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Research Article

Determination of Middle School Students' Opinions on STEM Professions

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Abstract

When the relevant studies in the literature are examined, it is seen that the general tendencies of the students towards STEM professions are evaluated by using quantitative data collection tools in the majority of the studies. In this study, a descriptive study with qualitative elements was carried out in order to determine the opinions of middle school students about STEM professions. The study group of the research consists of 40 middle school students studying in the central district of Uşak. Semi-structured interviews were conducted with the students and the data obtained were described using the content analysis method. As a result of the research, it has been determined that middle school students have superficial knowledge about STEM professions, and students who are self-sufficient in Science and Mathematics and who are interested in science are more willing to choose these occupational groups in the future. In addition, it was also determined that technology-based professions among STEM professions are more popular among students, and that the opinions of parents and teachers play a major role in students' vocational preferences.

Ortaokul Öğrencilerinin FeTeMM Mesleklerine Yönelik Görüşlerinin Belirlenmesi

Öz

Literatürde yer alan ilgili araştırmalar incelendiğinde yapılan çalışmaların çoğunluğunda nicel veri toplama araçları kullanılarak öğrencilerin FeTeMM mesleklerine yönelik genel eğilimlerinin değerlendirildiği görülmektedir. Bu araştırmada ise ortaokul öğrencilerinin FeTeMM mesleklerine yönelik görüşlerini belirlemek amacı ile nitel unsurlar barındıran betimsel bir çalışma yürütülmüştür. Araştırmanın çalışma grubunu Uşak ili Merkez ilçesinde öğrenim görmekte olan 40 ortaokul öğrencisi oluşturmaktadır. Öğrenciler ile yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve elde edilen veriler içerik analizi yöntemi kullanılarak çözümlenmiştir. Araştırma sonucunda ortaokul öğrencilerinin FeTeMM mesleklerine ilişkin yüzeysel bilgilere sahip olduğu, Fen Bilimleri ve Matematik derslerinde kendini yeterli gören ve bilime ilgi duyan öğrencilerin bu meslek gruplarını gelecekte tercih etme konusunda daha istekli olduğu belirlenmiştir. Ayrıca FeTeMM mesleklerinden teknoloji tabanlı mesleklerin öğrenciler tarafından daha çok rağbet gördüğü, öğrencilerin mesleki tercihlerinde aile ve öğretmenlerinin görüşlerinin de büyük rol oynadığı da belirlenen sonuçlar arasındadır.

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Introduction

STEM education studies (Herdem & Ünal, 2018), which have been included in the international literature since the 90s (Ejiwale, 2013), is a holistic field formed by the combination of knowledge related to different disciplines. The concept of STEM in English consists of the initials of science, technology, engineering and mathematics. In Turkey, this concept is translated into Turkish as FeTeMM, which stands for science, technology, engineering and mathematics (Tezel, & Yaman, 2017). STEM education was first developed in 1985 in the USA (Breiner et al., 2012) in order to raise science and technology literate individuals (Çakıcı, 2009). The aim of STEM education is to provide students with 21st century skill including critical thinking, questioning, decision-making and problem solving (Aydın et al., 2017), to enable them to apply these knowledge and skills they have acquired in the learning process in their daily lives (Ejiwale, 2013), and to provide students with the ability to look at problems by developing different perspectives (Karakaya et al., 2018). While students gain different thinking skills through STEM education practices (Baran et al., 2015), studies are also carried out to improve their knowledge and awareness of STEM professions (Karakaya et al, 2018).

STEM professions generally include professional fields related to medicine, finance, education, engineering, technology and natural sciences (Koyunlu-Ünlü et al., 2016). When the studies in the literature are examined, it is seen that variables such as gender, grade level, and frequency of technology use affect students' tendencies towards STEM professions (Herdem, & Ünal, 2018; Karakaya et al, 2018; Timur, & Badur, 2020). In his study, Uğraş (2019) found that middle school students' interest levels in STEM professions differed according to their gender and parents' education level. In a similar study, Karakaya et al., (2018) concluded that middle school students' interest in STEM professions varied positively according to their gender, frequency of technology use, and academic achievement. Wiebe et al. (2018) stated in their study that the departments that students are oriented to in STEM occupational groups differ according to their gender. Timur and Badur (2020) also stated in their study that students' gender and grade level affect their interest in STEM professions. Dönmez and İdin (2020), on the other hand, stated that middle school students' STEM career interests were affected by self-efficacy, personal goals, outcome expectancy, interest in science, contextual support, and individual inputs. They also determined that STEM career interest was directly proportional to grade level, but not related to gender. Balçın et al. (2018) also concluded in their research that the interest levels of middle school students towards STEM professions changed positively and significantly according to their grade levels, but there was no significant difference between the level of interest in terms of gender and the place of residence of their school. Zorlu and Zorlu (2017), who evaluated the vocational interests of students from a different perspective, determined that there were low or moderate relationships between STEM career interest and science process skills of middle school students. Bozkurt Altan et al. (2019), who conducted a descriptive study, stated that the interest levels of middle school students in developing a career in STEM professions are at a sufficient level. Abe and Chikoko (2020), in their research with university students in South Africa, stated that personal differences, family and future expectations were effective in students' views on STEM professions. Hacıoğlu and Gülhan (2021), as a result of study conducted with secondary school students, stated that STEM education improved students' awareness of STEM careers and that there were students who reported that they would turn to STEM professions in the future after the trainings provided. In addition, Vela et al. (2020) organized a one-week STEM summer camp for middle school students. As a result of their study with middle school students who participated in the STEM summer camp, they found that camp activities increased students' perceptions of STEM careers. Similarly, Luo et al. (2021) conducted a study with middle school students and found that STEM activities increased students' awareness of STEM careers. Chen et al. (2024), in their study with elementary and middle school students, found that students' self-perception, media use, and school facilities influenced their STEM career aims.

