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DETERMINATION OF THE EFFECTS OF STEM EDUCATION APPROACH ON CAREER CHOICES OF GIFTED AND TALENTED STUDENTS

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ABSTRACT

This study proposed to determine the effect of STEM practices on the choices of gifted and talented students for future profession. The research was carried out in a Science and Arts Centre (SAC) affiliated to Ankara Provincial Directorate of National Education during 2016-2017 academic year. The study group composed of 17 gifted and talented students. The research was designed according to the case study design that is one of the qualitative research methods. The data were collected through a semi-structured interview form generated by the researchers. Content analysis technique was conducted to analyse the qualitative data collected during the research. As a result of the analysis of the data, it was revealed that the STEM practices enabled the students to recognize the profession they wanted to choose, that the STEM education improved the professional thoughts of the students, and that the STEM practices had a positive effect on STEM professions.

Keywords: *STEM, Science Education, Gifted and Talented Students, Career Planning*

INTRODUCTION

It is a common fact that science education is an important aspect in the age of information and technology in which the scientific knowledge is rapidly increasing and the technological developments are rapidly progressing and the sciences and technology are observed in every aspect of our life (Ministry of National Education [MoNE], 2006). Through the renewed science education program in our country, it is important that every individual is science literate regardless of their individual differences (MoNE, 2013a). Science literacy means that the individuals are able to comprehend the scientific knowledge at a basic level, to understand the events, to establish a relationship between events, and to be able to follow the technological developments, and to use them in their lives (Kavak, Tufan, & Demirelli, 2006). In this context, the business world in 21st century requires the individuals to become science literate. Besides, the world of competition at present requires the individuals not only to be a science literate, but also mathematics, technology, and media literate. Furthermore, the individuals are expected to have such features as critical thinking, problem solving, and group work. Therefore, the countries need new educational approaches to satisfy the needs of the business community (Khalil, & Osman, 2017). One of these educational approaches is STEM education approach.

STEM which is an abbreviation of Science, Technology, Engineering and Mathematics was first introduced in 2001 (Zollman, 2012). It is understood that the emergence of this educational approach is based on that the interest of the students in science, mathematics and engineering, and especially in mathematics and physics, are not at a sufficient level (Anderson, Chiu, & Yore, 2010; Hipkins & Bolstad,

2005; Stine & Matthews, 2009). Moreover, STEM education focuses on science and mathematics fields, however the important role of engineering and technology is ignored (English, 2015). In addition, the importance of engineering and technology fields are taken into consideration as well as ensuring the interest of the students in these fields through STEM education. When the literature is examined, it is observed that the interest of the students in STEM fields have increased through the STEM education practice (Yıldırım, 2016). In addition, it is understood that so many studies have been conducted so as to increase the interest of the students, especially female students, in STEM fields (The Girl Scout Research Institute [GSRI], 2012). Moreover, STEM education contributes to the development of such skills as critical thinking, and group work that are required for the business world in 21st century (Childress, 1996). In addition, STEM education is preferred for many reasons such as establishing an industrial school connection, improving stem literacy, increasing academic success, contributing to PISA/TIMSS exam. (Morrison, 2006; Silver & Snider, 2014). Therefore, STEM education has been included as curricular or extracurricular activities in education systems in US, Turkey, and other different countries, and they have heavily invested in STEM education (Banks & Barlex, 2014; Van Langen & Dekkers, 2005). However, it is understood that STEM education cannot be adequately integrated into courses or is incorrectly integrated into courses. When the literature is examined, it is observed that there are many misconceptions such as that the STEM education is pure science experiments, that it includes robotic studies, and that the technology and engineering are separate from each other (Morrison, 2006). One of these misconceptions is that STEM education can only be applied to gifted and talented students (Yıldırım, 2016). When the literature is examined, it is understood that STEM education is implemented at different levels (Gülhan & Şahin, 2016; Hacıoğlu, 2017). Therefore, STEM education can be provided to everyone without considering gender or skill difference. Therefore, it is important for the future and development of the country to present differentiated programs and learning environments to gifted and talented students for such teaching-learning processes as STEM that can give different disciplines.

