and control groups with respect to the students' levels of academic achievement (Álvarez & Larrañaga, 2015).

When other related studies in literature were examined, it was seen that there was an increase in the number of such studies on programming with robots. Figure 3 presents the numbers of studies on programming with robots for the years 2012 to 2016 according to the Scopus database.

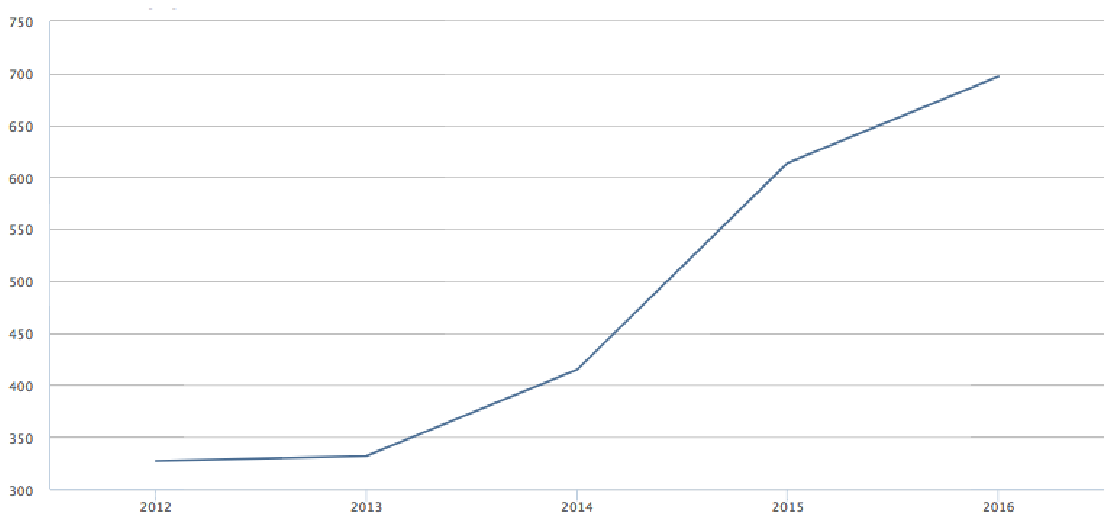

Figure 3. Numbers of studies on programming with robots by year

When Figure 3 is examined, it is seen that there was a rapid increase in the number of studies on programming with robots by year. Therefore, it could be stated that programming with robots is a popular and important field. Programming with robots is not just field related to programming education but an important field of research which contributes to students' thinking skills involving information processing as well as to their creative problem-solving skills. In Turkey, a very few related studies have been conducted. Considering the importance of programming with robots in international literature, more studies in number are expected to be conducted in our country. Therefore, the purpose of the present study was to examine the performances and views of students taking education on programming with robots.

Method

This part includes the research model, data collection tools, participants, data analysis, validity and reliability studies and the application process.

Research Design

In the study, the mixed research design involving the combined use of qualitative and quantitative methods was applied. According to Creswell (2009), mixed methods require use of qualitative and quantitative data together and include the phases of data collection, analysis and interpretation. In addition, mixed methods allow collecting more detailed data thanks to the two methods. This study also has a correlation research design due to its quantitative aspect.

When the related literature is examined, it is seen that there are a number of classification methods for mixed method studies. In a classification provided by Johnson and Onwuegbuzie (2004), a three-dimensional typology was used: (1) Level of mixing (partially mixed versus fully mixed), (2) time orientation (concurrent versus sequential) and (3) emphasis of approaches (equal status versus dominant status). Depending on the typology mentioned above, the present study can be regarded as partially mixed method research being sequential in terms of time orientation (first quantitative and then qualitative) and dominant in terms of status.

Participants

The participants in the study were nine students from the sixth and seventh grades of Zağnospaşa Secondary School in the city of Balıkesir. While determining the number of the participants, the number of robots to be used during the education was taken into account. Of all the participants, five of them were male, and four of them were female. Among the participants, only one student learned the subject of scratch within the scope of the course of Information Technologies, and none of the other students had any experience in programming.