When the related studies in the literature are examined, it is seen that the majority of the studies evaluated the general tendencies of students towards STEM professions by using quantitative data collection tools such as questionnaires and scales. In this study, whereas, unlike the literature, it was aimed to conduct a qualitative research in order to reveal students' thoughts about the related professions in detail. As it is known, qualified individuals who perform STEM professions covering the fields of finance, health and technology, which are important for the future of a country, affect the development levels of countries and play a critical role in increasing the welfare levels of societies (Gökbayrak & Karışan, 2017; Balçın et al., 2018; Wyss et al., 2012). For this reason, it is important to increase students' knowledge and awareness of these professions from an early age, to determine their tendencies, and to have positive attitudes and understandings towards these professions (Irkıçatal, 2016; Koyunlu-Ünlü & Dere, 2018; Kurt & Benzer, 2020). In this aspect, determining the interest of middle school students in our country towards STEM professions is a worthy topic for research. In this study, it was aimed to determine the views of middle school students studying in Uşak province towards STEM professions. For this purpose, the problem statement of the research was determined as "What are the views of middle school students towards STEM professions?"

Method

Research Model

This research is a descriptive study with qualitative elements in order to determine the views of middle school students towards STEM professions. Descriptive studies are conducted in order to illuminate a situation or phenomenon, to make evaluations according to standards, to illuminate the relationships between events and to reveal the current situation (Büyüköztürk et al., 2012). In the study, semi-structured interview method was used to learn students' views on STEM professions. Semi-structured interviews are used to determine the feelings and thoughts of the individual about the subject within the framework of predetermined questions (Çepni, 2014).

Study Group

The study group of the research consists of 40 middle school students in the central district of Uşak province. The participants of the study were determined using maximum variation sampling method, which is one of the purposeful sampling methods. Purposive sampling methods involve the identification and selection of individuals or groups who are knowledgeable and experienced about the subject studied in qualitative research (Yağar, & Dökme, 2018). In qualitative research, these selections are often determined in a purposeful way and carried out with a small number of samples (Baltacı, 2018). Maximum diversity sampling is based on creating a maximum diversity sample by finding cases that are as different from each other as possible. The aim of maximum diversity sampling is to identify the experiences of different stakeholders in different contexts (Yağar, & Dökme, 2018). In this study, students who differed in terms of gender and grade level were included in the study. Some demographic information about the study group is presented in Table 1.

Table 1. *Descriptive Statistics of the Students*

Variable	n	%	Variable	n	%	Variable	n	%
School			*Grade Level*			*Gender*		
School 1	8	20	Grade 5	10	25	Girl	20	50
School 2	8	20	Grade 6	10	25	Boy	20	50
School 3	8	20	Grade 7	10	25	Total	40	100
School 4	8	20	Grade 8	10	25			
School 5	8	20	Total	40	100			
Total	40	100						

As can be seen in Table 1, 40 participants were selected from 5 different secondary schools in Uşak Center as 8 students each, 10 students each according to their grade levels and 20 students each according to their gender. In other words, 2 students were selected from each grade level, one girl and one boy, so 8 students from each school and 40 students in total were selected as participants.

Data Collection Tools

In this study, a semi-structured interview form consisting of ten questions was created for students' views on STEM professions. For the internal validity of the semi-structured interview form, the opinions of three experts, two of whom are associate professors and one professor in science education, who have studies in the field of STEM, were obtained. After the expert opinions, three questions in the semi-structured interview form were removed from the form because they did not overlap with the research sub-problem and the Semi-structured Interview Form for STEM Professions was finalized. The questions in the semi-structured interview form are as follows:

1. What do you know about STEM professions?
2. Which STEM professions do you think might emerge in the future? How can existing STEM professions develop?
3. What do you like about STEM professions?
4. What do you dislike about STEM professions?
5. Would you like to have a STEM profession in the future? Why? / If you were to choose a STEM profession in the future, which one would you choose?
6. What kind of education do you think you need to have in order to have a STEM profession? Have you ever researched it?
7. What challenges do you think people in STEM professions face? Do you think STEM professions are difficult or easy? Why do you think so?

