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The Effects of STEAM-Based Activities on Gifted Students' STEAM Attitudes, Cooperative Working Skills and Career Choices

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ABSTRACT STEAM is one of the teaching strategies frequently used in science education in recent years to ensure the development of students of different ages and characteristics. This study aimed to reveal the effect of STEAM-based activities on gifted students' STEAM attitudes, cooperative working skills, and career choices. For this purpose, a single group pre-test post-test design was used. Thirty-seven secondary school fifth-grade students (10-11 years old) diagnosed as gifted participated in the research. STEAM-based activities were applied to the students for ten weeks. STEAM Attitude Scale, Cooperative Learning Process Scale, and an open-ended question form for career choices were used as data collection tools. The Wilcoxon Signed Rank Test was used for the quantitative data analysis, and thematic analysis was used for qualitative data. At the end of the application, it was observed that the students' attitudes toward STEAM increased; cooperative working skills improved; they turned to STEAM disciplines in their career choices. It is recommended to give STEAM education to gifted students from an early and guide them to shape their careers.

Keywords Gifted students, STEAM career, STEAM attitude, Cooperative working skills, Career choices

1. INTRODUCTION

Today, life problems have changed, and accordingly, with industry 4.0 or the fourth industrial revolution, professions that will play an essential role in the economy have also differentiated. Many countries of the world are aware of the changes in globalization and are shaping their education systems accordingly (Jackson, Basham, Thomas & Hunt, 2020). The reason for the emergence of STEM (Science, Technology, Engineering, Mathematics) education can be attributed to this. STEM education was born in America primarily for economic reasons. In addition to the scientific method, educators integrated engineering processes at the K-12 level and aimed to direct students to STEM professions in national education programs (Hallinen, 2021). Because STEM includes the knowledge and skills that the current qualified workforce should have (Pricewaterhouse Coopers Australia (PwC), 2015). There are various definitions of STEM education. According to Vasquez, Comer & Sneider (2013), STEM education is an interdisciplinary approach that removes the traditional barriers separating science, technology, engineering, and mathematics and integrates students with real-world and relevant learning experiences. According to Furner & Kumar (2007), STEM is a strategy that enables students to achieve different achievements simultaneously by integrating other disciplines around a fundamental discipline.

While STEM education is a priority in America and Europe (Gonzalez & Kuenzi, 2012; Kuenzi, 2008), STEAM education at the primary level has come to the fore, especially in Korea (Yakman & Lee, 2012; Jin, Chong & Cho, 2012). STEAM education is an interdisciplinary approach obtained by adding the art (A) field (STEM + A) to STEM education (Park & Ko, 2012; Armknecht, 2015). In STEAM teaching, (1) project-based learning, (2) technology within the scope of creativity and design, (3) an approach to questioning a problem using multiple ways, (4) science, technology, engineering, arts/humanities, and mathematics as required by the problem, (5) cooperative problem solving comes to the fore (Herro & Quigley, 2017). One of the most important reasons for the emergence of STEAM is that art is not different from the

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way of thinking in STEM fields and that many engineers and scientists shape their work with artistic creativity (Plonczak & Zwirn, 2015; Watson & Watson, 2013). For this reason, STEAM's working areas are where the student finds solutions to problems and designs products by imagining, producing, and marketing them (Sheridan et al., 2014; Dixon & Martin, 2014).

1.1 STEAM Attitudes and Career Choices

STEAM education aims to: improve students' problem-solving skills and increase their interest in science and technology (Kim, 2015); support students' motivation to learn to improve their ability to solve multidisciplinary problems (Oh, Lee & Kim, 2013); ensure active participation of students within their differences (Allina, 2018; Cook, Bush & Cox, 2017); to increase students' interest in STEM career fields (Sochacka, Guyotte & Walther, 2016). Researchers in a National Science Foundation project decided to use Social Cognitive Career Theory (SSCT) as a theoretical framework to reveal the challenges and barriers students face in pursuing a STEM career and to understand how they determine academic interests and career choices (Lent & Brown, 2008; Lent, Brown, & Hackett, 2000). Four interrelated career development models are explored within the framework of SCCT: interest, choice, performance (Lent, Brown & Hackett, 1994), and satisfaction (Lent, 2013). This study examined the change in students' career choices as a result of STEM education. Global change, problem-solving skills, innovation, and financial success have recently become dependent on science, technology, engineering, and mathematics (STEM) career fields (Clynes, 2016). Students begin to shape their professional careers at the secondary school level (Tai, Qi Liu, Maltese & Fan, 2006). However, students may be unable to make the right career choices at this age because they do not have complete knowledge of the professions. For this reason, encouraging students to pursue careers in STEM fields has forced educators (Masnick, Valenti, Cox & Osman, 2010). It is necessary to increase students' awareness in the early period to increase the number of students who will continue their careers in STEM (or STEAM) fields (Wyss, Heulskamp & Siebert, 2012). An essential factor in increasing students' STEM career interests is their positive attitudes towards STEM (Brown & Lent, 2016; Lent, Brown & Hackett, 2000). Attitude can be defined as individual beliefs about the qualities of a particular object (Fishbein & Ajzen, 1975) and can be influenced by various factors (Ajzen, 2001; Crano & Prislin, 2006). For this reason, determining students' STEM attitudes is important in making changes that will increase and support their future learning (Mahoney, 2010; Tseng, Chang, Lou & Chen, 2013). Based on this, one study aimed to determine the students' STEAM attitudes and develop them positively.