Data Collection Tools

Within the scope of the study, the research data were collected via the Creative Problem-Solving Test (CPST), applied performance evaluation questions and a semi-structured interview form.

1. *Creative Problem-Solving Test (CPST)*: CPST included the problem-solving questions found in PISA 2012. In CPST, there were open-ended multiple-choice questions. The answer key of the test was prepared by OECD, and the students' responses to the test were scored using this answer key. In this test, the participants were exposed to real-life case problems (for example, buying a train ticket) in a two-dimensional simulated environment. The simulations were presented to the students in a web-page environment

in which HTML5 Canvas was used. The students interacted with the simulations and responded to the questions related to the simulations.

2. *Applied Performance Evaluation Questions*: These questions were those directed at the end of the education in relation to the subjects the students learned. The exam was conducted in an applied manner, and the students tested the questions on robots. The exam questions were prepared by one of the researchers and arranged and finalized in line with the suggestions of the other two researchers.
3. *Semi-Structured Interview Form*: The semi-structured interview form was made up of seven open-ended and one close-ended questions. The interview form was developed collaboratively in line with the related studies in literature.

Data Analysis

Within the scope of the study, for CPST applied to the students, the evaluation key of PISA was used, and the scores obtained were noted down. As for the analysis of the participants' responses to the applied performance evaluation questions, their responses were evaluated first individually. Following this, different aspects were evaluated together for consistency. The qualitative data were analyzed using the thematic analysis method. This process included three phases: description, analysis and interpretation. In the description phase, what the students said was determined. In the analysis phase, relationships were established between the data and the themes obtained via the data. With the interpretation of the findings within the context of the study, the qualitative research process suggested by Yıldırım and Şimşek (2008) was completed.

Validity and Reliability

For CPST, one of the data collection tools used in the study, the evaluation key of PISA was used. For the applied performance evaluation questions, the researchers formed the scoring system collaboratively, and all the questions were evaluated together. In this way, the purpose was to ensure consistency. The data collected via the semi-structured interview form were evaluated one by one, and each researcher created his or her own coding key. The reliability of the coding schemes formed by the researchers was examined by a field expert, and the coding schemes were found to be consistent with each other. After ensuring consistency, the data were divided into themes. In addition, by providing frequent quotations, the students' views were reflected strikingly.

Application Process

On the first education day, the students were informed first about the purpose of the study and then about how the process would function as well as about what they would meet. Before starting the education, CPST prepared by PISA (2012) was applied to the students via a web form. Following this, the robots were distributed to the students, and few sample applications were carried out in relation to what the robots could do. During the education, the focus was first on algorithm and on basic programming. Next, related examples were given. Following this one-week phase of education, the applied performance evaluation questions prepared by the researchers were directed to the students. Lastly, individual interviews were held with all the students regarding the robot education they had taken.

Findings and Discussion

This part presents the findings in Tables, and the findings were interpreted in comparison with the findings obtained in other studies in related literature.

Table 1
Distribution of Students' CPST Scores and Their Performance Evaluation Scores

Student Code	Performance Evaluation	CPST*
S1	100	82
S2	55	64
S3	75	36
S4	75	55
S5	50	23
S6	55	32
S7	90	59
S8	85	45
S9	80	45
Mean	74	49

*CPST scores were given out of 100.

The CPST coding key is originally evaluated out of maximum 22 points. Therefore, the scores were converted into scores out of 100 to make it possible to make comparisons with the performance evaluation scores. When the students' scores in the CPST test applied before the education were examined, it was seen that they had a mean score of 49 out of 100. This mean score could be said to be generally low except for one or two students. At the end of the one-week education, the applied performance evaluation questions were directed to the students, and the students' mean score was calculated to be 74. When their performance scores were examined, it was seen that they had high scores except for one or two students. Depending on this situation, it could be stated that the education the students took was beneficial. In most of the studies reported in related literature (Kurebayashi et al., 2009; Liang et al., 2013; Liu et al., 2013; Lykke et al., 2014; Major et al., 2012; Patterson, 2011), findings supporting the situation in question were obtained.

