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Attitudes of the Students Attending Out-of-School STEM Workshops towards STEM Education

Okul Dışı STEM Atölye Çalışmalarına Katılan Öğrencilerin STEM Eğitimine Yönelik Tutumları

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ABSTRACT: In this study, the attitudes of students toward STEM education were examined according to various demographic characteristics and mixed research method was used. 170 students ranging between 7 and 14 years old participating municipalities in a province outside of school STEM workshops in Turkey constituted the sample of the study. The sampling was determined by non-random sampling method. Data were collected by STEM Attitude Scale adapted to Turkish by Yıldırım and Selvi (2015) and semi-structured interviews with students were conducted in order to get the opinions of the students in detail. Results indicated that out-of-school STEM workshops improve students' attitudes towards STEM. In addition, STEM attitude scores of the students did not differ by gender. It was also investigated whether the scores of the students from STEM attitude scale differ according to mother and father education level. There was only significant difference in engineering sub-dimension of the STEM attitude scale in terms of mother education status. On the other hand, it was determined that STEM attitude scale scores of the students did not differ according to father education status. Semi-structured interviews showed that students had lack of knowledge about STEM education and, also concluded that the achievement of a concrete result for children learning by doing affects their attitudes positively.

Keywords: STEM, workshop, attitude, out-of-school learning.

ÖZ: Araştırmada okul dışı STEM atölye çalışmalarına katılan öğrencilerin STEM eğitimine yönelik tutumları çeşitli demografik özelliklere göre incelenmiştir. Araştırmanın örneklemini Türkiye'deki bir ilin belediyesinde okul dışı STEM atölye çalışmalarına katılan yaşları 7 ile 14 arasında değişen 170 öğrenci oluşturmaktadır. Örneklem seçkisiz olmayan örnekleme yöntemi ile belirlenmiştir. Veri toplama aracı olarak; Yıldırım ve Selvi (2015) tarafından Türkçeye uyarlanmış STEM Tutum Ölçeği ve öğrencilerin görüşlerini detaylı bir şekilde alabilmek için yarı-yapılandırılmış görüşmeler yapılmıştır. Sonuçlar, okul dışı STEM atölyelerinin öğrencilerin STEM'e yönelik tutumlarını geliştirdiğini göstermiştir. Ayrıca, öğrencilerin STEM tutum puanlarının cinsiyete göre değişmediği tespit edilmiştir. Öğrencilerin STEM tutum ölçeğinden aldıkları puanların anne ve baba eğitim düzeyine göre farklılık gösterip göstermediği de araştırılmıştır. STEM tutum ölçeğinin mühendislik alt boyutunda annenin eğitim durumu açısından istatistiksel olarak anlamlı bir farklılık bulunmuştur. Öte yandan, öğrencilerin STEM tutum ölçeği puanlarının baba eğitim durumuna göre farklılık göstermediği belirlenmiştir. Yarı yapılandırılmış görüşmeler öğrencilerin STEM eğitimi hakkında yeterince bilgi sahibi olmadıklarını ve aynı zamanda yaparak öğrenen çocuklar için somut bir sonuç elde etmenin onların tutumlarını olumlu yönde etkilediği de tespit edilmiştir.

Anahtar kelimeler: STEM, çalıştay, tutum, okul dışı öğrenme.

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STEM takes its name from the first letters of Science, Technology, Engineering, and Mathematics. The general purpose of STEM education is to integrate the fields of science, technology, engineering and mathematics and to direct students to these fields by including in-class and extra-curricular activities to all levels of education from kindergarten to university (Dugger, 2010). STEM education brings together these different disciplines and enables learning to be more effective and multidimensional (Smith & Karr-Kidwell, 2000).

