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Examining coding skills of five-year-old children

Sermin Metin [1], Mehmet Basaran [2*], Damla Kalyenci [3]

[1] Department of Preschool Teacher Education, Faculty of Education, Hasan Kalyoncu University, Gaziantep, TURKEY
[2] Department of Educational Sciences, Faculty of Education, Gaziantep University, Gaziantep, TURKEY
[3] Ministry of National Education, Adiyaman, TURKEY
***Corresponding Author:** mehmetbasaran@gantep.edu.tr

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ABSTRACT

The purpose of this research is to examine the coding skills of five-year-old children in terms of some variables. The research sample comprises 160 children aged five years studying in kindergarten affiliated with the Ministry of National Education in Gaziantep city center in the 2021-2022 academic year. As a data collection tool in the research, the "personal information form," which includes personal information about children and their parents, and "CodingTest 2", the short form of "CodingTest" and "CodingTest," developed by Kalyenci et al. (2022), were used to evaluate the coding skill levels of five-year-old children. Pearson correlation analysis, t-test, and ANOVA were used to analyze data. As a result of the findings obtained from the research, it was concluded that coding skills were not related to gender but were related to whether the children had coding education, the education level of parents, and their families' income level.

Keywords: early childhood, coding, coding skills

INTRODUCTION

Coding, which is a new literacy of the 21st century, is not only a necessity when we look at the technological developments and the needs of our age, and the responsibilities that will arise in the future, but it is expected that today's children will have skills such as critical for cognitive development, algorithmic thinking, problem-solving, and solving similar situations (Dallasega et al., 2018; Sayin & Seferoglu, 2016).

Developed or developing countries have realized the importance of many skills, such as problem-solving, analytical thinking, computational thinking, critical thinking, and design-oriented thinking to go further in the 21st century and have made changes in their education systems in this direction (Campbell & Walsh, 2017; Harel, 1988; Johnston et al., 2018; Kucukkara & Aksut, 2021; Lee & Junoh, 2019; Manches & Plowman, 2017; Mohaghegh & McCauley, 2016; Rogoff, 1995).

Technological developments reveal the importance of individuals gaining technological skills early on. Knowing the importance of experience in the early years has enabled early childhood classes to be enriched with technological tools. However, using these tools for educational purposes is not enough. Besides, children must gain digital literacy skills to understand these language tools. Coding is a tool for acquiring these skills (Marsh et al., 2016; Sulistyaningtyas et al., 2021).

Early childhood is a critical time to develop core competencies and trends for a future driven by innovation and technology (Marsh et al., 2016). Children should be acquainted with coding, an essential digital literacy and digital language of the age, in their early years (Futschek & Moschitz, 2010). Coding skills gained in the early years will contribute significantly to children's social-emotional, mental, and language development beyond raising future engineers or software developers. (Bers, 2008; Clements, 1999; Lee et al., 2013; Sulistyaningtyas et al., 2021¸ Sullivan & Bers, 2013). Coding also contributes to developing digital literacy skills by enabling children to interact with technology and providing them with basic programming concepts. In this process, children also acquire a symbolic language (Bers, 2008, 2010, 2014, 2018, 2019; Bers et al., 2002, 2022; Cejka et al., 2006; Mason, 2017; Mclennan, 2017; Sullivan & Bers, 2013; Wyeth, 2008).

Coding skills, an important skill to be acquired in the early years and added to the curricula of many countries, have also become an important issue in Turkey, and many studies and educational practices have been made on this subject. For these reasons, determining the coding skills of preschool children and revealing the factors affecting the acquisition of these skills are seen as critical issues in determining the studies and educational approaches in the field. This study was carried out to reveal the factors affecting the coding skills of preschool children.

Table 1. Coding process

Coding content	
Signs	Direction arrows.
Arrangement	Algorithm steps are the instruction steps given while performing.
Debugging	It detects and corrects incorrect statements and operations in the algorithm.
Loops	Repeating a code sequence multiple times.
Modularity	It is the process of breaking down tasks into simpler ones.
Algorithm	The algorithm is the consolidation of smaller tasks into more complex tasks.
Program development	Create a plan for what a program will do.

CODING

Considering the definitions made about coding in the literature, the process algorithm that emerges in compiling and running these commands together in which computers make the operations they can understand into sequences of commands, is called coding (Van Roy & Haridi, 2004). In other words, "it is defined as an application development process using command sets to solve problems, provide human-computer interaction, and perform a specific task by the computer" (Bers et al., 2019; Demirer & Sak, 2016; Fesakis & Serafeim, 2009; Kalelioglu et al. al., 2016; McLennan, 2018; Vorderman, 2019; Wing, 2006).