1.2 STEAM Education and Gifted Students

STEM education should be given to students of different ages and characteristics from an early age. Gifted students also differ from their peers in cognitive, affective, and social aspects (Clark, 1997; Davaslıgil, 2004). Many gifted students spend most of their time in standard classroom settings (National Association for Gifted Children, 2009). This situation causes students not to receive adequate and appropriate education (Reis & Renzulli, 2010). For this reason, teachers can use various strategies to provide education that meets the needs of gifted students (National Research Council, 2013). The STEM/STEAM approach is one of them. For example, environmental studies provide opportunities to develop skills in science, technology, engineering, and mathematics (STEM) (Schroth & Helfer, 2017). Exposing students to the challenges of engineering design supports the needs of gifted students and provides an opportunity to explore the potential of other students (Adams et al., 2008). STEAM education enables gifted children to increase their interest and curiosity, search for solutions to problems, reason, and explore phenomena by thinking and acting creatively (Lee, Baek & Lee, 2013; Lee, Seo, Jung, Kang & Lee, 2012). For gifted students to receive integrated science and mathematics education for their interests and readiness, STEM education should be applied to them, and their interest in professions in the STEM field should be determined and directed at an early age (Özçelik & Akgündüz, 2018). This approach can be an interdisciplinary tool gifted children use to compete in the global economy and seek new solutions to problems (Roman, 2012). Thus, by using the potential of gifted students, significant contributions can be made to countries' economies.

1.3 STEAM Education and Cooperative Learning

Companies that host STEAM professions emphasize that their employees need individuals with twenty-first-century skills such as flexible, multidisciplinary problem solving, good communication, cooperative working, critical thinking, and creativity (Binkley et al., 2012; Voogt & Roblin, 2010). Studies on 21st-century skills in the literature state that student success depends on various cooperative problem-solving skills (Trilling & Fadel, 2009). Cooperative learning or working means that students work together in a group; learn individually and in groups by giving feedback and discussing each other (Johnson, Johnson & Smith, 2007). Cooperative learning contributes to students' deep learning, making progress in critical thinking, and developing social and communication skills they will use after graduation. Some studies have used cooperative learning to increase student engagement, improve learning outcomes, and develop students' teamwork skills (e.g., Herrmann, 2013; Johnson & Johnson, 2008; Smith, 1995). Cooperative working, one of the 21st-century skills, has also come to the fore in STEAM education. Likewise, cooperation in STEM education is

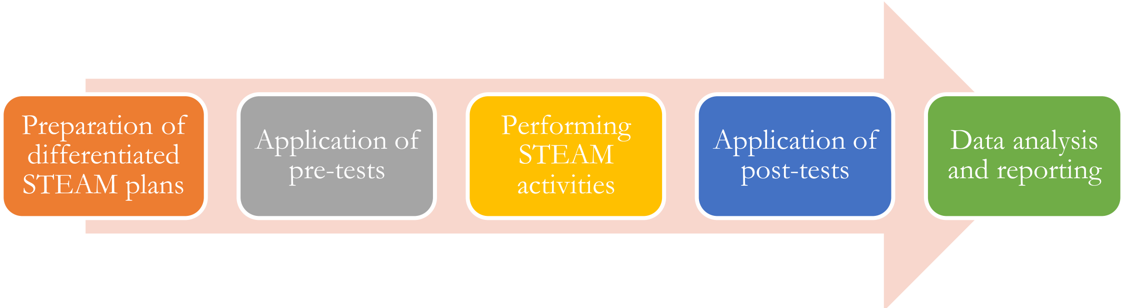

Figure 1 The scheme of the research mechanism

considered essential. STEM education focuses on interdisciplinary cooperation, and students should be encouraged to work in collaboration (Aslan-Tutak, Akaygün, & Tezsezen, 2017). According to Slavin (2014), cooperative learning should be included in all STEM classes. Models applied when considering STEAM disciplines may include collaborative or cooperative learning, in which students assume the role of experts and work together as a group to complete the task (Thompson, Chapman & Kanasa, 2020). Group work, which is also used in the education of gifted students, which is the study group of this research, is one of the crucial ways of enrichment (Neber, Finsterwald & Urban, 2001; Rankin, 2016). In addition to high-level cognitive skills, developing their social and affective skills is vital. Although the inherent abilities of gifted students are seen as individual strengths for them, the importance of teamwork and cooperation is the necessity of the age (Tennant, McMullen & Kaczynski, 2009; Trilling & Fadel, 2009). For this reason, these issues should be considered when making program enrichment studies in their education. This study aims to contribute to the collaborative working characteristics of gifted students, one of the 21st-century skills.

