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The Effect of Coding Education on Analytical Thinking of Gifted Students

Berrak Kocaman*
Ministry of Education, TURKEY

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Abstract: This research aims to examine the effect of coding education on the analytical thinking skills of gifted students. The participants are 18 students, 11 to 12 years old. An embedded experimental mixed design was used in the research. The data collection was carried out with the Analytical Thinking Skill Scale to determine the difference in the analytical thinking skills of the study group before and after the coding training; the Analytical Thinking Skill Observation Form to determine the analytical thinking skill levels during the implementation process; and the semi-structured interview form to get their opinions on the coding training. The data were analyzed with a pre-test-post-test quasi-experimental design, descriptive analysis, and content analysis. The results show that coding education developed the participants' analytical thinking skills. The difference in the analytical thinking skills of the study group was not statistically significant in terms of gender. According to the students' views on the coding education application process, there was an improvement in the sub-dimensions of sorting, classification, comparison, and evaluation in analytical thinking skills; coding education developed problem-solving and thinking skills, was useful, encouraged students to choose a profession, and was entertaining, as well as negative opinions such as being difficult, boring, and requiring a lack of time.

Keywords: *Analytical thinking, coding, gifted students.*

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Introduction

In the twenty-first century, individuals are expected to develop skills such as problem-solving, analytical thinking, critical thinking, creativity, cooperation, communication and technology literacy (Partnership for 21st Century Skills, 2018). Technology literacy, which is defined among these skills, is actually the coding skill, which is a complex and difficult process. As a result, one of the 21st century skills preparing kids for the future is coding (Sayın & Seferoğlu, 2016). Coding (programming) is expressed as the whole of the series of commands written in order to ensure the interaction between computers and other technological tools and people and to have certain tasks done according to the processing steps (Sayın & Seferoğlu, 2016). Coding is not only about creating a program but also producing original solutions to problems (Shin et al., 2013).

In many studies in the literature, it has been seen that coding education contributes to higher-order thinking (Fessakis et al., 2013; Hwang et al., 2008; Nouri et al., 2020; Oluk et al., 2018; Rodríguez-Martínez et al., 2020; Sáez-López et al., 2016). Considering that analytical thinking skills form the basis of high-level thinking, coding training should be given for the development of analytical thinking skills of gifted students.

According to the World Economic Forum (WEF, 2020) report, the definition of analytical thinking is stated as the capacity to investigate information and use logic to solve problems and issues, and to employ different thinking to develop new, innovative, and original ideas and answers. For this reason, it is seen that the qualities of analytical thinking and the characteristics of coding skills are compatible with each other. According to Sternberg (2003) analytical, creative, and practical abilities enable people to be successful in their own specific social and cultural contexts, and individuals who achieve this success are called gifted individuals. A person's ability to regulate and use any or all of their intellectual, analytical, and creative abilities when necessary is at the heart of what is considered to be giftedness. Students who excel in creativity can produce good ideas, but they need a high level analytical ability, which requires them to assess opinions to be more productive (Stemler et al., 2009). This situation justifies that gifted students should develop their analytical thinking skills.

* **Correspondence:**
Berrak Kocaman, Ministry of Education, Salihli, Manisa, Turkey ✉ berrak.kocaman4@gmail.com

Gifted students, like the others, need opportunities to take care of and increase their knowledge and reasoning skills (Sternberg & Grigorenko, 1997). When all these characteristics of gifted students are taken into account and supported by the necessary environment, it is predicted that they will manage to improve their 21st century skills and grow up as useful individuals for their country. Considering that gifted students, who can change the world and lead countries, are an economic value for society, it is crucial to present opportunities for these students to develop 21st century skills such as productive thinking and problem solving. According to Özçelik and Akgündüz (2018), coding education has the potential to allow gifted students to develop solutions to global problems that they are more sensitive to than their peers, as well as to combine different disciplines.

Coding improves students' computational thinking, which includes problem solving beyond coding skills (Lye & Koh, 2014). Wing (2006) defines computational thinking as a form of analytical thinking that aims to understand human behavior and proposes a pattern related to basic concepts, produces system designs for problem solving, and processes information. In recent years, there has been an increase in studies accepting a relationship between computational thinking and coding (Bocconi et al., 2016; Wing, 2017). However, studies on analytical thinking and coding are scarce in the literature. This study will not focus on computational thinking. However, although it is understood that computational thinking is a form of analytical thinking in the definition, this study will focus on analytical thinking and its sub-dimensions.