Gifted and talented is defined as the synthesis of high mind, intelligence, and creativity, and it is generally known that the gifted individuals have developed analytical, creative, and practical thinking skills (Davidson, 2012; Sternberg, 2009). In this context, STEM education approach programs conducted in the Science and Arts Centre (SAC) in which gifted and talented students are educated outside their schools' purpose to increase the attitudes, knowledge and skills of the students towards these fields and to determine the interests and abilities of each student. When the literature is examined, it is seen that there is a limitation of the studies on early childhood (4 to 6 years) career guidance and educational practices for the gifted and talented students in our country. In this context, it is thought that the study will strengthen the literature in terms of content and practices and contributing to the career guidance of gifted and talented students. Moreover, when the literature is reviewed, that there has not been any study on the effect of STEM education on the career choice of gifted and talented students reveals the importance and originality of this present study.

In short, the purpose of this study is to determine the effect of STEM education approach on career choices of gifted and talented students. For this purpose, the question "Do STEM practices have an effect on the career choice of the students, their professional thoughts, and their recognition of the profession they want to choose in the future?" was sought in the study.

METHODOLOGY

Research Design

This research was structured according to the case study design which is one of the qualitative research methods. A case study is a qualitative research approach that allows an in-depth study of a subject or a situation within a certain period of time (Creswell, 2003). The case studies examine one or more cases in depth and provide the whole perspective of the process through detailed data. In this context, the study was limited to the views on the effect of STEM education on the professional choices of gifted and talented students.

Research Group

Criterion sampling method among the purposeful sampling methods was used in determining the study group. Criterion sampling is to create a sample including the individuals, events, objects, or situations with the qualifications determined in relation to the research question (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014). In this context, the study sample consisted of 17 gift and talented students (3 females and 14 males; 13 to 15 age). The study was conducted in the 2016-2017 academic year. During the formation of the study group, the students were informed about the study, and the volunteer students were included in the study. In this direction, the students were given such codes as Student 1, Student 2, etc.

Data Collection Instrument

The researchers used "STEM Education Interview Form (SEIF)" as the data collection instrument for this research. The use of the semi-structured interview form within the scope of the research gives the researcher the opportunity to control the course of the interview (Merriam, 2009). With the help of SEIF consisting of 16 questions in its first draft, the opinions of the students on "the effect of STEM practices on their future career choices" were tried to be determined. After the interview questions were prepared in the SEIF, it was presented to two experts in STEM education field for the evaluation. After this process, the interview form is finalized. As a result of the editing, SEIF consisting of 14 questions was generated as the data collection instrument for this study. Sample questions regarding SEIF are given in below.

1. What are the factors that affect your career choice?
2. What is the reason why you prefer STEM education?"

Data Analysis

Content analysis technique was conducted in the analysis of the qualitative data collected as a result of the interviews carried out with the students during the data collection process. The main purpose of the content analysis is to reach the concepts and relations that can explain the data collected in the study. The fundamental process of content analysis is to bring similar data together within the framework of certain concepts and themes and to interpret them in a way that the reader can understand (Yıldırım & Şimşek, 2011). During the content analysis, coding process was performed three times by the researchers so as to make the coding reliable. The three-coding process were re-examined, and the final form was created. Afterwards, a list of themes, categories, and codes was formed, and the list of themes, categories, and codes was generated as a result of the review of the relevant literature. The reliability formula [Reliability = Consensus / (Consensus + Dissensus) x 100] proposed by Miles and Huberman (1994) was used in order to calculate the reliability of the study. As a result of the calculation, the reliability of the study was calculated as 75%.

Practice Process

The practice process of the research was carried out through a 3-hour course per week for 16 weeks in a SAC affiliated to Ankara Provincial Directorate of National Education. Eight different STEM activities such as Electric World, and Cryptology were performed in this research. Each activity is planned as 6 lessons. Initially, science and mathematics knowledge were presented to the students as determined in lesson plans.

After the knowledge of science and mathematics, the students were given a problem situation in which they could use the knowledge they learned. Based on the given problem situation, they were then asked to form a model. Initially, the students drew the model (Figure 1), and then the model was created. The model was brainstormed by the students. After the brainstorming step, each group presented their own model. After the presentation, the three-stage evaluation process was completed, and the practice process was finished.