Coding, which allows analysis, problem-solving, and concept development, creates algorithms by separating problems and expressing these algorithms with a programming language. With coding, an expression tool like language, children also express their thoughts and opinions (Bers, 2008). As with language (Vygotsky, 1978), which is a means of thinking and expressing the obtained knowledge, children also acquire a new way of thinking by learning a programming language (García-Peñalvo et al., 2016).

Coding, a new language, must be taught to children in ways appropriate to their development. Children construct knowledge based on experiences, actively participating, and interacting with peers and adults (Piaget, 1973; Vygotsky, 1980). Bers (2018) defines this experience process as "a developmental progression that begins with discovering what coding activities, programming, and technology are, and results in the ability to deliberately create a program to express themselves in a meaningful way." Concrete experiences are essential in providing learning for children mentally in the preoperational period (Wang et al., 2011). Studies have shown that these activities are successful based on children's active participation (Menon et al., 2019; Sullivan & Bers, 2016; Wang et al., 2011). Many operations and concepts remain abstract for students in the coding teaching process, especially since young children are in the preoperational and concrete operational periods.

Basic skills in coding in early childhood; includes directional signs, sequencing, debugging, function creation, looping, program development, and algorithmic thinking (Futschek, 2006; Kalyenci et al., 2022; Lee & Junoh, 2019; Mittermeir, 2013; Relkin et al., 2021; Welch et al., 2019; Zamin et al., 2018). In addition, K-12 standards for coding skills were set forth by CSTA (2003, 2011, 2019) and ISTE (2016). Coding skills for early childhood are given in **Table 1**.

Supporting children's coding skills has been a rapidly developing field in the international arena. However, the issue of supporting these skills in early childhood has become clear in recent years. Due to the developmental characteristics of early childhood, there has been a widespread belief that coding practices, teaching methods, and techniques should be based on concrete experiences (Bers, 2019; Bers et al., 2019; Futschek & Moschitz, 2010; Kazakoff, 2014; Kazakoff & Bers, 2012; Metin, 2020).

Educational Approaches

Coding education should be based on concrete experiences due to the developmental characteristics of early childhood. According to Piaget (1973), children act with their senses in early childhood to understand and give concrete meaning to the world. However, today, children are exposed to tangible tools and objects and digital and virtual tools (Strawhacker & Bers, 2019). This exposure is realized through technological tools. Papert's constructivism forms the basis of coding and robotics. Influenced by the ideas of Piaget (1973), with whom he worked, Papert took constructivism one step further and developed a constructionism learning approach. While Piaget's (1973) constructivism is based on the person's structuring of information through the information in his inner world, Papert's constructivism also includes the use of computers and technology in this structuring process and the child's construction through these tools (Bers et al., 2014). Many ways are suggested, such as coding in a computerless environment, coding in a computerized environment, robotics, interdisciplinary approaches, and activities. Since programming is abstract, coding activities should be suitable for children's developmental levels and integrated into the curriculum. Here, activity-based non-computer coding (unplugged coding) allows children to perform abstract operations with concrete applications.

Unplugged coding activities allow learning by concretizing abstract concepts and enabling learning to be designed and created. Studies have shown that it is more appropriate for children to learn through activities rather than complex tools such as computers to understand the basic logic of coding (Bell et al., 2012; Bell & Vahrenhold, 2018; Bers, 2018; Metin, 2020; Wang et al., 2011). One of the unplugged activities is the use of robotic tools to support coding skills. Resnick and Rosenbaum (2013) state that educational robotic kits provide meaningful learning. In addition, these robotic kits allow children to collaborate with their peers and see the concrete outputs of their programs more clearly (Bers et al., 2019; Campbell & Walsh, 2017; García-Peñalvo et al., 2016; Resnick & Siegel, 2015; Sullivan & Bers, 2016).

If the concrete product creation phase of coding takes place in the digital world, children do not only manipulate objects; they create them; they learn the rules, test them, and write them; they construct, review, share and renew works in virtual environments. Therefore, coding activities allow students to collaborate with their peers and provide sustainable participation in problem-solving and reasoning (Fox & Farmer, 2011). Thus, studies show that coding practices contribute significantly to the cognitive development of children (Hwang et al., 2008; Grover & Pea, 2013; Kazakoff & Bers, 2012; Kazakoff et al., 2013; Linn & Clancy, 1992; Papadakis et al., 2016; Strawhacker et al., 2015; Strawhacker & Bers, 2019; Turan & Aydogdu, 2020).

