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Gokhan Guven & Nevin Kozcu Cakir

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Investigation of the Opinions of Teachers Who Received In-Service Training for Arduino-Assisted Robotic Coding Applications

Gökhan GÜVEN[1]
Muğla Sıtkı Koçman University
Nevin KOZCU ÇAKIR[2]
Muğla Sıtkı Koçman University

Abstract:

The aim of this study is to determine the opinions of primary school teachers who received in-service training on robotic coding applications. For this purpose, descriptive study model, which is one of the qualitative research methods, was utilized. The study group of the research consisted of six primary school teachers who voluntarily gave opinions out of 30 teachers who participated in in-service robotic coding training in the first semester of 2018-2019 academic year. "Semi-structured interview form" was used as data collection tool. The data obtained from the participants were transferred to NVivo 12 program and analyzed by content analysis method and classified under certain categories. Direct quotations were included to reflect the responses of the participants in a striking manner. As a result of the research, participants stated that the in-service training period was inadequate and limited, and that a limited number of examples of robotic coding applications were covered. In addition, it was found that the participants generally did not incorporate such practices in their own classes after the training. They made various explanations about the reasons of this situation. In line with the results of this research, it is suggested that more time should be devoted to the applications related to robotic coding provided to teachers during in-service training, and that activities related to how to integrate them into classroom teaching practices should be organized.

Keywords: Robotics coding, in-service training, primary school teachers

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[1] Dr., Faculty of Education, Muğla Sıtkı Koçman University, Turkey, ORCID: 0000-0001-9204-5502

Correspondence: gokhanguven@mu.edu.tr

[2] Dr., Faculty of Education, Muğla Sıtkı Koçman University, Turkey, ORCID: 0000-0002-7538-7882,

Email: nkozcu@mu.edu.tr

Introduction

Technological and scientific changes in the world have been reflected in the education process and brought digitalization of education to the agenda. Especially in educational environments, the use of technology comes to the forefront in helping students gain the 21st century skills, adapting easily to the developing technology, increasing the quality of education and creating effective learning and teaching environments. The reflections of the use of technology in education are seen in many different forms such as augmented reality, simulation, digital storytelling, digital games, three-dimensional printing, social network-based learning, QR code applications and mobile applications. These applications are some of the educational technologies currently being developed and proposed for use in educational settings (Adams Becker, Freeman, Giesinger Hall, Cummins, & Yuhnke, 2016; Johnson, Adams Becker, Estrada, & Freeman, 2015). Robotic coding applications are among the most important technologies in addition to these technologies (Benitti, 2012; Johnson, et.al., 2015).

Coding can be defined as the whole or part of a set of commands written to have a mechanism made up of mechanical systems or a computer or an electronic circuit do something, or to achieve a specific purpose. Text-based or block-based programs are used in the coding process. In text-based coding, codes and commands are generated by the students in the form of text in compliance with some certain procedures by using the keyboard. This allows students to create commands without difficulty. As the text-based coding includes its own syntactic rules, has an abstract structure and is considered to be difficult for new beginners, coding education is perceived to be difficult by students (Baser & Ozden, 2015; Gomes & Mendes, 2007). As the block based coding can be performed without writing any code, the use of platforms or tools such as game lab, code.org, scratch, App Inventor, Greenfoot and mBlock have come to the fore in coding education. In addition, as these platforms or tools have an easy and convenient interface, work in a language close to the daily language instead of syntax and allow combining the code blocks with drag-and-drop method instead of writing codes and as the code blocks can be combined in only one single correct way just like jigsaw pieces, they are recommended to be used in educational environments. In the existing research, it was found that the use of block-based coding as a teaching tool was effective in developing students' problem solving, creativity, questioning, algorithmic thinking and cognitive skills (Czerkawski & Lyman, 2015; Lau & Yuen, 2011; Psycharis & Kallia, 2017; Strawhacker & Bers, 2015; Wang, Li, Feng, Jiang, & Liu, 2012). In this context, learning of block-based coding allows the emergence of various robotic structures.

Robotic refers to the functional tools that can be programmed to do a task. Reactions are generated in robots by interpreting the data obtained by means of the sensors that can sense the environment as programmed by the microcontroller or processor. Such educational robots enable students to work with concrete objects, enabling them to deal with real-life problems. In educational robotic applications, students work with engineering materials such as gears, motors and sensors, make coding by using their own imagination and algorithmic thinking, collect data by interacting with their environment and create their own projects in the light of these data. In other words, in a simple robotic activity, students use the computational thinking sub-dimensions of logical inquiry, algorithmic thinking, parsing, evaluation, debugging, abstraction and generalization (Cetin & Toluk Ucar, 2017). This allows students to acquire many skills such as solving daily problems, critical thinking, discovering their own abilities, learning by experiencing, being more willing to use technology and increasing their level of technology use (Costa & Fernandes, 2005). Alimisis and Kynigos (2009) define that the use of robotics activities in education as a new way opening to constructivist learning. In this context, the use of various tools such as robots that can do coding in educational environments, smart objects, self-build kits, virtual robot coding platforms and robot programming languages has become widespread. Examples of such robotic tools are; Lego Mindstorms Kits (NXT, EV3), VEX IQ Platform Kits (Starter Kits), Fischertechnik Kits (Fischertechnik Introduction to STEM I and II), Makeblock Kits (mBot - STEM Educational Robot Kit), Dash and Dot, Primo and Robo Mind (Numanoglu & Keser, 2017). In addition, microcontroller arduino sets which are easy to use and understand in learning environments, supported by programs running with drag-and-drop system, enabling the production of different creative projects with various sensors and enabling interaction and communication with the environment are recommended in education.

Arduino-assisted robotic coding applications consist of arduino microcontroller, related basic components, sensors and coding platforms. Firstly, students code in a block-based program that works with a drag and drop system, and they load these codes into robotic tools in order for them to become functional. For example, students can code in mBlock platform which has a compiler and converter that can convert code blocks into C ++ language and can perform coding with drag-and-drop system without writing code. Afterwards, they can load the code blocks they have created to the arduino microprocessor and run them independently of the computer and manage the workings of the robotic devices (Sahin, 2018). Thus, students are provided with rich learning environments that enable them to acquire engineering design skills as well as building, algorithmic thinking, collaborative work, creativity and problem-solving gains (Zengin, 2016). In addition, in the literature, such robotic coding applications are suggested to improve students' many cognitive functions such as academic achievement, creativity, multi-faceted thinking, critical and analytical thinking, computational thinking, high-level thinking, product creation and problem-solving (Petre & Price, 2004; Sullivan, 2017; Williams, Ma, Prejean, Ford, & Lai, 2007); affective functions such as motivation, interest towards the course, perception of their own learning and attitude towards the course (Prensky, 2010; Roblyer & Edwards, 2005); and psycho-motor characteristics (Roblyer & Edwards, 2005) such as ability development (Benitti, 2012; Gura, 2012). In this context, the necessity of bringing the robotic coding applications into the learning environments and integrating them into the courses comes to the forefront.