When the literature is examined, it is seen that there are studies concerning gifted students and coding (Ashenfelter, 2017; Hagge, 2017; Schroth et al., 2019; Siegle, 2009; Wang et al., 2014; Yıldız-Durak & Güyer, 2019). However, it has been determined that there is a lack of studies in which the high-level thinking skills, which should exist in gifted students and are based on analytical thinking, are examined through coding.

In this context, the aim of the study is to determine the effect of coding education on the analytical thinking skills of gifted students at the secondary school level. It is thought that the results of this study will fill this gap in the literature and will be a source for future studies in this field. The following questions are formed under this general purpose:

1. Is there a significant difference in the analytical thinking skills of gifted students studying coding?

2. What is the level of analytical thinking skills of gifted students studying coding?

3. What are the views of gifted students about coding education?

Methodology

Research Design

Embedded experimental mixed design, one of the types of mixed model design, was used in the research. This design is used when the researcher incorporates qualitative data before or after the experimental process or in the experimental application process (Creswell & Plano Clark, 2015). One method is contained within the other. Priority is given to the quantitative methodology, and the qualitative dataset is supportive (Creswell & Plano Clark, 2007). The obtained quantitative and qualitative data are necessarily mixed. Multiple inferences are made by integrating the results after the analysis (Teddlie & Tashakkori, 2009). In the study, a single group pre-test post-test experimental design was used in the quantitative approach of the embedded experimental mixed design, and a case study design was used in the qualitative approach. In the experimental phase of the study, the effect of coding education on analytical thinking skills was examined. Before the application, quantitative data were collected with the Analytical Thinking Skills Scale (ATSS). During the implementation process, the change in the analytical thinking skills of the study group was determined through the Analytical Thinking Skill Observation Form (ATSOF). At the end of the application, students' opinions and qualitative data were collected and analyzed. After the application, post-test data were collected and analyzed with ATSS. In this way, inferences were made by integrating the results obtained as a result of the analysis of quantitative and qualitative data.

Sample and Data Collection

The study group consisted of 18 secondary school students aged 11-12 in Salihli Science and Art Center who were reported to be gifted with certain tests. The group was divided into 3 with six people in each and participated in the practice for four hours a week. The application was completed in 6 weeks and took a total of 72 hours.

Three different tools were used to collect the data. These are the Analytical Thinking Skills Scale (ATSS) to determine students' analytical thinking skills, the Analytical Thinking Skills Observation Form (ATSOF) to determine students' analytical thinking skills throughout the application, and the Student Interview Form (SIF) to determine students' opinions about the application process.

ATSS, which is used to find out if coding education had an effect on the analytical thinking skills of gifted students, was developed by Kocaman (2022). It is a 5-point Likert-type scale that includes 29 items and consists of 4 sub-dimensions: sorting, classification, comparison, and evaluation. There are six items in the sorting, five items in the classification, eight items in the comparison, and ten items in the evaluation sub-dimension.

ATSOF was developed by Kocaman (2022). The researcher aimed to ensure that the analytical thinking skills determined for ATSS were also compatible with the observation form. For this reason, ATSOF was created by taking into account the sorting, classification, comparison, and evaluation sub-dimensions in ATSS. It is a 5-point Likert type consisting of 33 items as follows: always observed (5), often observed (4), sometimes observed (3), occasionally observed (2), and never observed (1).

The SIF developed by the researcher was applied to collect the opinions of participants about coding education. In order to ensure the validity and reliability of the prepared draft of it, it was submitted to the opinion of two experts in the field of science education and two science teachers, and necessary arrangements were made. The questions created are: "What did you pay attention to while writing the algorithm? What skills did creating algorithms and coding develop? What were the positive features of the coding education? What were the negative features of the coding education?"

Application

This study was carried out within the scope of the Information and Communication Technologies course in the Science and Art Center, where gifted students are educated at the secondary school level. 18 students were divided into 3 groups of 6 people and each group participated in the practice for 4 hours a week. The application was completed for 6 weeks and took a total of 72 hours. The students in the group in which the research was conducted had not received any training on coding before.

First of all, lesson plans for coding practice were prepared. In order to prepare lesson plans, the Computer Programming and Robotic Coding Training Course Program (Ministry of National Education [MoNE], 2021) published by the MoNE was examined, and lesson plans were created by adding the attainments for analytical thinking skills on the basis of this program. Course durations and training contents were determined by two gifted trainers and a computer trainer. Draft lesson plans were presented for the feedback of two expert computer teachers who work with gifted students. Required corrections were made according to experts' comments. In the coding training application, the application was carried out through a computer for each student and a smart board belonging to the trainer.