STEM originated in the 1990s as an abbreviation of science, technology, engineering and mathematics at the National Science Foundation (NSF) (Bybee, 2013). There are many definitions of STEM education in literature. For instance;

> "for most, it means only science and mathematics, even though the products of technology and engineering have so greatly influenced everyday life. A true STEM education should increase students' understanding of how things work and improve their use of technologies. STEM education should also introduce more engineering during precollege education. Engineering is directly involved in problem solving and innovation, two themes with high priorities on every nation's agenda. Given its economic importance to society, students should learn about engineering and develop some of the skills and abilities associated with the design process." (Bybee, 2010, p. 996)

The overall objective of STEM education in US schools is to prepare all students for post-secondary and 21st century labor force (Kennedy & Odell, 2014). According to Kennedy and Odell (2014), the curriculum that incorporates students into STEM encourages teaching strategies that promote students to innovate and invent. Technology should be integrated into culture, curriculum, teaching strategies, and daily operations of courses to improve learning. High-quality STEM training programs also offer teachers the opportunity to collaborate in combined efforts aimed at integrating four subjects into a single teaching and learning method. When this goal is achieved, students are provided with access to meaningful curriculum opportunities that develop critical thinking skills that can be applied to their daily lives as well as their academic lives. STEM in K-12 education system offer students opportunities to master their skills and content of knowledge for today's age. Students are given opportunities to reach challenging learning depths using a variety of activity-based learning models. Learning is facilitated to encourage students to learn more deeply about topics that concern them. Developing students' reasoning skills, critical thinking skills, creativity and innovation through integrated and connected STEM curriculum and pedagogical practices ensure equality among students from different backgrounds (Meyrick, 2011). However, it is not easy to implement research-based reform on a large scale in STEM. Despite intense efforts to develop and disseminate curriculum products and ideas, progress has been slow (Henderson & Dancy, 2011)

Even though it has been transformed and changed in line with needs and opinions in the course of time, it continues to be developed. Worldwide interest with allocated high budget to STEM studies attracted the attention of researchers in Turkey. In order for countries to develop, to make leaps in the field of technology and economy, the necessity of raising a generation that is interested in STEM, entrepreneurial and creative thinking has emerged in schools. There was a need for an education culture that developed a sense of responsibility among the students, encouraged them to think, equipped them with technological information such as computer programming from an early age, emphasized the importance of solidarity and collaboration, and instilled an entrepreneurial spirit (Akgündüz, Ertepinar, Ger, Kaplan Sayi & Turk, 2015).

Global economic competition and technological changes in science and technology have accelerated since the second half of the twentieth century (Aydın, 2011). Due to the fact that we are living in the information age, the state of economic structure and technological developments have determined the status of the states in the international arena. School and education adapt to changing political, social, economic and global contexts. To be a leader among countries is possible by following the current education policies and making innovative reforms in education (Blackley & Howell, 2015). STEM reform is a new phenomenon of education that aims to increase students' understanding of science, technology, engineering and mathematics. The aim is to educate individuals in STEM literacy, which can solve complex problems by using the existing knowledge of students by developing their high-level thinking skills (Fan & Ritz, 2014). It has been seen that the basic knowledge needed for national development consists of science, mathematics and technical concepts since World War II. The rapid technological developments in the first half of the 21st century have a direct impact on the economy, and the reports indicating that the existing training was not sufficient in building the skilled labor force for the sustainability of engineering skills and technological developments attracted the attention of STEM employees (Aerospace Industries Association [AIAA], 2008; Business Roundtable, 2005; Bybee, 2013; Fan & Ritz, 2014; Toulmin & Groome, 2007). These reports emphasized that that the current system was insufficient to educate future generations in science, technology, engineering and mathematics.

In the United States, students' tendency towards science, mathematics, and engineering has gradually declined, and therefore United State has begun to lose competitiveness in technology and engineering. In order to increase the quality of education in these areas and the number of people, United States has initiated a reform movement called STEM education (Dugger, 2010). The European Commission has focused to STEM policy since the 1990s. Asian countries (such as Korea, Japan, China and Taiwan) with very high-performance education systems and growing economies, have conducted broader national policies and research and development studies on science and technology. Western countries have put STEM work on the agenda, and it has become one of the professional and economic objectives funded by governments and supported by politicians (Williams, 2011).