We see that especially robotic coding applications support STEM education which has become an important element in the science curriculum whose content was arranged in 2018 (MoNE, 2018) and they constitute an application example for STEM applications (Sullivan, 2017). In addition, such practices have become important in educational environments in terms of the use of tools and equipment that form the basis of STEM education, the determination of how the mechanisms work and the easy integration of technology (Bybee, 2010). When all these are taken into consideration, integrating technology into teaching programs using student-centered and constructivist theory emerges as an indispensable element. In addition, the integration of technology into teaching has enabled constructivist approach applications to become more applicable (Karagiorgi & Symeou, 2005). In Turkey, robotic coding applications have been put into practice only within the scope of Information Technologies and Software course since 2012, and their integration into any curriculum for the implementation of other courses has not been established directly. However, the Ministry of National Education has been organizing in-service training programs for teachers working in different branches in order to ensure the effective use of robotic coding practices in other courses. Similarly, such trainings are given to teachers in various countries in Europe, and various training platforms are established in this direction. In addition, feedback is received from teachers on the effectiveness of such trainings, and arrangements are made accordingly (Kim, Yuan, Kim, Doshi, Thai, Hill, & Melias, 2017). In this context, the extent to which the in-service trainings for robotic coding practices in Turkey contributed to the teachers, who provided them, whether the teachers included such practices in their own classes after the trainings, and the feedback received from teachers about the problems encountered during the practices should be determined, and recommendations regarding content and example implementations should be put forward. It is important to determine what the status of teachers (knowledge, usage skills, ability to integrate into courses) is and what they think about robotic coding applications in terms of eliminating the deficiencies of teachers regarding these applications. When the studies carried out on this subject are examined, we see that the situation assessment has not been made about the extent to which the primary school teachers who have received in-service training and working in public schools have knowledge about this subject and how much they can perform after the training. Thus, the aim of this study is to determine the opinions of primary school teachers who have received in-service training on robotic coding applications. Accordingly, the following research questions were examined.

(1) What are the opinions of the teachers participating in in-service robotic coding training about the training provided?

(2) What are the reasons for teachers participating in in-service robotics coding training to include or not to include such practices in their classrooms?

(3) What do teachers attending in-service robotic coding training think about the applicability of such practices in the classroom environment?

(4) What do the teachers participating in in-service robotic coding training think about what needs to be done in order to further implement such applications in the classroom environment?

Methodology

In this study, which aimed to reveal the opinions of primary school teachers who participated in in-service-robotic-coding training about robotic coding applications, of the qualitative research designs descriptive method is utilized. Descriptive method focuses on the phenomenon under scrutiny with the purpose of describing the nature of the phenomenon without focusing on the reasons of that phenomenon (Creswell, 2013).

Study Group

The study group of the research consisted of six primary school teachers (4 females, 2 males) who voluntarily gave opinions out of 30 teachers who participated in in-service robotic coding training in the first semester of 2018-2019 academic year. In the in-service training, robotic coding applications lasted a total of 15 hours, both theoretical and practical. Within the scope of this training, the importance of robotic coding, computational thinking, algorithmic operations, teaching of algorithms through games, introduction to coding environments, introduction to code.org and scratch programs, giving general information about arduino and its basic components, various sensor connections and sample applications were covered. As the in-service training given in this direction aimed to give basic information about robotic coding to the teachers and to get them to experience the applications at a simple level, primary school teachers were preferred as the study group in the research. This is because primary school teachers are expected to be the first ones to give basic level knowledge and awareness about robotic coding to primary school students. In this context, the study group was selected using purposeful sampling method. Demographic information about the participants is given in Table 1.

Table 1. Demographic Information about Participating Primary School Teachers

Participants	Gender	Professional experience	Grade level	Class size	Graduate education
Participant 1	Male	24 years	2nd grade	20	Yes
Participant 2	Female	20 years	2nd grade	17	No
Participant 3	Male	8 years	1st grade	17	Yes
Participant 4	Female	23 years	3rd grade	16	No
Participant 5	Female	22 years	2nd grade	16	No
Participant 6	Female	15 years	4th grade	18	No

Data Collection Tools

"Semi-structured interview form" was used as data collection tool. The questions in the interview form consist of 4 open-ended questions prepared by the researchers. The purpose of these questions is bringing out the teachers' thoughts about the duration, content, competence of the instructor, the suitability of the environment, the adequacy of the applications, find out whether they have included such applications in their own classes after the training, the applicability of the robotic coding applications in the classroom environment and what should be done to ensure the implementation of these applications in the classroom environment. In order to ensure the construct validity of the prepared questions, expert opinions (a field expert in science education, two field experts who have conducted studies on robotic coding and a measurement and evaluation expert) were sought. On the basis of the feedbacks received from the experts, some corrections were made and final form of the interview form was given. In this context, six months after the end of the training, 30-minute semi-structured interviews were conducted with each of the classroom teachers. The interviews were tape-recorded. The questions in the interview form are given below; (1) What are the opinions of the teachers participating in in-service robotic coding training about the training provided? (2) What are the reasons for teachers participating in in-service robotics coding training to include or not to include such practices in their classrooms? (3) What do teachers attending in-service robotic coding training think about the applicability of such practices in the classroom environment? (4) What do the teachers who participated in in-service robotic coding training think about what needs to be done in order to further implement such practices in the classroom environment?

Analyzing of Data

The responses of the participants were analyzed by content analysis method. Content analysis can be defined as an analysis technique to determine and make sense of the main consistencies and meanings by taking qualitative material with a certain volume. The basic meanings found through content analysis can be called general patterns or themes (Patton, 2014). In this respect, the data obtained from the interviews were analyzed and transferred to NVivo 12 and classified under certain categories. Similar data were brought together in the framework of certain concepts and themes, and models were created.