Coding training was carried out by an instructor working as a technology and design teacher in the Science and Art Center, where gifted students are educated. Applications were made with the "scratch" application. Scratch is based on the ideas of the constructivist learning and "logo" project (Papert, 1980) and a free programming language in which interactive stories, games, and animations can be created. This program also allows students to create and develop programs related to animations, games, interfaces, and presentations that can broaden their understanding of computing concepts and applications. The Scratch application aims to provide an accessible starting point for learning for students with limited or no programming background (Good, 2011). Students learned to create algorithms in the first week of the 6-week period. During the second and third week, they learned the basics of programming with Scratch. For the next three weeks, they produced solutions to the problems presented to them using scratch. They designed an animation and a game for solving problems. The process information for the application is given in Table 1.

Table1. Coding Implementation Process

Duration	Activity	Application
4 class hours	Algorithm Development and Problem Solving	1. The concept of algorithm was defined. 2. They were asked to write down the algorithm of what they do in daily life step by step. 3. The order of the steps for solving a problem was identified. 4. They expressed the algorithm they develop for solving a problem in lines. They also explained the sequential operations in the algorithm. 5. They showed the solution of a problem that requires sequential operations with a row algorithm.
4 class hours	Recognizing Code Blocks	1. The features and types of code blocks (Motion, Looks, Sound, events, control, sensing, operators, variables, my blocks) were explained. 2. Coding was done using the drag-and-drop method. 3. They implemented sequential operations using coding blocks
4 class hours	Using mathematical operations (Spirit and Stage)	1. The concept of the coordinate plane was explained. 2. The X and Y axes were explained in the coordinate plane. 3. The students practiced moving the puppet right, left, up and down on the coordinate plane with block codes. 4. They changed the puppet's view dimensions. 5. They changed the decor of the stage.

Table1. Continued

Duration	Activity	Application
4 class hours	Problem identification and coding	1. The problem of creating a short story using at least two puppets and a scene was given. 2. Algorithm was created by the students by determining the priority order with code blocks for the problem. 3. Coding was done in accordance with the algorithm. Each student provided an application.
4 class hours	Creating an Animation	1. An animation coding that would change the type of decor and the size of the puppets was identified as a problem. 2.Students first created the algorithms and animation coding using different code blocks. All students carried out the application.
4 class hours	Creating a Game	1. Creation of a game with a scoring problem was identified. After the students created the necessary algorithm, they coded the game they determined with code blocks.

Data Analysis

In the research, first of all, the normality test was conducted to determine the type of test to check if there was a significant difference in the analytical thinking skills of the study group before and after the application. The study group consists of 18 people. When the number of observations is low (n<50), the Shapiro Wilks test is more powerful than the Kolmogorov-Smirnov test (Büyüköztürk, 2010). The results of the normality test of the data obtained from the pre-test and post-test analytical thinking skills scale are given in Table 2.

Table 2. Distribution of Data

Groups	N	Kolmogorov Smirnov	ShapiroWilk	Skewness	Curtosis	Standardized Error
Pre-test	31	.200	.758	.232	-.616	.147
Post-test	31	.093	.306	.746	.827	.236
Post-test-pre-test difference	31	.155	.927	.555	1.543	.222

According to the Shapiro-Wilk test, normality was observed (p<.05). Skewness and kurtosis values are compared with ±1.96 for 5% significance level (Büyüköztürk, 2010). When the Skewness value (.555) and kurtosis value (1.543) are examined in the table, it is seen that they provide normality.

In order to determine whether there is a difference in the analytical thinking skills and sub-dimensions of gifted students receiving coding training, the ATSS was applied as a pre- and post-test and analyzed with the paired t-test. In this section, effect analyses were made on the findings in order to evaluate the findings obtained from the data in a more reliable way and the comments were made in line with these analyses. The most commonly used calculation in the calculation of the effect size is the calculation of (d) developed by Cohen (1988, as cited in Yıldırım & Şimşek, 2011). A d value of less than 0.2 is defined as weak, an effect size of 0.5 is considered medium, and a value greater than 0.8 is defined as strong (Yıldırım & Şimşek, 2011).

