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Primary School Students' Interests on Professions and Opinions on STEM Implementations[1]

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SUMMARY

In current research, it was aimed to determine the interests and opinions of the 4th grade Science course taught with STEM implementations. The implementation of the study was carried out in the second semester of the 2017-2018 academic year in 4thgrade of a Primary School in Emirdağ district of Afyonkarahisar. The study was designed in the form of action research. As data collection tools STEM Professional Interest Scale and semi-structured interviews were used. In the study, it was determined that STEM implementations positively increased the interest, perception and attitudes of students towards STEM occupations. At the end of the implementations the students perceive the fields of science, technology, engineering and mathematics as integrated; It is concluded that students find STEM activities interesting and entertaining, increase their motivation, are happy and increase their interest in STEM professions.

Keywords: STEM, STEM implementations, STEM professions, primary school students

INTRODUCTION

The concept of competitiveness, which first originated in the field of agriculture, shifted towards the industrial area with the industrial revolution in the 19th century. Nowadays, with globalization, borders between countries disappeared (Erdem & Köseoğlu, 2014), and the communication and interaction between people living in different parts of the globe and states have increased mutually. As a consequence, reduced resources accelerated the innovation race, and leadership in the technological development and defense industry gained importance (Akgündüz et al, 2015). In other words, development models based on agriculture, natural resources, and geopolitical position have been replaced by an economy based on information and technology. Now, countries that can produce and efficiently use information can have a say in the economy (Berberoğlu, 2010; Şirin, 2014). In this era, referred to as the information age, the education quality of the society is an important indicator of the development level of the country, individuals with qualified workforce support the development of technology to contribute to production. Therefore, it is necessary to educate individuals in line with the needs of the society and the era (Aydın, 2003; Çalışkan et al, 2013). In accordance, countries have started to give importance to STEM education to have a say in the economic order by making changes in their education systems.

STEM is the abbreviation of science, technology, engineering and mathematics (Dugger, 2010). STEM education endeavors to integrate science, mathematics, technology, and engineering disciplines by establishing a relationship between a unit or lesson with real-life problems and content (Bozkurt, 2014). It is an expression in itself that leads to effective and high-quality learning, takes the knowledge existing in nature and puts it into use in daily life, and includes military, economic and high-level thinking (Yıldırım & Altun, 2015). With STEM education, it is believed that individuals that understand science, technology, engineering, and mathematics, who can create contemporary products, research, question, and think critically and analytically, will be raised (Yamak et al, 2014; Akgündüz et al, 2015).

There are various approaches to teach STEM. One of these approaches is to teach the four STEM disciplines independently (S-T-E-M). Another approach is to teach each of the four STEM disciplines with more emphasis on one or two of the four. The third approach is to integrate one of the STEM disciplines into the other trio. For example, engineering content can be integrated into science, technology, and math classes (E-STM). A more comprehensive way is to teach holistically by handling the four disciplines together. For example, there is technological, engineering, and mathematical content in science. Therefore, technology, engineering, and mathematics can be integrated into science (Dugger, 2010). The process of integrating STEM into lectures is shown in Figure 1 (National Research Council, 2014).

[1] This study is part of Ümit Yavuz's master's thesis conducted under the supervision of Prof. Dr. Nil Yildiz Duban