Data Analysis

The data obtained as a result of the research were analyzed using the content analysis method. The purpose of content analysis is to provide unbiased, systematic and statistical information about the texts formed by discourses (Koçak, & Arun, 2013). The students' responses to the questions in the Semi-structured Interview Form for STEM Professions were first organized into codes and then themes appropriate to these codes were determined. In order to ensure the validity and reliability of the data analysis, expert opinion was obtained from a research assistant who is a PhD student in Science Education. The research assistant was asked to analyze the data of the first 10 students in the study group and the similarity-difference ratio in coding was calculated. As a result of the calculation, it was determined that the analyzes were 95% similar.

Findings

The findings obtained in this part of the study were tabulated and interpreted with themes and codes. The frequency and percentage values as a result of the analysis based on the answers to the question "What do you know about STEM professions?" are presented in Table 2.

Table 2. *Middle School Students' Responses to the Question "What do you know about STEM professions?"*

Theme	Code	f	%	∑f	∑%
Features	Difficult professions / Professions that require effort / labor	19	20		
	Interesting / Beautiful / Dreamed of / Admired / Loved professions	15	16	44	46
	Promising future / Innovative professions	6	6		
	Occupations with separate departments/tasks	2	2		
	Other (Related occupations)	2	2		
Objectives	Making human life easier	16	16	18	18
	Solving life's problems	2	2		
Contributions	Contribution to the development of humanity/society	9	9		
	Contribution to technology	4	4	18	18
	Contribution to the development of the country	4	4		
	Contribution to science	1	1		
Scopes	Based on Science and Mathematics	9	9		
	Science-based	4	4	18	18
	Technology-based	4	4		
	Research-based	1	1		
	Total	98	100	98	100

All of the middle school students who participated in the interview shared their knowledge about STEM professions. There was no any students who stated that they had no knowledge about STEM occupational groups. The characteristics of these occupational groups constitute 46% (f=44) of middle school students' existing knowledge about STEM professions. About the characteristics of STEM occupational groups, students stated that they are difficult, demanding professions with a frequency of 20% (f=19); interesting, admired and loved professions with a frequency of 16% (f=15); promising future and innovative professions with a frequency of 6% (f=6). Despite the students who argue that STEM occupational groups have separate departments and duties, there are also those who argue that these are related occupations. Students' knowledge of STEM professions included the purposes of these professions with a frequency of 19% (f=18). Students expressed the purposes of STEM professions as facilitating human life (16%) (f=16) and solving problems related to life (2%) (f=2). Students also mentioned the contributions of STEM occupational groups with a frequency of 18% (f=18). Middle school students stated that STEM occupational groups contribute to the development of humanity, society, technology, country and science. Some students expressed their views on this issue with the words "*They work for the development and comfort of people*", "*They contribute to the development of the country*", "*They ensure the progress of science*". In the statements of the students, the scope of STEM occupational groups is included with a frequency of 18% (f=18). Students stated that STEM professions are related to science and mathematics, based on science, technology and research. One student's opinion on this issue is "*They work in the field of technology and science.*"

Table 3 presents the frequency and percentage values of the students' responses to the question "Which professions do you think may emerge in the future in the field of STEM?" asked to them in order to determine their views on STEM professions.

Table 3. *Middle School Students' Responses to the Question "Which professions do you think may emerge in the future in the field of STEM?"*

Theme	Code	f	%	∑f	∑%
Technology	Occupations in the field of technology	5	26	9	47
	Professions in software	2	11		
	Professions in artificial intelligence	1	5		
	Virtual professions	1	5		
Engineering	Occupations for maintenance/repair/development of robots	5	26	5	26
Science	New teaching branches	2	11	4	21
	New fields of medicine	1	5		
	New professions in science	1	5		
Other	Occupations in service areas	1	5	1	5
	Total	19	100	19	100

Regarding the question, 15% (n=6) of the middle school students who participated in the interview answered that new professions will not emerge even most of the professions will disappear and the number of professions will decrease. When Table 3 showing the distribution of the answers of the students who expressed their opinion that new professions will be formed to this question is examined, it is seen that the foresight of the students for the STEM professions that may emerge in the future consist of technology-related professions with a frequency of 47% (f=9). Students think that future STEM professions will diversify in the fields of technology, software and artificial intelligence and virtual professions will emerge. Some students expressed their views on this issue by saying "*There will be more virtual professions*" and "*Professions in the field of artificial intelligence will emerge*". Students' predictions for future STEM occupations are engineering professions involving the maintenance, repair, and development of robots with a frequency of 26% (f=5). In addition, students think that STEM professions will diversify in the field of science in the future and new teaching branches and new fields of medicine will emerge. Some students whereas stated that STEM professions will also diversify in service fields. A student's opinion on this subject is "*New and technological service areas may emerge.*"

Table 4 presents the frequency and percentage values of students' responses to the question " How can existing STEM professions develop?", which was asked to them in order to determine their views on STEM professions. With this question, it was aimed to reveal students' thoughts on how STEM professions could be developed in the future.