Some operations were performed in relation to reliability and validity of the data collected in the current study on the basis of the concepts of credibility, transferability, dependability and confirmability. Yildirim and Simsek (2018) emphasize that in the qualitative research, the concepts of credibility, transferability, dependability and confirmability are important in establishing the validity and reliability, and that necessary actions and explanations regarding these situations should be made. In this direction, expert analysis and participant confirmation methods were used to ensure the credibility of the research. In the expert examination method, two experts who have general knowledge about robotic coding training and specialized in qualitative research methods examined this research from its different dimensions and made various suggestions. In this expert review, the experts made suggestions about the design of the research, data collection and analysis, reaching the results and interpretation stages. Within the context of the participant confirmation method, the data obtained from the study were analyzed and the findings, results and evaluations were sent to the participants in a report. Participants gave feedback on whether their views were correctly reflected in this report. In the current study, the detailed description method was applied to enhance the transferability of the results of the research. Within the context of the description method, direct quotations were made from the statements of the teachers. In the current study, consistency analysis and confirmation analysis method was used within the concept of "dependability" regarding the reliability of qualitative data. In line with these methods, an expert in qualitative research looked at the research as an outsider and conducted an examination of the consistency of the researchers in the process of the construction of data collection tools, data collection, analysis and coding. The required arrangements were made for these analyses by the researchers.

Findings

In this study, the opinions of primary school teachers who participated in in-service training about robotic coding applications were examined for each research question by identifying sub-themes and codes related to these sub-themes. In addition, direct quotations were included to reflect the responses of the participants in a striking manner.

Teachers' opinions about in-service robotics coding education

Within the scope of the study, themes about robotic coding training and related to this theme, sub-themes of duration of training, content, competence of the instructor, suitability of the training environment and adequacy of the applications were determined. In line with these sub-themes, participants' opinions were examined and related codes were formed. In this context, according to the data obtained from the participants' views, the model in Figure 1 was created for the theme, sub-theme and related codes of the first research question.

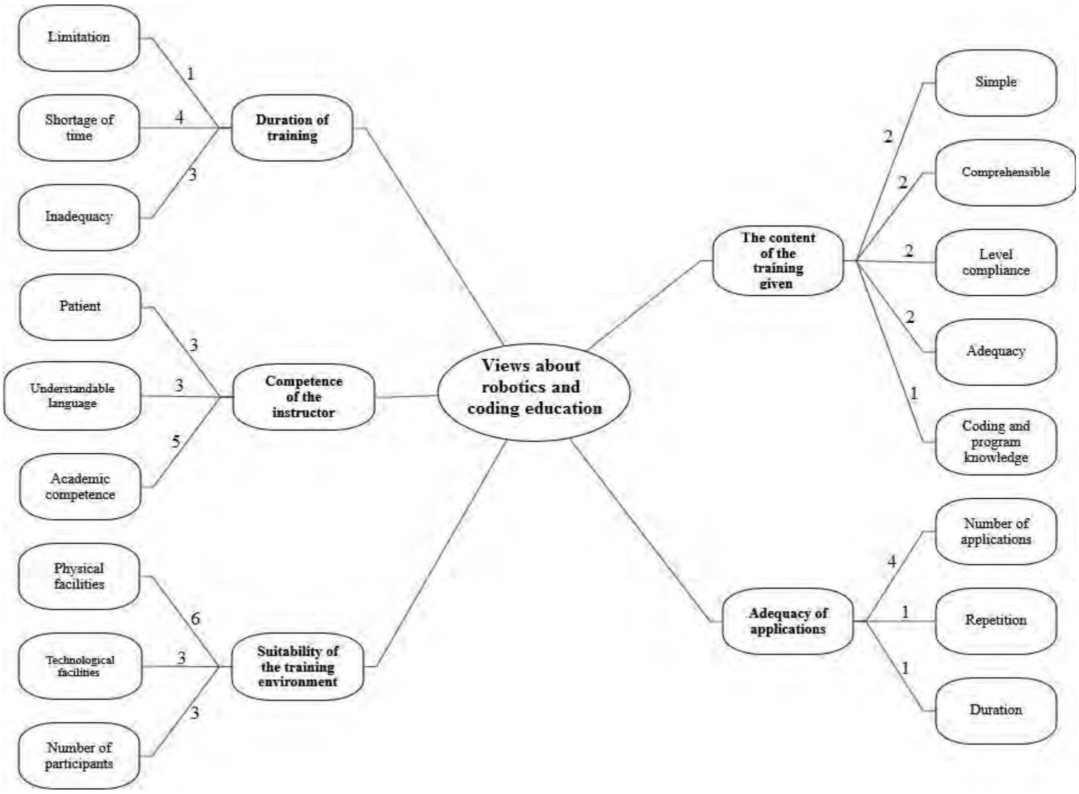

Figure 1. Model for views on robotic coding training

When the model in Figure 1 is examined, we see that various codes have been formed according to the sub-themes relating to the views of primary school teachers about robotic coding training and we see the number of participants who emphasized those codes. In this context, the participants stated that the duration of the training was limited (n = 1), insufficient (n = 3), and the duration was short (n = 4). The participants emphasized simple (n = 2), comprehensible (n = 2), level-appropriate (n = 2), adequate (n = 2) and comprehensive coding and program knowledge (n = 1) codes for the sub-theme of the content of the training. In addition, participants mentioned codes such as number of applications (n = 4), gaining experience by applying them repeatedly (n = 1) and time allocated for application (n = 1) about the sub-theme of adequacy of applications performed in robotic coding training. Moreover, participants gave statements about the physical facilities (n = 6), technological facilities (n = 3) and number of participants (n = 3) codes for the sub-theme of the suitability of the environment in which this training was given. Finally, the participants stated that the instructor was patient (n = 3), using comprehensible language (n = 3) and academically competent (n = 5) for the sub-theme of the instructor's competence.

In this context, the codes created for the answers of primary school teachers about the robotic coding training given in-service training in line with sub-themes are examined in detail below.

When the responses to the sub-theme of the duration of the training given were examined;

Three of the six teachers who participated in the training emphasized that there wasn't enough time for the training and therefore the matter could not be fully understood. In this regard, Participant 5 (P5) stated that the training was inadequate in terms of time by saying, "*For a better comprehension of the training, we need it to be longer*."

When the responses to the sub-theme of the content of the training were examined;

The teachers who participated in the training stated that the content of the training was simple, understandable and appropriate for their level. However, the participants stated that the training was not comprehensive enough for them to be able to fully develop themselves. On this issue, P2 stated that the training should cover a broader range and said, "*The training should have been more practical and should have included detailed instructions*."