21st century skills are the skills that individuals must have, and coding is one of these skills and shows that it should be added to the competencies that every student should gain in their school life (Voogt et al., 2015). Coding provides the necessary motivation for children to learn programming in more detail. In this way, it provides an environment for them to turn their ideas into products and affects their development in many ways (Heikkilä, 2020). Studies carried out; on cognitive and social development, motor skills (Flannery & Bers, 2013), sequencing skills (Caballero-Gonzalez et al., 2019; Chou, 2020; Kazakoff et al., 2013; Kazakoff & Bers, 2014), peer collaboration, social relations (Lee et al., 2013), academic and social experiences (Pugnali et al., 2017), problem-solving skills (Akyol Altun, 2018; Fessakis et al., 2013), creativity (Resnick et al., 2009; Siper Kabadayi, 2019; Sullivan et al., 2017), decision-making skills (Strawhacker & Bers, 2015), self-regulation (Kazakhoff, 2014), and computational thinking (Kalogiannakis & Papadakis, 2017; Kazakoff et al., 2013; Papadakis et al. al., 2016), visual-spatial skills and executive functions (Di Lieto et al., 2017). At the same time, gaining coding skills also gives children 21st century skills such as computational thinking, technology literacy, problem-solving, and critical thinking (Bers, 2008; Bers et al., 2002; Bers & Horn, 2010; Clements & Gullo, 1984; Clements & Meredith, 1993; Kazakoff & Bers, 2012; Lee et al., 2013; Portelance et al., 2016; Strawhacker et al., 2015).

Evaluation of Coding Skills

In the evaluation of coding skills in early years, Bers (2019), Bers et al. (2019), Chaldi and Mantzanidou (2021), González and Muñoz-Repiso (2018), and Sáez-López et al. (2016) survey; Metin (2020), Patan (2016), Sullivan and Bers (2019), and Wang et al. (2011) observation form; checklists of Bers et al. (2019), Kalelioglu (2015), Kalelioglu and Gulbahar (2014), and Pugnali et al. (2017) used a problem-solving inventory.

In recent years, tests with validity and reliability have been developed rapidly. CodingTest by Kalyenci et al. (2022) to measure the coding skills of children (five-seven years); Strawhacker et al. (2022) evaluation of applications made with KIBO robot coding stages evaluation-(*CodingStagesAssessment (CSA)-KIBO); CSA*-ScratchJr (coding stages assessment-ScratchJr) was developed by Unahalekhaka and Bers (2022) to evaluate ScratchJr skills of children (five-seven years). Govind and Bers (2021) developed the KIBO project rubric to assess children's robotic skills. In this study, children's coding skills Kalyenci et al. (2022). The short form of "CodingTest" developed will be tested with "CodingTest 2" and examined in terms of different variables.

Factors Affecting Coding Skills

Approaches and studies on coding education in early childhood, especially conformity to development recommended by the CSTA (2019), ISTE (2016), and NAECY (2012) standards are considered in educational practices. It is an essential factor to be kept in front of students and affects children's coding skills (Campbell & Walsh, 2017; Levy & Mioduser, 2010; Metin, 2020; Resnick & Siegel, 2015; Sullivan & Bers, 2016; Wang et al., 2011). Studies reveal that children can learn to code from age three (Bers et al., 2019; Ciftci & Bildiren, 2020; Papadakis et al., 2016; Strawhacker et al., 2022). Therefore, Bers (2019) emphasizes that early experience is essential for children to learn this artificial language as they learn the language.

Studies and applications for coding, an essential skill, and literacy in the last ten years have increased. Some factors affect children's coding skills. One of the factors affecting children's coding skills is seen as gender. The gap between girls and boys in technology use, access to technology, and gender inequality has been known for years. It is emphasized that gender is essential, especially in success and interest in STEM disciplines and that women tend to this field less (Butler, 2000; Ceci et al., 2009; Heemskerk et al., 2009; Hill et al., 2010; Landivar, 2013; National Science Foundation, 2013; National Center for Women & Information Technology, 2017; Pila et al., 2019; Wang et al., 2013). However, in recent years, efforts to eliminate this inequality have accelerated, and inequality has decreased, especially in STEM fields (Hill et al., 2010; Madkins et al., 2020; National Center for Women & Informational Technology, 2011). Sullivan and Bers (2016) report that gender stereotypes have become more firmly rooted (Metz, 2007; Steele, 1997; Sullivan & Bers, 2016).