In this section, effect analyzes were made on the findings in order to evaluate the findings obtained from the data in a more reliable way and the comments were made in line with these analyzes. The Cronbach's alpha value for the reliability of ATSS development research was determined to be 0.86. Reliability values were determined as .79 in the sorting sub-dimension, .77 in the classification, .85 in the comparison, and .89 in the evaluation. In this study, the Cronbach's alpha value for the ATSS was found to be 0.84. In the ranking sub-dimension, the pre-test is.71, and the post-test is.74; in the classification sub-dimension, the pre-test is .73, and the post-test is .76; in the comparison subscale, the pre-test is .78, and the post-test is .81; and in the evaluation subscale, the pre-test is .83, and the post-test is .85.During the coding education process, the development of analytical thinking skills in the study group was determined by ATSOF and weekly distribution was given in the graphics using descriptive statistics. The classification of students' ATSOF scores is as follows: 1.00-1.80 very low, 1.81-2.60 low, 2.61-3.40 medium, 3.41-4.20 high, and 4.21-5.00 very high. The Cronbach alpha coefficient was determined to be .82 as a result of the ATSOF reliability analysis. It was determined to be .78 in this study.

Qualitative data were written by two researchers and analyzed thematically to ensure inter-rater reliability. In the study, first of all, each data collection tool was examined, and the data were systematically divided into categories in line with the answers from the students and the notes taken by the researcher during the process by the researcher and the observer participating in the application. Then, the common areas were gathered under the theme, and sub-categories of these organized themes were created. Interview data were analyzed using ATLAS.ti text analysis software

version 8 to establish relationships between words and phrases. The themes that emerged as a result of the content analysis of the data obtained from the data collection tools after the research are analytical thinking skills, positive opinions and negative opinions. Themes, codes, and quotations from the participants are explained in detail in the findings section.

In order to ensure validity and reliability in qualitative data in the research, the researcher should be consistent in data collection, analysis and interpretation, and the researcher is expected to reveal how s/he reached the results (Yıldırım & Şimşek, 2011). In the process of preparing the interview form for semi-structured interviews, a computer teacher and a gifted education specialist worked together. While developing the content of the interview questions, the national and international literature was reviewed. In the interview form, expert opinion was taken from three instructors who teach gifted students. With this view, the number of questions was reduced from 10 to 5. With the final version of the form, interviews were held with 5 gifted students for pre-application. The number of questions was reduced from 5 to 4, and the sentence structures of the questions were changed. In qualitative research, the use of interviews in the last step of the research is the most appropriate time period for the study (Fraenkel & Wallen, 2005). For this reason, the interviews took place during the week when the training ended. It was realized with the permission and voluntary participation of gifted students and their parents. Each interview with individual students lasted for 8 to 10 minutes on average. All interviews were audio-recorded to prevent data loss. The data obtained in the student interview questions were written by two researchers to ensure inter-rater reliability and were analyzed thematically by content analysis. Within the scope of the themes and codes created in the light of the data obtained, the issues with "consensus" and "disagreement" were discussed and necessary arrangements were made. The reliability formula suggested by Miles and Huberman (1994) was used to calculate the reliability of the study: Reliability = Consensus / (Agreement + Disagreement). The method yielded an estimate of 82% dependability for the study. For research, reliability calculations over 70% are regarded as reliable (Miles & Huberman, 1994). This result is thought to be trustworthy for study.

Findings / Results

1. Is there a significant difference in the analytical thinking skills of gifted students after studying coding? For the sub-problem, it was examined whether there was a significant difference between the analytical thinking skills of the students before and after the application. Paired t-test results for students' pre- and post-test scores are given in Table 3.

Table 3. Pre and Post-Test Analysis for ATSS

Dimension	Group	N	$\bar{X}$	SD	df	t	p	d
ATSS	Pre	18	3.16	.147	17	25.473	.00	-.681
	Post		4.50	.236				
Classification	Pre		3.22	.221	17	-17.015	.00	.324
	Post	18	4.53	.225				
	Pre		3.06	.314	17	-15.561	.00	.501
Sorting	Post	18	4.45	.235				
	Pre		3.13	.260	17	-12.924	.00	.380
Comparison	Post	18	4.46	.421				
	Pre		3.20	.214	17	-15.584	.00	.471
Evaluation	Post	18	4.53	.337				

In Table 3, it is seen that there is a statistically significant difference in favor of post-test scores in the paired t-test results (t= -25,473, p.00) for ATSS pre-test post-test mean scores. ATSS post-test mean score ($\bar{X}$ = 4.50) is higher than pre-test mean score ($\bar{X}$ = 3.16). At this point, an effect size analysis was carried out in order to evaluate the findings of the research more accurately, and the Cohen's d value was found to be 0.681. It shows that the coding education applied has a moderate level effect.

