The Effects of Coding, Robotics, 3d Design and Game Design Education on 21st Century Skills of Primary School Students

AYLİN PAKMAN
ICT Teacher / Bahcesehir University, Institute of Educational Sciences, Educational Technology, Istanbul, Turkey
ORCID ID: 0000-0001-6961-5669
aylinpakman@gmail.com

NABİ PAKMAN
ICT Teacher / Bahcesehir University, Institute of Educational Sciences, Educational Technology, Istanbul, Turkey
ORCID ID: 0000-0001-8820-0602
nabipakman@gmail.com

ASSOC. PROF. YAVUZ SAMUR
Head of Department - Computer Education and Instructional Technologies / Bahcesehir University, Institute of Educational Sciences, Educational Technology, Istanbul, Turkey
ORCID ID: 0000-0003-4269-7099
yavuz.samur@es.bau.edu.tr

ABSTRACT
This study is important because it deals with 21st century skills and current techniques in the field of educational technology and the studies in this field are limited in the literature. The purpose of this study is to determine the effects of coding, robotics, 3D design and game design education on problem solving and reflective thinking skills of 8/10-year-old students and on problem solving and metacognitive awareness levels of 11/14-year-old students. In this study, a quasi-experimental research model with a single group pre-test / post-test pattern, which is considered one of the quantitative research methods, was used. The research was carried out with a total of 36 participants, 15 in the 8-10 age group and 21 in the 11-14 age group, enrolled in a course organized by a higher education institution. The duration of the training is 8 weeks, 2 hours per week. The data of this study were collected through a questionnaire. The questionnaires used consist of 2 parts: Problem Solving Inventory and Reflective Thinking Skills Scale for Problem Solving for Primary Education Level Children aged 8-10, and Problem Solving Inventory and Metacognitive Awareness Inventory for Children - Form B for 11/14-year-old students. As a result of all these applications, it was observed that there was an increase in students' problem solving and metacognitive awareness skills, but it was not statistically significant. It was observed that there was a statistically significant increase in the reflective thinking skills of 8/10-year-old students.
KEYWORDS: Coding, Robotics, Game Design, 21st Century Skills, Elementary Education

INTRODUCTION
The development of science and technology in the 21st century, the information age, has also caused changes in the social structure. In order for the new generation not to lag behind the times, it is expected that they are social, inquisitive, have high reasoning power and have a command of technology (Yükseltürk and Altıok, 2016b). For this reason, alternative methods have increased and education programs have been updated. While coding education in our country was given only in vocational high schools and some undergraduate engineering departments until recently, Ministry of National Education, MEB, made Information Technologies course compulsory for 5th and 6th grades as of 2013. The curriculum included programming, original product development and problem solving (Yükseltürk, Altıok, & Üçgül, 2016). It is seen that the units of the Computer Science course consist of society, ethics, security, problem solving and algorithms, web-based programming, robot programming, mobile programming. With the introduction of block-based programming education into the curriculum, the importance of such training has increased (Altun and Kasalak, 2018). Karataş (2021), in his survey model study, examined the studies of the countries where the coding course was included in the curriculum and concluded that the Information Technologies and Software course should be compulsory in the 7th and 8th grades.

Skills such as digital citizenship, learning to learn, structuring knowledge, international cooperation and communication, innovative and creative design, computational thinking are the achievements of the Computer Science course (MEB, 2018a, 2018b). Considering these learning outcomes, the effect of coding, robotics, 3D design and game design trainings given to primary school students aged 8-14, who are the learners of this study, on 21st century skills such as problem solving, reflective thinking and metacognitive awareness has been a matter of curiosity.

Coding, robotics, 3D design and game design concepts have recently become a new focus for researchers with their rapid spread in the world of education. However, the number of studies on these areas is not sufficient. When the studies in the literature are examined, it is seen that the effects on different age levels are discussed by using different approaches and tools in coding, robotics, game design and 3D design education. However, no study has been found that examines the effects of training in 4 different modules on problem solving, reflective thinking, and metacognitive awareness skills. It is expected that this study will be a source for future studies and the research findings will contribute to the literature.

In this context, it was aimed to determine the effect of coding, robotics, 3D design and game design education on problem solving and reflective thinking skills of 8/10-year-old students, and on problem solving and metacognitive awareness levels of 11/14-year-old students, and answers were sought for the following questions:

1. Students aged 8-10 who receive coding, robotics, 3D design and game design education,
a. Is there a significant difference between the pre-test and post-test scores of problem solving skills and their sub-factors (confidence in problem solving skills, self-control, avoidance)?
b. Is there a significant difference between the pre-test and post-test scores of reflective thinking skills and sub-factors (questioning, reasoning, evaluation) for problem solving?

2. Students aged 11-14 who receive coding, robotics, 3D design and game design education,
a. Is there a significant difference between the pre-test and post-test scores of problem solving skills and their sub-factors (confidence in problem solving ability, approach-avoidance, personal control)?
b. Is there a significant difference between the pre-test and post-test scores of metacognitive awareness levels?

BACKGROUND

Coding Education

Coding education, forming the basis of this study, is the first module of the research. Coding is the processing of various instruction sets into the computer to perform certain tasks (Sayın & Seferoğlu, 2016). In developed countries, coding education begins to be taught at an early age. This training not only develops the ability to write a computer program, but also develops individuals' skills of metacognitive thinking, looking at problems from different perspectives, and creativity (Yükseltürk & Altıok, 2016a). Even if students do not have the idea of working in the field of software in the future, it is thought that coding education will help them to be successful in other fields (Karabak & Güneş, 2013).

In his studies, Garner (2003) stated that students understand the programming structures (loop, variable, condition) described on the board, but they have problems in producing solutions to them (Demir, 2015). Such problems were avoided by designing different tools to facilitate teaching coding to students. Tools such as Scratch, Code.org, Arduino, App Inventor, Codemonkey, which contain various media tools, have a structure that can attract children's attention with their simple interface and coding logic. Students can do coding activities suitable for their age level by dragging and dropping code blocks. In a study by Baz (2018), 40 different coding platforms were investigated. It has been concluded that Code.org, Scratch and App Inventor coding platforms are more qualified than other coding tools. Even though each programming language contains its own special codes, the working logic of the codes is similar. Therefore, learning algorithm structure from an early age can prepare students to choose a programming language at a later stage.

Scratch and Arduino platforms were used in the coding education in this research. The Scratch platform is a block-based program developer interface improved by MIT University to teach coding to children. It is considered as a coding tool that can eliminate the difficulties in the field of software, thanks to its easy interface and programming language structure, allowing students of all ages to design games (Malan & Leitner, 2007). Arduino is an open source electronic platform designed to create interactive objects that can be used alone or with software on a computer (Sart, 2016). It provides the opportunity to apply basic coding knowledge to electronic circuit components. Students may have difficulties in the beginning because of the need to master the electronic circuit infrastructure (Meço & Arı, 2021). Its microprocessor board can be coded in the C programming language. With the different sensors it contains, the surrounding data can be collected and communication can be established with the devices in the environment (Erdoğan, 2017). The fact that students can get concrete outputs can help them learn the subject faster.