1.4 Purpose of the Study

Considering the characteristics of STEAM-based education, it is expected to positively affect students' career choices, cooperative workings, and STEAM attitudes. General studies conducted with gifted students in the literature (Mann, Mann, Strutz, Duncan & Yoon, 2011; Robinson, Dailey, Hughes & Cotabish, 2014; Sternberg, 2019; Sloan, 2020); studies on STEM careers of gifted students (Kim, Roh & Cho, 2016; Şahin & Yildirim, 2020; Yu & Jen, 2021); studies on talented students' STEM attitudes (Wieselmann, Roehrig & Kim, 2020; Bircan & Köksal, 2020; Ceylan, Ermiş & Yıldız, 2018). However, a limited number of studies (Sağat & Karakuş, 2020) have been encountered in the field of STEAM education in gifted students, and no study has been encountered on the effect of STEAM on cooperative working skills. Based on the studies, STEAM activities were implemented to develop students' interest in STEAM, thus their positive attitudes, and to reflect this attitude on their career choice. These activities are also expected to affect students' cooperative working skills, one of the twenty-first-century skills. Thus, this study is expected to contribute to the subject of cooperation, one of the 21st-century skills, and to the field of STEAM education for gifted students. For this reason, this study aims to reveal the effects of STEAM-based activities applied to gifted students on students' STEAM attitudes, cooperative working skills, and career choices. Based on this aim, answers to the following questions were sought:

1. Do STEAM-based activities applied to gifted students affect students' STEAM attitudes?
2. Do STEAM-based activities applied to gifted students affect students' cooperative working skills?
3. Do STEAM-based activities applied to gifted students affect their career choices?

2. METHOD

This study used a single group pre-test post-test design, one type of pre-experimental design, to reveal the effects of STEAM-based activities applied to gifted students on students' STEAM attitude, cooperative work, and career choices. A single-group pre-test post-test design is a type of design used by researchers to determine the effect of an intervention on a particular sample (Allen, 2017). Since the aim is to examine the students' STEAM attitudes, collaborative working skills, and career choices before and after the intervention, a single-group pre, and post-test research design model was used (Frankel & Wallen, 2003). The scheme of the research mechanism is shown in Figure 1.

2.1 Participants

The study participants are 37 gifted secondary school fifth-grade students (10-11 years old) studying at a science and art center (SAC in Istanbul, Turkey. The participants are the students of the first researcher, and therefore they were selected with an easily accessible sampling method. In Turkey, gifted children are identified by talent screening tests administered by the Ministry of National Education. Children diagnosed as talented receive support education in addition to their formal education in educational institutions called Science and Art Center (SAC), affiliated with the Ministry of National Education. This educational content is prepared by considering the characteristics of gifted students.

2.2 Data Collection Tools

2.2.1 STEAM Attitude Scale

The scale was used to determine the effect of STEAM activities on students' STEAM attitudes and developed by Genç et al. (2020) using the five-point Likert type. The scale consists of 40 items and sub-dimensions of science, technology, engineering, art, and mathematics. The score values were obtained from the scale range of 40-200 points. According to the data obtained in the Confirmatory Factor Analysis (CFA), RMSEA was found to be 0.043; NFI was found to be 0.94; GFI was found to be 0.97; SRMR was found to be 0.049, and AGFI was 0.87. According to the reliability analyses of the scale, the Cronbach-Alpha reliability coefficient of the entire scale was determined as 0.917.

The students applied the STEAM attitude scale as a pre-test and final test. According to the reliability analysis performed for the preliminary test, the Cronbach alpha value was found to be 0.925. Therefore, it can be said that the scale has an internal consistency of over 0.70 (Clark-Carter, 1997), and it can be used in gifted students who are the participating group.

2.2.2 Cooperative Learning Process Scale

The Cooperative Learning Process Scale to measure whether STEAM activities take place cooperatively was developed by Bay & Çetin (2012) for undergraduate students. For this reason, the researchers conducted an adaptation study of the scale for secondary school students. The original version of the scale consists of 40 items and five dimensions. However, Bay & Çetin (2012) stated that the scale could also be used as one-dimensional.

The adaptation study of the scale was carried out with 458 secondary school students. As a result of the explanatory factor analysis, it was seen that the scale consisted of one dimension and the KMO value was 0.988. The Barlett significance value was p=.000. For the data to be suitable for confirmatory factor analysis, the KMO should be higher than 0.60, and the Barlett Test should be significant (Büyüköztürk, 2013). At this point, it was decided to use the single-factor version of the scale. CFA was conducted on a single factor. As a result, CMIN/DFI ($\chi 2$/sd) = 2.433; RMSEA = 0.056; CFI = 0.952; NFI = 0.922; IFI = 0.953 values were found. These values were in the acceptable range (Hu & Bentler, 1999; McQuitty, 2004). The scale's reliability was checked with the internal consistency coefficient for the entire scale. The Cronbach Alpha coefficient obtained was found to be 0.99. As a result of the adaptation study of the scale, it was found that it was suitable for secondary school students and was applied to the students without making any changes. The score values that can be obtained from the scale are in the range of 40-200 points.

The Cooperative Learning Process Scale was administered to the students as a pre-test and post-test. According to the reliability analysis performed in the pre-test, the Cronbach alpha value was 0.875. If Cronbach's alpha value is over 0.70, it can be said that the scale has internal consistency (Clark-Carter, 1997) and can be used with gifted students in the participant group.