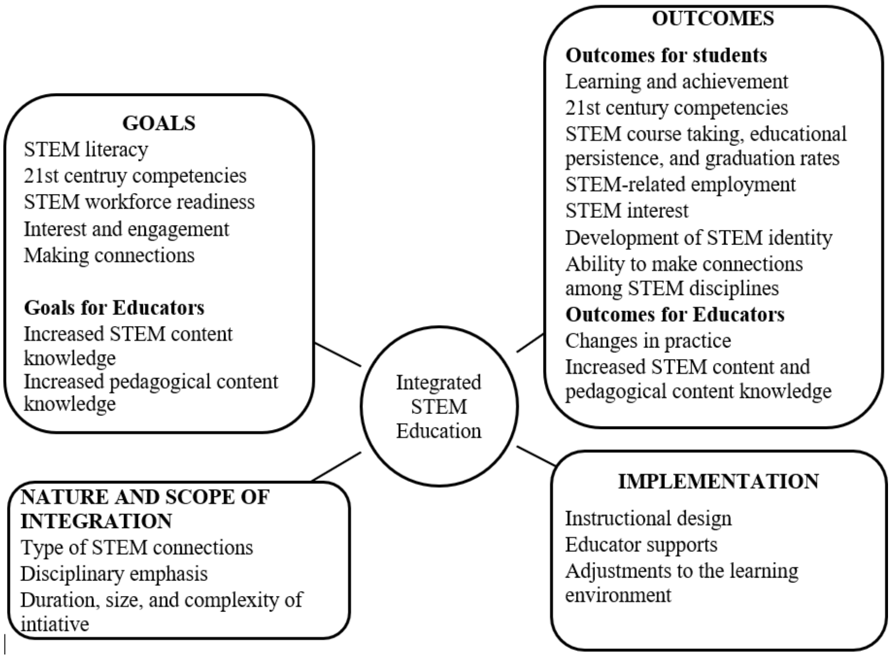

Figure 1. General Features of Integrated STEM Education (NRC, 2014).

In Figure 1, the nature and scope of integrated STEM education, aims, applications, and results are presented. Accordingly, the aim is for STEM students to be individuals with 21st century skills, STEM literate, ready for STEM workforce; and to increase the STEM content knowledge and pedagogical content knowledge of educators. It is understood that in order to achieve these goals for students and educators, the nature and scope of STEM should be determined and integrated into the curriculum, and the support of the educators and the learning environments should be arranged in accordance with STEM education. Essentially, STEM education has two main objectives. The first is to increase the number of students preparing for a university career in science, technology, engineering, and mathematics; the second is to increase the competence of all students in the field of basic STEM knowledge. The purpose is to develop the skills of students and employees to evaluate problems, use STEM concepts, and apply creative solutions to their daily lives (Thomasson & National Research Council, 2011). In other words, STEM education aims to raise scientists and engineers who will continue to research and develop for the country's economic growth, competent workers to meet the demands of labor in STEM-related business areas, and scientifically literate citizens who make wise decisions about public policy and understand the world around them (Tsupros et al, 2009; Barakos et al, 2012).

STEM affects the modern world. The products people produce, the food they eat, the vehicles they use, the information they receive, medicines, and many aspects of modern life are shaped by STEM (National Research Council, 2014). In this respect, STEM professions; play an instrumental role in the advancement of technical works in the fields of science, technology, engineering, and mathematics, in the expansion of scientific boundaries, and the development of new products and technological progress. These professions are concentrated in the most advanced industries such as computer systems design, scientific research and development, and the manufacturing of technological products. Even though the educational requirements are different, most of these professions must be at the undergraduate or graduate level (Cover et al, 2011). Increasing the number of high school, university and graduate students specializing in STEM subjects is of great importance for economic development. Most STEM graduates enter high-paying and fast-growing STEM jobs. Besides, people working in STEM professions have lower unemployment rates compared to workers in other fields. This implies that STEM employees have higher job security. Moreover, students who study a department on STEM professions can easily adapt even when they work in non-STEM professions (Thomasian & NGA, 2011). As a result, the belief that pursuing a career in a STEM-related field will increase personal living standards and economic levels leads students to this area for all countries (Douglas & Strobel, 2015).