Table 4. *Middle School Students' Responses to the Question " How can existing STEM professions develop?"*

Theme	Code	f	%	∑f	∑%
Technological	Technological progress /robotization/mechanization in STEM professions	28	40	61	88
	Robots/ Apps replacing/helping humans	27	39		
	Development of computer software/programming	6	9		
Ergonomic	Working from home	4	6	7	10
	Making STEM professions easier/comfortable/reducing manpower	3	4		
Other	Separation of STEM occupational groups into new branches	1	1	2	2
	Increasing the productive power of STEM professions	1	1		
	Total	70	100	70	100

Among the middle school students who participated in the interview, 97% (n=39) of them answered that STEM professions will develop and 3% (n=1) of them answered that these professions will not develop much. When Table 4 is analyzed, it is seen that 88% (f=61) of the students think that STEM professions will develop technologically in the future. Students stated that technological tools, robotization and mechanization will increase in STEM professions, robots and applications will help people and even replace human, and

professions such as computer software and programming will continue to develop. Some of the students thought that STEM professions will develop ergonomically in the future and that people will adapt to work from home systems and that the ease of work will increase and the required manpower will decrease. One student's opinion on this issue is as follows: "*Remote, online procedures and studies will increase, such as doctors being able to operate on people with the help of robots.*" In addition, there are students who state that STEM occupational groups will be divided into new branches and increase their production power.

Table 5 presents the frequency and percentage values of students' responses to the question " What do you like about STEM professions?" which was asked to them in order to determine their views on STEM professions.

Table 5. *Middle School Students' Responses to the Question "What aspects of STEM professions do you like?"*

Theme	Code	f	%	∑f	∑%
Social	Being useful/helpful/sharing with people	17	16		
	Working for humanity/Making inventions	7	7	34	33
	Making life/work easier/ Ensure the time saving	7	7		
	Being future-oriented/self-developing professions	3	3		
Vocational	Promising future/Being prominent/ Important/ Liked/ Expectation-fulfilling being professions	13	12		
	Enjoyable/Interesting/Appeal to the field of interest	7	7		
	Science and Mathematics related professions	3	3	29	28
	Being professions that require special skills/labor	3	3		
	Being comfortable professions	2	2		
	Being interrelated professions	1	1		
Scientific	Curious / Patient / Intelligent / Researcher people doing these professions	5	5		
	Conducting research/experiments/observations	4	4		
	Learning new information	2	2	14	14
	Being thinking-oriented	2	2		
	Learning from mistakes	1	1		
Technological	Being related to technology	5	5		
	Establishing/producing useful programs/applications	3	3	12	12
	Use of new/technological tools	3	3		
	Facilitating communication	1	1		
Economic	Developing the country	4	4		
	Enabling them to generate more revenue	3	3	10	10
	Cultivating/Developing quality/new products	3	3		
Other	Providing experiences that cannot be done in normal life	1	1		
	Improving the world	1	1	3	3
	Supporting education	1	1		
	Total	102	100	102	100

Among the middle school students who participated in the interview, 97% (n=39) answered that there are aspects they like about STEM professions. When Table 5 is analyzed, it is seen that 33% (f=34) of the students liked STEM professions for social reasons. Students stated that they liked these professions because they thought useful and helpful to people, served humanity, facilitated and accelerated the functioning of life, and were self-developing professions. Students made positive evaluations about the professional aspects of STEM professions with a frequency of 28% (f=29). They stated the related professions as important, admired, enjoyable, interesting, related to Science and Mathematics, requiring special skills and labor, comfortable, and related to each other. Students emphasized that they liked STEM professions because of their scientific aspect with a frequency of 14% (f=14). Students think that STEM professions are carried out by people who are patient, intelligent, inquisitive, and learn from their mistakes, that they are oriented towards thinking, that these professions involve research, experiments and observations, and that new information is learned. Some students expressed their views on this issue with the words "*I like that scientists can think creatively.*", "*It is nice to learn new things through research, experiments and observations.*" With a frequency of 12% (f=12), students also liked STEM professions from a technological point of view for reasons such as being related to

technology, establishing and producing useful programs and applications, using new technological tools and facilitating communication. In addition, students stated that STEM professions develop the country, that people with these professions earn more economic income, and that they develop quality and new products. Some students stated that they liked STEM professions because they provide different experiences, improve the world and support education. One student's opinion that STEM professions provide different experiences is as follows: " *It must be nice to do things that normal people cannot live with, for example to go into space and observe the space live, to hold a heart or a brain in your hand and examine it.*"

Table 6 presents the frequency and percentage values of the students' responses to the question " What do you dislike about STEM professions?" which was asked to them in order to determine their views on STEM professions.