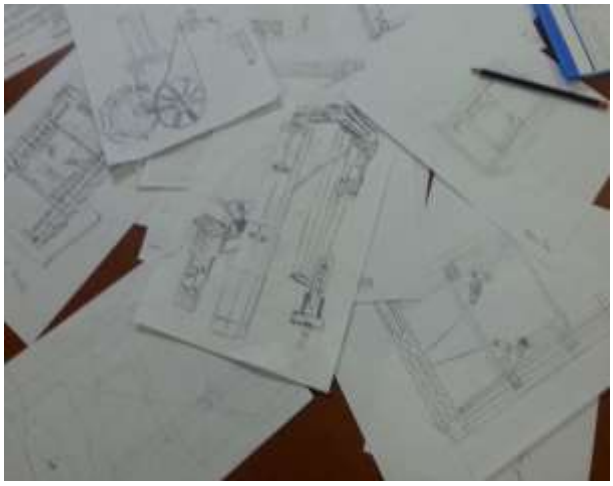

Figure 1. Draft drawings created by the students

FINDINGS

In this part of the research, the questions in the interview form were grouped according to the research question, and the findings were presented. The findings were supported by the expressions of the students in the interviews. While presenting the data in the analysis, the opinions of the participants were quoted by coding without giving their names on the basis of confidentiality. The findings related to the question "What is the profession you want to choose in the future?" are presented in Table 1.

Table 1
Opinions about the desired occupations

Category	Codes	f
The desired occupations	Computer Engineering	4
	Physicist	4
	Software Engineering	3
	Electrical-Electronics Engineering	1
	Mathematician	1
	Aircraft Engineering	1
	Doctor	1
	Stuntman	1
	Scientist	1

When Table 1 is examined, the students stated that they would like to be computer engineer, physicist, and software engineer. Some of the opinions of the students on this question are shown below:

S11: I would like to become a software engineer or electrical-electronics engineer in the future.
S7: I want to be a doctor because I like to cure people.

The findings related to the question "What are the factors that affect your career choice?" are presented in Table 2.

Table 2
Opinions about the reasons affecting the career choice

Category	Codes	f
Career Choice	Interest	10
	Family/Environment	6
	Ability	5
	SAC	3
	Observation	2
	Financial Income	1

When Table 2 is examined, the majority of the students stated that they chose a profession in accordance with their interests. The students mentioned that the second factor affecting the career choice was the family / environment factor. Some of the opinions of the students on this question are presented as follows:

S1: For instance, my cousin is an engineer, and I'm very interested in what he is doing.
S16: Ability factor is also important for this career choice.

The findings related to question "What should you pay attention in choosing a profession?" are seen in Table 3.

Table 3
Opinions about the characteristics of career choices

Category	Codes	f
Choosing profession	Interest	16
	Ability	11
	Professional conditions	1

When Table 3 is examined, the students focused on three situations for their choices. These are respectively expressed as interest, ability, and professional conditions. Some of the opinions of the students on this question are provided below:

S4: A person should do his / her favourite profession that he / she is interested in.
S9: We need to interrogate ourselves whether we have the required ability for that profession in choosing a career.

The findings related to the question "What is the reason why you prefer STEM education?" are shown in Table 4.

Table 4
Opinions about the reasons for choosing STEM education

Category	Codes	f
Preferability	Suitable for interests	9
	Because of STEM disciplines	9
	Usefulness	2
	Family/Environment	1
	Suitable for abilities	1
	Being applied	1

When Table 4 is examined, it is understood that students prefer STEM education because they are suitable for their interests, they include STEM fields the students wish, and they believe that STEM education will be beneficial. Some of the opinions of the students on this question are presented as follows:

S1: It has focused a lot of fields that I am interested in on a common focus.
S6: I have a great interest in both physics and mathematics.

The findings related to the question "What are the first three professions that come to your mind when talking about STEM professions?" are given in Table 5.