2.2.3 Open-Ended Questionnaire on Career Choices

After the STEAM activities were applied to the students, the researchers prepared an open-ended question form to reveal whether their career choices had changed. The first and second questions were asked to the students before and after the STEAM training, and the third one after the STEAM training. Examining a STEAM education specialist and a language specialist, the questions were finalized. The questions asked to the students are as follows;

1. What is STEAM? Have you had any previous experience with STEAM?
2. What will be your career choice in the future? Why do you want to choose this career?
3. Do you want to make a career in STEAM at the end of STEAM activities? If yes, which STEAM discipline do you prefer?

2.3 Data Analysis

The data obtained from the STEAM attitude scale and the Cooperative Learning Process Scale pre-test and post-test were analyzed with the SPSS 23 program. According to Jamieson (2004), ordinal data cannot be made into interval data. According to Boone & Boone (2012), if parametric testing is to be preferred in Likert-type scales, The number of samples must be above 50, and the data must have a normal distribution and equal variances. Based on these sources, the Wilcoxon Signed-Rank Test, one of the non-parametric tests, was applied to the data. Thematic analysis was used in the open-ended question form analysis for the student's career choices. Thematic analysis is a qualitative data analysis method used to reveal themes and meaning patterns in the data set of a research question (Braun & Clarke, 2006). To ensure reliability, two independent coders made the coding. According to Miles & Huberman's (1994) encoding consensus-disagreement formula, the reliability was 0.95. If the result of the coding reliability formula is at least 0.70, it can be said that inter-rater reliability is achieved (Miles & Huberman, 1994).

2.4 Application Process

The implementation process of the research started by collecting data with pre-tests. Students are divided into groups of three or four. Then, STEAM activities were applied to gifted fifth-grade students for ten weeks, with a different activity each week. The students were asked to do all the application steps of the activities (Figure 2) with group work. The activities used are adapted from Özkan's (2020) study. The central theme of the activities is force and movement. The activity contents are force concept, weight, gravitational force, friction force, pressure force, liquid pressure, gas pressure, and energy types. In the science

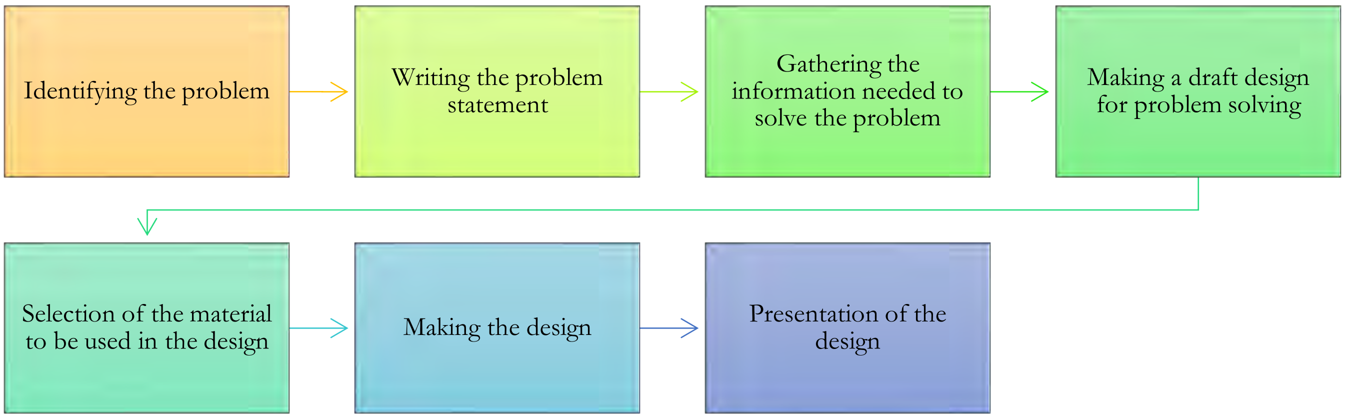

Figure 2 Implementation process of STEAM activities

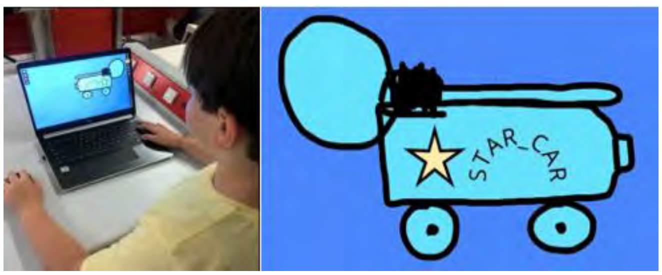

Figure 3 S21 Coded Student's Drawing with Sketch.io

curriculum of the Turkish Ministry of National Education (Ministry of National Education, 2018), only the basic force concept and friction force are included in the 5th-grade science lesson. Interventions such as acceleration and enrichment should be used in the education of gifted students (Colangelo, Assouline, & Gross, 2004; Rogers, 2004; Şahin, 2015). For this reason, the content of STEAM activities has also been accelerated and enriched. With the acceleration, students are taught the curriculum topics of the advanced classes. The subject of pressure and energy types, which is at the upper level of fifth-graders, was added to these activities. The general process of implementing STEAM activities is as follows;