Table 6. *Middle School Students' Responses to the Question "What aspects of STEM professions don't you like?"*

Theme	Code	f	%	∑f	∑%
Vocational	Being professions that require hard/effort/interest/skill	36	49	46	62
	Being related to Science and Mathematics	3	4		
	Professions that require excessive knowledge/memorization	3	4		
	They will be cut off in the distant future	3	4		
	Being professions with a long education process	1	1		
Social	The fact that they make people lazy/assertive	5	8	12	18
	They can negatively affect human health/psychology	4	6		
	Asocializing people/making them dependent on technology	3	4		
Scientific	Research/Efforts may be wasted	3	4	6	8
	Focus on a single issue/problem	2	3		
	Contain information used in the past	1	1		
Technological	Misuse of the developed technology/application	4	6	5	7
	Increased mechanization	1	1		
Economic	Overshadowing old professions/Technological machines replacing people (Unemployment)	3	4	4	5
	Insufficient income level	1	1		
	Total	73	100	73	100

Among the middle school students who participated in the interview, 82% (n=33) responded that there were aspects of STEM professions that they did not like, while 18% (n=7) responded that there were no aspects of STEM professions that they did not like. When Table 6 is analyzed, 62% (f=46) of the students stated the aspects of STEM professions that they did not like in terms of professional aspects. Students dislike these occupational groups because they see these occupational groups as difficult, requiring labor, interest, skill, excessive knowledge and memorization, related to Science and Mathematics, which will be closed in the distant future and have a long education process. With a frequency of 18% (f=12), students think that STEM professions cause social problems such as making people lazy, negatively affecting human health and psychology, asocializing people and making them dependent on technology. With a frequency of 8% (f=6), students think that researches are not given the necessary importance in STEM professions, that research focuses on a single problem and that these profession groups have access to new information with their past knowledge. Therefore, they see STEM professions as insufficient from a scientific point of view. The misuse of technologies and applications developed through STEM professions and the fact that these developments increase mechanization are among the technological aspects of STEM professions that students dislike. Some students expressed their views on this issue by saying "*Errors may increase in the work done with mechanization, this is not good.*", "*Software can be used for malicious purposes and personal information can be stolen.*", "*Virtualization also increases insecurity.*" In addition, when students examine STEM professions from an economic point of view, they state that these professions overshadow the old professions that require manual labor, with the replacement of people by technological machines and that these professions do not have sufficient income. One student's opinion on this issue is as follows: "*These professions can cause other professions to lose their importance by developing.*"

Table 7 presents the frequency and percentage values of the students' responses to the question "Would you like to have a STEM profession in the future?" which was asked to them in order to determine their views on STEM professions. While answering the question, students were asked to consider the aspects they liked and disliked in STEM professions.

Table 7. *Middle School Students' Preferences for the Question "Would you like to have a STEM profession in the future?"*

Code	n	%
Yes	31	78
No	9	22
Total	40	100

When Table 7 is analyzed, 78% (n=31) of the middle school students who participated in the interview want to have a STEM profession, while 22% (n=9) do not want to have a STEM profession in the future.

Following the question "Would you like to have a STEM profession in the future?", students who would like to have a STEM profession in the future were asked the reason for their preference and student responses are presented in Table 8.

Table 8. *Middle School Students' Reasons for Wanting to Have a STEM Profession in the Future*

Theme	Code	f	%	∑f	∑%
Personal	Being of interest / Being an area of interest	16	17		
	For dreaming/love	6	6		
	Having a talent for such professions	5	5	30	31
	Being proud professions	2	2		
	To be respected	1	1		
Social	To help people/make their lives easier	22	24		
	To contribute to the development of the country	2	2	26	28
	To plan for the future	1	1		
	To contribute to the development of the world	1	1		
Vocational	Being related to Science and Mathematics	7	8		
	Being professions that make you feel enjoyable/happy/beautiful	7	8		
	Being comfortable/easy professions	5	5	26	28
	Being intriguing/striking/interesting professions	4	4		
	Being promising future professions	3	3		
Scientific	To conduct new projects/experiments/research	4	4		
	To make new inventions/products	3	3	10	10
	Because it contains new information	2	2		
	Being science-based professions	1	1		
Economic	Good income level	2	2	3	3
	Finding a job abroad	1	1		
	Total	95	100	95	100