A significant difference was found for ATSS pre-post-test mean scores for the classification sub-dimension is (t= -17,015, p.=00), for the sorting (t= -15,561, p.=00), for comparison (t= -12.924, p.=00) and the evaluation sub-dimension (t= -15,584, p.00). The post-test mean scores are higher in all subdimensions as classification sub-dimension post-test mean score is ($\bar{X}$ = 4.53), pre-test mean score ($\bar{X}$ = 3.22); sorting sub-dimension post-test mean score ($\bar{X}$ = 4.45), pre-test mean score ($\bar{X}$ = 3.06); comparison sub-dimension post-test mean score ($\bar{X}$ = 4.46), pre-test mean score ($\bar{X}$ = 3.13); assessment sub-dimension post-test mean score ($\bar{X}$ = 4.53), pre-test mean scores ($\bar{X}$ = 3.20). According to these findings, it was seen that the experimental application was significantly effective in favor of the post-test in the sub-dimensions of ATSS. At this point, an effect size analysis was performed in order to evaluate the findings of the research more accurately and the effect sizes (Cohen's d value) were found to be 0.324 for the classification sub-dimension, 0.501 for the sorting sub-dimension, 0.380 for the comparison sub-dimension, and 0.471 for the evaluation sub-dimension. It was determined that the coding education applied according to the obtained values had a moderate effect on the difference between the pre-test and post-test average scores in its sub-dimensions.

2. What is the level of analytical thinking skills of gifted students studying coding? For the sub-problem, the analytical thinking skills of the students were monitored weekly by the researcher and the observer throughout the coding education implementation process, and the results of the observation were recorded in the ATSOF separately for each student. According to the ATSOF, the weekly analytical thinking skill levels of the students throughout the implementation process are given in Table 4.

Table 4. ATSOF Weekly Mean Scores

ATSOF	N	$\bar{X}$	Min.	Max.	Sd
Week-1	18	3.11	2.64	3.79	.274
Week-2	18	3.27	3.00	3.55	.146
Week-3	18	3.56	3.15	4.91	.436
Week-4	18	3.72	3.18	4.91	.431
Week-5	18	4.04	3.61	4.58	.265
Week-6	18	4.17	3.61	4.94	.296

According to Table 4, the average scores for analytical thinking skills from the first week were 3.11, 3.27, 3.56, 3.72, 4.04, and 4.17. In Figure 1, weekly changes in analytical thinking skills and its sub-dimensions are given.

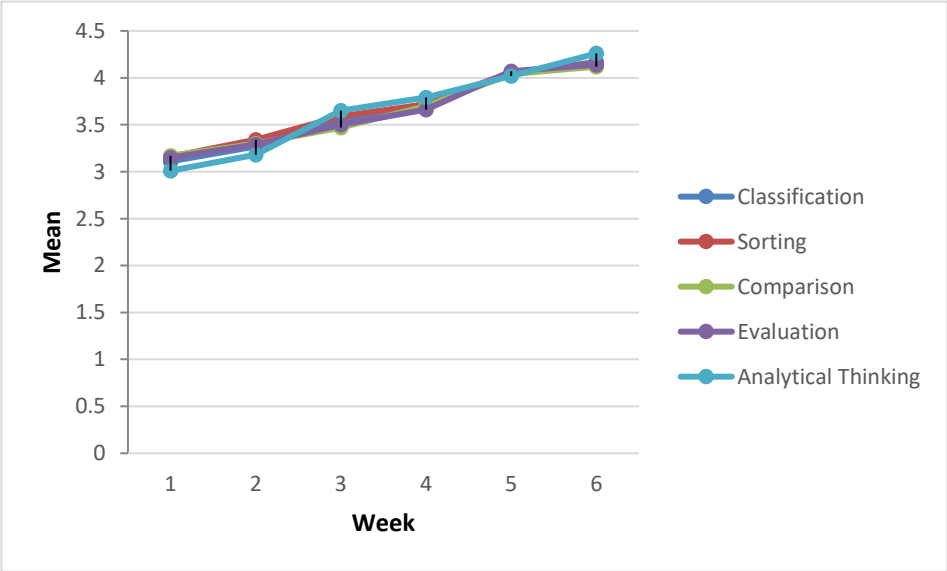

Figure 1. Students' Analytical Thinking Skill Levels during Coding Education Application