STEM training is an integrated approach that enables students to adopt creative problem-solving techniques (Akgündüz et al., 2015; Gülhan & Şahin, 2016; Gökbayrak & Karışan, 2017). For a productive generation and a thriving economy, there is an obligation to raise an innovative, entrepreneurial, creative thinking generation that is interested in STEM fields in schools (Akgündüz et al. 2015). STEM-based workshops are gaining importance day by day by private educational institutions and especially by institutions that function as out-of-school learning environments in education. In Turkey, many studies have been conducted in the field of STEM recently, but there is no study recorded regarding the workshop practices carried out in out-of-school learning environments. The aim of this study is to investigate the attitude of the students attending the workshop practices conducted in out-of-school learning environments towards STEM. For this purpose, four research questions guided this study:

- Does the practice of workshops in out-of-school learning environments have an impact on students' attitudes towards STEM?

- Do the students' attitudes towards STEM differ according to gender?
- Do the students' attitudes towards STEM differ according to the level of mother educational status?
- Do the students' attitudes towards STEM differ according to the father education status?
- What are the students' opinions on the practices in STEM workshops?

Method

In this study, students who participated in extracurricular workshop activities were examined about their attitudes towards STEM education. In this study, both qualitative and quantitative methods were utilized. The descriptive research method, which is one of the quantitative research methods, was carried out based on cross-sectional scanning model. Case study method was used as a qualitative research method.

Sample of the Study

The sample of the study consists of students aged ranging between 7 and 14 who have never participated in a STEM workshop. The sample was determined by random sampling method.

Data Collection Tools

Ethical rules were followed while collecting research data. The research participants participated in the research on a voluntary basis. Demographic characteristics of students such as gender, maternal education status, father education status was asked. Moreover, STEM Attitude Scale developed by Faber et al. (2013) and adapted into Turkish by Yıldırım and Selvi (2015) was used to measure the attitudes of the students attending out-of-school stem workshops towards STEM education. The Turkish version of the STEM Attitude Scale is a 5-point likert type scale including 37 items from 'strongly agree' to 'strongly disagree'. This scale has four factors; these are science (9 items), engineering (9 items), 21st century skills (11 items) and mathematics (8 items). Validity and reliability studies of the scale were conducted by Yıldırım and Selvi (2015) and the reliability of this instrument was found to be .94. The cronbach alpha values of the 4 factors of the test were found to be over .80. In addition, semi-structured interviews with students were conducted in order to get the opinions of the students in detail.

Data Analysis

The demographic characteristics of students were interpreted with descriptive analysis methods. The data obtained from the research were analyzed with SPSS. The t-test was used to investigate whether the participants' attitude scores towards STEM differ according to their participation in STEM workshops and gender. In addition, one-way analysis of variance-ANOVA was conducted to determine whether the scores of the students from STEM attitude scale change according to mother and father educational status. Descriptive analysis was used in the analysis of the interview questions. Apart from the researcher, two assistant researchers coded the data. For the validity and reliability of the data Miles and Huberman (1994) formula was used. With the help of this formula, the consensus between the first and second researchers was calculated as .81. That is to say, the resulting inter-rater agreement was 81% (Cohen's κ=.81).

Implementation of the Research

The STEM workshops, which started from October until the end of May, proceeded as modules. The three-dimensional design program Tinkercad, followed by the block-based coding program Scratch, the electronic circuit design set consisting of snaps that attract attention thanks to its simple use, Arduino sets that enable the use of code-writing and block-based coding features constitute the steps of these modules. The modules were implemented starting from Tinkercad application by adopting the Stem approach. Students were asked to design the objects associated with various courses with Tinkercad application and the designed objects were printed from 3D printers. The module has been completed with planning that will allow students to create their own designs. For example, students were provided to learn Tinkercad program by designing the bottle opener. They were shown practical examples (e.g. square, circle) of how to make the cavity in the mineral water bottle opener by selecting ready-made objects on the computer. Scratch program can be called to give life to any object. In this study, cat puppet was chosen in the Scratch program. It is practically shown how the puppet is selected, how the puppet is shaped, how its color changes, how its background is selected, how it is moved on the coordinate system, how to add multiple puppets and how to combine them to produce a product. Arduino is an open-source electronics platform based on easy-to-use hardware and software. The working principle of the Arduino and the parts of the Arduino set are introduced before practicing. Providing the electrical transition to Arduino board, the working principle of the traffic lights with the help of led lighting on the Arduino board was explained. In addition, the operating principle of sensors used in vehicle parking with the help of motion sensors, the use of moisture detection sensor, the use of light sensor, the temperature sensor and its application areas were also shown. All modules were planned to be completed between October and May following this process. In each completed module, students were able to prepare a project by combining it with the previous module. At the beginning of the next October (at the beginning of the new semester), the STEM Attitude Scale adapted to Turkish by Yıldırım and Selvi (2015) was applied to the students. The same scale was applied to the students in the city center where there was a school with students who had never participated in STEM workshops. The evaluation steps were then followed.