Robotics Education

The term robotics is a concept that we have heard frequently in education recently and it constitutes the second module of this research. The word robot is derived from the Czech and Slovak word robota, meaning work done by slaves, in 1921 (Horáková and Kelemen, 2003). Robots are manageable and coded technological devices with sensors consisting of mechanical and electronic components (Arora, 2008). Afterwards, the concept of robotics was derived from the term "robot" by Isaac Asimov in 1941 and covers all areas related to robotic technology. Although robots were considered as servants designed to help people in the first years they were produced, they have started to play an important role in many fields such as medicine, industry, entertainment, education, search and rescue and space studies in recent years (Ünver, 2017; Şişman, 2016).

The use of robots in education as teachers and teaching materials brought innovation to the field of science and technology in the early 1980s (Yolcu and Demirer, 2017; Şişman, 2016). Training of robotic coding can provide students with the opportunity to embody the software processes and observe the coding outputs on a hardware. (Kasalak, 2017). Robotics education in the world is mainly done using Lego sets. The name Lego, which was pinpointed by the wooden toy manufacturer Christiansen in 1934, means "play well" in Danish and "combine" in Latin (Kılınç, 2014). The learning environment in which Lego is used appears as a combination of constructivist approach and technology. Lego robots allow students to develop their skills in science, technology, engineering and mathematics (STEM) in an entertaining way (Alimisis, 2013). Robotic activities increase students' motivation to learn, as they allow students to create their own products (Liu, Lin, Feng, & Hou, 2013).

Today, different robotic kits such as Lego Wedo 2.0, Lego Mindstorms EV3, Lego Education Spike Prime, Arduino, Makeblock mBot, VEX Robotics are used. In the robotics training of this research, Lego Mindstorms EV3 and Lego Wedo 2.0 sets were used. Robots created with these sets can interact with the environment through the sensors. All basic coding operations can be performed by combining visual code blocks instead of text-based coding (Çankaya, Durak, & Yünkül, 2017). Robotics education is thought to be supportive in the fields of creativity, self-confidence, communication, leadership and putting theoretical knowledge into practice.

3D Design Education

3D design helps students who transition from a concrete period to an abstract period to realize their dreams, and is the third module of this research. 3D printers, one of the technological inventions of recent times, are tools that send files designed with computer software to the printer without the need for models, molds and similar tools, and turn the materials into products by adding them on top of each other (Yılmaz, 2013). With 3D printers, models in the computer environment can be converted into concrete products and customized production can be made. In order to get 3D printing, first of all, a three-dimensional model must be designed in digital environment with CAD (Computer Aided Design) software. This 3D design can be designed on a computer or transmitted to a computer via a ready-made scanner. The STL (Stereo Lithography) output of the model is sent to the 3D printer. The design is created by spraying binders and layers on solid, liquid or powder materials in a 3D printer (Çelik, Karakoç, Çakır, & Duysak, 2013). Plastic, resin, ceramic, play dough, metal, powder, glass, cement, food and composite materials can all be used as raw materials for 3D printers (D'aveni, 2015).

Some CAD software that supports 3D modeling are TinkerCad, Solidworks, SketchUp, Maya, 3ds Max, Fusion 360, Blender, Rhino, ZBrush, 123D Design, Meshmixer, Smoothie 3D and FreeCAD (Dere, 2017). The TinkerCad application used in the 3D design module of this research is a web-based design tool. Founded in 2011, TinkerCad became part of Autodesk in 2013 and joined the 123D family.

The contributions of this technology, whose effects we will see more in the coming years, to many sectors such as engineering, architectural design, industrial design, space science, health, fashion, education and food are noteworthy. 3D design in education can support students to create innovative designs to solve problems in their environment. Being able to touch the objects they have designed can give them a different experience and thus permanent learning can be achieved. The lack of standards, slowness compared to mass production and the difficulty of producing some complex structures can be seen as the disadvantages of this technology (Kuzu D. et al., 2016).

Game Design Education
Game design education, which is the fourth module of the research, supports the students to be the generation that goes into production, not just the generation that plays games. With the development of digital games, the replacement of traditional street games by game consoles has also changed children's understanding of entertainment (Aksoy, 2014). The fact that computers have become a part of daily lives and students spend most of their time playing games in the digital environment has increased the importance of using digital games in the field of education. “Digital games are games that have certain rules and purposes and are played through a hardware (mobile phone, tablet, game console, etc.)” (Samur, 2016). It is thought that computer games make the educational process more interesting, accelerate learning, improve problem-solving skills and collaborative work (Kebritchi, Hirumi, & Bai, 2010).

For a successful education, the game design process should be included in the education as well as digital games. Children's interest in games can be combined with the field of programming and this can help them reach many skills such as creative thinking, collaborative work, and problem solving (Samur, 2016). The game design process is based on design thinking skills. Design thinking skills consist of empathy, identification, ideation, prototyping and testing (Bulut, 2015). Prensky (2001), emphasized that rules, purpose, feedback, competition, difficulty, presentation, interaction and story elements should be included in the designing process of these games.

Many students like to play games but have problems designing their own digital games. These problems can be seen as difficulties in game designing tools and lack of programming language. It is difficult for students to learn languages such as Java, C and C++, which are necessary for programming games, in a short time (Gomes & Mendes, 2007). Platforms such as Kodu Game Lab, Scratch, Unity 3D and Alice have been developed so that students can easily design games. Kodu Game Lab was used in the game design training of this research. Kodu Game Lab, developed by Microsoft and XNA Game Studio, is a game design tool that supports children who do not know the programming language to learn the basics of coding. It has a simple interface with visual elements for programming and a clear coding structure consisting of nouns, verbs and adjectives (Yıldırım, 2016).

21st Century Skills
21st century skills that should be acquired by students are problem solving, creative and critical thinking, analysis-synthesis, innovation, productivity, information literacy, technology and media literacy, responsibility, communication and collaboration skills. When all these skills are put into focus, today's students are expected to use technology effectively (Erdoğan, 2017). It is emphasized to be very important to include problem solving and project-based studies while applying the basic skills of 4Cs (critical thinking, communication, cooperation and creativity) in the classroom environment for students to be successful in the future (Eguchi, 2014; Kivunja, 2015).

Problem Solving Skills
Individuals face many problems throughout their lives. John Dewey defines problems as things that confuse and force people's minds (Çetin, 2012). Problem solving skills are the processes by which people propose appropriate solutions to problems and use their knowledge, experience and skills (Lai & Yang, 2011). According to the PISA 2003 study, the steps of the problem solving process are understanding the problem situation, defining relevant information and constraints, presenting possible solutions, choosing solution strategies, solving the problem, checking the solution and sharing the results (OECD, 2004).

It is predicted that people who have developed problem-solving skills will not be unresponsive to the problems they will face in the future, they will question, think multi-dimensionally, make decisions without difficulty, and produce solutions (Dow & Mayer, 2004). Problem solving ability is an innate trait. However, the maturity, motivation, education, social and cultural environment of the individual affect the problem solving ability. For this reason, trainings that will improve problem-solving skills should be prepared by paying attention to individual differences (Silik, 2016).

Reflective Thinking Skill
According to Dewey's (1910) definition, reflective thinking is the process of careful and continuous evaluation of any hypothetical information, with reasons to support this information, and drawing future conclusions. Reflective thinking is a skill that will improve critical thinking skills and help the individual develop strategies in the face of problems (Kızılkaya & Aşkar, 2009).