According to Figure 1, it is seen that the level of analytical thinking skills of the students increased with the application of coding education. In the analytical thinking observation form, the evaluation of the sub-dimensions of analytical thinking skills such as sorting, classification, comparison, and evaluation throughout the application are given in this section. The average scores of sorting skills from the first week were 3.17, 3.30, 3.47, 3.70, 4.04, and 4.12. While the average score of sorting skill was at a moderate level of 3.17 in the first week, it increased to a high level with 4.12 in the last week. The weekly average scores of classification skills are 3.15, 3.29, 3.50, 3.66, 4.07, and 4.14. While the average score of classification skill was 3.15 in the first week, it increased to a high level with 4.14 in the last week. The mean scores of comparison skills were 3.16, 3.34, 3.59, 3.72, 4.06, and 4.15. While the mean score of comparison skill was at moderate level of 3.16 in the first week, it increased to a high level with 4.15 in the last week. The average score of evaluation skills was 3.01 in the first week while in the following weeks it was respectively 3.18, 3.65, 3.79, 4.02, and 4.26. While the mean score of comparison skill was at a moderate level as 3.01 in the first week, it increased to a high level with 4.26 in the last week. According to these findings, it is seen that there is an increase in the analytical thinking skills and sub-dimension scores of the students after the coding training.

3. What are the opinions of gifted students about coding education application? The analysis of the findings for the sub-problem, themes and codes network is given in Figure 2.

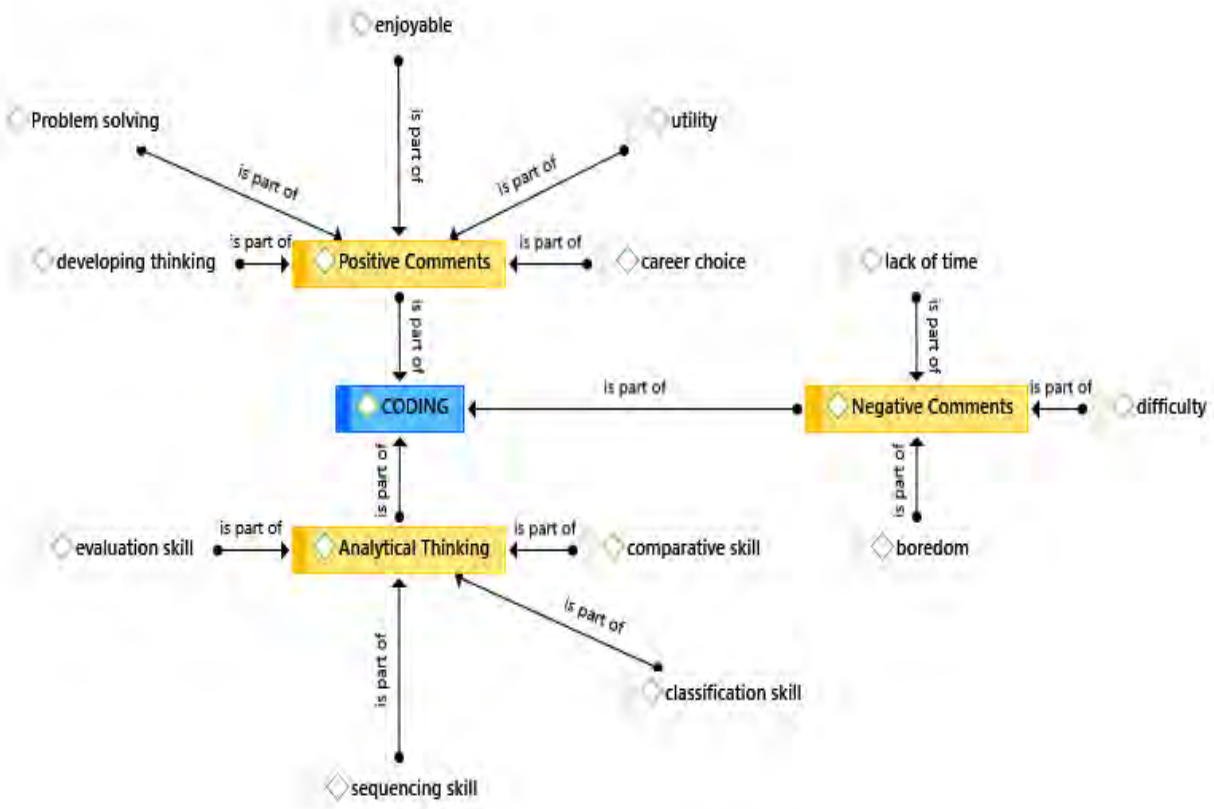

Figure 2. Coding Education Opinions Theme-Code Network

The image of the theme code network is given in Figure 2. As a result of the analysis of the theme code network, the frequency and percentage values are given in Table 5.