Table 5
Opinions about STEM professions

Category	Codes	f
STEM Professions	Physicist	10
	Mechatronics engineering	6
	Computer engineering	5
	Mathematician	5
	Professor	3
	Machine engineering	2
	Programming	2
	Architect	2
	Civil engineering	2
	Software engineering	2
	Electrical-electronics engineering	1
	Specialist	1
	Aircraft engineering	1
	Innovationist	1
	Scientist	1

When Table 5 is examined, the students have focused on many different occupations as STEM fields. Some of the opinions of the students on this question are seen below.

S3: Robotics engineering, mechatronics, and programming.
S6: Physicist, mathematician, and computer engineer.

The findings related to the question "Can you use what you have learnt and done through STEM education in the profession you have chosen?" are given in Table 6.

Table 6
Opinions about whether the information learned in STEM education can be used in selected professions

Category	Codes	f
Usability	Yes	16
	No	1

When Table 6 is examined, while almost all of the students mentioned that they could apply the knowledge they learned through the STEM education in their own professional lives, a student said that he/she would not apply the knowledge they learned. Some of the opinions of the students on this question are illustrated below:

S1: I can use. For instance, we learn how to think critically through STEM education.
S4: I can use since we did some software activities last year, and we made software by utilizing the robot sets of fischer tehnic designer.

The findings related to the question "When did you decide on the profession you want to work in?" are presented in Table 7.

Table 7
Data related to the decision-making process for the desired profession

Category	Codes	f
STEM Education	Before	6
	After	11

When Table 7 is examined, the majority of the students have mentioned that STEM education affects the choice of profession. Some of the opinions of the students on this question are shown below:

S4: I had wanted to be a physics engineer before I started STEM. Sometime after I started STEM, I started to think about being a computer engineer.
S14: I wanted to be a doctor when I was little, but after starting STEM, I've been thinking about physics for the last two years.

The findings related to the question "What are STEM practices?" are demonstrated in Table 8.

Table 8
Opinions about STEM practices

Category	Codes	f
STEM Practices	Programming / Software	8
	Algodoo	4
	Simulation	2
	Fischer Tehnic Designer	1
	Modelling	1

When Table 8 is examined, the students stated that programming / software, Algodoo, and Simulation practices are STEM practices. Some of the opinions of the students on this question are provided as follows:

S5: Simulations and software.
S11: Modelling that we do to prove physics.

The findings related to the question "Do STEM practices have an effect on your career choice?" shown in Table 9.

Table 9
Opinions on the effect of STEM education on career choice

Category	Codes	f
Career choice	Effective	11
	Ineffective	3
	Partially effective	3

When Table 9 is examined, it is observed that whereas the majority of the students stated that STEM practices affected the career choices, the three students stated that STEM practices had no effect on the career choice of the students, and that the remaining three students mentioned that STEM practices partially affected their choice of career. Some of the opinions of the students on this question are seen below.

S6: No. It didn't affect my choice too much. It just increased my interest.
S9: Yes, it enabled me to know the profession better.

The findings related to the question "What are the abilities you need to be successful in STEM professions?" are given in Table 10.

Table 10
Opinions about the abilities required to be successful in STEM professions

Category	Codes	f
Required abilities to be successful in STEM professions	Group Study	3
	Curiosity	2
	Investigative Personality	2
	Industriousness	2
	Creativity	2
	Unorthodoxy	2
	Entrepreneurship	2
	Patience	2
	Interrogative	2
	Accountability	1
	Visual, Auditory, Tactile Abilities	1
	Imagination	1
	Interest	1
	Truthfulness	1
	Objectivity	1
	Responsibility	1
	Analysing	1
	Observer Personality	1
	Long-sightedness	1
	Making comments	1
	Determination	1

When the Table 10 is examined, the students emphasized that there should be such abilities as group work, curiosity, industriousness, creativity, entrepreneurship, and patience in order to be successful in STEM professions. Some of the opinions of the students on this question are listed as follows:

S10: The interests appropriate to STEM and to have visual, auditory, and tactile abilities.
S11: They require patience. Also, one needs to be an entrepreneur.

The findings related to the question "Did STEM education contribute to the development of 21st century skills?" are given in Table 11.