It is stated that reflective thinking includes a total of 5 steps: suggestion, problem, hypothesis, reasoning and testing. In the suggestion step, in case the individual encounters a problem, the idea and possibilities of solving this problem occur. In the problem step, in complex situations, the whole event is looked at rather than the small details. In the hypothesis step, the suggestions formed in the mind are analyzed. In the reasoning step, thoughts, knowledge and past experiences are analyzed. In the testing step, results are found for existing problems and this result is used as a source for new problems.

When the differences between the reflective learning method and the traditional methods are examined, it is observed that the main important point in the traditional learning method is the direct transfer of information from the teacher to the student, the teacher being in an informative position, correcting the student's mistakes directly, and the increase in test scores as the criteria for success. However, in the reflective learning model, the student's competencies and inadequacies are important, the student takes the responsibility of learning, and the teachers communicate with the students in a positive and consistent manner while giving feedback. It is observed that the students' ability to freely express their opinions is a criterion for success (Ünver, 2003).

Metacognitive Awareness Skill

The first step in the information processing process begins when the individual receives stimuli from his environment with his sense organs. Some of these stimuli are perceived and recognized for a short period by sensory recording, and many are discarded. The senses are transferred to short-term memory through processes of perception and attention. The information is then repeated and transferred to long-term memory. It is recalled from long-term memory when necessary. The last step of the system is metacognition that manages the whole process (Berliner, 1988). Metacognition is the individual's awareness and control of his own learning (Özsoy, 2008). According to Karakelle and Saraç (2007), cognition includes perception, understanding, remembering and similar processes; Metacognition involves thinking about mental processes such as one's own perception, understanding, remembering, and so on. Metacognition, in its shortest definition, is thinking to think. It helps individuals know where, how and when to use strategies. Blakey and Spence (1990) suggest that students define what they know and do not know, express what they think, solve collaborative problems, keep a thinking agenda, make plans, question the thinking process, and evaluate themselves in order to develop their metacognitive awareness skills.

It is stated in studies that it will not be possible to acquire and use metacognitive skills at all ages. These are the periods when, for ages 5 and under, strategies are not used at all, for ages 6-9, strategies can be used but there is no production, and for ages 9 and above, strategies can be produced and used (Senemoğlu, 2012). When the studies were examined, it was stated that the recommended method for teaching metacognition was structured teaching.

METHODS

Research Design

This research was conducted with a quasi-experimental research model with a single-group pre-test / post-test pattern, one of the quantitative research methods. This research is a cross-sectional type of research and it is a multi-subject research according to the number of subjects.

Participants

In Study, the universe of the research consists of 8-10 and 11-14 age group students in Istanbul in the 2017-2018 academic year. The sample of the research consists of 15 students aged 8-10 and 21 students aged 11-14, who attended the coding, robotics, 3D design and game design training organized by the Educational Sciences Institute of a private university on different dates.

Descriptive statistics regarding the distribution of students by age group and gender are given in Table 1. In this study, convenient sampling method, one of the sampling methods, was used.

Table 1. Distribution of students by age group and gender

Group	Age Group	Girl	Boy	Total
Study 1	8-10 Age	6	9	15
Study 2	11-14 Age	7	14	21
Total	8-14 Age	13	23	36

Experimental Process

Necessary permissions were obtained from the Institute of Educational Sciences of a private university for data collection studies within the scope of the research. Questionnaire forms were applied to the study group directly. The average time to answer a survey is 15 minutes. Questionnaire forms were applied for the pre-test in the first hour of the training without meeting the students. For the post-test, 8 weeks after the start of the training, the last hour of the training was applied. Data were collected from the students of 7 different groups participating in the training. All ethical rules were strictly followed during the research process. The number of students participating in the study, the pre-test and post-test application dates are shown in Table 2.

Table 2. Data collection procedures

Study	Group	Number of Students	Pre-test Date	Post-test Date
Study 1	1st Group	5	04.11.2017	24.12.2017
Study 1	2nd Group	4	03.12.2017	21.01.2018
Study 1	3rd Group	4	29.01.2018	02.02.2018
Study 1	4th Group	2	03.03.2018	21.04.2018
Study 2	1st Group	9	04.11.2017	24.12.2017
Study 2	2nd Group	9	03.12.2017	21.01.2018
Study 2	3rd Group	3	29.01.2018	02.02.2018

Training Plan

The education lasted for 8 weeks, 2 hours a week, in the 2017-2018 academic year. Field experts at the university created the achievement points of education, planned the activities for these learning outcomes and applied them to the working group. This designed training consists of 4 different modules for both age groups: coding, robotics, 3D design and game design. The materials used differ according to the age level. Weekly training plans are illustrated in Appendix.

Coding module, which is planned in order to enable students to acquire learning outcomes such as problem solving, algorithmic thinking, and creative and critical thinking, forms the basis of this training. In this study, Scratch and Code.org coding tools were used for the 8-10 age group, and Code.org and Arduino IDE coding tool was used for the 11-14 age group.

Figure 1: Coding module

Robotics module is aimed that students who have acquired coding skills will use these skills in the process of programming and designing robots in line with the 4C approach. In this study, Lego Wedo 2.0 robotic set was used for the 8-10 age group, and LEGO Mindstorms EV3 robotic set for the 11-14 age group.

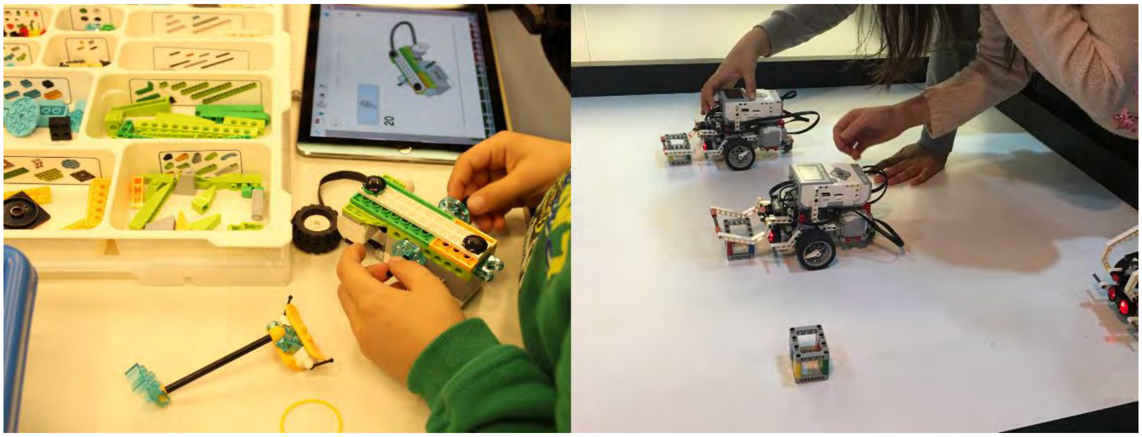

Figure 2: Robotics module

3D design module is aimed that students embody the objects they imagine in order to develop their design and creative thinking skills. In this study, TinkerCad application was used in both age groups. The designs were printed from 3D printers and distributed to the students.