Results

In addition to the interview findings, students' STEM attitude scale scores according to their participation in STEM workshop, gender and mother-father educational status were presented in this section.

STEM Attitude Scale Score Analysis of Students

Table 1 shows the t-test results of students' STEM attitude scale scores according to their participation in STEM workshops.

Table 1

T-Test Results of Students' STEM Attitude Scale Scores according to Their Participation in STEM Workshops

Sub-Scale	SWPS*	*n*	$\bar{X}$	*sd*	*df*	*t*	*p*
Science	Yes	67	36.92	6.97	168	2.43	.016
	No	103	34.07	7.78			
21st Century Skills	Yes	67	47.23	5.18	168	2.96	.003
	No	103	44.10	8.58			
Engineering	Yes	67	37.84	6.10	168	2.72	.007
	No	103	34.66	8.16			
Mathematics	Yes	67	24.66	3.20	168	-.17	.86
	No	103	24.77	4.40			
Total	Yes	67	146.67	16.78	168	2.66	.008
	No	103	137.61	24.30			

*SWPS: STEM Workshop Participation Status

According to Table 1, t-test results obtained from the attitude scale of STEM indicated that there is a significant mean difference between the attitude scores of students according to their STEM participation status [$t(168)=2.66$; $p<.05$]. The mean scores of the students who participated in STEM workshop ($\bar{X}=146.67$) were higher than those who did not ($\bar{X}=137.61$). In addition, when the sub-dimensions of the attitude towards STEM scale were examined, significant differences were found in all sub-dimensions of the scale in favor of the participants of STEM workshops except mathematics sub-dimension [$t(168)=-0.17$; $p>.05$]. Table 2 indicates the t-test results of students' STEM attitude scale scores according to gender.

Table 2

T-Test Results of Students' STEM Attitude Scale Scores according to Gender

Sub-Scale	Gender	*n*	$\bar{X}$	*sd*	*df*	*t*	*p*
Science	Girl	72	34.79	7.09	168	-.589	.557
	Boy	98	35.48	7.95			
21st Century Skills	Girl	72	45.72	6.21	168	.571	.569
	Boy	98	45.05	8.440			
Engineering	Girl	72	35.16	6.23	168	-1.10	.269
	Boy	98	36.47	8.39			
Mathematics	Girl	72	24.41	4.29	168	-.893	.373

	Boy	98	24.96	3.71			
Total	Girl	72	140.10	18.36	168	-.547	.585
	Boy	98	141.97	24.46			

In Table 2, it was determined that the stem scores of the students did not differ according to gender in total and for all sub-dimensions of the scale. It was also investigated whether students' attitudes towards STEM differ according to mother and father educational status. Table 3 indicated the one-way ANOVA test results of students' STEM attitude scale scores according to mother educational status. As seen in the below table, there was no significant difference in science, mathematics and 21st century sub-dimensions in terms of students' STEM scores with respect to mother education status apart from engineering sub-dimension (F=2.517, p=.032<.05). Table 3 demonstrates the one-way ANOVA test results of students' STEM attitude scale scores according to mother educational status.