Studies on the relationship between coding and gender are limited. It has been tried to start from the studies related to STEM. No or insignificant differences were found in learning STEM content (Martinez et al., 2015; Petersen & Hyde, 2014; Sullivan & Bers, 2013, 2019; Voyer & Voyer, 2014). Sullivan and Bers (2016) kindergarten, Nourbakhsh et al. (2004) high school, and Nourbakhsh et al. (2004) in their study on coding with secondary school children showed that girls and boys are equally enthusiastic and participatory in coding. However, there are also studies showing no relationship between coding and gender in studies conducted with kindergarten children (Papadakis et al., 2016; Pila et al., 2019; Portelance & Bers, 2015). Erete et al. (2016) found that six-year-old girls believe they are better at robotics and programming than boys, but exposure to coding and robotics can alleviate these stereotypes and help develop feelings of self-efficacy.

In recent years, digital applications designed to teach young children coding skills through fun and play have become widespread (García-Peñalvo et al., 2016; Murcia et al., 2020; Seow et al., 2017; Sullivan & Bers, 2013). However, most of these applications require either a tablet or a computer. There may be children who do not have access to these technological tools, or despite the availability of these tools, there may be a lack of skills in terms of parental education status or their necessity and how to guide their children. The family's socioeconomic status affects children's technology use and coding skills.

Research shows that individuals who are disadvantaged in the use of technology have low digital skills, which means that they are also disadvantaged in the labor market. He states that digital skills increase employability in the job market. European Commission (2020); states that low socioeconomic status is associated with low digital skills in most European countries. These findings raise some concerns about the inequality that started in the early years. These concerns are disadvantaged children show less interest in digital technology and tools at school and home, have low digital competence, and tend to work in less skilled jobs

Table 2. Distribution of the sample by demographic characteristics

		n	%			n	%
Gender	Female	85	53.1	Family income level	1,000-5,000 TL	24	15.0
	Male	75	46.9		5,001-9,001 TL	40	25.0
Father working status	Working	160	100.0		9,002-13,002 TL	23	14.4
	Not working	0	0.0		13,003 TL and above	73	45.6
Status of receiving coding training	Yes	103	64.4	Mother working status	Working	98	61.3
	No	57	35.6		Not working	62	38.8
Mother education status	Primary school	0	0.0	Father educational status	Primary school	0	0.0
	Middle School	7	4.4		Middle School	3	1.9
	High school	40	25.0		High school	33	20.6
	Undergraduate	34	21.3		Undergraduate	31	19.4
	Master's degree	66	41.3		Master's degree	73	45.6
	Doctorate	13	8.1		Doctorate	20	12.5

(Karpinski et al., 2021). In addition, access to technology may vary according to race, socioeconomic status, and other factors (Google Inc. & Gallup Inc., 2016). European Commission (2020); found that low socioeconomic status was associated with low digital skills in most European countries. In addition, a 2021 international study revealed that those from economically advantageous backgrounds have higher information technology skills than children from disadvantaged regions (Karpinski et al., 2021).

Kafai and Burke (2014) stated that it is a responsibility to develop the CT skill to return to the schools the coding that has been used and interested mainly by computer scientists until today. Today, coding is recognized by educators, academic and scientific communities as a crucial skill for all children, an international necessity, and even a new form of literacy (Kafai & Burke, 2014; Stamatios, 2022; Papadakis et al., 2016). For this reason, many researchers and countries focused on instructional approaches to CT and coding for preschool children, and many applications were made (Campbell & Walsh, 2017; Johnston et al., 2018; Lee & Junoh, 2019; Manches & Plowman, 2017; Stamatios, 2022).

Resnick and Silverman (2005) state that while everyone believes in the value of learning to program, they know the difficulties of learning to program. They emphasize that many programmers and children can now write simple programs but must go further. As efforts and practices towards coding, which is a skill that should be among the skills such as mathematics, science, and literacy that should be gained in early years, have increased, the programs to be prepared to gain these skills have increased, and nowadays there are applications to support children's coding skills, and the quality of these programs has begun to be discussed. For this reason, many factors must be addressed to prepare developmentally appropriate programs for preschool children. Therefore, this study aimed to reveal the factors affecting children's coding skills. It is thought that the findings of this study will prepare an infrastructure for educational applications to be prepared in the future.

METHOD

Research Design

This research is based on the general screening model. The screening model is a model that is carried out with a sample to be taken from the universe in order to reach a general judgment about the universe with different elements (Buyukozturk et al., 2012).

Working Group

In order to determine the study group consisting of five 160 children attending kindergarten in Gaziantep Province, a convenient sampling method was used due to its convenience in terms of time and workforce (Buyukozturk et al., 2012) (**Table 2**).