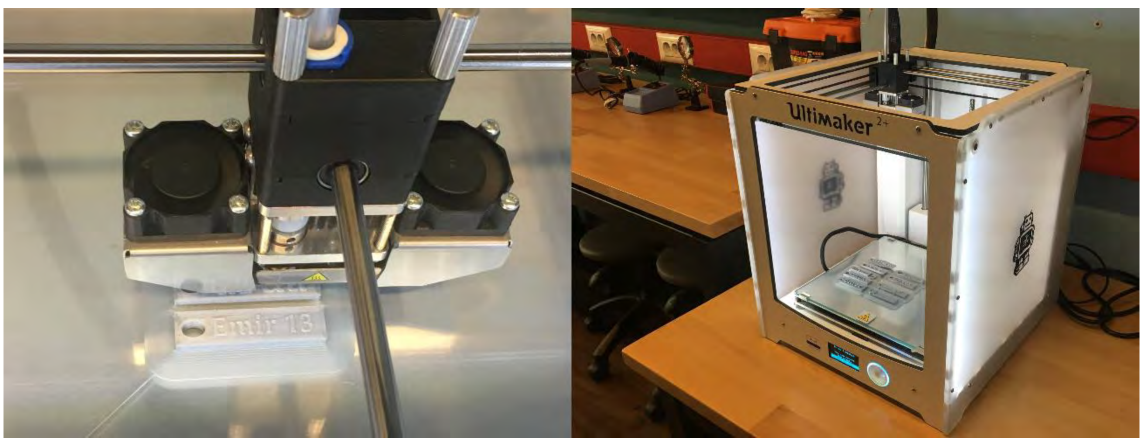

Figure 3: 3D design module

Digital game design module is based on the design thinking steps, it is aimed that students design their own digital games within the framework of game elements. In this study, Microsoft Kodu Game Lab application was used in both age groups.

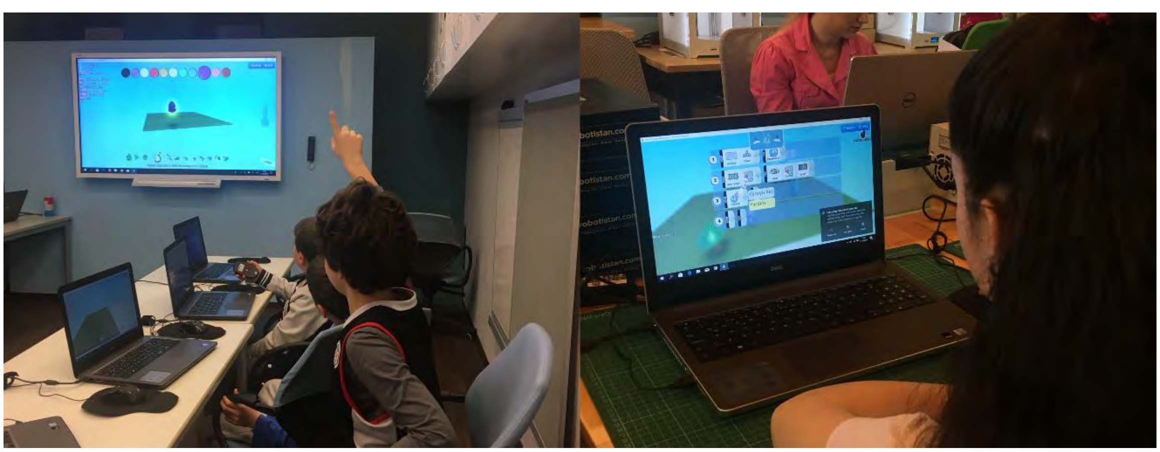

Figure 4: Digital game design module

Measuring Tools
The data of this study were collected by means of a questionnaire, and the questionnaires used differ according to age levels.

Measuring Tools In Study 1
The questionnaire in Study 1 consists of two parts, the Problem Solving Inventory for Primary School Children and the Reflective Thinking Scale for Problem Solving.

Problem solving inventory for primary school children is an inventory consisting of 24 items with a total of 3 factors: confidence in problem solving skills (12 items), self-control (7 items) and avoidance (5 items). The Cronbach's alpha reliability coefficient of the scale is 0.80. This result shows that the scale is reliable. The scale has a 5-point Likert structure. For the items in the scale, "Always", "Often", "Occasionally", "Rarely" and "Never" degrees are used. The items are scored as 1, 2, 3, 4, 5 in order, starting from the "Never" category. While evaluating the items 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23 under the "Confidence in Problem Solving Skill" factor, the degree of participation of the students in the proposition is high when the score is close to 5, and it is considered low when the score is close to 1. Items 2, 4, 6, 8, 10, 12, 14 under the "Self-Control" factor and items 16, 18, 20, 22, 24 under the "Avoidance" factor are reversely scored (Serin, Serin, & Saygılı, 2010).

Reflective thinking skill scale for problem solving is an inventory consisting of 14 items with a total of 3 factors: questioning, reasoning and evaluation. Reliability results of the scale are 0.73 for the “Questioning” factor including items 1, 3, 7, 9, 13. It is 0.71 for the “Reasoning” factor including items 5, 8, 11, 12. It is 0.69 for the “Evaluation” factor including items 2, 4, 6 10, 14. Reliability result is 0.83 for the whole scale. The scale has a 5-point Likert structure. For the items in the scale, "Always", "Often", "Sometimes", "Rarely" and "Never" degrees are used. The items are scored as 1, 2, 3, 4, 5 in order, starting from the "Never" category (Kızılkaya & Aşkar, 2009).

Measuring Tools In Study 2
The questionnaire in Study 2 consists of two parts, the Problem Solving Inventory and the Metacognitive Awareness Inventory for Children - Form B.

The Problem Solving Inventory for adults developed by Heppner and Peterson (1982) was adapted into Turkish by Şahin, Şahin and Heppner (1993). Later, it was adapted for primary school 5th grade students. The scale consists of 3 sub-factors: confidence in problem solving ability (8 items), approach-avoidance (7 items), and personal control (5 items) (Kardaş, Anagün, & Yalçınoğlu, 2014). The Cronbach's alpha reliability coefficient of the scale is 0.74. This result shows that the scale is reliable. Problem Solving Inventory is a 20-item scale with a 4-point Likert structure. For the items in the scale, “I strongly disagree”, “Sometimes I agree”, “I mostly agree” and “I totally agree” degrees are used. The items are scored as 1, 2, 3, 4 in order, starting from the "I strongly disagree" category. In the process of calculating the scores of the participants, while the items 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17, 19 and 20 were evaluated, the degree of participation of the students in the proposition was high when the score was close to 4, and it is considered low when close to 1. Items 1, 2, 7, 14, 15 and 18 are reversely scored (Kardaş, 2013).

The Metacognitive Awareness Scale for adults was developed by Schraw and Dennison (1994). It was adapted into Turkish by Akın, Abacı and Çetin (2007). Later, Sperling, Howard, Miller, and Murphy (2002) simplified the scale and developed the Metacognitive Awareness Inventory for Children, which consists of 2 forms for children of different ages. Form A contains 12 items for 3rd, 4th and 5th grade students; and form B contains 18 items for 6th, 7th, 8th and 9th grade students. The Cronbach Alpha reliability coefficient of the Metacognitive Awareness Inventory for Children - Form B is 0.80. This result shows that the scale is reliable. “Never”, “Rarely”, “Sometimes”, “Often” and “Always” degrees are used for the items in this 5-point Likert scale. The items are scored as 1, 2, 3, 4, 5 in order, starting from the "Never" category (Karakelle & Saraç, 2007).

Data Analysis
IBM SPSS Statistics 20 program was applied for statistical analysis used in the study. All statistical operations are based on .05 error level.