The students who participated in the interview and wanted to have a STEM profession in the future stated personal reasons with a frequency of 31% (f=30). These are; STEM professions are professions that they are interested in and appeal to their interests, that they dream of and love, and that they are proud of. In addition, students' perception of themselves as talented in such professions and their desire to become a respected person are also among the reasons for preferring STEM professions from a personal perspective. "*When you do one of these professions, you become a respected person.*" was one student's opinion on this issue. With a frequency of 28% (f=26), students want to have STEM professions from a social perspective to help people and make their lives easier, to contribute to the development of our country and the world by planning the future. Some students expressed their views on this issue by saying "*It is good to contribute to the development of the world*", "*It is good to make plans for the future*", "*You contribute to your country*". With the same frequency (28%, f=26), students wants to prefer because they see STEM professions as occupations related to Science and Mathematics, enjoyable, happy, beautiful, comfortable, easy, intriguing, remarkable, interesting and promising. With a frequency of 10% (f=10), students prefer STEM professions from a scientific point of view in order to make new inventions and products by conducting new projects, experiments, researches, and at the same time, the fact that they think that STEM professions contain new knowledge and are science-based professions also affects their preferences. In addition, students think that the income level of STEM professions is high in economic terms and that job opportunities abroad are better, and therefore they

want to choose STEM professions. One student's opinion on this issue is as follows: "*It is easier to find a job abroad with these professions.*"

Following the question "Do you want to have a STEM profession in the future?", students who did not want to have a STEM profession in the future were also asked the reason for this preference and student responses are presented in Table 9.

Table 9. *Middle School Students' Reasons for don't Want to Have a STEM Profession in the Future*

Theme	Code	f	%	∑f	∑%
Personal	Not being professions that are compatible with their hobbies/interesting	4	29	10	72
	Lack of professions he/she can do	4	29		
	Fear of not passing the required exams	1	7		
	Being weak at Science and Mathematics courses.	1	7		
Vocational	Being professions that can make you feel stressed/boring/unhappy	3	21	3	21
Scientific	Scientific research is difficult	1	7	1	7
	Total	14	100	14	100

The students who participated in the interview and did not want to have a STEM profession in the future stated personal reasons with a frequency of 72% (f=10). These are: STEM professions do not appeal to their interests or hobbies, students do not believe that they can do such professions, they are afraid of failing the exams required for such professions, and they have poor science and mathematics courses. Some students expressed their views on this issue by saying, "*I am good at math, but what if I cannot pass the required exams?*" and "*I am not very good at numerical courses.*" 21% (f=3) of the students did not prefer STEM professions professionally because they believed that it would make them feel stressful, boring or unhappy. Some students did not prefer STEM professions from a scientific perspective because they thought scientific research was difficult. One student's opinion on this issue was "*Scientific research is difficult, it is not for me.*"

Table 10 presents the frequency and percentage values of the responses of the students who plan to choose a STEM profession in the future to the question "If you were to choose a STEM profession in the future, which one would you choose?" in order to determine their views on STEM professions.

Table 10. *Middle School Students' Responses to the Question "If you were to choose a STEM profession in the future, which one would you choose?"*

Code	f	%
Software/Computer Engineer	12	35
Doctor	8	24
Mathematics teacher/professor	3	8
Architect/Construction Engineer	2	6
Engineer	2	6
Pharmacist/Health employee	2	6
Mechanical Engineer	1	3
Electrical and electronic engineering	1	3
Chemist	1	3
Nurse	1	3
Astronaut	1	3
Total	34	100

Students who participated in the interview and planned to choose a STEM profession in the future stated that they wanted to be a software or computer engineer with a frequency of 35% (f=12), a doctor with a frequency of 24% (f=8), and a math teacher or professor with a frequency of 8% (f=3). Students stated that they wanted to be an architect, civil engineer, engineer, pharmacist and health worker with a frequency of 6% (f=2) each. It was also found that students wanted to be mechanical engineers, electrical and electronic engineers, chemists, nurses and astronauts with frequencies of 3% (f=1) each.

Table 11 presents the frequency and percentage values of the students'responses to the question "What kind of education do you think you should receive in order to have a STEM profession?" which was asked to them in order to determine their views on STEM professions.

Table 11. *Middle School Students' Responses to the Question "What kind of education do you think you should receive in order to have a STEM profession?"*

Theme	Code	f	%	∑f	∑%
Corporate	Training in relevant schools/faculties	10	14		
	Studying/graduating from a good university/school	10	14	31	43
	Studying at a science high school	6	8		
	Studying in the numerical department	5	7		
Educational	All/Science and Mathematics courses are good	12	17		
	Knowing information technologies well	9	12	23	31
	To know the basic concepts	1	1		
	Good drawing skills	1	1		
Individual	Trying hard/working hard/not giving up	12	16		
	Becoming conscious/self-improvement	4	6	19	26
	Private lessons / Higher education	3	4		
	Total	73	100	73	100