Data Collection Tools

The researcher prepared the "personal information form," "CodingTest" was developed by Kalyenci et al. (2022), and the short form "CodingTest 2" were used as a data collection tool to collect information about children and their families.

Coding Test

The "coding test," which measures the coding skills (computerless and robotic coding) of children aged five-seven, was developed by Kalyenci et al. (2022). The test consists of two forms to measure computer-free coding skills (form A) and robotic coding skills (form B). A validity and reliability analysis of the test was performed. The reliability results of the test were found to be KR-20=0.973>0.70 for form A and KR-20=0.978>0.70 for form B.

Form A contains a 9×9 square coding sheet, signs, and story cards, while form B contains a 6×6 square coding sheet, story cards, and a robotic tool. Each form consists of two examples and six applications. The coding skills in the applications are ordered from simple to challenging. Each app measures different coding skills and has a plot-related story. Form A consists of 13 items, and form B consists of 14 items, and correct and incorrect answers are scored (0/1).

All materials are introduced to the children during the application process, and the application starts when the child is ready. The practitioner tells a story for each question, and the child is expected to show the coding with his finger first and then code using the cards on the coding carpet. The practitioner records the child's answers. Before moving on to the next question, the child

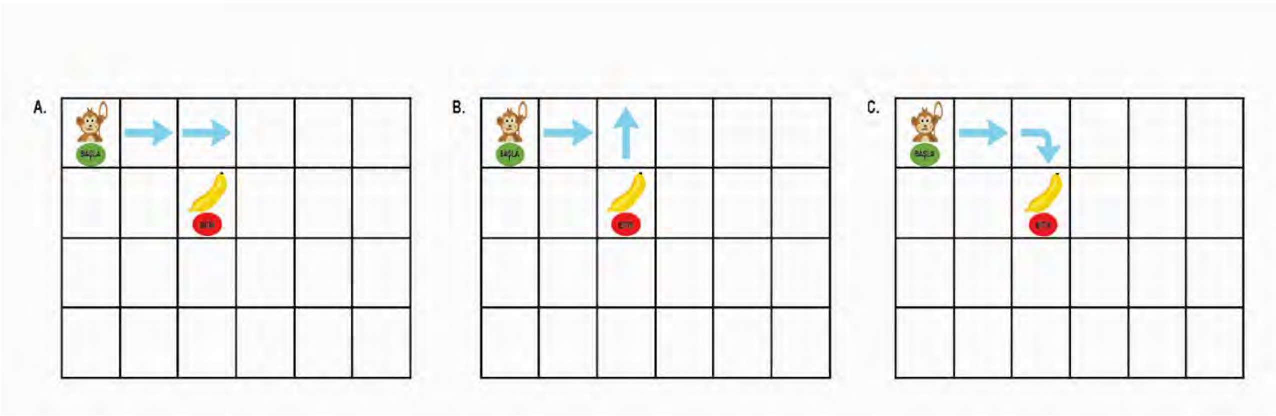

Figure 1. “CodingTest 2” stylish (Kalyenci, 2020)