Turkey also needs to invest in STEM education to produce products with high added value so that it can develop economically and reduce the current account deficit (Aydagül & Terzioğlu, 2014). In order to determine to what extent these investments have succeeded, Turkey's performance in STEM education should be measured and its place in the global competition should be determined (Sirin, 2014). For this purpose, Turkey's participation in exams where countries can compare their education system with other countries, such as international measurement and evaluation studies PIRLS, TALIS, TIMSS, PISA, is important. The International Mathematics and Science Trends (TIMSS) survey is held every 4 years to measure the knowledge and skills acquired by 4th and 8th grade students in the department of mathematics and science. Turkey participated in the survey, which was first conducted in 1995, at the 8th grade level in 1999 and 2007; and at the 4th and 8th grade level in 2011 and 2015 (TIMSS, 2015). In the field of science at the 4th grade level, it received 463 points (score of TIMMS) in 2011 and 483 points in 2015, increasing 20 points compared to the previous period. In 4th and 8th grade level, Turkey is located at the intermediate level in international science proficiency levels, which are determined as lower, middle, upper, and advanced levels. Similarly, supported by the OECD (Organization for Economic Cooperation and Development), PISA (International Student Assessment Program) measures how well 15-year-old students have the necessary knowledge and skills to become new-age individuals. In this exam, science, mathematics and reading skills are evaluated. It concentrates more around a specific area in each cycle. In the PISA exam held in 2015, science literacy was determined as the weighted area. Turkey ranked 47th with 424 points among 57 countries participating in the scientific literacy weighted exam of 2006 and 54th among 72 countries with 425 points in the science literacy field achievement test of 2015, ranking below the OECD average (PISA, 2015). As can be seen from the statistical data given above, it is clear that we are not at a sufficient level in PISA and TIMSS exams as a country. It would be fair to say that Turkey needs to develop its educational goals and methods to compete with other countries in the global economy. This situation brings STEM education to the fore, which is one of the most important educational approaches. Indeed, when Turkey STEM Education Report was examined, it has been stated that, if applied correctly, STEM education will enable training students who can be successful in the PISA exams (MOE, 2016).

Purpose of the Study

This study aimed to determine the effect of the 4th grade Science course, which is taught with STEM applications, on students' interest in STEM professions and their opinions about the course.

For this purpose, answers to the following questions were explored.

- Is there a significant difference between the pre-test and post-test scores of the students in the STEM Career Interest Survey depending on STEM applications?
- What are the students' opinions about the Science lesson taught with STEM applications?

METHOD

Research Model

In the study, a section from the study designed as an action research is presented. Action research, it is a systematic research that enables people to find effective solutions to the problems they encounter in their daily lives. Unlike traditional experimental scientific research that seeks generalizable explanations that can be applied to all contexts, action research focuses on specific situations and local solutions (Stringer, 2007). In this study, among the data collection tools used in action research, the semi-structured interview and STEM Career Interest Survey were used.

Participants

The working group of the research consists of 4th grade students of 2017-2018 academic year studying in the Gömü Primary School located in Gömü Town of Emirdağ District in Afyonkarahisar city. The class size is 26 students, with 13 girls and 13 boys. The action research was carried out by including all students in the classroom. For semi-structured interviews, criterion sampling, which is one of the purposeful sampling methods, was used. Face-to-face interviews were conducted with a total of 12 students, three students in each of the upper, middle, and low academic success levels.

Data Collection Tools

In the study, "STEM Career Interest Survey" was used as a pre-test and a post-test. At the end of the research, a semi-structured interview was conducted with the students.

STEM Career Interest Survey

In the study, "STEM Career Interest Survey", which was adapted to Turkish by Unlu et al, (2016), consists of science, technology, engineering and mathematics sub-dimensions. The Survey used the 5-point Likert scale: strongly disagree, disagree, undecided, agree, and absolutely agree. The test by Unlu et al, was examined by Turkish and English field experts for its validity, and necessary corrections were made. The Cronbach Alpha reliability coefficient is 0.93. The necessary permission to use this survey was taken from the researchers who adapted it to Turkish.

Semi-Structured Interview

Semi-structured interviews combine both fixed and in-depth field analysis. It can be analyzed easily, and it provides in-depth information and ease of self-expression to the interviewee (Büyüköztürk et al, 2011). The semi-structured interview forms used in the study were prepared by the researchers. In order to ensure the internal validity of the questions, these questions were given to four field experts and the form was finalized by correcting the questions under the supervision of the experts. Afterward, a pilot study was conducted with a student to measure the operability of these questions. The results of the pilot study were examined in order to determine whether the questions were clear and understandable and whether the answers were compatible with the questions asked. After seeing that the pilot study functions properly with no problems, face-to-face interviews were conducted with the students using semi-structured forms at the end of the implementation process.