Table 11
Opinions on the contribution of STEM education on the 21st century skills

Category	Codes	f
The contribution of STEM education on the 21st century skills	Contributive	17
	Uncontributive	-

When Table 11 is examined, all of the students stated that the STEM education contributed to the development of such 21st century abilities as critical thinking and problem-solving. Some of the opinions of the students on this question are given below.

S12: Yes. There were many complicated problems here, and we tried to solve these problems by using our logic together with our friends.
S13: Yes. After all, you need to be successful not only in that field but also in the other fields.

The findings of the question "Did STEM education and practices affect your success in the science course? How?" are stated in Table 12.

Table 12
Opinions on the effect of STEM education on the success in science course

Category	Codes	f
Success in Science Course	Effective	13
	Partially effective	3
	Ineffective	1

When the Table 12 is examined, the majority of the students stated that STEM education and its practices increased the success in the science course, and whereas three students stated that there was a partially effect in success increase, only one of the participants mentioned that there was no effect for success increase in science course. Some of the opinions of the students on this question are shown below.

S2: Yes, it did. For example, the project I'm doing right now is on simple machines.
S4: It affected. I'm more willing and successful in science course.

The findings related to the question "Are you able to use what you learned in STEM education in science courses?" are provided in Table 13.

Table 13
Opinions about the use of STEM education in science course

Category	Codes	f
Usability in Science Course	Usable	14
	Unusable	2
	Partially usable	1

When Table 13 is examined, the majority of the students stated that they could use the knowledge they learned in STEM education in the science course. Some of the opinions of the students on this question are given below.

S2: I can use. For example, the expressions that my teachers stated two years ago are now beneficial.
S14: Actually, I can't use them because my teacher at school doesn't allow it, and we learn theoretically and go on.

The findings related to the question "Did STEM education had an effect on your interest in science?" are given in Table 14.

Table 14
Opinions on the effect of STEM education on interest in science course

Category	Codes	f
Interest in Science	Effective	14
	Ineffective	2
	Partially effective	1

When Table 14 is examined, the majority of the students stated that STEM education increased their interest in the science course. Some of the opinions of the students on this question are demonstrated below.

S1: Yes. What I'm doing here makes me happy, which increases my interest in science by making the things become more permanent in my mind.
S17: It increased. I did not use to like science that much.

DISCUSSION

After analysing the findings obtained in accordance with the research question and the purposes of the study, the following results were acquired.

The first result obtained from the study is that the gifted students want to choose the fields of computer, electrical-electronics, software and aircraft engineering. In addition, it is concluded that some of the students want to be stuntmen, mathematician and scientists. When the literature is examined, it will be observed that the students are less interested in mathematics. According to Stone, Alfeld, and Pearson (2008), students have low interest in mathematics since mathematics is considered as a difficult and time-consuming field for the students (Bingolbali, Monaghan, & Roper, 2007). An increase in interest of a student in the mathematics field indicates that STEM practices positively changed their interest in mathematics. Gifted and talented students demonstrated that there are two important situations in choosing the profession. They listed their interests in the first order and the effects of family/environment in the second one. In addition, the gifted and talented students particularly emphasized that they have taken the interest in profession, ability, and professional conditions into consideration in choosing a profession. It shows that STEM practices have a positive effect on the career choices of the students. Similarly, Sarı, Alıcı, and Şen (2018) mentioned that STEM education had a positive effect on the career perception and interests of the students. Moreover, when the literature is examined, it is observed that there are some other studies overlapping with the results of this study (Şahin, Ayar, & Adıgüzel, 2014). Another result concluded from the findings of the study showed that the students want to have STEM education when they think that STEM education will be appropriate for the profession they want to choose and that it will contribute to the profession they will choose. Furthermore, family / environment, being suitable for abilities, and being applied are among the reasons to choose STEM education. Doppelt, Mehalik, Schunn, Silk, and Krysinski (2008) found that STEM education increased the interests of the students in science and their academic achievement. Therefore, this result is very similar to the findings in this study. Contrary to the literature, the fact that this long-term study is the first study showing that STEM education has positively changed the career choices and interests of the gifted students makes this study important.