All of the middle school students who participated in the interviews expressed their knowledge and opinions about what needs to be done to have a STEM profession. When Table 11 is examined, middle school students with a frequency of 43% (f=31) stated that in order to have a STEM profession, it is necessary to receive education in institutionally relevant schools or a faculty, to study at a good university and even make degree, to study in a science high school or numerical department. Students stated that with a frequency of 31% (f=23), in order to have a STEM profession, it is necessary to have a good educational background in all courses or Science and Mathematics courses, to know coding, software languages, computer, basic concepts and to have good drawing skills for engineering or architecture departments. Some students expressed their views on this issue by saying "*I should know coding and software*", "*I should work on drawings for architecture*". In addition to these, 26% (f=19) of the students think that in order to have a STEM profession, it is necessary to be an individual who strives hard, works hard, does not give up, is conscious, continuously improves himself/herself and that get special courses and higher education are required. One student's opinion on this issue is "*I should constantly improve myself in my field.*"

Following the question "What kind of education do you think you need to have in order to have a STEM profession?", the students were asked whether they obtained the information and ideas they stated about the education required to have a STEM profession by researching them and the related rates are presented in Table 12.

Table 12. *Rates of Middle School Students' Research on What Kind of Education Should be Taken in Order to Have a STEM Profession*

Code	n	%
I did not investigate	24	60
Investigated	16	40
Total	40	100

When Table 12 is analyzed, it is determined that 60% (n=24) of the middle school students did not investigate their knowledge about what kind of education should be taken in order to have a STEM profession and their existing knowledge was hearsay information obtained through teachers, parents or friends. It was determined that 40% (n=24) of the students created self-consciousness by doing their own research on this subject.

Table 13 presents the frequencies and percentages of the students' responses to the question "What difficulties do you think people in STEM professions face?" which was asked to them in order to determine their views on STEM professions. While answering the question, students were asked to consider STEM professions and their answers to the previous interview questions. All of the middle school students who participated in the interview reported ideas and opinions about what kind of difficulties people doing STEM professions might face. When Table 13 is examined, the students argue that 47% (f=32) of the difficulties that may be encountered can occur professionally. According to the students who participated in the interview, these challenges are that risky and rare situations can be encountered in STEM professions, challenging, intense and tiring working hours, constant empathy or communication with people, mental and physical health can be negatively affected and these professional groups require a lot of effort. Some of the students' views on this issue are as follows: "*It is difficult to understand people, to explain yourself to them.*", "*They may encounter people who are not educated.*" 29% (f=19) of the students think that the difficulties that can be encountered

can be caused by personal abilities. According to the students who participated in the interviews, people who do STEM professions should be careful and detailed thinkers, patient, resilient, follow innovations and developments, have broad thinking or horizons and be brave person. One student's opinion on this subject was *"They should be brave, they should be able to take that risk even if it is death."* is in the form. With a frequency of 24% (f=15), students think that the difficulties that may be encountered may be caused by the society. The students who participated in the interview stated that people with STEM professions may be subjected to violence and bullying, restrictions and obstacles by the society, they may not be rewarded for their labor, and they may encounter malicious people. In addition, students also stated that people in this profession group may have difficulty in gaining the trust of the society. One student's opinion on this issue is as follows "*For example, when a doctor recommends surgery, people go to a few more doctors.*"

Table 13. *Middle School Students' Responses to the Question " What challenges do you think people in STEM professions face?"*

Theme	Code	f	%	∑f	∑%
Vocational	Encountering risky/rare situations	14	21		
	Challenging/intense/strenuous working hours	7	10		
	Constant empathy/communication with people	7	10	32	47
	Mental/Bodily health may be negatively affected	2	3		
	Can require a lot of effort	2	3		
Personal Capability	Careful/Detailed thinking	6	9		
	To be a patient/durable person	5	8		
	To follow innovations/developments	4	6	19	29
	To be a person with a broad mind/ horizon	2	3		
	Being a brave person	2	3		
Social	Being exposed to violence/bullying	7	10		
	Being exposed to restrictions/blocks	3	5		
	Not seeing the fruits of your labor	3	5	15	24
	Encountering people with bad intentions	1	2		
	Failure to gain people's trust	1	2		
	Total	66	100	66	100

Table 14 presents the percentages of the students' responses to the question "Do you think STEM professions are difficult or easy professions?" which was asked to them in order to determine their views on STEM professions.

Table 14. *Ratios of Middle School Students Finding STEM Professions Difficult/Easy*

Code	n	%
Difficult Professions	29	73
Neither Hard nor Easy Professions	6	15
Easy Professions	5	12
Total	40	100

When Table 14 is examined, all of the students participating in the interview participated in the rating and 73% of them see STEM professions as difficult, 15% as neither difficult nor easy, and 12% as easy professions.