Data Collection Process

Before STEM activities, the "STEM Career Interest Survey" was applied as a pre-test, and then the action research implementation process was initiated. During the implementation process, five STEM activity (action) plans were used in the 4th grade Science course. The first three activity plans are related to the unit's "Lighting Technologies from Past to Present", while the other two are about "Sound Technologies from Past to Present". Five activity plans in the research were prepared under the titles "Lighting Technologies from Past to Present and the Importance of Lighting", "Proper Lighting", "Light Pollution", "Sound Technologies from Past to Present" and "Sound Pollution". The data collection calendar regarding the action research process is presented in Table 1.

Table 1. The calendar for the data collection process

Before Implementation			
Application of the STEM Career Interest Survey			
Implementation Process			
March 30, 2018 April 4, 2018 April 6, 2018	First Activity Plan	Lighting Technologies from Past to Present	Video recording. Diaries.
April 11, 2018 Validity Committee			
April 12, 2018 April 13, 2018	Second Activity Plan	Proper Lighting	Video recording. Diaries.
April 18, 2018 April 19, 2018 April 26, 2018	Third Activity Plan	Light Pollution	
April 30, 2018 Validity Committee			
May 2, 2018 May 18, 2018	Fourth Activity Plan	Sound Technologies from Past to Present	Video recording. Diaries.
May 23, 2018 Validity Committee			
May 24, 2018 May 31, 2018	Fifth Activity Plan	Sound Pollution	Video recording. Diaries.
Post- Implementation			
Application of the STEM Career Interest Survey			
Conducting a Semi-Structured Interview			

In the lessons conducted with STEM applications, 4 Arduino uno (S4A) Program was used in certain activities in the effective use of technology and engineering dimensions. Before starting action research studies, games related to "Blockly Games", one of the block-based coding tools on EBA, have been played to serve as a basis for the S4A program. Later, simple coding and algorithm creation activities related to Scratch were carried out. The studies here have supported the implementation phase of the action research. For example, the S4A program was used in the "Let's Light a Light Bulb with Coding" activity. S4A program provides the connection with Arduino uno so that students can see how the coding made with Scratch works in real life. At the beginning of the lesson, Arduino uno set was given and introduced to each group. They were explained simply how to use it. During the application phase, the students created the circuit together with the teacher, using the method of making by demonstration. The groups that made the circuit started the light bulb lighting activity by opening the

S4A coding program in their computers and connecting the Arduino uno to the computer. Photos related to the application are presented in Photo 1 and Photo 2.

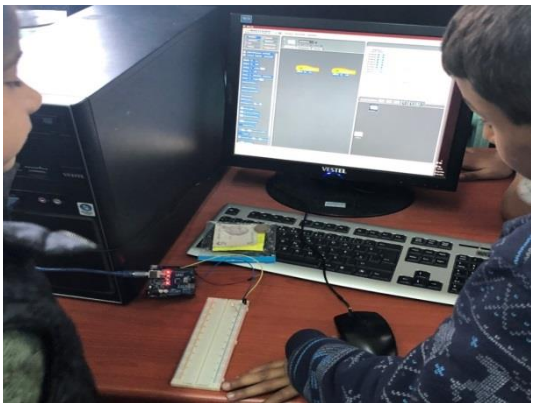

Photo 1. Light Bulb Lighting Activity

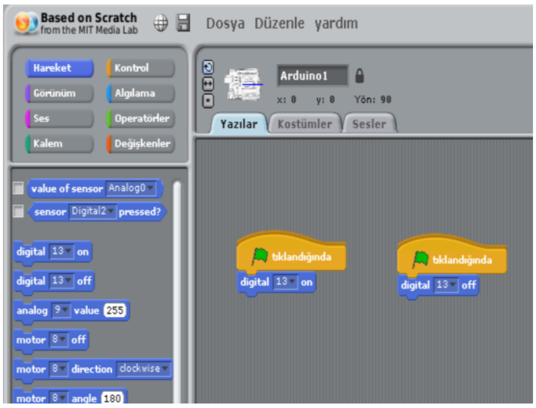

Photo 2. Light Bulb On and Off Algorithm

After the exercise, the "STEM Career Interest Survey" was re-applied, this time as a post-test. In addition, the data collection process was completed by conducting semi-structured interviews with 12 determined students.