In the study, the relationship between the students' CPST scores prior to the education and their performance scores was examined. For this purpose, "Spearman's rank-order correlation analysis" was conducted on the data.

Table 2
Relationship between the Students' CPST Scores and Their Performance Scores

			Performance	CPST
Spearman's rho	Performance	Correlation Coefficient	1,000	,624*
		Sig.	.	,036
		N	9	9
	CPST	Correlation Coefficient	,624*	1,000
		Sig.	,036	.
		N	9	9

* Significance level was taken as 0.05.

When Table 2 is examined, it is seen that Spearman's rank-order correlation analysis applied to determine whether there was a relationship between the students' applied performance scores and their CPST scores revealed a moderate level of positive significant relationship between two variables ($r=,624$; $p<,05$). This finding was found consistent with those obtained in other studies in related literature (Czerkawski & Lyman, 2015; Lau & Yuen, 2011; Wang et al., 2012).

Students' Views about Education on Programming with Robots

Table 3 and Table 4 demonstrate the themes and sub-themes obtained via the interviews held with the students.

Table 3
Students' Views Before the Education on Programming with Robots

Themes	Frequency (f)
Experience in Education on Programming	
Yes	1
No	8
Experience in Education on Programming with Robots	
Yes	0
No	9
Views before Education	
Feeling of curiosity	6
Expecting it to be entertaining	5
Expecting it to be difficult	2

When Table 3 was examined, it was seen that almost all the students did not have any previous experience in programming education. Similarly, it was also seen that the students did not have any experience in programming education with robots. Before the education, the students' most frequent responses to the question of "what were your thoughts when you first heard about such an education?" included "I was curious about it" and "I thought it would be entertaining". Among the students, two of them reported that it would be difficult. In relation to this, one of the students, S2, said *"I thought it would be beautiful and entertaining"*, while another student, S8, said *"At the beginning, I was curious about it, and I thus got excited. I was also happy to receive education on coding"*. S1, another student who thought it would be difficult, said *"...I expected it to be nice, but I thought it would be difficult because I know robots are complex"*. The students' expectations that education on programming with robots would be difficult are parallel to the findings of other studies reported in related literature (Liang et al., 2013; Lykke et al., 2014). One reason for such expectations could be the fact that robots have a mechanically complex structure.

Table 4

Students' Views about Education on Programming with Robots

Themes	Frequency (f)
Your overall views about the education	
Positive	9
Negative	0
I had no related difficulty	7
I sometimes experienced difficulty	2
Robots' contribution to programming education	
I prefer education on programming with robots	9
I prefer education programming without robots	0
This education programming contributed to my learning	7
This education programming did not contribute to my learning	2
Motivation & interest in programming	
It increased my motivation	9
It increased my interest in programming	9
Spread of education on programming with robots	
It should be spread	9
Programming education should be given at earlier ages	5