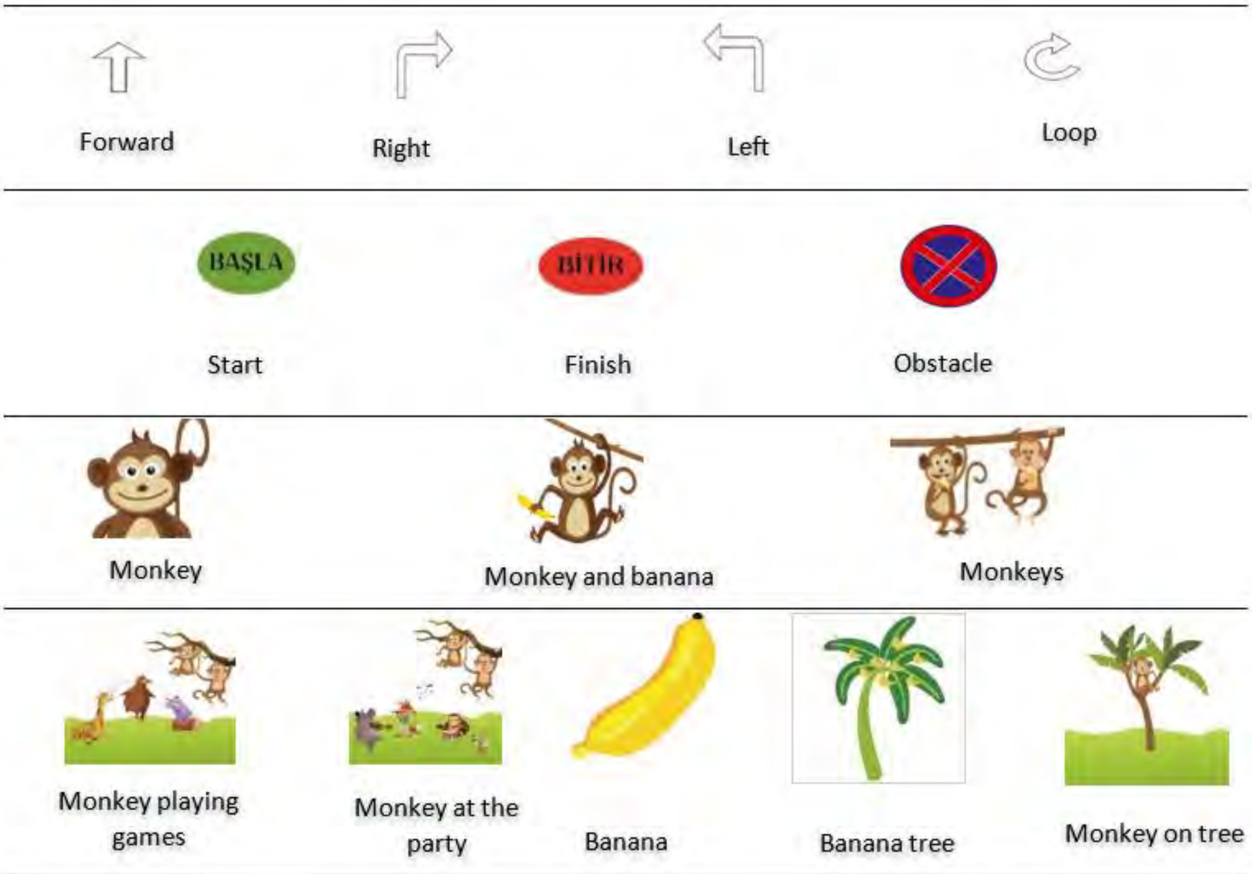

Figure 2. “CodingTest 2” signs and images (Kalyenci, 2020)

is expected to put the cards back in their place. The application of the test takes an average of 30-45 minutes. Practitioners must receive special training and materials to use the CodingTest. The reliability analysis of CodingTest 2 was made to reach more people, save application time, and provide ease of use.

Coding Test 2

The reliability of “CodingTest,” the short form of “CodingTest,” was checked to measure children’s coding skills without a computer easily and quickly. For the short form of Coding Test 2, the stories were shortened, and three visual response options (**Figure 1**) to evaluate each skill were added. Answer options consist of 6×6 squares. Before the application, a page introducing the materials was added to the children (**Figure 1** and **Figure 2**). As in the original test, the child is read the story of each question and is expected to say or show the correct option from among the three options.

In order to check whether the questions in the test are clear and understandable, whether they measure the skill to be measured, and whether they are scientifically appropriate (Baykul & Guzeller, 2015), the opinions of nine experts were taken (two instructional technologies education, two child development, and education, two preschool education, measurement and evaluation, graphic and visual arts, and a Turkish language and education lecturer). The pre-application of the modified test was tested on 30 children with different socioeconomic conditions. The individual test takes 10-15 minutes on average.

Table 3. Result of Pearson correlation analysis

	n	Pearson's	p-value
CodingTest-CodingTest2	160	0.967*	<.001

Note. *p<.001

Table 4. t-test results of coding skill scores by gender

	Group	n	Mean	SD	SE	t	p-value
Codiing	Male	75	0.140	4.836	0.558	0.140	0.889
	Female	85	0.074	4.638	0.503		

Table 5. t-test results of coding skill scores according to previous coding training status

	Group	n	Mean	SD	SE	t	p-value
Codiing	Trainee	103	11.155	1.803	0.178	24.711	<0.001
	Uneducated	57	2.404	2.658	0.352		

"CodingTest 2" can be applied using a tablet, computer, and A4 paper. The application to be made with an A4 paper has been prepared, so there will be question-and-answer options on one page. The coding carpet in the test consists of 6×6 squares. Six applications in "CodingTest" were transformed into two sample questions and 11 main questions in "CodingTest 2". The stories in "CodingTest 2" are shorter than the stories in "CodingTest," and there are three answer choices for each question (**Figure 1**). Only one of these answer choices is the correct answer. The child who writes or says the correct answer to the question gets one point, and the child who shows the wrong answer gets zero points. Application 6 in "CodingTest" corresponds to Question 11 in "CodingTest 2". Question 11 measures children's programming skills. There are no answer options in question 11. Here, the child is expected to draw by making his program. If the child makes and draws the program, he gets one point; if he cannot program or draw, he gets zero points. A total score of 11 points is taken from the test.