Analysis and Interpretation of the Data

In the quantitative dimension of the study, "STEM Career Interest Survey" was used. Collected data were analyzed with a computer program. In the analysis, the mean and standard deviations of the pre-test and post-test results of the students participating in the research were calculated. Normality analyzes of these tests were performed and Skewness and Kurtosis values were evaluated. According to this, it was determined that the data of the "STEM Career Interest Survey" were normally distributed. Due to the normal distribution of the data, the STEM Career Interest Survey was analyzed using the "Paired Sample t-test".

Descriptive analysis method was used for the analysis of qualitative data. In descriptive analysis, the data are summarized and interpreted according to pre-determined themes. The data can be arranged according to the themes revealed by the research questions or they can be presented by considering the questions during the interview and observation processes. In descriptive analysis, direct quotations are used to reflect the views of the observed or interviewed individuals in a remarkable way. For this purpose, data are first described in a systematic and clear manner. Later, these descriptions are explained and interpreted, cause-effect relationships are examined and some results are achieved (Yıldırım & Şimşek, 2016). After semi-structured interviews were conducted with 12 students, the audio of the interviews was recorded on the computer and then transcribed. In order to ensure reliability, the data were examined in their original format by two researchers independently. Subsequently, the issues with "consensus" and "disagreement" were discussed and necessary arrangements were made. For the reliability, the percentage of agreement suggested by Miles and Huberman was used and the reliability was calculated as 88. Reliability calculations above 70% are considered reliable for research (Miles & Huberman, 1994). The result obtained here indicates that the study is reliable.

FINDINGS

Findings Regarding the STEM Career Interest Survey

Table 2 shows the Dependent Groups t-Test results of the "STEM Career Interest Survey" applied to 26 students before and after STEM implementations.

Table 2. STEM Career Interest Survey Pre-test and Post-test Dependent Groups t Test Results

		N	Mean	ss	s.d.	t	p
Science	**Pre-test**	26	36.46	6.80	25	-5.472	0.000
Dimension	**Post-test**	26	43.23	4.56			
Mathematics	**Pre-test**	26	36.61	8.30	25	-3.614	0.001
Dimension	**Post-test**	26	41.61	4.89			
Technology	**Pre-test**	26	40.00	7.26	25	-3.613	0.001
Dimension	**Post-test**	26	44.76	4.72			

Engineering Dimension	**Pre-test**	26	37.57	6.74	25	-6.144	0.000
	Post-test	26	44.38	4.46			
TOTAL	**Pre-test**	26	150.65	26.34	25	-5.524	0.000
	Post-test	26	174.00	14.93			

As shown in Table 2, comparison of the STEM Career Interest Survey pre-test scores (Mean: 150.65) and post-test scores (Mean: 174.00) reveals a statistically significant difference in favor of the post-test ($t_{25} = -5.524$; $p < 0.05$). When examined in the context of sub-dimensions, the difference between the Science dimension pre-test (Mean: 36.46) - post-test (Mean: 43.23); Mathematics dimension pre-test (Mean: 36.41) - post-test (Mean: 41.61); Technology dimension pre-test (Mean: 40.00) - post-test (Mean: 44.76) and Engineering dimension pre-test Mean: 37.57) - post-test (Mean: 44.38) scores is striking. Besides, there is a statistically significant difference in favor of the post-test also in the sub-dimensions. According to these findings, it can be said that students' perceptions of STEM careers changed positively after STEM implementations.

Student Opinions on STEM Implementations

Semi-structured interviews were conducted with 12 students after the end of STEM implementations. This interview was aimed to determine the opinions of primary school 4th grade students about the Science course taught with STEM applications. Interview data were divided into themes, sub-themes and categories. The categories related to the Science, Technology, Engineering and Mathematics Connections sub-theme are presented in Table 3.