In the study, the students were asked to report their overall views about the education on programming with robots and to state whether they experienced any related difficulty or not. It was found that all the students reported positive views about the given education. In relation to this, one of the students, S4, said *"We learned really necessary things via the education, and the lessons were quite entertaining."* During the education, a great majority of the students stated that they did not experience any related difficulty. In literature, it was reported that during an education on programming with robots, certain compelling situations are likely to be encountered especially in the installation phase of robots (Liang et al., 2013; Lykke et al., 2014). In order to avoid such difficulties, students could be provided with guidance regarding the installation of robots at the beginning of such an education. Another finding obtained in the present study was that the Lego MindStorms EV3 robots used during the education had a relatively simple structure when compared to other similar robots. On the other hand, two of the students pointed out that they experienced difficulty in certain applications. In relation to this, one of the students, S1, said *"While doing the codings with robots, I found the mathematical operations difficult."* Following the education on programming with robots, all the students stated that they preferred to take the education on programming with robots. Regarding this, S5 said *"I prefer the coding education given with robots because I learned more easily when tested it on robots"*, while another student, S1, said *"I prefer the coding education with robots not only it is entertaining but also because it contributes to our* *concentration".* In the study, most of the students stated that the education they had taken contributed to their learning programming, while two of the students reported that the education did not make any related contribution. In relation to this, S5 said *"I don't think it made any contribution to my learning. As it mainly has a structure similar to the coding language, I think we will be able to write codes much more easily if we learn the coding language".* All these findings are consistent with those obtained in a number of studies examined by Patterson (2011), who reviewed the related literature. As a response to the question directed to examine the influence of programming education with robots on the students' motivations, all the students stated that it increased their motivation and that the education increased their interest in programming. In relation to this, one of the students, S6, said "*I was already interested in coding, but with this education, my interest in coding increased more".* Another student, S9, said *"... of course, it increased my motivation. Also, my interest in coding increased as well"*. All these findings are supported by those obtained in other related studies which revealed that programming with robots contributes to students' motivation (Álvarez & Larrañaga, 2015; Kurebayashi et al., 2009; Liu et al., 2013; Major et al., 2012; Patterson, 2011). Lastly, the students were asked to report their views about the spread of programming education with robots in future, and all the students reported that such educations should be spread. In addition, most of the students suggested giving such educations at earlier ages. In relation to this, one of the students, S4, said *"It should be spread because it is both entertaining and productive. I really would like to go on taking such education", while* S5, another student, added *"Also, it should be given throughout Turkey"*.

Conclusion and Suggestions

The present study, which aimed to determine the views of students taking programming education with robots about the method, was limited to a total of nine students attending a secondary school in the city of Balıkesir. In the research process, where qualitative and quantitative methods were used together, the education given could be said to lead to positive results. It was seen that the students who had not taken any programming education before had a high achievement mean score in the evaluation done at the end of a one-week education. The results revealed a moderate level of relationship between the students' creative problem-solving skills and their post-education performance evaluation scores. Therefore, students with a high level of creative problem-solving skills could be said to be more successful in programming education.

In addition, the students reported that they found the given education entertaining and that it increased their motivation. Considering the fact that all the students preferred programming education with robots to traditional programming education, it could be stated that the spread of such applied education should be spread. Depending on the findings obtained in the study, the following suggestions could be put forward:

- Experimental studies could be conducted to reveal the differences between traditional programming education and programming education with robots.
- Attitude scale development studies could be designed regarding programming education with robots. In this way, students' attitudes could be examined with respect to several variables.
- In line with the positive findings, it is important to use robots in programming education especially at K-12 level and to include programming education more in curricula.

References

Ala-Mutka, K. M. (2004). Problems in learning and teaching programming-a literature study for developing visualizations in the Codewitz-Minerva project. Retrieved September 20, 2017, from https://www.cs.tut.fi/~edge/literature_study.pdf

Alimisis, D. (2013). Themes in science and technology education. *Themes in Science and Technology Education*, *6*(1), 63–71.

Álvarez, A., & Larrañaga, M. (2015). Experiences incorporating Lego Mindstorms Robots in the basic programming syllabus: Lessons learned. *Journal of Intelligent and Robotic Systems: Theory and Applications*, 117–129. http://doi.org/10.1007/s10846-015-0202-6

Barr, V., & Stephenson, C. (2011). Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community? *ACM Inroads*, *2*(1), 48–54. http://doi.org/10.1145/1929887.1929905

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage.

Czerkawski, B. C., & Lyman, E. W. (2015). Exploring issues about computational thinking in higher education. *TechTrends*, *59*(2), 57–65. http://doi.org/10.1007/s11528-015-0840-3

Eguchi, A. (2015). RoboCupJunior for promoting STEM education, 21st century skills, and technological advancement through robotics competition. *Robotics and Autonomous Systems*, *75*, 692–699. http://doi.org/10.1016/j.robot.2015.05.013

Grover, S., & Pea, R. (2013). Computational thinking in K-12: A review of the state of the field. *Educational Researcher*, *42*(1), 38–43. http://doi.org/10.3102/0013189X12463051

Johnson, R., & Onwuegbuzie, A. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14–26. http://doi.org/10.2307/3700093

Kelleher, C., & Pausch, R. (2005). Lowering the barriers to programming. *ACM Computing Surveys*, *37*(2), 83–137. http://doi.org/10.1145/1089733.1089734

Koç, A., & Böyük, U. (2013). Fen ve teknoloji eğitiminde teknoloji tabanlı öğrenme: Robotik uygulamaları. *Türk Fen Eğitimi Dergisi*, *10*(1), 139–155.