During the application phase of the test, the test or tablet is placed so the child can easily see it. The practitioner reads the questions and asks the child to show or mark the answer option. The application of the test starts with sample question 1. If the child answers sample question 1 correctly, the test is started, and if the child gives a wrong answer, sample question 2 is asked. The primary practice starts with the child who answers sample question 2, and the test is terminated when answered incorrectly. Guiding answers are not given to the child's questions about what to do during the test application, and the practitioner does not make any other explanations by rereading the question.

Data were collected using "CodingTest" and "CodingTest 2". The application was made in a quiet room and individually—the practitioner communicated with the child by chatting before the application. First, the "Coding Test" and then "Coding Test 2" were administered to 80 children. "CodingTest 2" was applied first to the other 80 children, and then "CodingTest" was applied. In the application phase of the test, first, the heroes of the story in the test and the coding signs are introduced. At the practice table, the practitioner and the child sit face to face. "CodingTest 2" was administered to 80 children using the A4 printout and the other 80 children using tablets. Before the application, the practitioner opened the page with the signs in the test and the images related to the story, chatted with the child, and introduced the materials. After the practitioner's questions, which were put into practice, were read comprehensibly and clearly, he was asked to choose one option. He recorded the answers given by the child. The application took about five-10 minutes.

As a result of the correlation analysis (**Table 3**), it was seen that the relationship between "CodingTest" and "CodingTest2" was significant and positive (r=.967, p<.001).

Analysis of Data

Data analysis was conducted using the SPSS 23 statistical package program and the Jamovi package program to determine the children's coding skills. The data set was examined with QQ graphs and determined to show a normal distribution. Descriptive statistics (arithmetic mean, standard deviation), t-test for independent samples, and one-way analysis of variance (ANOVA) were used in data analysis.

RESULTS

The findings of the study, which examined the coding skills of five-year-old children according to some variables, are presented below.

Table 4 shows no statistically significant difference between the mean scores of children's coding skills ($t_{(4,836)}$=0.889) according to gender. This finding shows that gender does not affect children's coding skills.

It was found that the children's coding education made a significant difference in their coding skill mean scores (t[1.803]=24.711). The coding skill averages of the children who had previously received coding education (X=11.155) were significantly higher than those who did not (X=2.404) (**Table 5**).

It was determined that the difference between the children's coding skill scores and the mother's education level was statistically significant (**Table 6**). The coding skill means the score of the children whose mother's education level is a university (X=7.91) is higher than the mean (X=3.25) of the children whose mother's education level is a secondary school (X=2.14) and high

Table 6. ANOVA results of children's coding skills according to their mothers' educational status

Variables		SS	SD	MS	F	p-value	Significant difference
Coding skills	Between groups	2,011.137	4	502.784	51.048	.000	University>Middle school, High school Masters>Middle school, High school PhD>Middle school, High school
	Within groups	1,526.638	155	9.849			
	Total	3,537.775	159				
	Within groups	910.334	155	5.873			
	Total	2,360.975	159				

Note. *p<.05

Table 7. ANOVA results of children's coding skills according to their fathers' educational status

Variables		SS	SD	MS	F	p-value	Significant difference
Coding skills	Between groups	1,888.593	4	472.148	44.375	.000	University>Middle school, High school Masters>Middle school, High school PhD>Middle school, High school
	Within groups	1,649.182	155	10.640			
	Total	3,537.775	159				
	Within groups	1,023.905	155	6.606			
	Total	2,360.975	159				

Note. *p<.05

Table 8. ANOVA results of children's coding skills by family income

Variables		SS	SD	MS	F	p-value	Significant difference
Coding skills	Between groups	2,512.066	3	837.355	127.353	.000	13,003 TL and above>9,002-13,002 TL and 5,001-9,001 TL
	Within groups	1,025.709	156	6.575			
	Total	3,537.775	159				
	Within groups	626.369	156	4.015			
	Total	2,360.975	159				

Note. *p<.05

school. Similarly, the coding skill mean scores of the children whose mothers had a master's degree (X=10.93) were higher than the averages of the children whose mothers had secondary education (X=2.14) and high school (X=3.25). On the other hand, the mean of coding skills (X=12.08) of the children whose mother's education level is doctorate is higher than the children in secondary school (X=2.14) and high school (X=3.25).