Table 3. STEM Theme Science, Technology, Engineering and Mathematics Connections Sub-Themes and Categories

Theme	Sub-Theme	Categories	f
STEM (Science, Technology, Engineering and Mathematics)	Science, Technology, Engineering and Mathematics Connections	Independent	11
		Science, Technology and Engineering	1
		Integrated	12

As presented in Table 3, before the activities in the Science course; 11 of the students interviewed stated that they thought science, technology, engineering, and mathematics fields are independent of each other; while one student thought of science, technology, and engineering fields together and mathematics field separately. All 12 students stated that their ideas changed after the application, and they thought of science, technology, engineering, and mathematics in an integrated manner. Direct quotations from students on this subject are as follows;

> Furkan: *Since we have just started working, I was thinking separately, after our activities I started to think in an unified way. Because we did all the lessons in the activities.*
> Gamze: *First, I was thinking separately, I didn't know what to do, then I started to think about them all together.*
> Rojat: *I was thinking separately, but I thought integrated after the studies. Because we used science, technology, engineering and mathematics together in activities.*
> Selin: *I was thinking separately, I thought together after the activities. Because I learned that we use them for the same things.*
> Melike: *I was thinking of science, technology, engineering and mathematics as separate things. Because I hardly thought we could invent new things. After the studies, I thought of them all together.*
> Aslı: *I could think of science technology, and engineering together, but I was thinking about mathematics separately. After the work we did, I thought of them all together and designed a cabinet.*
> Ahmet: *I was thinking separately before the application. Then I realized that they were together. Because every study we did had science, mathematics, engineering, and technology.*

Within the scope of this research, the relationship between science, technology, engineering and mathematics was made clear to the students with the studies carried out during the STEM activities and an interdisciplinary perspective was encouraged. It can be said that this situation has changed the way they think about STEM fields

The categories related to the Science, Technology, Engineering and Mathematics Dimensions sub-theme are presented in Table 4.

Table 4. STEM Theme Science, Technology, Engineering and Mathematics Dimensions Sub-Themes and Categories

Theme	Sub-Theme	Categories	f
STEM (Science, Technology, Engineering and Mathematics)	Science	Lighting Technologies	7
		Sound Technologies	5
	Technology	Product	10
		Sound	1
		Design (generating ideas)	1
	Engineering	Calculation (gauge, reaper) - Construction	12
	Mathematics	Prisms	5
		Angles	2
		Drawing (ruler)	5

Table 4 shows that students related science with lighting technologies and sound technologies; technology with making a new product; engineering with construction; and mathematics with prisms, drawing and angles. Direct quotations from students on this subject are as follows:

> Aslı: *Engineering was in my product design, technology in making a new product, mathematics in using prisms, and science in light.*
> Vildan: *While we were building an illuminated wall, we used engineering to construct, mathematics to draw a cube, science to install a light bulb and technology to develop products.*
> Şaban: *I used science in sound, mathematics in drawing, technology in making products, and engineering in building.*
> Selin: *We used mathematics while cutting cardboard paper in a rectangular shape, science in lights, engineering while designing our invention, and technology in creating a new product.*
> Ahmet: *There were angles in mathematics, there was light in science, we drew a house with wall light in engineering, and we produced a product in technology.*
> Ali: *Technology is related with product, mathematics with shapes, engineering with product and science with sound.*
> Gamze: *Science was about light, mathematics about angles, engineering about construction, and technology about generating ideas.*
> Furkan: *Mathematics was in drawing, engineering was in building, science was in sound and lighting.*
> Rojat: *We used science in lights, mathematics in drawing, engineering in building walls, and technology in inventing.*

It can be said that the mini researches and mini applications conducted during the studies affected the students in this regard. As a matter of fact, lighting light bulbs on Arduino uno with the S4A coding program in the event "Let's Light a Bulb with Coding" and "Let's Make a Room's Light System" provided the opportunity to test the results of their work in real life. After the mini researches are completed, the transition to big designs makes it possible for students to see all STEM disciplines in these processes.

The categories related to the Interesting Section sub-theme are presented in Table 5.