Korkmaz, O. (2016). The effect of Lego Mindstorms Ev3 based design activities on students' attitudes towards learning computer programming, self-efficacy beliefs and levels of academic achievement. *Baltic Journal of Modern Computing*, *4*(4), 994–1007. http://doi.org/10.22364/bjmc.2016.4.4.24

Kurebayashi, S., Kamada, T., & Kanemune, S. (2009). Learning computer programming with autonomous robots. In *International Conference on Informatics in Secondary Schools - Evolution and Perspectives* (pp. 138–149).

Lau, W. W. F., & Yuen, A. H. K. (2011). Modelling programming performance: Beyond the influence of learner characteristics. *Computers and Education*, *57*(1), 1202–1213. http://doi.org/10.1016/j.compedu.2011.01.002

Liang, H. N., Fleming, C., Man, K. L., & Tillo, T. (2013). A first introduction to programming for first-year students at a Chinese university using LEGO MindStorms. *Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering*, 233–238. http://doi.org/10.1109/TALE.2013.6654435

Liu, A., Newsom, J., Schunn, C., & Shoop, R. (2013). Students learn programming faster through robotic simulation. *Tech Directions*, *72*(8), 16–19.

Lykke, M., Coto, M., Mora, S., Vandel, N., & Jantzen, C. (2014). Motivating programming students by problem based learning and LEGO robots. *IEEE Global Engineering Education Conference*, 544–555. http://doi.org/10.1109/EDUCON.2014.6826146

Major, L., Kyriacou, T., & Brereton, O. P. (2012). Systematic literature review: teaching novices programming using robots. *IET Software*, *6*(6), 502. http://doi.org/10.1049/iet-sen.2011.0125

Mayer, R. E. (2013). *Teaching and Learning Computer Programming: Multiple Research Perspectives*. Routledge.

Passey, D. (2017). Computer science (CS) in the compulsory education curriculum: Implications for future research. *Education and Information Technologies*, *22*(2), 421–443. http://doi.org/10.1007/s10639-016-9475-z

Patterson, R. (2011). *Teaching Computer Programming Using Educational Robots*. Masters' Thesis, Information Systems, Athabasca University.

Robins, A., Rountree, J., & Rountree, N. (2003). Learning and teaching programming: A review and discussion. *Computer Science Education*. http://doi.org/10.1076/csed.13.2.137.14200

Wang, Y., Li, H., Feng, Y., Jiang, Y., & Liu, Y. (2012). Assessment of programming language learning based on peer code review model: Implementation and experience report. *Computers and Education*, *59*(2), 412–422. http://doi.org/10.1016/j.compedu.2012.01.007

Witherspoon, E. B., Schunn, C. D., Higashi, R. M., & Baehr, E. C. (2016). Gender, interest, and prior experience shape opportunities to learn programming in robotics competitions. *International Journal of STEM Education*, *3*(1), 18. http://doi.org/10.1186/s40594-016-0052-1

Wong, G. K. W., Cheung, H. Y., Ching, E. C. C., & Huen, J. M. H. (2016). School perceptions of coding education in K-12: A large scale quantitative study to inform innovative practices. In *Proceedings of 2015 IEEE International Conference on Teaching, Assessment and Learning for Engineering* (pp. 5–10). http://doi.org/10.1109/TALE.2015.7386007

Yildirim, A., & Simsek, H. (2008). *Sosyal Bilimlerde Nitel Arastirma Yontemleri* (6. baski). Ankara: Seckin Yayinevi.