When the responses to the sub-theme of competence of the instructor were examined;

The three teachers who participated in the training stated that the instructor used understandable language to inform them about robotic coding and always showed patience to them even when they had difficulty understanding the subject matter and structuring it in their minds and thus failed in application. One participant (P3) said, "*The instructor was very good in terms of communication. She was friendly and patient and had a desire to teach. She was competent in her field.*," and supported the general consensus.

When the responses to the sub-theme of suitability of the training environment were examined;

The six teachers who participated in the training stated that the physical environment of the educational environment such as table, chair and classroom size was suitable for conducting both theoretical and practical instruction about robotic coding. However, three of the participants stated that the training environment was not suitable in terms of internet connection, smart board and sufficient number of computers and put emphasis on technological opportunities. On this issue, P6 stated that, "*Internet connection could have been better in the educational environment. Training could have been carried out with well-equipped computers with internet connection*."

When the responses regarding the sub-theme of the adequacy of applications were examined;

Four of the teachers who participated in the training stated that there was a limited number of applications regarding robotic coding. The participants stated that the low number of applications was due to lack of time, the crowded groups and the low number of application examples. In addition, one of the participants emphasized that the activities related to robotic coding in the training included only one application, that it was not repeated and that it was done in a short time. Regarding these issues, the statement made by P1 seems to support that finding; "*The number of applications about coding and robotic applications needed to be increased and the application needed to be repeated frequently.*

We should have practiced on our own to gain experience, but it was only limited to the level of teaching."

Classroom applications after in-service robotics coding training

Within the scope of the study, the theme of classroom practices after training and the sub-themes of economic, self-sufficiency, physical facilities and student qualification related to this theme were determined. In line with these sub-themes, participants' opinions were examined and related codes were formed. In this context, according to the data obtained from the participants' views, the model in Figure 2 was created for the theme, sub-theme and related codes of the second research question.

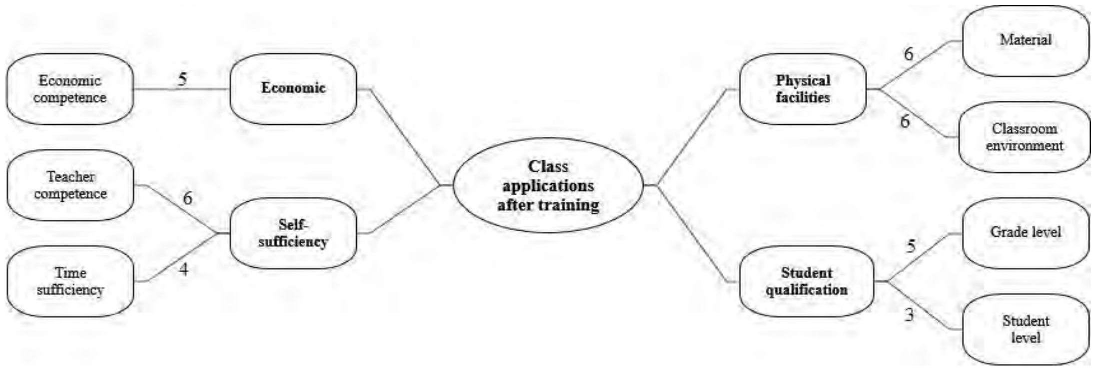

Figure 2. Model for post-training classroom applications

When the model in Figure 2 is examined, we see that various codes have been formed according to the sub-themes relating to the views of primary school teachers about post-training classroom applications and we see the number of participants who emphasized those codes. In this context, the participants mentioned the importance of economic competence (n = 5) related to the economic sub-theme in the implementation of the activity related to robotic coding in post-training classroom applications. The participants emphasized teacher competence (n = 6) and time sufficiency (n = 4) regarding their own competence sub-theme in doing such applications. In addition, the participants made statements about materials (n = 6) and classroom environment (n = 6) in the sub-theme of physical facilities. Finally, the participants emphasized the importance of grade level (n = 5) and student level (n = 3) in student competence sub-theme related to the implementation of robotic coding activities.

In this context, the codes created according to the answers of primary school teachers about the post-training classroom applications in line with sub-themes are examined in detail below.

When the responses to the economic sub-theme were examined;

It was observed that five of the six teachers participating in the training stated that robotic sets could not be procured by each student due to economic reasons and that the applications could not be performed due to the low socioeconomic status of the students. The statement made by P4, "*Economically, not all of our students may be able to obtain those sets,*" supports that finding.

When the responses regarding self-sufficiency sub-theme were examined;

It was found that four of the teachers who participated in the training performed such practices in their classrooms after the training and included robotic coding practices in their classes. In addition, these participants stated that they carried out example practices based on simple activities at a basic level. Only one participant (P6) stated that he/she considered himself/herself to be competent to carry out activities for robotic coding applications in the classroom environment. Three of the participants (P1, P2 and P5) stated that they considered themselves partially competent to perform simple robotic coding activities. However, two of the participants (P3 and P4) emphasized that they could not perform such practices in their own classrooms because they did not consider themselves and their education to be adequate. P6 said, "*Financial support is required for the implementation of such practices. I was able to buy only two sets. It would be better if there was a practice room at school, I feel competent enough to teach such classes,"* on the issue of self-sufficiency. In addition, four of the participants stated that time is important in the implementation of robotic coding applications in the classroom environment because such applications take a long time. On this subject, P3 said, "*It takes a long time to do robotic coding activities in my classroom. Because it is not easy for students to do coding and to set up robotic devices,*" and pointed out that doing such applications in the classroom environment takes up a lot of time.

When the responses to the physical facilities sub-theme were examined;

Six of the teachers who participated in the training stated that the lack of the necessary sets, computer laboratories and the physical facilities of the school for the implementation of robotic coding constitute an obstacle to the realization of such applications. In his/her statement, P2 emphasized the necessity for materials, "*Even if we want to do robotic coding applications in the classroom, we do not have enough robotic materials and we do not have a computer laboratory.*" The participants stated that the classes were not suitable for such applications in terms of layout of the desks, technological equipment and class size.