Within the scope of the study, the gifted and talented students emphasized many professions while expressing the fields of STEM education. The students have expressed such professions as physicist, engineer, computer engineer, mechatronics engineer and mathematician as the STEM professions. Moreover, the students mentioned that they could use the information they learned during the STEM practices in their professional life in the future. This result is an important result indicating that STEM education has positive effect on the gifted and talented students.

Another result of the study was that the students stated that STEM practices had a positive effect on career choice of the students. In addition, the students were asked to give examples about STEM practices. The students mentioned that programming/software and Algodoo are particularly listed as STEM practices. This result does not coincide with the literature. In the literature, it is emphasized that the different STEM practices take place (Herdem & Ünal, 2018; Yıldırım, 2016). Furthermore, the students stated that these STEM practices affect their career choices. In another study, Gülhan (2016) concluded that the effect of STEM education on the perceptions of 5th grade students on STEM fields is generally positive, that it was effective in their positive development of their perceptions of the engineering profession, that the effect on their attitudes towards STEM fields was generally positive, and that it generally increased the possibility of choosing the professions in STEM fields. When the literature is reviewed, there are many studies that show that STEM education has a positive effect on the career choices of the students (Gülhan & Şahin, 2016). Our results are consistent with the literature.

Within the scope of the study, the students emphasized that the individuals should be critical, creative, entrepreneurial, and patient so as to be able to be successful in STEM professions. Besides, the students stated that STEM practices had a positive effect on the development of such abilities as critical thinking,

and problem-solving. Similarly, Sarı et al. (2018) concluded that STEM activities based on a problem developed such abilities of the students as teamwork, cooperative work, problem-solving, and creativity. When the literature is reviewed, it is observed that there are studies that overlap with the results of this study and that indicate that the STEM practices develop the 21st century skills (Childress, 1996; Yıldırım, 2016). In his study, Hacıoğlu (2017) determined that STEM education had a positive effect on the abilities of scientific creativity and critical thinking. Similarly, Özçelik (2017) found that STEM education for gifted and talented students enabled the students to acquire 21st century skills such as creativity, critical thinking, collaboration, and communication as well as science and mathematics acquisition. Our results are consistent with the literature.

Another result of the study is related to the increase in success provided by STEM education and its practices for the science course. As a result of this study, the gifted and talented students mentioned that STEM education and its practices led to an increase in science education achievements. In another study, Irkıçatal (2016) examined the effects of STEM-based after-school activities applied in accordance with the engineering design process on student achievements and interests in simple machines. As a result of the study, it was concluded that STEM practices increased the success and interest in the course. Similarly, Salman (2017) investigated the effect of STEM practices on the success of students in science courses. As a result of the study, it is seen that STEM practices have a positive effect on the success in science. Besides, the students expressed that they could use the information they learned during STEM education in the science course. When the literature is examined, many studies have revealed that STEM education increases the success and interests of the students in the science course (Naizer, Hawthorne, & Henley, 2014; Sarıcan, 2017; Yıldırım & Selvi, 2017; Gülhan & Şahin, 2016). Therefore, this result is very similar to the findings in this study.

CONCLUSION

The first result obtained from the study is that the gifted students want to choose the fields of computer, electrical-electronics, software and aircraft engineering. In addition, it is concluded that some of the students wanted to be stuntman, mathematicians and scientists. The first result obtained from the study is that Gifted and talented students demonstrated that there are two important situations in choosing the profession. They listed their interests in the first order and the effects of family/environment in the second one.

The gifted and talented students particularly emphasized that they have taken the interest in profession, ability, and professional conditions into consideration in choosing a profession. Another result concluded from the findings of the study showed that the students want to have STEM education when they think that STEM education will be appropriate for the profession they want to choose and that it will contribute to the profession they will choose. Within the scope of the study, the gifted and talented students emphasized many professions while expressing the fields of STEM education. The students have expressed such professions as physicist, engineer, computer engineer, mechatronics engineer and mathematician as the STEM professions. Another result of the study was that the students stated that STEM practices had a positive effect on career choice of the students. Within the scope of the study, the students emphasized that the individuals should be critical, creative, entrepreneurial, and patient so as to be able to be successful in STEM professions. Another result of the study is related to the increase in success provided by STEM education and its practices for the science course.

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