In the study, Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to determine whether students' problem solving skills, reflective thinking skills and metacognitive awareness levels were normally distributed in the pre-test and post-test. Kolmogorov-Smirnov and Shapiro-Wilk test results are shown in Table 3.

Table 3. Analysis results of kolmogorov-smirnov and shapiro-wilk tests applied to the study group

	Group	Application	Kolmogorov Smirnov Z	Asymp. Sig (2-talied)	Shapiro Wilk Z	Asymp. Sig (2-talied)
Problem Solving Inventory for Primary School Children	Study 1	Pre-test Post-test	.120 .143	.200 .200	.974 .927	.915 .245
Reflective Thinking Scale for Problem Solving	Study 1	Pre-test Post-test	.119 .206	.200 .088	.965 .940	.786 .382
Problem Solving Inventory	Study 2	Pre-test Post-test	.109 .160	.200 .173	.968 .932	.692 .148
Metacognitive Awareness Inventory for Children - Form B	Study 2	Pre-test Post-test	.091 .188	.200 .050	.979 .930	.903 .136

As the results in Table 3 were examined, it was observed that the students' problem solving skills, reflective thinking skills and metacognitive awareness levels were normally distributed ($p>.05$). In the Kolmogorov Smirnov and Shapiro-Wilk test, there was no significant difference in the data set according to p value. It was decided to analyze the pre-test and post-test values applied in this analysis with the related samples t-Test.

It was examined whether the changes in the results of the pre-test applied before the 8-week education and the post-test applied after were significant, and samples related to repeated measurements were obtained with the t-Test.

RESULTS

Table 4 shows the descriptive analyzes of the pre-test and post-test scores of the 8/10-year-old students in Study 1 group in terms of their problem solving and reflective thinking skill levels.

Table 4. Related sample t-test analysis results of pre-test and post-test values of study 1 group

	Factor	Test	N	X	S	Sd	t	P
Problem Solving Inventory for Primary School Children	Confidence in Problem Solving Skills	Pre-test Post-test	15 15	45.80 47.20	8.46 8.43	14	-.711	.489
	Self-Control	Pre-test Post-test	15 15	23.86 25.33	6.19 7.67	14	-1.153	.268
	Avoidance	Pre-test Post-test	15 15	19.46 19.20	3.56 4.42	14	.267	.793
	Total	Pre-test Post-test	15 15	89.13 91.73	8.52 11.83	14	-.891	.388
Reflective Thinking Scale for Problem Solving	Questioning	Pre-test Post-test	15 15	16.20 19.20	5.15 3.91	14	-3	.010*
	Reasoning	Pre-test Post-test	15 15	13.73 15.60	4.38 4.18	14	-1.99	.066
	Evaluation	Pre-test Post-test	15 15	17.46 18.33	4.01 3.69	14	-.988	.340
	Total	Pre-test Post-test	15 15	47.40 53.13	11.73 10.70	14	-2.556	.023*

Note. $^{*}p < .05$.

As the data in Table 4 are examined, it is seen that the average of the problem solving skill values of the study group was measured as X=89.13 for the pre-test and X=91.73 for the post-test. When the pre-test and post-test mean scores of the students were examined, it was seen that there was an increase in the post-test mean scores, but the difference was not statistically significant ($t=-.891$, $p>.05$).

It is seen that the mean values of reflective thinking skills for problem solving of the study group were measured as X=47.40 for the pre-test and X=53.13 for the post-test. Considering the pre-test and post-test mean scores of the students, a statistically significant increase was found in the post-test mean scores (t=-2.556, p<.05). When examined in terms of factors, a statistically significant increase was found only in the pre-test and post-test mean scores of the questioning factor value (t=-3, p<.05).

The findings regarding the descriptive analyzes of the pre-test and post-test scores of 11/14-year-old students in Study 2 group in terms of problem solving and metacognitive awareness skill levels are given in Table 5.

Table 5. Related sample t-test analysis results of pre-test and post-test values of study 2 group

	Factor	Test	N	X	S	Sd	t	P
Problem Solving Inventory	Confidence in Problem Solving Ability	Pre-test Post-test	21 21	23.42 23.71	2.92 2.70	20	-.400	.693
	Approach-Avoidance	Pre-test Post-test	21 21	20.28 20.52	2.79 2.71	20	-.316	.755
	Self-Check	Pre-test Post-test	21 21	15.04 14.76	2.08 2.09	20	.538	.596
	Total	Pre-test Post-test	21 21	58.19 58.47	6.74 5.87	20	-.217	.830
Metacognitive Awareness Inventory for Children - Form B		Pre-test Post-test	21 21	66.19 68.52	10.24 8.47	20	-.1.164	.258

As the data in Table 5 are examined, it is seen that the average of the problem solving skill values of the study group was measured as X=58.19 for the pre-test and X=58.47 for the post-test. When the pre-test and post-test mean scores of the students were examined, it was seen that there was an increase in the post-test mean scores, but the difference was not statistically significant (t=-.217, p>.05). When examined in terms of factors, no statistically significant difference was found in the pre-test and post-test mean scores.

It is seen that the average of the metacognitive awareness values of the study group was measured as X=66.19 for the pre-test and X=68.52 for the post-test. When the pre-test and post-test mean scores of the students were examined, it was seen that there was an increase in the post-test mean scores, but the difference was not statistically significant (t=-1.164, p>.05).

CONCLUSION

In this research, the effects of coding, robotics, 3D design and game design education on the problem solving and reflective thinking skills of 8/10-year-old students, and the problem solving and metacognitive awareness levels of 11/14-year-old students were discussed. According to the findings obtained in the study, it is observed that education contributes to the problem-solving skills of 8/10-year-old students, but this difference was not statistically significant. However, it contributed statistically significant effect to their reflective thinking skills for problem solving. When examined in terms of factors, it was observed that there was a significant increase in the questioning factor. It was seen that education contributed to the problem solving and metacognitive awareness levels of 11/14-year-old students, but this difference was not statistically significant.

When the studies in the literature on coding, robotics, 3D design and game design are examined, it is noteworthy that the trainings given were focused on a single subject area. In a study conducted by Yünkül, Durak, Çankaya, and Mısırlı (2017), a significant increase was observed in the problem-solving, algorithmic thinking and creative thinking skills of students studying coding with Scratch. As a result of Çetin's (2012) research with 17 students, it was stated that programming education had a positive effect on students' problem-solving skills. When the studies of Calder (2010), and Kaucic and Asic (2001) are examined, it is seen that programming education improves students' problem solving skills. In a study conducted by Kasalak (2017), secondary school students were given Arduino programming training with Scratch in a 5-week period. There was a positive and significant change in the students' self-efficacy perceptions towards programming. Olgun (2014) observed that programming education had an effect on 5 out of 13 thinking styles after Scratch education of 6th grade students. Oluk, Korkmaz and Oluk's (2018) study with 5th grade students concluded that students who use Scratch in algorithm learning have a significant increase in computational thinking skills compared to students who do not. Coşar (2013) gave a web-based computer programming course to 58 7th grade students. It was observed that this study had a positive effect on students' academic achievement, critical thinking dispositions and attitudes towards computers. According to the results of a research conducted by Bağra and Kılınç (2021) with 5th and 6th grade students, they stated that students see coding education as a means of production and that it is very fun for them to produce something. However, problems such as lack of materials, low number of weekly lessons were encountered. Ramazanoğlu (2021), in a study with 63 students, concluded that robotic coding practices reduced students' anxiety about their attitudes towards computers, and their self-efficacy perceptions towards computational thinking skills increased. In a study conducted with 4th grade students, Papatğa (2016) gave training with Scratch for 15 weeks. At the end of the training, it was concluded that the reading comprehension skills of the students improved significantly. Yüksel (2017) gave Scratch training to 6th grade students and concluded that at the end of the training, it had positive effects on the students' attitudes towards the course and the permanence of their knowledge. In his study, Sohn (2014) carried out Arduino applications with 26 students for 5 weeks. It has been concluded that there is a significant difference in the problem solving skills of the students who do activities with Arduino.