When the responses regarding student competency were examined;

Five of the teachers who participated in the training stated that the grade level is important in the implementation of robotic coding applications and that it can be given to students starting from the fifth grade of primary school. Participants P3, P4 and P5 emphasized the importance of grade level by saying, "*Robotic coding applications should be done starting from the fifth grade. However, as of the third grade, the training has to be given with the purpose of introducing them at a basic level.*" In addition, one of the participants (P1) stated that robotic coding applications could be done at the second grade of primary school. P1 said in his/her statement, "*When we consider the fact that students* *encounter reading and writing in the first grade for the first time and that it's all very challenging, this subject may not be suitable for them. But they will be able to do such activities in the second grade.* " In addition, three of the participants stated that besides the grade level, the student level was also important in the implementation of robotic coding applications. In other words, the participants emphasized that the cognitive, affective and psycho-motor levels of the students regarding coding and robotic mechanisms should be adequate. On this subject P6 said, "*Some students in my class can do this kind of practice, but some cannot. When I asked the students who couldn't why they couldn't, they said that they didn't have any information on the subject matter, that they had seen it for the first time and that they had difficulty connecting the robotic pins.*", and emphasized that the students' cognitive, affective and psycho-motor levels should be at a certain level.

Applicability of robotics coding activities in classroom environment

Within the scope of the study, the theme of applicability of robotic coding activities in the classroom environment and the sub-themes of gain, curriculum intensity, cognitive level of students and psycho-motor level of students were determined. In line with these sub-themes, participants' opinions were examined and related codes were formed. In this context, according to the data obtained from the participants' views, the model in Figure 3 was created for the theme, sub-theme and related codes of the third research question.

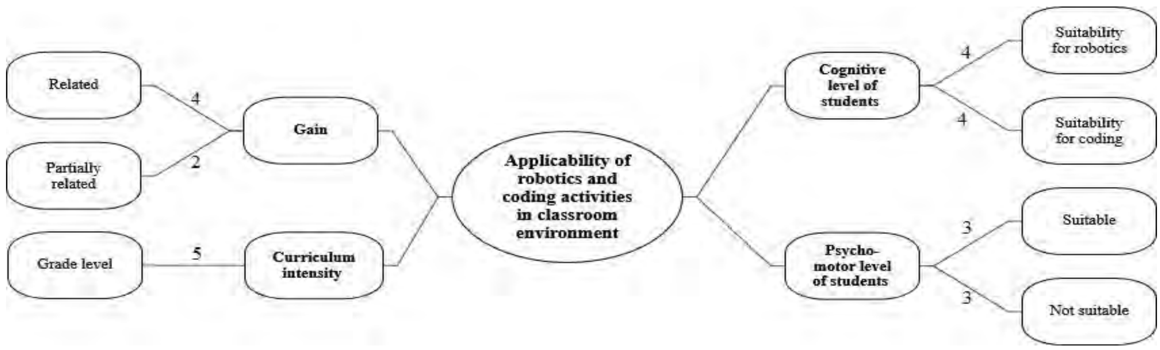

Figure 3. Model for the applicability of robotic coding activities in the classroom

When the model in Figure 3 is examined, we see that various codes have been formed according to the sub-themes relating to the views of primary school teachers about the applicability of robotic coding activities in the classroom and we see the number of participants who emphasized those codes. In this context, the participants made statements regarding the gains sub-theme about the grade level gains as being related to such practices (n = 4) or being partially related (n = 2). In addition, the participants mentioned the importance of the grade level (n = 5) regarding the curriculum intensity sub-theme in the implementation of such applications. In the sub-theme of the students' cognitive level, it was found that the participants made a distinction between suitability for robotics (n = 4) and suitability for coding (n = 4). Finally, it was observed that the participants made appropriate (n = 3) and not appropriate (n = 3) statements in the sub-theme of psycho-motor level of the students.

In this context, the codes created for primary school teachers' responses to the sub-themes about the applicability of robotic coding activities in the classroom environment are examined in detail below.

When responses to the sub-theme of gain were examined;

Six of the teachers who participated in the training stated that the gains of science and life science courses related to the applicability of the activities related to robotic coding and their relationship with the gains in the curriculum were more appropriate for such applications. The participants stated that robotic coding activities could be done on the subject of electrical circuits, traffic lights, direction and force. Two of the participants (P2 and P4) emphasized that such applications can be done partially in mathematics gains as well. P2 said, "*We can use them in mathematics lessons for teaching four operations, addition, subtraction or rhythmic counting or geometric shapes.*" And P4 said, "*When we look at our gains, we see that we can use these applications in many gains in the units. For example, I think we can do applications related to the gains of electricity and even many of the science subjects,*" and stated that the applications of robotic coding are related to the gains in science and mathematics courses.

When the responses to the curriculum intensity sub-theme were examined;

Five of the teachers who participated in the training expressed their opinions according to each grade level about whether such activities could be included in the classes according to the intensity of the content in the courses. In this context, the participants stated that since the first grade students did not yet learn to read and write, and because the curriculum was very loaded in the fourth grade and teachers were anxious to cover all the subjects, these levels were not suitable for robotic coding practices. However, the participants stated that second and third grade students could be given coding skills. About this P3 said, "*I want to teach my students robotic coding but they've only just learnt to read and write. So I plan to give them this training in second grade.*" And P6 said, "*While teaching robotic coding to my students, I think about how I'll be able to cover other curriculum subjects,*" and emphasized the importance of grade level and curriculum intensity in the implementation of robotic coding activities.

When the responses to the sub-theme of the cognitive level of the students were examined;

Teachers who participated in the training evaluated students' cognitive suitability for coding and for robotics in the application of robotic coding activities. Four of the participants stated that elementary school children are intertwined with technology and can do these things easily without difficulty. However, participants emphasized the necessity of the training for coding to begin in the second grade and the training for robotics to begin in the third grade. P3 said on the issue, "*The fact that very small materials are used in robotics activities may cause problems in the first and second* *grades. Because we sometimes have problems even with holding scissors in the first and second grades.*"

When the responses regarding the students' psycho-motor level sub-theme were examined;

The teachers who participated in the training emphasized the importance of psycho-motor skills in the easy implementation of robotic coding activities by the students. Three of the participants stated that fourth grade students could easily handle the connections of the pins and sensors to the arduino microprocessor in robotic devices. However, three of the participants stated that students could not be successful in these applications due to lack of development of fine muscle movements. P2 said, "*At the developmental level, it's only possible to deal with small, detailed works, to bring them together, to form a circuit after the fourth and fifth grades. Drawing a straight line in the first and second grade can be a problem, even in the third grade,*" and emphasized that students' psycho-motor levels are important in robotic coding applications.