Table 3

One-Way ANOVA Test Results of Students' STEM Attitude Scale Scores according to Mother Educational Status

Sub-Scale		Sum of Squares	*df*	Mean Square	*F*	*p*	Sig
Science	Between groups	490.99	5	98.19	1.743	.128	-
	Within groups	9239.82	164	56.34			
	Total	9730.82	169				
21st Century Skills	Between groups	251.03	5	50.20	.873	.501	-
	Within groups	9430.58	164	57.50			
	Total	9681.62	169				
Engineering	Between groups	688.50	5	137.70	2.517	.032	Bachelor's degree-Master of Science degree
	Within groups	8974.00	164	54.72			
	Total	9662.50	169				
Mathematics	Between groups	101.73	5	20.34	1.303	.265	-
	Within groups	2560.07	164	15.61			
	Total	2661.80	169				
Total	Between	4844.41	5	968.88	2.055	.074	-

	groups						
	Within groups	77316.03	164	471.43			
	Total	82160.44	169				

All possible pairs of groups were compared in order to see the groups with significant difference between them for engineering sub-dimension with respect to mother education status. Tukey test results related to the engineering sub-dimension showed that there was a significant means difference between STEM attitude scores of the students whose mothers has bachelor's degree and Master of Science degree.

Table 4 indicated the one-way ANOVA test results of students' STEM attitude scale scores according to father educational status. As clearly shown in the Table 4, STEM attitude scale scores of the students did not differ according to father education status. In other words, it was found that there was no significant mean difference between the STEM attitude scale scores of the students according to father educational status.

Table 4

One-Way ANOVA Test Results of Students' STEM Attitude Scale Scores according to Father Educational Status

Sub-scale		Sum of Squares	*df*	Mean Square	*F*	*p*	Sig
Science	Between Groups	626.64	5	125.32	2.258	.051	-
	Within Groups	9104.17	164	55.51			
	Total	9730.82	169				
21st century skills	Between Groups	501.21	5	100.24	1.791	.117	-
	Within Groups	9180.40	164	55.97			
	Total	9681.62	169				
Engineering	Between Groups	200.60	5	40.12	.695	.628	-
	Within Groups	9461.90	164	57.69			
	Total	9662.50	169				
Mathematics	Between Groups	39.45	5	7.89	.493	.781	-
	Within Groups	2622.35	164	15.99			
	Total	2661.80	169				

Analysis of Students' Answers to the Interview Questions

The interview questions prepared based on expert opinions consist of 7 questions.

1st Question: What do you know about STEM education? Where did you get the information about STEM? How do you evaluate the information you get in your daily life?

Table 5 indicates the students’ opinions about the STEM education.

Table 5

Students' Opinions about the 1st Question

Student Opinions	*f*	%
I don't know. I have no idea.	13	43
STEM stands for science, technology and engineering. STEM means that they are all integrated into the course. I learned this information in the robotic-maker workshop. I haven't seen a contribution in my daily life yet.	2	7
Engineering, science, etc. things. I learned this from my teacher. I can apply this information later.	1	3
I know it is related to science, mathematics, computer and engineering.	14	47

According to the Table 5, more than half of the students associate STEM with mathematics, engineering, computer and science, while about half of them did not have enough information about the subject matter. On the other hand, a few of them (7%) stated that they could not relate STEM to daily life.

2nd Question: What are your opinions on Coding, Robotics and Maker Workshop? Did you enjoy being in the workshop? What is the reason you would like to join this workshop?

The opinions of the students about the second question were given in Table 6.

Table 6

Students' Opinions about the 2nd Question

Student Opinions	*f*	%
Yes, it is beautiful and pleasant because the future depends on coding and robotics and is very enjoyable to do.	13	43
I think it's a nice workshop, I'm glad to come. I like being in the workshop. I like to learn new things and I can do something about it in the future.	7	23
I think it is funny. A place where we learned something about the computer, I think it is useful.	10	33

As seen in Table 6, almost all the students expressed their pleasure to attend the STEM workshop. They said that the technology of the future would be on coding and robotics. In addition to having fun in the workshop, they expressed that they learned new things about technology. They also specified that coding and robotics allowed them to acquire knowledge in innovative areas and thought that they would be useful for them.

3rd Question: Are you interested in designing your own story and moving it to a virtual environment with Scratch program? What kind of story do you design?

The opinions of the students about the third question were presented in Table 7.