As shown in Figure 2, the STEAM process begins with problem discovery. The science dimension is related to the subject of the problem. The technology dimension is associated with computers and tablets used in problem-solving and design. For example, the S21-coded student made a plan on the Sketch.io website (Figure 3). The Engineering and Art dimension requires two skills to make designs. The mathematical dimension was used in the calculation of the physics formulas. Examples of final designs can be seen in Figure 4

3. RESULT AND DISCUSSION

3.1. Results of STEAM Attitudes

The first question of the study sought to answer whether STEAM-based activities applied to gifted students affected students' STEAM attitudes. Accordingly, the pre-test and post-test comparisons of the general and sub-dimensions of the STEAM Attitude Scale are shown in Table 1.

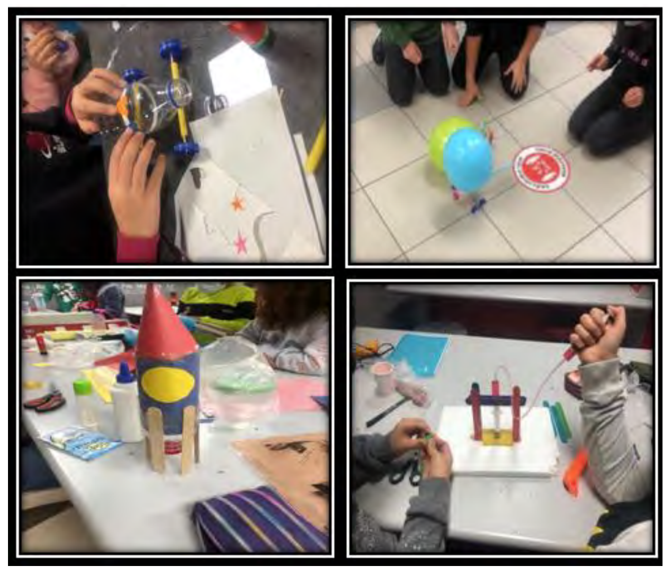

Figure 4 Students' STEAM desings examples

Table 1 shows the Wilcoxon Signed Rank Test results to compare the pre-test and post-test scores of the STEAM attitude scale. Accordingly, It is observed that there is a significant difference between the pre-test scores of students overall STEAM attitude ($Z = -5.154$, $p < .05$), science sub-dimension ($Z = -4,436$, $p < .05$), technology sub-dimension ($Z = -3.457$, $p < .05$), engineering sub-dimension dimension ($Z = -3.555$, $p < .05$), arts sub-dimension ($Z = -3.051$, $p < .05$) and mathematics sub-dimension ($Z = -4.019$, $p < .05$). It was observed that this difference was in favor of positive ranks, that is, in favor of post-tests. According to the negative rank values, two students in the STEAM attitude, four in the science sub-dimension, four in the engineering sub-dimension, three in the art sub-dimension, and three in the mathematics sub-dimension got lower scores in the post-test than in the pre-test. In general, as a result of the STEAM training of the students, it was observed that the scores of the general STEAM attitude scale and its sub-dimensions increased.

Table 1 Wilcoxon signed-rank test results of the STEAM attitude scale pre-test post-test comparisons

Dimensions	Pre-Post Tests	n	Mean Rank	Sum of Ranks	Z	p
STEAM Attitude	Negative Ranks	2	5.00	10.00	-5.154*	.000**
	Positive Ranks	35	19.80	693.00		
	Ties	0				
Science	Negative Ranks	4	9.75	39.00	-4.436*	.000**
	Positive Ranks	30	18.53	556.00		
	Ties	3				
Technology	Negative Ranks	0	.00	.00	-3.457*	.001**
	Positive Ranks	15	8.00	120.00		
	Ties	22				
Engineering	Negative Ranks	4	15.00	60.00	-3.555*	.000**
	Positive Ranks	26	15.58	405.00		
	Ties	7				
Arts	Negative Ranks	3	6.50	19.50	-3.051*	.002**
	Positive Ranks	16	10.66	170.50		
	Ties	18				
Mathematics	Negative Ranks	3	12.50	37.50	-4.019*	.000**
	Positive Ranks	27	15.83	427.50		
	Ties	7				

*Based on negative ranks; **p < .05

Table 2 Wilcoxon signed-rank test results of cooperative learning process scale pre-test post-test comparisons

Dimensions	Pre-Post Tests	n	Mean Rank	Sum of Ranks	Z	p
Cooperative Learning Process Scale	Negative Ranks	5	11.40	57.00	-4.445*	.000**
	Positive Ranks	32	20.19	646.00		
	Ties	0				

*Based on negative ranks; **p < .05

3.2. Results of Cooperative Working Skills

In the second question of the research, an answer was sought whether STEAM-based activities applied to gifted students affected the collaborative work of students. Accordingly, the Cooperative Learning Process Scale pre-test and post-test comparison findings are shown in Table 2.