Expectations for robotics coding applications

Within the scope of the study, the theme of expectations for further implementation of robotic coding applications in the classroom environment and related to this theme, physical opportunities, education and training activities and family support sub-themes were determined. In line with these sub-themes, participants' opinions were examined and related codes were formed. In this context, according to the data obtained from the participants' views, the model in Figure 4 was created for the theme, sub-theme and related codes of the fourth research question.

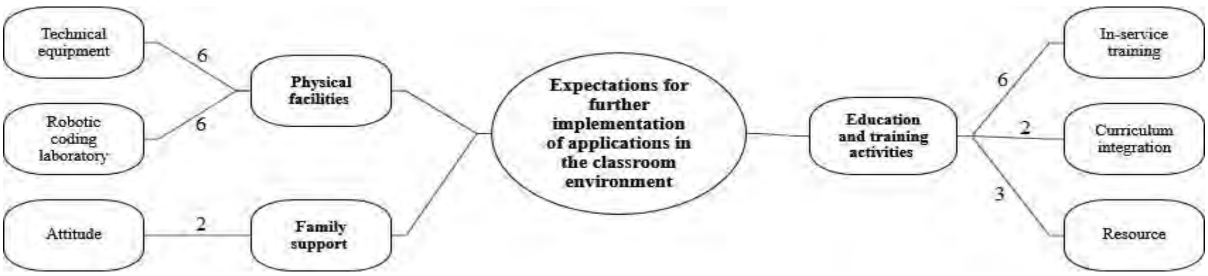

Figure 4. Model for expectations for further implementation of robotic coding applications in the classroom environment

When the model in Figure 4 is examined, we see that various codes have been formed according to the sub-themes relating to the views of primary school teachers about their expectations for further implementation of robotic coding applications in the classroom environment and we see the number of participants who emphasized those codes. In this context, the participants made explanations about the technical equipment (n = 6) and robotic coding laboratory (n = 6) related to the physical possibilities sub-theme. In addition, the participants expressed their opinions about in-service training (n = 6), curriculum integration (n = 2) and resources (n = 3) in the sub-theme of educational and training activities. Finally, the participants mentioned the importance of family attitude (n = 2) in the sub-theme of family support in the implementation of robotic coding activities in the classroom environment.

In this context, the codes created for primary school teachers' responses to the sub-themes about the applicability of robotic coding activities in the classroom environment in relation to further implementation of robotic coding activities are examined in detail below.

When the responses to the physical facilities sub-theme were examined;

Six of the teachers who participated in the training stated that there was insufficient physical means to implement robotic coding in schools and that materials should be provided for effective implementation. P2 said, "*In order to integrate these applications into the courses, it is necessary to obtain the required technical materials and establish the required laboratory environment. In fact, parents should be encouraged to buy this material.*" And P6 said, "*I bought two sets of robotic coding applications myself and did activities using my own computer. I saw that my students were very happy with the outcome,*" emphasizing the importance of technical equipment and laboratory supplies in such applications.

When the responses to the sub-theme of family support were examined;

Two of the six teachers who participated in the training expressed the importance of family support in the implementation of robotic coding practices in the classroom. One of the participants stated that they received support from parents for the provision of robotic coding materials and that the applications could be carried out at a basic level in the classroom environment. About this, P1 said, "*Parents support me in all matters for the education of students. They provide financial support by demonstrating positive attitudes in terms of robotic coding.*"

When the responses to the sub-theme of education and training activities are examined;

The six teachers who participated in the training stated that the in-service training on robotic coding was not sufficient and that training opportunities like that should be available more frequently. In addition, two of the participants stated that it is important that the applications related to robotic coding be taught to them in the courses integrated to the classes. P3 said on the issue; "*During in-service trainings, it is best to directly teach which robotic coding activity can be used in which class. Because even though we learn robotic coding in training, we don't know which class and gain we will use it in.*" Three of the teachers who participated in the training stated that they needed a resource manual at each grade level in order to remember or learn more about robotic coding. P5 said, "*There should be a manual on the basis of classes related to robotic coding. With such a guide, we can do effective applications in our classes,*" and emphasized the need for a reference book on robotic coding applications.

Discussion and Conclusion

In this research, opinions of primary school teachers who have received in-service training on robotic coding applications were examined. Within the scope of this training, the importance of robotic coding, computational thinking, algorithmic operations, teaching of algorithms with games, introduction to coding environments, introduction to code.org and scratch programs, giving general information about arduino and its basic components, various sensor connections and sample applications were covered. Six months after the in-service training, interviews were held with the primary school teachers and the following results were reached as a result of the interviews.

As the first result, in response to the first question of the study, primary school teachers who received in-service training for robotic coding applications stated that the duration of training was insufficient and limited, and that the duration of training should be longer in order to pass from cognitive comprehension level to application level by doing individual application examples. As the second result, primary school teachers stated that the content of the education was simple, comprehensible, appropriate for their own competency, and contained sufficient coding information. However, teachers emphasized that the training in developing robotic coding in general did not have a comprehensive content and included superficial and basic application examples. In addition, the primary school teachers stated that the examples given in the scope of the training were limited in number, that the applications were performed in a very short period of time and were not repeated for clarity. In this regard, Bers and Portsmore (2005) emphasized that one-term applications in teachers' in-service training would be insufficient for them to acquire the knowledge and skills to successfully integrate robotic technology into classes. In this direction, during in-service trainings and in the teaching of technology applications, it is necessary to carry out activities related to various sample applications within sufficient time (Flanagan & Jacobsen, 2003). As the third result, the primary school teachers stated that the instructor who gave the training had sufficient academic knowledge and competence and that he/she accompanied them as a good guide for learning related subjects. The role of educators who act as guides and are leading, especially in keeping up with constantly developing technology or producing new technologies, is of great importance. Educators are faced with the potential of students who use technology very well in line with the developing and renewed education approach (Reiner, 2009). In this context, educators should increase their potential to use technology in their classes. And finally, with regards to the first question of the research, primary school teachers emphasized that the environment in which education is provided should have better technical facilities in terms of internet connection, computers and robotic coding tools. When we consider the fact that one of the educational technologies is robotic coding applications, we see that it is necessary to equip the classroom environment with robotic technology tools for effective teaching (Alimisis & Kynigos, 2009).