In another study conducted on 6th grade students, a positive effect was observed on students' problem solving skills after Lego and robotic activities (Gibbon, 2007). Patterson (2011) states that the use of robots in programming education has a positive effect in 14 out of 19 research articles he has examined in the literature. In a study conducted with 4th grade students, Uşengül and Bahçeci (2020) concluded that there was a significant increase in students' attitudes towards science and computational thinking skills by giving robotic-assisted science education with the Lego Wedo 2.0 set. Koç (2012) carried out robotic-assisted science education with 7th grade students in an 8-week period. At the end of the training, a significant difference was observed in the scientific process skills and motivations of the students who were taught with the Lego Mindstorms EV3 set. In a study conducted by Çankaya, Durak, Yünkül (2017), 9 middle school students were given robot programming training with the Lego Mindstorms EV3 set for one week. At the end of the training, it was concluded that there was a significant increase in the problem solving and creativity skills of the students.

In a study conducted by Derman (2015) with 5th and 6th grade students, it was stated that the process of designing educational games had positive effects on students' creativity. Features such as creative thinking, problem solving, inclination to teamwork, being able to engage in an intense work, and mastery of game design processes come forward in game design students (Samur, 2016). It was seen that the Kodu Game Lab programming environment, which Alkan (2019) applied with gifted students, caused a significant increase in the problem solving skills of students. With the 3D printers integrated into the curriculum, it is ensured that the students' participation in the lesson increases, knowledge is taught in different ways, the subjects that are difficult to learn are made easier to understand for the students and positive support is given to academic success (Taştı, Yücel, & Yalçınalp, 2015).

The reason why the applied training did not show a statistically significant difference in problem solving and metacognitive awareness skills may be that the trainings remained at the entry level since 4 different modules were covered during the 8-week training period. It can be thought that the attention span of the students affects learning because it is studied with a small age group. However, it can be said that this education creates awareness for students. These data are similar to several studies in the literature. Kalelioğlu and Gülbahar (2014) concluded that coding education with Scratch applied to primary school 5th grade students did not significantly contribute to students' problem solving skills. However, students stated that they liked the Scratch platform and the easiness of programming with it. According to a study conducted by Solmaz (2014) on 39 students, it was shown that teaching programming with Alice software made students love programming. However, it was examined that it did not affect metacognitive awareness, problem solving skills and critical thinking skills. According to the results of a study conducted with 14 students in primary and preschool age groups, no positive effect was found on students' problem solving skills after Lego and robotics activities (Pollock, 1997). Sullivan (2008) stated that robotics activities increased students' scientific process skills in the robotics summer camp he held with 26 students. In the study of Yükseltürk, Altıok and Üçgül (2016), the increase in the problem solving skills of the students with the Kodu Game Lab and game design education was not found significant.

It can be said that coding, robotics, 3D design and game design trainings support 21st century skills such as problem solving, reflective thinking and metacognitive awareness. In line with this information, it is safe to predict that coding education will become a mandatory rather than a necessity (Sayın & Seferoğlu, 2016). According to the data obtained within the scope of the study, the following suggestions can be made:

- The number of similar studies in the literature can be increased by using different teaching methods and tools.
- The effects of increasing the duration of this training and increasing the learning outcomes for the training modules can be examined.
- Studies can be conducted to determine the effect of this education on different variables such as critical, creative and computational thinking. The effects in different branches can be examined.
- Similar other ones to this training can be applied to different age groups in order to generalize the target audience. More samples can be studied.
- With the qualitative research model, students' views on education can be obtained.

ACKNOWLEDGEMENTS
We would like to express our endless thanks to our advisor, Assoc. Prof. Yavuz SAMUR, for sharing his valuable knowledge with us and for his continuous interest and support in the realization of this study.

We would like to thank the Rector of Bahçeşehir University, Prof. Şirin KARADENİZ, for her support in the planning of this study.

We would also like to thank Barış ERDOĞAN, Lecturer of the Faculty of Educational Sciences of Bahçeşehir University, and the workshop trainers for their support in the implementation of the research.

REFERENCES
Aksoy, N. C. (2014). *Digital game-based mathematics teaching on 6th grade secondary school students' achievement, achievement motivation, self-efficacy and attitude characteristics* (PhD thesis). Gazi University Institute of Educational Sciences, Ankara.
Alimisis, D. (2013). Educational robotics: open questions and new challenges. *Themes in Science & Technology Education, 6*(1), 63-71.
Alkan, A. (2019). The effect of code game lab software on the level of problem solving skills in programming language teaching. *Mehmet Akif Ersoy University Journal of the Faculty of Education*, *50*, 480-493.
Altun, A., & Kasalak, İ. (2018). Self-efficacy perception scale development study related to block-based programming: Scratch example. *Educational Technology Theory and Practice*, *8*(1), 209-225.
Arora, M. (2008). *Design and development of friction compensator algorithm for one link robot* (Master's thesis). Thapar University, Patiala.
Bağra, A., & Kılınç, H. (2021). Secondary school students' views on coding education. *International Journal of Social and Humanistic Sciences, 4*(1), 36-51.
Baz, F. Ç. (2018). A comparative review on coding software for kids. *Curr Res Educ, 4*(1), 36-47.
Berliner, D. C. (1988). *Educational psychology*. Boston: Allyn and Bacon.
Blakey, E., & Spence, S. (1990). *Developing metacognition*. Syracuse, NY: ERIC Information Center Resources.
Bulut, D. (2015). *Effect of educational game design process on students' creativity* (Master's thesis). Bahcesehir University Institute of Educational Sciences, Istanbul.
Calder, N. (2010), Using scratch: an integrated problem-solving approach to mathematical thinking. *APMC, 15*(4).
Coşar, M. (2013). *Computer programming studies on academic achievement, critical thinking disposition and attitude towards computers in a problem-based learning environment* (PhD thesis). Gazi University Institute of Educational Sciences, Ankara.
Çankaya, S., Durak, G., & Yünkul, E. (2017). Programming education with robots: examination of students' experiences and opinions. *Turkish Online Journal of Qualitative Inquiry*, *8*(4), 428-445.
Çelik, İ., Karakoç, F., Çakır, M. C., & Duysak, A. (2013). Rapid prototyping technologies and application areas. *Dumlupınar University Journal of Science Institute, 31*, 53-69.
Çetin, E. (2012). *The effect of computer programming education on children's problem solving skills* (Master's thesis). Gazi University Institute of Educational Sciences, Ankara.
D'Aveni, R. (2015). The 3-D printing revolution. *Harvard Business Review*, 41-48.
Demir, F. (2015). *The effect of different uses of educational programming language in programming teaching on programming success and anxiety* (PhD thesis). Ataturk University Institute of Educational Sciences, Erzurum.