Table 5. Student Opinions on Coding Education Application

Theme	Code	f	%	Opinions
Analytical Thinking Skills	Sorting	13	29.6	S1: "I first created an algorithm to sort the codes one after the other." S14: "The logic of the algorithm and therefore the coding is to sort the codes correctly."
	Classification	12	27.2	S3: "Classifying code blocks as categories made our work easier." S6: "I first classify what I will do while creating the algorithm, then I list the codes."
	Comparison	9	20.5	S11: "I compared the features of the codes and chose the most suitable one for my algorithm." S12: "I made more than one coding suitable for my algorithm and found the best one by comparing it."
	Evaluation	10	22.7	S14: "I compared the algorithm I created with the coding and decided that it was appropriate." S16: "I became aware of my negative prejudices about coding and realized that coding is actually not difficult."
	Total	44	100	
Positive opinions about coding education	Utility	13	19.7	S8: "Coding made me think in detail and this way of thinking can be useful for me in other lessons." S15: "Coding opens doors in every field, it will be useful in my career choice."
	Career choice	8	12	S12: "The most popular professions today are software developers and coding education has been effective." S16: "They have to use software in commercials, games, movies, banks and many other domains, and the sooner we start coding, the better."

Table 5. Continued

Theme	Code	f	%	Opinions
	Enjoyable	13	19.7	S4: "I thought coding was boring, but the lessons were pretty fun." S14: "I had a lot of fun especially while designing games. Overall, it was fun."
	Problem solving	12	18.2	S18: "The algorithm I made before coding is similar to the steps I used when solving problems." S8: "Coding (is) something like problem solving."
	Developing thinking	10	15.2	S5: "Coding is actually a complete thinking job, the codes to be created make you think, it is not done randomly." S12: "It's like a math lesson, you need to think like a problem solver."
Negative opinions about coding education	Lack of time	5	7.6	S17: "I could not finish coding in the last lessons, the time was short." S6: "If the time had been a little longer, I could have done better coding."
	Boredom	2	3	S1: "I was a little bored at first, the last lessons were better." S9: "Coding is boring for me, but I did not get bored while coding games."
	Difficulty	3	4.6	S5: "I find coding necessary, but it is very hard work." S10: "It was really difficult for me to create algorithms and code. It is necessary to think ahead for them."
	Total	66	100	

According to Table 5, the most frequently repeated codes in the theme of analytical thinking skills are sorting (f=13, 29.6%), classification (f=12, 27.2%), evaluation (f=10, 22.7%) and comparison (f=9, 20.5%) codes. Opinions about coding education were analyzed together. The most frequently repeated codes in the theme of positive opinions are respectively utility (f=13, 19.7%), enjoyable (f=13, 19.7%), problem solving skills (f=12, 18.2%), developing thinking (f=10, 15.2%) and the career choice (f=8, 12%) codes. In the theme of negative opinions about coding education, the most frequently repeated codes are respectively lack of time (f=5, 11.9%), difficulty (f=3, 7.1%), and difficulty (f=2, 4.8%).

Discussion

In the study, it was determined that there was a statistically significant difference in favor of the post-test between the pre-test and post-test analytical thinking skills of gifted students who were given coding education. This finding shows that coding education improves the analytical thinking skills of gifted students and the skills in sub-dimensions (sorting, classification, comparison and evaluation). Applied coding education has a moderate level effect on increasing the analytical thinking skills and sub-dimensions (sequencing, classification, comparison, and evaluation) of gifted students, according to the effect size (d) analysis performed on the difference between the pre-test and post-test average scores of the ATSS. The change in the analytical thinking skills of the students during the coding education process was determined by ATSOF, and it was observed that the students' analytical thinking skills increased during the coding education. Similar results are found in the literature (Akçay & Çoklar, 2016; Akpınar & Altun, 2014; Demirer & Sak, 2016; Fessakis et al., 2013; Kafai & Burke, 2014; Saeli et al., 2011). Aljughaiman and Ayoub (2012) found that there are substantial disparities in favor of analytical abilities in their study on the effects of school enrichment programs on the analytical, creative, and practical abilities of gifted primary school kids. Göksoy and Yılmaz (2018), in their study with secondary school students, found that robotics and coding courses provided students with attainments such as analytical thinking, problem solving, and creative thinking. Popat and Starkey (2019) analyzed the educational outcomes for children learning to code at school and concluded that students' learning to code in school develops their high-level thinking skills. In the light of these findings, it can be said that coding education contributes to the analytical thinking skills of gifted students.