Table 2 shows the Wilcoxon Signed Rank Test results to compare the Cooperative Learning Process Scale pre-test and post-test scores. Accordingly, It is observed that there is a significant difference between the pre-test scores of students overall on the scale ($Z = -4.445$, $p < .05$). It was observed that this difference was in favor of positive ranks, that is, in favor of post-tests. According to the negative rank values, five students got lower scores in the post-test than in the pre-test. A significant increase was determined in the students' cooperative learning process scale scores after the STEAM-based activities.

3.3. Results of Career Choices

Three open-ended questions revealed whether STEAM activities affect students' career choices. The first question, "What is STEAM? Have you had any previous experience with STEAM?" is in the form. Thematic analysis was performed on the answers to the first question; the results are shown in Table 3.

Table 3 Results of students' STEAM knowledge and experience before STEAM activities

Theme	Codes	f
STEAM knowledge	Correct explanation	1
	Partially correct explanation	1
	Incorrect explanation/no explanation	35
STEAM experience	I had experience	7
	I had no experience	30

As seen in Table 3, the answers given by the students to the first question were grouped under two themes: STEAM knowledge and STEAM experience. Three codes for STEAM information and two codes for STEAM experience were created. It is seen that only one of the participating gifted students (N=37) explained the STEAM concept correctly, and one person partially explained it correctly. The student's answer with the code S23 explained correctly; *"We did STEAM at school. We designed a car, and then we raced our cars. They are activities where we think like engineers using our knowledge of science and mathematics."* The answer of the student coded S10, who explained it partially correctly, is as follows; *"It is the activities in which we make designs to solve a problem."* Although seven students stated that they had STEAM experience, five of them could not explain STEAM. In general, it was revealed that the students did not know about STEAM before the activities, and most did not have STEAM experience.

"What will be your career choice in the future? Why do you want to choose this career?" the questions were asked to the students before and after the activities, and their answers were analyzed with thematic analysis. For example, table 4 shows the analysis findings of the answers to the second question before the STEAM activities.

As it can be seen in Table 4, two categories were created from the student answers: *the career choices* and the *reasons for the choice*. The career choices have two themes: *STEAM professions* (f=18) and *other professions* (f=15). 11 codes were obtained from STEAM professions, and "architecture" (f=4) was preferred most frequently by students. Seven principles were obtained from other disciplines; "doctor" (f=4) and "football player" (f=4) were most preferred. The number of students who are undecided in choosing a profession is four. The reasons for the student's career choices before the STEAM activities were grouped under three themes: *personal, social*, and *vocational factors*. Personal factors (f=24) were the most preferred reasons for the choice. The student's "like" for the profession was the most frequently repeated reason among the personal factors. Three codes were collected under the social factors (f=5), and five were collected under the vocational factors (f=6).

Direct quotations from the answers given by the students to the second question before the activities are as follows;

S3: I want to be a software developer because it is a long-term job.

S4: I want to be a football player because I am talented and love football very much.

S8: I will be a Youtuber and take videos of the cakes I make and put them on the internet.

S19: Computer engineering. I am interested in technological tools (computers, phones, web 0.2 tools, etc.).

S28: I want to be an architect because I like drawing and designing houses.

Table 4 Results of the career choices and reasons of the students before the STEAM activities

Category	Theme	Codes	f
Career choices	STEAM professions	Architect	4
		Astronaut	2
		Engineer	2
		Computer engineer	2
		Programmer	2
		Construction engineer	1
		Coding professor	1
		Mathematician	1
		Biologist	1
		Genetic engineer	1
		Chemist	1
	Other professions	Doctor	4
		Football player	4
		Artist	2
		Youtuber	2
		Boxer	1
		Actor	1
		Pastry maker	1
		Indecisive	4
Reasons for choice	Personal factors	Like	13
		Interest	5
		Talent	4
		Curiosity	2
	Social factors	Beneficial to humanity	2
		My mother is a mathematician	1
		My father is a good coder	1
	Vocational factors	Interesting	2
		Fun	1
		Exciting	1
		Long-term	1
		High income	1

Table 5 Findings of the career choices and reasons of the students after the STEAM activities

Category	Theme	Codes	f
Career choices	STEAM professions	Architect	5
		Computer engineer	4
		Engineer	3
		Scientist	3
		Physicist	2
		Astronaut	2
		Software engineer	2
		Medical sciences	1
		Chemist	1
		Mathematician	1
		Genetic engineer	1
	Other professions	Football player	2
		Artist	2
		Boxer	1
		Fashion designer	1
		Actor	1
		Artist	1
		Doctor	1
		Indecisive	3
Reasons for choice	Personal factors	Interest	7
		Talent	5
		Love the design	4
		Like	3
		Love the experiment	1
		Researcher	1
	Social factors	Beneficial to humanity	2
	Vocational factors	Fun	4
		Up-and-coming	1
		High income	1

In Table 5, there are findings on the student's career choices after the STEAM education and the reasons for their choices.