Dere, H. E., (2017). *The effect of web-based 3d design applications on spatial visualization and mental rotation skills of secondary school students* (Master's thesis). Baskent University Institute of Educational Sciences, Ankara.
Dewey, J. (1910). *How we think?.* D. C. Heath & Co.
Dow, G. T., & Mayer, R. E. (2004). Teaching students to solve insight problems: Evidence for domain specificity in creativity training. *Creativity Research Journal, 16*(4), 389-401.
Eguchi, A. (2014). Educational robotics for promoting 21st century skills. *Journal of Automation, Mobile Robotics & Intelligent Systems*, *8*(1), 5-11.
Erdoğan, B. (2017). *Programming with arduino for kids*. Istanbul: Pusula Publishing.
Gibbon, L. W. (2007). *Effects of lego mindstorms on convergent and divergent problem solving and spatial abilities in fifth and sixth grade students*. Doctoral dissertation, Seattle Pacific University, Washington, USA.
Gomes, A., & Mendes, A. (2007). *Learning to program - difficulties and solutions*, International Conference on Engineering Education – ICEE 2007, Coimbra, Portugal.
Horáková, J., & Kelemen, J. (2003). *Čapek, Turing, von Neumann, and the 20th century evolution of the concept of machine*. International Conference in Memoriam John von Neumann, John von Neumann Computer Society, Budapest.
Kahyaoğlu, M., & Dede, F. (2016). *Explore Arduino with 25 projects*. Istanbul: Pusula Publishing.
Kalelioğlu, F., & Gülbahar, Y. (2014). The effects of teaching programming via scratch on problem solving skills: A discussion from learners' perspective. *Informatics in Education*, *13*(1), 33–50.
Karabak, D., & Güneş, A. (2013). Curriculum proposal in software development for middle school freshmen. *Journal of Research in Education and Teaching*, *2*(3)*,* 163-169.
Karakelle, S., & Saraç, S. (2007). A and B forms of the metacognitive awareness scale for children (MASF-C): validity and reliability study. *Turkish Psychology Writings, 10*(20), 87-103.
Karataş, H. (2021). 21st century skills in robotics and coding training Turkey and the world. *Education and Society In The 21st Century, 10*(30), 693-729.
Kardaş, N. (2013). *Effect of argumentation-oriented teaching on students' decision-making and problem-solving skills in science education* (Master's thesis). Eskisehir Osmangazi University Institute of Educational Sciences, Eskişehir.
Kardaş, N., Anagün, Ş. S., & Yalçınoğlu, P. (2014). The study of adapting the problem solving inventory to primary school students: results of confirmatory factor analysis. *Electronic Journal of Social Sciences, 13*(51), 182-194.
Kasalak, İ. (2017). *The effect of robotic coding activities on secondary school students' self-efficacy perceptions regarding coding and student experiences regarding the activities* (Master's thesis). Hacettepe University, Department of Computer Education and Instructional Technologies, Ankara.
Kaucic, B., & Asic, T. (2011). *Improving introductory programming with scratch?* MIPRO.
Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education, 55*, 427-443.
Kılınç, A. (2014). *The use of robotic technology in teaching 7th grade light unit* (Master's thesis). Erciyes University Institute of Educational Sciences, Kayseri.
Kızılkaya, G., & Aşkar, P. (2009). Developing the reflective thinking skill scale for problem solving. *Education and Science, 34*(154), 82-92.
Kivunja, C. (2015). Exploring the pedagogical meaning and implementations of the 4cs "super skills" for the 21st century through bruner's 5e lenses of knowledge construction to improve pedagogies of the new learning paradigm. *Creative Education*, *6*, 224-239.
Koç Şenol, A. (2012). *Robotic assisted science and technology laboratory applications: robolab* (Master's thesis). Erciyes University Institute of Educational Sciences, Kayseri.
Kuzu, Demir, E. B., Çaka, C., Tuğtekin, U., Demir, K., İslamoğlu, H., & Kuzu, A. (2016). Use of three-dimensional printing technologies in education: Applications in Turkey. *Ege Journal of Education 17*(2), 481-503.
Lai, A. F., & Yang, S. M. (2011). *The learning effect of visualized programming learning on 6 th graders' problem solving and logical reasoning abilities*. Electrical and Control Engineering (ICECE), 2011 International Conference on. IEEE.
Liu, E. ZF., Lin, C-H., Feng, H-C., & Hou, H-T. (2013). An analysis of teacher-student interaction patterns in a robotics course for kindergarten children: A pilot study. *The Turkish Online Journal of Educational Technology, 12*(1), 9-18.
Malan, D. J., & Leitner, H. H. (2007). Scratch for budding computer scientists. *SIGCSE Bulletin, 39*(1), 223-227.

Meço, G., & Arı, A. G. (2021). Secondary school students' views on stem activities supported with arduino. *The Journal of International Social Research, 14*(76), 497-507.
Ministry of National Education [MEB]. (2018). *Computer science course curriculum (Level 1-2).* http://mufredat.meb.gov.tr/Programlar.aspx
Ministry of National Education [MEB]. (2018). *Information technologies and software curriculum (Middle School 5th and 6th grades).* http://mufredat.meb.gov.tr/Programlar.aspx
OECD. (2004). Problem solving for tomorrow's world. *First Measures of Cross-Curricular Competencies*, PISA 2003.
Olgun, K. B. (2014). *The effect of programming on secondary school students' thinking styles* (Master's thesis). Istanbul University Institute of Science and Technology, Istanbul.
Oluk, A., Korkmaz, Ö., & Oluk, H. A. (2018). The effect of Scratch on 5th grade students' algorithm development and computational thinking skills. *Turkish Journal of Computer and Mathematics Education*, *9*(1), 54-71.
Özsoy, G. (2008). Metacognition. *Turkish Journal of Educational Sciences, 6*(4), 713-740.
Papatğa, E. (2016). *Developing reading comprehension skills through the scratch program* (PhD thesis). Anadolu University Institute of Educational Sciences, Eskisehir.
Patterson, R. (2011). *Teaching computer programming using educational robots* (Masters' Thesis). Information Systems, Athabasca University.
Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.
Pollock, M. L. (1997). *Facilitating cognitive abilities and positive school attitudes among elementary school students through lego-logo programming.* Doctoral dissertation, North Carolina State University, North Carolina, USA.
Ramazanoğlu, M. (2021). The effect of robotic coding applications on attitudes of the secondary school students towards computers and their perceptions of self-efficacy regarding computational thinking skills. *Turkish Journal of Social Research, 25*(1), 163-174.
Samur, Y. (2016). Digital game design. Istanbul: Pusula Publishing.
Sart, G. (Ed.). (2016). *Getting started with Arduino*. Istanbul: Aba Publishing.
Sayın, Z., & Seferoğlu, S. S. (2016). Coding education as a new 21st century skill and the effect of coding on education policies. *Academic Informatics,* 3-5.
Senemoğlu, N. (2012). *Developmental Learning and Teaching: From Theory to Practice* (21st ed.). Ankara: Pegem Academy.
Serin, O., Serin, N., & Saygılı, G. (2010). Developing a problem solving inventory (PPI) for primary school children. *Elementary Education Online, 9*(2), 446–458.
Silik, Y. (2016). *Effect of educational robotics applications on problem solving skills of pre-service science teachers* (Master's thesis). Karadeniz Technical University, Institute of Educational Sciences, Trabzon.
Sohn, W. (2014). Design and evaluation of computer programming education strategy using arduino. *Advanced Science and Technology Letters*, *66,* 73-77. doi:10.14257/astl.2014.66.18.
Solmaz, E. (2014). *Alice software on course success, critical thinking and problem solving skills and metacognitive awareness in programming language teaching* (PhD thesis). Gazi University Institute of Educational Sciences, Ankara.
Sperling, R., Howard, B., Miller, L., & Murphy, C. (2002). Measures of children's knowledge and regulation of cognition. *Contemporary Educational Psychology, 27,* 51-79.
Sullivan, F. R. (2008). Robotics and science literacy: Thinking skills, science process skills and systems understanding. *Journal of Research in Science Teaching*, *45*(3), 373-394.
Şahin, N., Şahin, N. H., & Heppner, P. P. (1993). Psychometric proportions of the problem solving inventory in a group of turkish university students, *Cognitive Therapy and Research, 4*(17), 379–396.
Şişman, B. (2016). The use of robots in education. İşman, A., Odabaşı, H. F., & Akkoyunlu, B. (Eds.), *Educational technologies readings* (pp. 299-314). The Turkish Online Journal of Educational Technology.
Taştı, M. B., Yücel, Ü. A., & Yalçınalp, S. (2015). Investigation of mathematics teacher candidates' processes of developing learning objects with three-dimensional modeling program. *International Journal of Social Sciences and Education Research*, *1*(2), 412-423.
Uşengül, L., & Bahçeci, F. (2020). The effect of lego wedo 2.0 education on academic achievement and attitudes and computational thinking skills of learners toward science. *World Journal of Education, 10*(4), 83-93.
Ünver, G. (2003). *Reflective thinking*. Ankara: Pegem Publications.
Ünver, Ş. (2017). *Development of gps sensor for Lego mindstorms nxt robot kit and navigation of mobile robot with proportional control algorithm* (Master's thesis). Afyon Kocatepe University Institute of Science and Technology, Afyon.