It is seen that there is a significant difference between the mean scores of children's coding skills and the education levels of the fathers (**Table 7**). The mean coding skills of the children of fathers with university education (X=5.03) are higher than those of fathers with secondary school (X=1.67) and high school (X=3.15). Similarly, the mean coding skills of the children of fathers with a master's degree (X=10.75) are higher than those of fathers with secondary school (X=1.67) and high school (X=3.15). In the same way, the mean coding skills of the children of fathers with a doctorate (X=11.80) are higher than those of fathers with secondary school (X=1.67) and high school (X=3.15).

The children's coding skill scores and the family's income status were statistically significant (**Table 8**). The coding skill mean score of the children whose family income is 13,003 TL and above (X=11.59) is higher than the mean score of the children whose family income is 13,003-13,002 TL (X=10.17) and 5001-9001 TL (X=3.18). This shows that the children's coding skills increase as the family income level increases.

DISCUSSION, CONCLUSION, AND IMPLICATIONS

In this study, the coding skills of five-year-old children were revealed according to certain variables. The research examined the reliability of "CodingTest 2", the short form of "CodingTest." As a result of the reliability analysis of the "Coding Test," whose validity and reliability studies were conducted, it was seen that the short form of the test, "Coding Test 2", is a valid tool for measuring coding skills. "CodingTest 2" has been developed because the application of "CodingTest" requires unique materials and a long time. This test provides convenience to practitioners in terms of being able to be applied with both paper and digital technology tools and saving time.

In the study, the relationship between coding skills and gender was examined, and it was seen that gender did not significantly affect coding skills. Sullivan and Bers (2016) state that there are stereotypes about boys and girls in STEM fields and technology. However, their study has revealed that girls and boys showed the same interest in the robotic kit they used, and if appropriate materials were provided, the gender difference would disappear. Sullivan and Bers (2013, 2016, 2019) also revealed that gender does not make a significant difference in their other studies on programming. On the other hand, Papadakis et al. (2016) and Pila et al. (2019) also conducted studies supporting these views.

Contrary to studies stating that gender does not make a difference in coding skills, Gomez and Benotti (2015) stated in their study with children aged three-11 that girls performed slightly better than boys in essential computer science concepts of children. Nourbakhsh et al. (2004) found that girls initially had less confidence in technology than boys, but their self-confidence increased significantly throughout the course. Nourbakhsh et al. (2004), in another study with high school students, found that girls initially had difficulty programming and had less self-confidence, but at the end of the course, girls' self-confidence increased more (Nourbakhsh et al., 2004).

Another finding from the research is that the children's coding skills are affected by the educational status of their parents. The higher educational status of parents allows children to have a more advantageous background. Thus, children with good backgrounds are more exposed to technological tools, allowing them to develop their coding skills better from their early years (Karpinski et al., 2021). It can be said that the high education level of the parents and their awareness of the importance of digital competence for children contribute to the development of coding skills.

The income status of families also creates a significant difference in the development of children's coding skills. Robotic kits and applications are of great importance in developing coding skills. These technological tools and applications require families to have a certain socioeconomic level, equipment, and knowledge (García Peñalvo et al., 2016; Sullivan & Bers, 2013, 2019; Sullivan et al., 2017). When suitable environmental conditions are provided for children to access technological tools, these tools support their coding skills (Ananadou & Claro, 2009; Govind & Bers, 2020; Lee & Junoh, 2019; Resnick & Siegel, 2015; Sullivan & Bers, 2016). Research reveals that disadvantaged children have low digital skills and that socioeconomic conditions affect their access to and use of technology (European Commission, 2020; Google Inc. & Gallup Inc., 2016; Karpinski et al., 2021).

Coding skills, one of the basic concepts of 21st century skills, new literacy, and computer science, are among the essential skills children should acquire in their early years. Factors that affect coding skills, which are tried to be added to educational environments and curricula, are essential in structuring these programs. In this study, while the gender of the children is not a factor in their coding skills, the family's education and income status affect the children's coding skills. The level of awareness of the family towards education and the educational needs of their children in the developing technological world enables them to support their children in this direction. In addition, it is seen that children's access to technology and the family's income status are essential factors in integrating technology into education. For this reason, it is thought that educational practices to support children's coding skills in the early years should consider the educational status of the family, raise awareness of families on this issue, and work to support families who have difficulties in accessing technology will increase the impact of educational practices in this area.

In this study, the coding skills of five-year-old children were examined in terms of gender, educational status of parents, and income level of the family. Based on these findings, it can be suggested that future studies should be conducted to evaluate children's coding skills over different variables and different age groups.

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