Table 5. STEM Theme, Interesting Section Sub-Theme and Categories

Theme	Sub-Theme	Categories	f
STEM (Science, Technology, Engineering and Mathematics)	Interesting Section	Science	3
		Technology	5
		Engineering	1
		Mathematics	1
		Integrated	2

Table 5 shows that throughout the application process among the fields of Science, Technology, Engineering and Mathematics; technology, science, engineering, and mathematics were found to be interesting by 5, 3, 2 and 1 student respectively and the connection between the STEM fields was found to be interesting by 1 student. Direct quotations from students on this subject are as follows:

Bedirhan: *The section that attracted my attention the most in the studies we did was technology. Because we have introduced new things.*
Şaban: *Technology because we are introducing a new product.*
Ali: *When I think of science, technology, engineering and mathematics, the most interesting section is technology. Because I want to design new products.*
Vildan: *Engineering attracted my attention the most in our studies. Because I liked building things.*
Melike: *Technology because I learned that I can achieve the products we make when I work hard.*
Gamze: *Science and technology. Because I learned light devices and created a new product.*
Rojat: *The most interesting section was science, because it was beautiful and fun.*
Ahmet: *The most interesting section was science. Because lights within the science subjects grasped my attention.*
Gamze: *The most interesting section was mathematics, because it was fun.*
Selin: *The interconnection of science, technology, engineering and mathematics drew my attention. Because together they create products.*

Aslı: *I was intrigued by their connection with each other. Because they can produce a product together. If I choose one, it can be engineering because we are designing something new.*

Sub-themes and categories related to STSE and Sensation themes are presented in Table 6.

Table 6. STSE and Sensation Themes, Sub-Themes and Categories

Theme	Sub-Theme	Categories	f
STSE (Science-Technology-Society-Environment)	Society	Helping People	12
	Science and Career Awareness	Professions	2
Sensation	Success	I succeeded	1
	Motivation	Fun-Beautiful-Happy	9

Table 6 summarizes the answers given to the question "What kind of product would you like to invent if you were a scientist?" after the students completed their STEM activities. The students stated that they wanted to invent products that would support people in general. Direct quotations from students on this subject are as follows:

Aslı: *I would like to design a cabinet. Because it can read fairy tales to young children and play games*.

Şaban: *I would like to make a device that will turn on automatically when the lights go out*.

Ahmet: *I would make a talking house. Because when there is a fire, it informs the fire department. When a thief enters the house, it calls 155 and allows the thieves to be caught.*

Melike: *I would design a product that would benefit people, a wall that would prevent sound and light pollution. Because it will absorb sound and light pollution, so people will not have blindness and deafness.*

Bedirhan: *I would like to invent a non-disturbing product that is beneficial for people.*

Ali: *Talking car. Because when the gasoline runs out, it will give a warning, when we say it will turn on its light, use it on its own, put on your seat belt.*

Rojat: *I would invent something useful.*

Gamze: *I would invent a light with umbrella to prevent light pollution.*

Vildan: *I would invent microscopic flashlights to easily see small creatures.*

Selin: *Smart bag because it will help when the children's bag is heavy and in the dark environment. It will have sleeves, but once inside the school it will be a normal bag. It will be able to wake up the kids.*

As it can be seen in Table 6, students stated that they have acquired new knowledge and skills, felt successful and had fun during STEM applications related to lighting and sound technologies. They also stated that it will support their professional life in the future. Quotations taken from students on this subject are as follows:

Aslı: *I think they were very good activities, I had a lot of fun doing it. I can understand the lessons better. I hope we can revive it in the future.*

Gamze: *I learned technology. I learned things that I did not know. I learned new things, words and devices. I felt good*

Bedirhan: *I learned new things. I can make products for the benefit of people.*

Ali: *It helped me learn science better, it was fun. I learned how to make a presentation.*

Şaban: *I learned that science, technology, engineering and mathematics go hand in hand.*

Vildan: *It will help our future career and we can solve questions more easily in the exam. I got information.*

Selin: *We carried out very good studies. I learned new things and had a lot of fun.*

Furkan: *I had a lot of fun at the activities. We made a penholder with led lamps. We had it connected to the computer. I learned how to connect the lamp.*

Rojat: *I learned the causes of sound and light pollution. I learned that we can use science, technology, engineering and mathematics together. I got information. I learned to invent something.*