It shows that coding education improves the analytical thinking skills of gifted students in the sub-dimensions of sorting the solution stages of the problem, classifying the information, comparing the solutions, and making judgments in order to make judgments. According to the effect size analysis, the moderate level effect of coding education on the development of analytical thinking skills can also be explained by the fact that gifted students have analytical thinking skills. Because, according to Sternberg et al. (2010), analytical thinking is associated with high academic intelligence. Most of the gifted students participating in this study had high academic achievement. At the same time, according to student opinions, it was seen that students had a positive attitude towards coding education. For this reason, it can be said that the coding education study group revealed the analytical thinking skills, which are its strengths. At the same time, according to Lye and Koh (2014), the most important advantages of scratch, which is the block-based coding used in the study, is that it is easy to learn and evaluate. Besides, the use of block-based and visual programming languages such as Scratch instead of traditional programming languages may be more effective in the acquisition or development

of high-level thinking. For this reason, it can be said that the use of Scratch coding language in the study contributed to the development of analytical thinking, which is one of the high-level thinking skills of students.

According to the students' opinions about coding education in the research, they stated that the coding education was fun, beneficial, contributed to the choice of profession, and developed problem solving and thinking. There are studies in the literature that support this. In their study, Sáez-López et al. (2016) stated that the motivation, entertainment, and attitudes of 5th and 6th grade students improved positively with coding education. Shin and Park (2014) state that coding improves learners' problem-solving skills. As a result of their research, Kalelioğlu and Gülbahar (2014) state that although coding does not make a significant difference in the problem-solving skills of secondary school students, it enables them to resort to different ways to solve problems as a result of their observations.

Similarly, it is stated in the literature that coding is considered fun (Genç & Karakuş, 2011). Again, the results of many studies show that children have a positive attitude towards coding education (Göksoy & Yılmaz, 2018; Kalelioğlu et al., 2014). Difficulty, boredom, and lack of time were determined as negative opinions in the study. Genç and Karakuş (2011) reached a similar conclusion and stated that some of the participants did not like the Scratch environment and found it boring. These negative views will reduce students' motivation towards coding and reduce their interest in coding. For this reason, the coding environment and course activities should be made attractive.

A growing number of countries have realized the importance of coding teaching in order to provide students with 21st century skills and have started to work in this direction. At the same time, the curricula were arranged to include coding education (Demirer & Sak, 2016; Lee et al., 2014). Since gifted students are an important social capital that can contribute to the innovative development of countries, they should receive coding education that will help them show and develop their potential by developing high-level thinking skills.

Conclusion

As a result, it is seen that coding education increases the analytical thinking skills which is a necessary skill for 21st century skills of gifted students, who are more sensitive to general world problems than their peers. At the same time, it has been determined that coding education also improves sub-skills of the analytical thinking skills of gifted students, which are sorting, classification, comparison and evaluation. According to the students' views on the coding education application process, they stated that there was improvement in the sub-dimensions of sorting, classification, comparison and evaluation in analytical thinking skills; coding education developed problem solving and thinking skills; it is useful, encouraging for career choice, fun, as well as negative opinions such as being a little difficult, boring and requiring more time.

Recommendations

For future studies, the studies can be expanded by increasing the number of participants and adding more coding education programs to the research. Considering the diversity of coding programs, working with one program (scratch) is a limitation, and more programs can be evaluated by including them in the educational content. The effect of coding education on different ways of thinking can also be investigated. The work should also be done with students at different levels. It is possible to examine the effect of coding on analytical thinking in different disciplines. At the same time, considering that coding is a necessary skill for the 21st century in the developing and changing world, it can be suggested that coding lessons should be given more space in the education of gifted students and that coding activity contents should be associated with course outcomes.

Limitations

In the study, coding education was limited to the implementation of the scratch program, the study group included 18 gifted secondary school students, and the examination of the effect of coding education was only on analytical thinking skills.

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