Various results were obtained regarding whether the primary school teachers who received in-service training about robotic coding applications included such applications in their own classes after the training or not and the reasons for their preferred proceedings. Regarding the first result of the second question, it was found that primary school teachers mostly did not use robotic coding practices in their own classes. Teachers explained this situation by stating that their schools could not afford robotic coding tools and technological equipment such as computers. In studies conducted on this situation, teachers stated that there was an inadequacy in accessing auxiliary materials related to robotic technologies in schools, providing technical and educational support, and providing relevant tools (Cinar, 2017). As a second reason, although the in-service training made them feel theoretically competent in the teaching of this subject, primary school teachers stated that they thought themselves to be inadequate in practice. In this regard, Cinar (2017) stated that teachers felt lack of knowledge and self-confidence in the use of robotic technologies in classroom applications. As the last reason, primary school teachers stated that the grade level is important in the implementation of robotic coding applications and that it can be given to students starting from the third grade of primary school. In studies carried out in this context, it was emphasized that activities and practices related to robotic coding should be given in schools starting from an early age (Elkin, Sullivan, & Bers, 2016; Sullivan & Bers, 2016). Barker and Ansorge (2007) carried out robot-supported trainings with third grade students in primary school and stated that students could successfully achieve the objectives given in these trainings. Berland and Wilensky (2015) also emphasized the necessity for students to experience teaching processes related to coding education and the use of robotic kits.

It was found out that primary school teachers make evaluations in terms of curriculum and students regarding the applicability of robotic coding applications in the classroom environment. As the first result of the third question of the research, primary school teachers stated that the gains of the courses such as Science, Mathematics, Turkish and Life Science are related to robotic coding applications and that such applications could be given to the students in relation to these gains. It was found in the literature that robotic coding applications were connected with gains in mathematics (Wei, Hung, Lee, & Chen, 2011), science subjects such as force and motion, matter and heat, electricity, light and sound (Hacker, 2003; Grubbs, 2013) and were taught accordingly. As the second result, primary school teachers emphasized that the content of coding knowledge and applications should be given to the students from the second year of primary school, and the content of robotic knowledge and applications should be given to the students beginning from the third year of primary school. As a reason for this situation, the teachers first stated that the students in the first grade of the primary school start receiving reading and writing education from scratch and that it was necessary to give the coding training before the robotics knowledge. As a second reason, teachers stated that second grade students could fail in activities requiring fine muscle movement such as the connection of pins and sensors to the arduino microprocessor in robotic devices as psycho-motor skills. In studies carried out on this issue, it was stated that it is important for students to learn coding logic even if they cannot do coding at an early age (Baz, 2018; Demirer & Sak, 2016; Karabak & Gunes, 2013). In addition, Elkin, Sullivan and Bers (2016), Sullivan and Bers, (2016) emphasize that basic coding training should be given starting from the pre-school period. Thus, the first step will be taken towards developing the 21st century skills such as exchange of ideas, creative thinking, collaborative work and critical thinking as well as students' intuition and visual thoughts. Strawhacker and Bers (2015), on the other hand, stated that in block-based programs related to coding, young students successfully accomplished most of the tasks including algorithms and coding concepts. However, it is recommended to use ready-made robotic sets such as Lego Mindstorms, Bee-bot, Cubelets and Ozobot at an early age and primary school level. It is stated that the robotic setups created using Arduino microprocessor should generally be used in the education of students who are in Piaget's concrete operations period. (Beug, 2012).

As the first result of the fourth question, it was determined that primary school teachers stated various opinions about further implementation of robotic coding applications in the classroom environment. In this context, teachers stated that schools should have physical and technological equipment and students should have a robotic coding set and a computer to create their codes in order to teach such applications to students in a learning environment in various classes. Similar to this situation, in their study, Saglik and Aldan Karademir (2019) stated that there are deficiencies in the physical and technological equipment of the schools for the classes related to the use of technology, as stated by teachers. This lack of equipment prevents effective teaching of technology. As the second result, primary school teachers stated that it is important to include in the in-service trainings knowledge about how to integrate robotic coding practices into the classes and practice activities. Similarly, Bers and Portsmore (2005) emphasized that in-service training should include practices on how to integrate robotic technology into classes. As the third result, primary school teachers emphasized that in order to enrich the education and training activities, this issue should be integrated into the curriculum, and resource books showing the practice activities should be prepared and the families' financial and moral support should be obtained. In studies conducted on this issue, teachers stated that they needed relevant materials, guidance books, and school and family support in order to provide effective robotic coding practices in their classes (Cinar, 2017; Khanlari, 2015).

Suggestions

In line with the results of this research, it is suggested that more time should be devoted to the applications related to robotic coding provided to teachers during in-service training, and that activities related to how to integrate them into classroom teaching practices should be organized. In addition, resource books should be prepared in order for teachers to have guidance and be able to implement robotic coding in their own classes. Schools should be well-equipped in terms of physical, technological and technical equipment (computer laboratory, robotic tools and educational robotic sets, coding programs) for robotic coding applications. Finally, it is suggested that elective courses for coding training and after that for robotic training should be included in the curriculum on the primary school level.

References

Adams Becker, S., Freeman, A., Giesinger Hall, C., Cummins, M., & Yuhnke, B. (2016). *NMC/CoSN horizon report: 2016 K-12 edition*. Austin, Texas: The New Media Consortium.

Alimisis, D., & Kynigos, C. (2009). Constructionism and robotics in education. D. Alimisis (Ed.), T*eacher education on robotics-enhanced constructivist pedagogical methods.* (pp. 11-26). ASPETE: Athens.

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

Baser, M., & Ozden, M.Y. (2015). Developing attitude scale toward computer programming. *International Journal of Social Science, 6*(6), 199-215.

Baz, F.Ç. (2018). A Comparative Analysis of Coding Software for Children. *Current Research in Education*, *4*(1), 36-47.

Benitti, F.B.V. (2012). Exploring the educational potential of robotics in schools: A systematic review. *Computers & Education, 58(3*), 978-988.

Berland, M., & Wilensky, U. (2015). Comparing virtual and physical robotics environments for supporting complex systems and computational thinking. *Journal of Science Education and Technology*, *24*(5), 628-647.

Bers, M.U., & Portsmore, M. (2005). Teaching partnerships: Early childhood and engineering students teaching math and science through robotics. *Journal of Science Education and Technology, 14*(1), 59-73.

Beug, A. (2012). *Teaching introductory programming concepts: A comparison of scratch and arduino.* Unpublished master thesis. California Polytechnic State University, San Luis Obispo.

Bybee, R.W. (2010). What is STEM education? *Science*, *329*(5995), 996-996.