Table 7

Students' Opinions about 3rd Question

Student Opinions	*f*	%
Yes, I was interested in designing an adventurous and action games.	14	48
I am not very interested.	9	31
No, I think it's boring.	1	3.5
Actually, I am not really interested but I had a game and a story that I did before, and I couldn't finish it, but it sounded fun.	1	3.5
In fact, I am always interested. I made the game of Harry Potter's life story.	1	3.5
I designed the Minecraft game. I would like to be a footballer in the future, but I would like to design a game and let me know everyone.	1	3.5
I was interested. I'd like to make a story about stop-motion.	1	3.5
Great. I have 210 projects and 310 followers.	1	3.5

As can be seen in Table 7, while the Scratch program attracts most students, some of them are also not interested. Most of them (48%) would like to design adventurous and action games. Those who want to design stories, action game, film characters, would like to design their stories. They would like to make a name for themselves with their designs and expressed that they wanted to be recognized in this way.

4th Question: What would you like to design with the web-based Tinker cad application?

The opinions of the students regarding the fourth question were given in Table 8.

Table 8

Students' Opinions about the 4th Question

Student Opinions	*f*	%
Actually nothing. In my opinion, the Tinker cad app is boring and does not give me pleasure.	1	3
I'm doing designs right now, nothing I want to do.	1	3
Everything. I would like to design robot, mechanical circuit, game character, race car, Harry Potter scepter, key chain.	25	78
I would like to design wings to fly.	1	3
I would like to make wand and do things for decoration.	1	3
I would like to make an artificial intelligence prototype.	1	3

I do not want to design.	1	3
I would like to make musical instruments.	1	3

Table 8 indicated that most of the students (78%) would like to make designs for their interests such as game character, racecar, mechanical circuit, key chain, musical instrument. In addition, a few of the students (3%) stated that they found Tinker cad program boring and did not give them pleasure. In addition to these, although there were few, there were students who would like to design wings to fly, those who would like to make wand and do things for decoration, those who would like to make an artificial intelligence prototype, and those who would like to make musical instruments.

5th Question: What kind of project would you like to design if you had your own Arduino set? Why would you design such a project?

The opinions of the students regarding the fifth question were given in Table 9.

Table 9

Students' Opinions about the 5th Question

Student Opinions	*f*	%
I would design a robot that would imitate me and make friends.	4	14
I would design an advanced radar or sonar system.	1	3
I would design a bell that rings when the door is opened.	2	7
I would like to design a controlled maid, which I can ask to direct from the phone when I'm tired.	1	3
I would like to design a system with led light.	2	7
I would like to design a self-recharging battery to avoid running out of charge.	1	7
I have difficulty waking up in the morning, so I want to design an alarm.	2	7
I want to make a camera system.	2	7
I would like to make a robot that will make my life easier.	4	14
I didn't want it to be an Arduino and I didn't want to do it.	3	10
Launch system.	1	3
I do not know.	4	14
I would like to make a smart home.	1	3
Arduino sounds fun. I'd like to design.	1	3

Arduino sets enable the use of electronic circuit design set, code writing and block-based coding features. Students stated that they would like to make robot design that would be friends for them and make their lives easier. Students who have difficulty waking up in the morning declared that they would like to design an alarm system to find a solution to a problem in their daily lives. There are students who want to make a smart home system and an alarm system that is activated when the door is opened. Furthermore, there are some students indicating that they do not want to have an Arduino. There are also students who have no knowledge of Arduino (See Table 9).

6th Question: Do you think it is fun to learn to build electrical circuits with electronic circuit design? What kind of circuits would you make if you had such a set?

The opinions of the students regarding the sixth question were given in Table 10.