Two themes were created after the STEAM activities: *STEAM professions* (f=25) and *other professions* (f=9). Eleven codes were obtained from STEAM professions and seven codes from other professions. The most preferred STEAM profession was "architecture" (f=5). The most preferred ones were "football player" (f=2) and "artist" (f=2) in other professions. The number of students who are indecisive in choosing a profession is three. After the activities, different types of preferred professions emerged. In addition, there has been an increase in the number of students choosing STEAM professions. The number of indecisive students who prefer other professional groups has decreased. The reasons for choosing a profession after the STEAM activities, the students were grouped under three themes: *personal, social,* and *vocational* factors. Personal factors (f=21) were the most preferred reason for a profession. Among the personal factors, the "interest" of the students (f=7) was the most preferred reason. Under environmental factors (f=2), it was only the "Beneficial to humanity" code. Three codes were collected under occupational factors (f=6).

Direct quotations from the answers given by the students to the second question after the activities are as follows;

S1: I want to be a software engineer because my interests are mathematics and coding.

S9: I want to be interested in art to help people.

S17: I would like to be a scientist because I want to do new experiments.

S25: Fashion designer, because I love to design.

S33: It is my dream to be a physicist at CERN because it is so funny!

Finally, "Would you prefer a profession from the STEAM field at the end of STEAM activities? If your answer is yes, which STEAM field would you prefer?" the question was directed to the students. The findings obtained from the thematic analysis of student answers are shown in Table 6.

Table 6 Results of the students' STEAM field career preferences

Category	Theme	f
STEAM career choice	Yes	28
	No	4
	Indecisive	5
Preferred STEAM discipline	Science	7
	Technology	4
	Engineering	6
	Arts	9
	Mathematics	5

After the STEAM activities, most students (f=28) stated that they would prefer one of the fields of science, technology, engineering, art, and mathematics in their careers. The number of undecided students is five. It has been revealed that students prefer art (f=9) and technology (f=4) the least.

3.4. Discussion

This study aims to reveal the effect of STEAM-based activities on gifted students' STEAM attitudes, cooperative working skills, and career choices. The study results showed that STEAM-based actions that lasted for ten weeks positively affected the STEAM attitudes of gifted secondary school students and improved their cooperative working skills. In addition, at the end of the process, it was revealed that the students turned to STEAM professions in their career preferences.

The first question is whether STEAM-based activities affect gifted students' STEAM attitudes. According to the STEAM attitude pre-test and post-test comparison results, a significant difference was observed in favor of the post-test across the STEAM attitude scale of the students. In addition, there was a significant difference in favor of the post-test in the sub-dimensions of science, technology, engineering, art, and mathematics, which are STEAM disciplines. In support of this result, Sağat & Karakuş (2020) stated in their study that STEAM attitudes of gifted students in science education based on STEAM activities improved. Studies in which students' STEM/STEAM attitudes are developed using different methods and techniques. For example, problem-based learning (Sari, Alici, & Sen, 2018; Rehmat, 2015; Lou, Shih, Diez, & Tseng, 2011), engineering design-based learning (Guzey, Moore, Harwell, & Moreno, 2016), and project-based activities (Bingolbali, Monaghan, & Roper, 2007) showed a positive change in students' attitudes.

Contrary to this result, Leonard et al. (2016) found that rural and local secondary school students who participated in robotics and game design intervention did not change their attitudes toward STEM.

On the other hand, Ceylan, Ermiş & Yıldız (2018) found that gifted students initially had positive attitudes toward STEM. Osborne, Simon & Collins (2003) stated that a student's initial attitude towards a course strongly determines a student's future career choice. Based on these statements, it is thought that the effect of STEAM attitude on gifteds' career choices is important. Demir, Önal & Önal (2021) stated in their study that as students' mathematics and science achievements increase, their STEAM attitudes increase. Gifted students are also generally academically successful. Therefore, their natural interest and success may have supported their positive attitude towards STEAM. In general, it can be said that the student's location, interests, and special abilities will affect the STEAM attitude. A well-prepared STEM activity should increase students' knowledge development and affective intention toward STEM (Apedoe, Reynolds, Ellefson & Schunn, 2008). The formation of positive attitudes towards STEM, which starts in secondary school, will affect students' career choices (Unfried, Faber, Stanhope & Wiebe, 2015). Developing a positive attitude towards STEAM by gifted students is considered necessary in terms of their role in the economy of countries in the future, considering their high potential. The second question of the research is about the effect of STEAM-based activities on the cooperative working skills of gifted students. As a result of the study, it was seen that STEAM-based activities positively affected the collaborative work of the students.

Similarly, Parlakay's (2017) study with fifth-grade students revealed that STEM practices significantly and positively affect cooperation, which is one of the sub-dimensions of motivation. Studies show the importance of making STEM/STEAM applications in cooperation. Cooperative learning is a method used to encourage students to think critically and solve problems (Gillies, 2014). Since the STEAM activities implemented in this study are based on various problem scenarios, students' ability to collaborate while solving a problem has improved. Students share their knowledge and learn from each other in an organized and structured way during cooperative learning (Shimazoe & Aldrich, 2010). Hew & Brush (2007) state that collaboration/cooperation in STEAM applications is a necessity of 21st-century skills. In this process, students experience how to manage their learning while learning actively. This is the desired output from the modern understanding of education. It is thought that students' ability to work cooperatively at an early age will positively affect their professional life in the future. Çorlu & Çallı (2017) suggested in their study that individuals who constantly collaborate with their colleagues in different countries are successful. Hallaç (2019), on the other hand, revealed in his study that when students asked about the skills that help them find a job in the STEAM fields, they mostly talked about collaboration skills.