DISCUSSION and CONCLUSION

Results of Interest Survey for STEM Professions

In order to determine the interest level of primary school 4th grade students towards STEM professions, the STEM Career Interest Survey was applied before and after the application. According to the comparison between the Science pre-test (36.46) and post-test (42.23) averages, it was concluded that there was a positive increase in the students' interest in Science professions. Comparing the Technology pre-test (40.00) and post-test (44.76) averages, it was also determined that the students' interest in Technology professions increased in favor of the post-test. When the averages of Engineering pre-test (37.57) and post-test (44.38) were compared, the positive increase in the students' interest in Engineering professions was determined. Students also stated in the interviews that they felt like engineers. Likewise, when the averages of Mathematics pre-test (36.46) and post-test (41.61) were compared, there was a positive increase in students' interest in Mathematics professions. Collectively, the pre-test (150.65) and post-test (174,00) results emphasize an increase in interest towards STEM professions. It can be concluded that learning by doing and experiencing method, and student-centered educational environment affect students' perceptions of STEM professions. The increase in students' interest in STEM professions after STEM-related activities was put forward in many studies in the literature. The research by Şahin, Adıgüzel, and Ayar (2014), focusing on the effects of STEM-based after-school activities on students between 4th and 12th grades, concluded that after STEM activities, students' interest in STEM professions increase. Similarly, Baran et al, (2016); Gökbayrak & Mixing (2017); Knezek et al, (2013) found in their research with middle school students that STEM-based activities increase students' interest in STEM professions. However, the research by Saad (2014) on 8th grade students concluded that there was no significant increase in students' interest in STEM subjects and professions. Yet, it was also noted that a short three-week period in performing the space balloon activity might have negatively affected the result, and a positive result could be obtained in a longer period.

Results Obtained from Student Opinions

Student opinions, which reflect their understanding before and after the STEM implementations, revealed that most of the students perceived the fields of science, technology, engineering, and mathematics independent from each other before attending STEM activities. The reason for this situation might be the lack of attention to interdisciplinary connections in Science courses. It was concluded that after the application, all students started to perceive STEM fields in an integrated manner. Similarly, Gökbayrak & Mixan's (2017) study with middle school students concluded that students perceive science, technology, engineering and mathematics fields as interrelated and integrated after STEM-based activities.

In the interviews, students mentioned that technology is constantly developing in the activities related to lighting technologies, and they find STEM applications fun and feel happy after the activities. In parallel with the results of this research, a study by Nağaç (2018) with 6th grade students revealed that STEM Education increased the interest in the lessons and the lessons became fun. Similarly, Acar (2018) stated that primary school 4th grade students enjoyed STEM applications.

Student interviews revealed that they found the STEM applications fun, and hence they could learn the subjects in the science lesson better and they believed that this information would help them in their future professional life. In addition, it was concluded that students found STEM activities interesting and entertaining, felt happy and motivated, and increased interest in STEM professions. Likewise, in the study conducted by Gülhan & Şahin (2016), the development of the experimental group within itself made clear that there is a positive increase in the perceptions about engineering, technology, career, and STEM. Pekbay (2017) also concluded that there was a positive increase in the interest of middle school students towards STEM after STEM applications.

At the end of STEM implementations, students found the fields of science and technology most interesting. When the students' opinions were examined, it was understood that conducting scientific research and producing a new product in the science lessons were what made science and technology interesting. It was also revealed that all the students participating in the interview wanted to invent products for the benefit of society. These products were; "Talking House", which informs the fire department in case of fire and the police in case of theft; a "Wall" that can prevent sound and light pollution; “Microscopic Flashlight” that will allow small creatures to be seen easily, and a “Smart Bag” that can support young children in their daily life. It can be thought that stem implementations offer an opportunity to reveal the creative and innovative thinking skills of children.

Recommendations

- Quantitative and qualitative studies on STEM applications can also be conducted at primary school 1st, 2nd and 3rd grade levels.
- Qualitative and quantitative studies can be carried out for different units on STEM implementations at primary school level.
- Explanations and activities that can set an example for teachers about STEM implementations can be included in the Primary School Science Program.
- In-service training on STEM education can be provided to teachers.
- Material support can be provided to students so that they can work on STEM.

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