Table 10

Students' Opinions about the 6th Question

Student Opinions	*f*	%
Yes, good, enjoyable and fun.	18	60
I don't think it's fun.	3	10
I think it's fun to install a working circuit because it's very encouraging. Unfortunately, nothing comes to my mind.	1	3
Yes, it is fun. If I had a set, I'd love to do something about Led again.	2	6
Yes, it is fun. I would like to make a computer circuit.	1	3
Yes, it is funny. I would love to make helicopters, lights and songs.	1	3
Very fun I would like to make the robot by myself.	2	6
I do not know this.	2	6
I don't want to do anything.	1	3

Table 10 showed that most of the students stated that it is pleasant, nice and fun to learn to design electrical circuits with electronic circuit design, and that it is encouraging to build a working circuit. A few of the students said that they would want to work with Led if they have electronic circuit set. In addition, there are also students who want to make a computer circuit and make a robot. There is a student who wants to make circuits that can play helicopters, lights and melodies with the parts in the circuit set. There are two students who do not know about this set and one student who does not want to build any circuit.

7th Question: Which of these courses can help you better learn the lessons/courses you are studying at school? What do you think about this?

The opinions of the students about the seventh question were given in Table 11.

Table 11

Students' Opinions about the 7th Question

Student Opinions	*f*	%
I think it is related to Information Technologies course.	6	21
It can provide a better understanding of Science and Mathematics courses.	12	43
I think none of them because there is no question about these course subjects in exams.	1	4
I could not connect with any courses.	3	11
All courses except music and physical education.	1	3
Any lessons because there is no course related about it in our school.	2	7
All lessons.	2	7
I think it will be very useful for me in technology design class.	1	4

As it is seen in Table 11, most of the students (43%) stated that they thought they would provide a better understanding of Science and Mathematics courses. There are six students who think that they are related to Information Technology course, a student who associates with Technology design course, a student who associates them with all courses except music and physical education courses, and there are two students who associate them with all courses. In addition, there are students who stated that they would not benefit from any of the courses in the school because there was no question in the exams, and that there were no similar studies in their school and therefore no lessons would be of benefit to their learning.

Discussion and Conclusion

In this study, attitudes of the students attending workshop practices conducted in out-of-school learning environments towards STEM were investigated and statistically significant mean difference was found in terms of STEM attitude scale scores of students in favor of the STEM workshop participants. Similar to the current study, out-of-school time has a positive effect on student interest in STEM (Cooper & Heaverlo 2013; Young, Ortiz, & Young, 2017). When the subscales of the STEM attitude scale were examined; there are significant mean differences in terms of STEM attitude scale scores in the sub-dimensions of science, engineering and 21st century skills except for mathematics sub-dimension in favor of STEM participants. Sahin, Ayar, and Adiguzel (2014) stated that STEM related activities have the potential to promote collaborative learning and inquiry as well as to contribute to the development of 21st century skills. In addition, Gülhan and Şahin (2016), who examined the effects of STEM education on students 'attitudes, concluded that STEM education positively affected students' attitudes.

In the current study, it was determined that the scores of the students from STEM attitude scale did not change by gender. Cooper & Heaverlo (2013) stated that girls interested in problem solving could be interested in all four STEM subject areas. They emphasized that interest in creativity and design is also an important predictor of interest in computer and engineering issues. Greenfield (1997) assessed students' attitudes toward and participation in science, and how they might vary by gender and grade. The results of the study showed that both girls and boys expressed similar attitudes toward science but younger students were more positive than older ones. Girls and boys did not differ in their perceptions of scientists and science careers, except that it is more likely that boys believe that science is basically a masculine field of study and requires high levels of intelligence. In addition, girls and boys did not differ in their level of using science materials. It has also been investigated whether the scores of the students from STEM attitude scale differ according to mother and father education level in the present study. There was a significant mean difference only in engineering sub-dimension of the STEM attitude scale in terms of mother educational status. On the other hand, it was determined that STEM attitude scale scores of the students did not differ according to father educational status.

Semi-structured interviews in the current study showed that students had lack of knowledge about STEM education. Students stated that they enjoyed being in the coding, robotics and maker workshops, and they generally liked the Scratch application.