The research's third question aims to reveal the effect of STEAM-based activities on the career choices of gifted students. Two open-ended questions were asked to measure students' prior STEAM knowledge and career preferences to reveal the change in the implementation process. The third question investigating the effect on career choices was directed to the students at the end of the application. As a result of the first question, it was revealed that the vast majority of gifted students did not have STEAM knowledge. This result may be that the students are in the fifth grade and have not encountered STEAM in primary school. In support of this result, Azkın (2019) stated in his study that the participating students had not heard of STEAM before.

Contrary to the study results, Ceylan, Ermiş & Yıldız (2018) revealed in their studies that gifted secondary school students know STEM. Therefore, it is thought important for gifted students to have knowledge and experience in STEM/STEAM. Because if gifted students have experience using their interests and knowledge in a STEM profession, they are more likely to follow and continue a STEM discipline in the future (Vu, Harshbarger, Crow & Henderson, 2019).

Another result of the research showed that the number of students who chose STEAM professions and those who chose other professions before STEAM activities were close to each other. Personal, social, and occupational factors emerged as the reason for preference. Similar results were seen in different studies (Leppel, Williams & Waldauer, 2001; Mau, 2016; Mitchell, 2016; Sahin, Gulacar, & Stuessy, 2015; Sarı, Alıcı & Şen, 2018; Şahin & Yildirim, 2020; Özkan, 2020). In this study, personal factors came to the fore in career preferences before and after the application. At the end of the application, the family factor disappeared. Unlike this study, factors that may affect gifted students' STEM discipline career choices were observed. These factors are intrinsic and extrinsic motivation (Soria & Stebleton, 2013), after-school programs (Adams et al., 2008), self-efficacy (Porter & Umbach, 2006), gender (Stoeger, Duan, Schirner, Greindl & Ziegler, 2013; Wieselmann, Dare, Roehrig & Ring-Whalen, 2019) and race or ethnicity (Coleman, 2014). After the activities, the students were again asked about their career preferences, and an increase was observed in the number of students who preferred STEAM fields. It can be said that the implemented activities positively affect the STEAM careers of the students, and they generally make their choices based on personal factors. Similarly, in some studies (Özkan, 2020; Kong, Dabney & Tai, 2014), it is seen that the choice of professions belonging to STEM/STEAM disciplines increased after the practice, and students made their preferences for personal reasons. In addition, the students stated that they wanted to make a career in the field of art, which is one of the STEAM disciplines. At the same time, architecture has been the most preferred profession before and after the events. This may be because STEAM education is design/engineering-based, and the activities are about physics. Bircan & Köksal (2020) also stated that gifted students mostly prefer engineering professions. The second STEAM profession was science. Gifted students' natural interest in science may be the reason for this situation. Also, students who were undecided about choosing a career before and after STEAM education were identified. This can be explained by the fact that gifted students with perfectionism feel pressure to make the "perfect" career choice (Sampson & Chason, 2008). Some studies have also suggested that gifted students have difficulties making decisions about undergraduate majors or occupations (Corwith & Olszewski-Kubilius, 2012; Sajjadi, Rejskind & Shore, 2001).

4. CONCLUSION

As a result of the study, it was seen that the STEAM activities applied positively affected the attitudes of gifted students towards STEAM. It is known that a positive attitude towards STEAM impacts students' choice of STEAM professions in the future. STEM education contributes to raising a competent workforce in engineering, informing gifted students about their education and career plans, and raising conscious citizens who can meet the needs of society (Subotnik, 2006). Furthermore, it is known that 21st-century skills are gained with STEAM/STEM education. One of these skills is collaborative work. In this study, it was found that the collaborative work of gifted students improved through STEAM activities. In addition, the applied activities contributed to the development of the student's cognitive and affective skills.

The results of the research revealed suggestions for STEAM education of the gifted. Students' lack of knowledge about STEAM education may negatively affect their orientation towards STEAM professions. For this reason, it can be recommended to give STEAM education, especially to gifted students starting from primary school age. Besides, it is suggested that STEAM applications should be included more frequently while the curriculum studies are carried out. In this study, STEAM activities on physics were applied. Educators are advised to prepare activities that center on other STEAM areas. Thus, it can be ensured that students approach the professions with a broad perspective. This study obtained findings through quantitative research methods for students' attitudes and cooperative work. In-depth information can be obtained, and contributions to the field can be made using qualitative methods in subsequent studies. The applications were carried out only at the fifth-grade level. The effect of grade level can be investigated by including students at different grade levels. In recent years, there have been various studies on the role of gender in STEM/STEAM education (Koyunlu Ünlü & Dökme, 2018; Sloan, 2020; Yu & Jen, 2021). In future studies, the results of STEAM activities on the gender variable effect of gifted students can be revealed. Finally, this study was conducted on a single-group sample. The research results can be expanded by including the control group in the following study.

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