Cetin, I., & Toluk Ucar, Z. (2017). Bilgi işlemsel düşünme tanımı ve kapsamı. Y. Gülbahar (Ed.), *Bilgi İşlemsel Düşünmeden Programlamaya*, (pp.41-74). Pegem Akademi: Ankara.

Cinar, S. (2017, April). *Fen bilgisi öğretmen adaylarının öğretim materyali olarak robotik teknoloji kullanımı ile ilgili düşünceleri.* Paper presented at the VIII. International Congress on Research on Education, Çanakkale.

Costa, M.F., & Fernandes, J.F. (2005 July). Robots at school. The eurobotice project. *Proceedings of the 2nd International Conference Hands-on Science: Science in a Changing Education*, (pp.219-221), Rethymno, Greece.

Creswell, J.W. (2013). *Nitel araştırma yöntemleri: Beş yaklaşıma göre nitel araştırma ve araştırma deseni (3. Baskı)*, M. Bütün & S.B. Demir (Çev. Ed.), Siyasal Kitabevi: Ankara.

Czerkawski, B.C., & Lyman, E.W. (2015). Exploring issues about computational thinking in higher education. *TechTrends*, *59*(2), 57-65.

Demirer, V., & Sak, N. (2016). Programming education and new approaches around the world and in Turkey. *Journal of Theory and Practise in Education, 12*(3), 521-546.

Elkin, M., Sullivan, A., & Bers, M.U. (2016). Programming with the KIBO robotics kit in preschool classrooms. *Computers in the Schools, 33(3*), 169-186

Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration*, *41*(2), 124-142.

Gomes, A., & Mendes, A.J. (2007 September). Learning to program-difficulties and solutions. *1st International Conference on Engineering Education*, University of Coimbra, Portugal.

Grubbs, M. (2013). Robotics intrigue middle school students and build STEM skills. *Technology and Engineering Teacher, 72*(6), 12-16.

Gura, M. (2012). Lego robotics: STEM sport of the mind. *Learning and Leading with Technology, 40(1*), 12-16.

Hacker, L. (2003). *Robotics in education: ROBOLAB and robotic technology as tools for learning science and engineering.* Unpublished senior thesis. Department of Child Development, Tufts University, Medford.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMC horizon report: 2015 higher education edition*. Austin, Texas: The New Media Consortium.

Karabak, D., & Gunes, A. (2013). Curriculum proposal for first class secondary school students in the field of software development. *Journal of Research in Education and Teaching, 2*(3), 163-169.

Karagiorgi, Y., & Symeou, L. (2005). Translating constructivism into instructional design: Potential and limitations. *Journal of Educational Technology & Society, 8*(1), 17-27.

Khanlari, A. (2015). Teachers' perceptions of the benefits and the challenges of integrating educational robots into primary/elementary curricula. *European Journal of Engineering Education, 41*(3), 320-330.

Kim, C.M., Yuan, J., Kim, D., Doshi, P., Thai, C.N., Hill, R.B., & Melias, E. (2017). Studying the usability of an intervention to promote teachers' use of robotics in STEM education, *Journal of Educational Computing Research*, *56*(8), 1179-1212.

Lau, W.W., & Yuen, A.H. (2011). Modelling programming performance: Beyond the influence of learner characteristics. *Computers & Education, 57*(1), 1202-1213.

Ministry Education [MoNE], (2018). F*en bilimleri dersi öğretim programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar).* Milli Eğitim Yayınları: Ankara.

Numanoglu, M., & Keser, H. (2017). Robot usage in programming teaching-Mbot example. *Bartin University Journal of Faculty of Education*, *6*(2), 497-515.

Patton, M.Q. (2014). *Nitel araştırma ve değerlendirme yöntemleri*, M. Bütün & S.B. Demir (Çev. Ed.), Pegem Akademi: Ankara.

Petre, M., & Price, B. (2004). Using robotics to motivate 'back door' learning. *Education and Information Technologies*, *9*(2), 147-158.

Prensky, M. (2010). *Teaching digital natives: Partnering for real learning.* Thousand Oaks, California: Corvin.

Psycharis, S., & Kallia, M. (2017). The effects of computer programming on high school students' reasoning skills and mathematical self-efficacy and problem solving. *Instructional Science, 45*(5), 583-602.

Reiner, M. (2009). Sensory cues, visualization and physics learning. *International Journal of Science Education*, *31*(3), 343-364.

Roblyer, M., & Edwards, J. (2005). *Integrating educational technology into teaching* (4th ed.). Upper Saddler River, NJ: Prentice-Hall.

Saglık, M.A., & Karademir, Ç.A. (2019). Evaluation of technology and design course 2018 curriculum according to teachers' views. *Journal of Qualitative Research in Education, 7(1),* 302-319.

Sahin, S.K. (2018). *Kodlama Serüveni: Scratch ve mBlock ile Arduino [Coding Adventure: Arduino with Scratch and mBlock]*. İstanbul: Abaküs Yayınevi.

Strawhacker, A., & Bers, M.U. (2015). "I want my robot to look for food": Comparing kindergartner's programming comprehension using tangible, graphic, and hybrid user interfaces. *International Journal of Technology and Design Education, 25(3)*, 293-319.

Sullivan, A., & Bers, M.U. (2016). Robotics in the early childhood classroom: Learning outcomes from an 8-week robotics curriculum in pre-kindergarten through second grade. *International Journal of Technology and Design Education, 26(1*), 3-20.

Sullivan, F.R. (2017). The creative nature of robotics activity: Design and problem solving. M.S. Khine (Ed.), *Robotics in STEM Education: Redesigning the Learning Experience.* (pp.213-230). Springer International Publishing.

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 & Education*, *59*(2), 412–422.

Wei, C.W., Hung, I.C., Lee L., & Chen, N.S. (2011). A joyful classroom learning system with robot learning companion for children to learn mathematics multiplication. *Turkish Online Journal of Educational Technology, 10*(2), 11-23.

Williams, D.C., Ma, Y., Prejean, L., Ford, M.J., & Lai, G. (2007). Acquisition of physics content knowledge and scientific inquiry skills in a robotics summer camp. *Journal of Research on Technology in Education*, *40*(2), 201-216.

Yildirim, A. & Simsek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık: Ankara.

Zengin, M. (2016). Opinions on the use of robotic systems in the interdisciplinary education and training of primary, secondary and high school students. *Journal of Gifted Education Research, 4*(2), 48-70.