Considering the students who want to design games with scratch, it can be concluded that they have the desire to play games in the foreground. It was concluded that students had general knowledge about the web-based Tinkercad application which provides three-dimensional design. There are students who want to design by associating them with other robotics programs, and it can be said that students can establish and use them among each other. When the analysis of the answers given to the question about Arduino robotic application was examined, it was concluded that the students would like to make projects to find solutions to daily problems. Students, who stated that electronic circuit design is enjoyable to create a working circuit, said that it is motivating to build a working circuit. Based on the data obtained from the study, it was concluded that the achievement of a concrete result for children who learn by doing by doing has a positive effect on their attitudes towards that course. The study of Baran, Bilici, Mesutoglu, and Ocak (2016) implemented an integrated out-of-school STEM education program for 6th grade students to identify students' perceptions on the content and skills gained, the challenges and limitations faced and suggestions for improvement. The students in this study stated that this approach contributes to their cognitive, design, engineering and computer skills. The results of the research showed also that the integration of STEM activities into the out-of-school education programs could support the development of students' interest in STEM-related careers. Likewise, Baran, Canbazoglu Bilici, Mesutoglu, and Ocak (2019) and Guzey, Tank, Wang, Roehrig, and Moore (2014) stated that STEM training programs are important in improving student attitudes towards STEM. Duran and Sendag (2012) indicated that technology/inquiry and design-based collaborative learning strategies and technology-supported IT/STEM experiences have a significant effect on the development of critical thinking of urban high school students. Mahoney (2010) pointed out that the male students did display a statistically significant more positive attitude for STEM when compared to the female students for the content areas of technology and engineering unlike science and mathematics. In another study, students mentioned in interview that they had a positive attitude towards STEM. They also thought that having professional science knowledge would be beneficial for their future careers and that this technology can improve their lives and societies by making the world a more comfortable and productive place. Despite the positive thoughts, there were some students mentioned the negative effects of technology on society and environment (Tseng, Chang, Lou, & Chen, 2013). In addition to these, teachers believe that students require more opportunities to engage with technology however, it was also observed that schools are lacking technology resources. They also consider that problem solving ability and previous knowledge related to science and mathematics are important for students to understand in order to be successful in STEM integration. Teachers believe that this way of teaching encourages student learning and student confidence in mathematics and science courses. Furthermore, teachers think that STEM integration is a natural way of thinking about teaching, because many problems in the real world go beyond disciplinary boundaries (Wang, Moore, Roehrig, & Park, 2011). In addition, National Research Council (2011) stated that integrated teacher training programs train teachers to implement STEM training so that they can increase the innovation capacity of students.

It was also concluded that the students who stated that the programs and practices used would enable them to learn science and mathematics courses at school better relate the subjects to these courses more easily. Mohr-Schroeder et al. (2014) stated that many students have a lack of interest and proficiency in mathematics and science. They investigated middle level students' attitudes, perceptions, and interest in and toward STEM fields and careers changed after participating in an informal learning environment of a five-day camp organized on the campus of a major university in the mid-south. The results revealed an increase in students' motivation and interest in STEM. In addition, most of the STEM training participants found the STEM content sessions 'fun' and 'engaging' especially based on their practical experience. Sahin (2013) specified that engaging students with STEM-related clubs in early years of their secondary education promotes STEM interest in students, thus they were more likely to choose a STEM-related field as a career. When the negative and false answers given to the semi-structured interview questions are taken into consideration, it can be concluded that the majority of them are due to lack of knowledge about the subject matter and students' interests. More applications can be made for information deficiencies identified by examining training programs. Vennix, Brok and Taconis (2018) emphasized that outreach learning environments certainly creates opportunities to increase students' motivation in STEM and attitude towards STEM. The subjects that will keep the interests of the students alive can be identified and related projects can be made with students. As a result of the current study, it was concluded that STEM applications had positive effect on students' attitude. Similarly, Yıldırım and Selvi (2017) concluded that students 'attitudes improved positively with STEM education. Despite consistent evidence of the benefits of STEM programs, further research is needed to make generalizable decisions about the factors that differentiate the success of STEM programs.

Statement of Responsibility

Serkan Timur; conceptualization, methodology, software, formal analysis, writing - reviewing & editing, supervision, and project administration. Betül Timur; conceptualization, validation, investigation, resources, data curation, writing - original draft, and writing- reviewing & editing. Eylem Yalçınkaya-Önder; formal analysis, and writing- reviewing & editing. Didem Küçük; software, validation, investigation, resources, data curation, and writing - original draft.

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