Yıldırım, E. (2016). The importance of digital game design programs in education. *Journal of Professional Sciences, 5*(2), 12-19.
Yılmaz, F. (2013, October). Revolution in manufacturing Transition from 2D printing to 3D printing. *World Newspaper*.
Yolcu, V., & Demirer, V. (2017). A systematic overview of the studies on the use of robotics in education. *SDU International Journal of Educational Studies, 4*(2), 127-139.
Yüksel, S. (2017). *Effect of the use of the split-join technique in the teaching of the Scratch program on the attitude of the students towards the course, their academic success and permanence* (Master's thesis). Adnan Menderes University, Institute of Social Sciences, Aydın.
Yükseltürk, E., & Altıok, S. (2016a). Perceptions of pre-service information technology teachers about the use of the scratch tool in programming teaching. *Journal of Mersin University Faculty of Education, 12*(1), 39-52.
Yükseltürk, E., & Altıok, S. (2016b). Examination of educational games developed with scratch visual programming tool by IT teacher candidates. *SDU International Journal of Educational Studies, 3*(1), 59-66.
Yükseltürk, E., Altıok, S., & Üçgül, M. (2016). The effects of game programming on primary school students' problem solving skills: a summer camp experience. *ResearchGate.*
Yünkül, E., Durak, G., Çankaya, S., & Mısırlı, Z. A. (2017). The effect of Scratch software on students' computational thinking skills. *Necatibey Education Faculty Electronic Journal of Science and Mathematics Education*, *11*(2), 502-517.

APPENDIX

Table 6. Training plan applied to study 1 group

Module	Week	Activity
Coding	Week 1	Basic Algorithm and Coding Activities aimed at acquiring basic problem solving skills. Definition of coding and its real life equivalent. Using coding for problem definition and solution steps. Basic coding studies with Code.org and similar coding platforms.
	Week 2	Introduction to Coding with Scratch - Dancing Puppets Introducing the Scratch interface and code blocks. Decor library and making your own decor. Adding puppet from the library and creating your own puppet. Giving the puppets the basic movements.
	Week 3	Coding with Scratch - Create Your Own Story Creating a short story scenario. Designing the decor and puppets of the story. Coding the story flow and fixing the errors. Adding sound to the story.
Robotics	Week 4	Robotics with LEGO WeDo 2.0 - Mechanisms -1 (Cogwheels) Robots around us and their tasks. Machines around us and their tasks. Cogwheels systems and motion patterns. Acceleration, deceleration and change of direction with cogwheels systems. Interface and code blocks of WeDo 2.0 software. Animation of the cogwheels system with WeDo 2.0 software.
	Week 5	Robotics with LEGO WeDo 2.0 - Mechanisms -2 (Pulleys) Pulley systems and movement patterns. Acceleration, deceleration and change of direction with pulley systems. Design and coding of a moving pulley system with LEGO WeDo 2.0.
	Week 6	Robotics with LEGO WeDo 2.0 - Racing Car Designing the car that will go the fastest. Coding of the designed vehicle. Race of designed vehicles.
3D Design	Week 7	3D Design with TinkerCad TinkerCad Membership and login to TinkerCad platform. Examination of the TinkerCad interface. Using basic design tools. Designing the given sample objects. 3D printing of the designed keychains.
Digital Game Design	Week 8	Microsoft Kodu Game Lab Ability to add characters to the game field. Ability to add collectible or fixed objects to the game field. Being able to design a score collecting game using the scoreboard.

Table 7. Training plan applied to study 2 group

Module	Week	Activity
Coding	Week 1	Basic Algorithm and Coding Activities aimed at acquiring basic problem solving skills. Definition of coding and its real life equivalent. Using coding for problem definition and solution steps. Basic coding studies with Code.org, CodeMonkey and similar coding platforms.
	Week 2	Basic Electronics, Simple Circuit Design and Introduction to Arduino Coding with mBlock. Voltage, current and resistance concepts. Ohm's law and series/parallel connection. Led circuit designs. Features of the Arduino board. Coding mBlock and Arduino programming led samples with mBlock.
	Week 3	Introduction to Physical Programming with Arduino IDE. Making appropriate settings for Arduino IDE setup. Arduino IDE interface and basic code blocks. LED applications with Arduino IDE.
Robotics	Week 4	Robotics with LEGO Mindstorms EV3 - Basic Mechanical Design and Use of Large Engines Introduction of basic mechanical parts. Relationships between parts. Building the educational robot. Introduction of the software interface. Establishing the connection between the software and the robot. Gaining basic movements to the robot with a large motor.
	Week 5	Robotics with LEGO Mindstorms EV3 - Basic Movements Performing forward and backward movements according to different measurement units. Ability to perform rotation movements appropriately. Completing motion tasks on the theme.
	Week 6	Robotics with LEGO Mindstorms EV3 - Medium Motor and Tasks Medium motor usage. Being able to take the desired object to the desired place. To be able to do the related tasks on the theme.
3D Design	Week 7	3D Design with TinkerCad Membership and login to TinkerCad platform. Examination of the TinkerCad interface. Using basic design tools. Designing the given sample objects. 3D printing of the designed keychains.
Digital Game Design	Week 8	Microsoft Kodu Game Lab Adding characters to the game field. Build the game story by adding craftable objects to the game field. Being able to design a score collecting game using the scoreboard.