Following the question "Do you think STEM professions are difficult or easy professions?", students were asked the reasons why they see STEM professions as difficult/easy professions and student responses are presented in Table 15. All of the middle school students who participated in the interview stated the reason for finding STEM professions difficult/easy. Since students' reasons for finding STEM professions difficult or easy are similar, the data are presented in a single table. When Table 15 is analyzed, 78% (f=39) of the students stated that in order to do STEM professions, it is necessary to fulfill the requirements of these professions. According to the students who participated in the interviews, STEM professions require perseverance, intensive research (28%, f=14), a lot and memorize information (14%, f=7), labor, effort (14%, f=7), expertise, experience, different strategies, skills and self-confidence. Therefore, these occupational groups can be made by people who love these. Some students expressed their views on this issue with the words "*You need to follow the developments and produce new strategies all the time.*", "*You need to love your profession and not be timid,*

you need to be self-confident." Students evaluated the difficulty of STEM professions according to their characteristics with a frequency of 22% (f=11). According to the students who participated in the interview, STEM professions are difficult to study but easy to work (6%, f=3). According to the students who participated in the interview, STEM professions are difficult to study but easy to work (6%, f=3), at the same time, mistakes cannot be made (6%, f=3) and stressful. In addition, the fact that they are professions related to Science and Mathematics is a facilitating reason for some students and a complicating reason for others. Some students' views on this issue are as follows "*When you make a mistake, the whole world can be affected.*", "*You work hard until you get the profession, but it is easy after you get your profession.*" According to the students, the fact that there is no workload in these occupational groups is a facilitating factor, while the fact that they are professions that do not receive the necessary value is a complicating factor.

Table 15. *Middle School Students' Justifications for the Difficulty of STEM Professions*

Theme	Code	f	%	∑f	∑%
Needs of STEM Professions	Requires ambitious work/intensive research	14	28	39	78
	Requiring much/memorized knowledge	7	14		
	Requiring labor/effort	7	14		
	Requires expertise/experience	6	12		
	People who love can do it	2	4		
	Require different strategies/skills	2	4		
	They require self-confidence	1	2		
Characteristics of STEM Professions	Professions that are hard to study, easy to work	3	6	11	22
	Professions where mistakes cannot be made	3	6		
	Numerical occupations	2	4		
	Stressful occupations	1	2		
	Underappreciated professions	1	2		
	No workload	1	2		
	Total	50	100	50	100

Conclusion and Discussion

In the study, a descriptive study with qualitative elements was conducted to determine the views of middle school students towards STEM professions. The data of the study group of 40 students, 10 (half girls and half boys) of whom were selected from each grade level, were analyzed using the content analysis method. As a result of the data analysis, although middle school students characterize STEM professions as difficult and demanding professions, they see these professions as interesting, admired and loved professions. At the same time, it was determined that students had knowledge that STEM professions are mostly related to Science and Mathematics and that their purpose is to facilitate human life by ensuring the development of humanity and society. Blotnicky et al. (2018) reported similar findings in their study and stated that students' knowledge of STEM professions was limited. Hacıoğlu and Gülhan (2021) stated that students characterized STEM professions as difficult in their interviews with students.

Students think that in the future, STEM professions may include new professions in the field of technology and software, that professions related to the maintenance, repair and development of robots will be popular with the increase in mechanization, and that new teaching and doctor branches professions will emerge.

Students think that in the future, current STEM professions will be technologically advanced, the use of robots and machines will increase in these professions, robots and applications (computer programs) can help people in their work and even replace humans. In addition, students also believe that current STEM professions will be easier and more comfortable in the future, and that applications will increase such as working from home and reduce manpower.

Students like STEM professions because they are professions that develop the country, have open prospects and meet expectations, and they find these professions enjoyable and interesting. They also see people in these professions as curious, patient, intelligent and inquisitive. Supporting this view, Koyunlu-Ünlü and Dökme (2020), in their study with secondary school students who support this view, stated that students with researcher characteristics, that is, students who think analytically, focus on tasks, have critical attitudes, logical and curious, are more likely to turn to STEM professions. The fact that STEM professions work for humanity by making new inventions and discoveries through research, experiments and observations, and that they save time by making daily life or working life easier are among the reasons why students like these occupational groups.

Most of the students who participated in the interviews stated that although they liked STEM professions, there were also aspects of these professions that they did not like. Students see STEM professions as difficult professions that require effort, labor, interest and skill, and they dislike these professions because they think that they are related to science and mathematics and require excessive knowledge and memorization. Similarly, Blotnicky et al. (2018) found that students with low levels of mathematics self-efficacy also had low levels of interest in STEM professions. With the development of STEM professions, technological machines replaced humans and some professions lost their importance, which students stated as a negative aspect of these professions. Students also reported that the mental and physical health of people in STEM professions can be negatively affected due to difficult working conditions. Related to this issue, Luo et al. (2021) argue that educators should carefully examine students' stereotypes of STEM professions and transform them into more realistic and diversified understandings.

The most common reason most students want to pursue a STEM profession in the future is because they love helping people and making their lives easier. Students' perception of STEM professions as enjoyable, happy, intriguing, interesting and interesting professions, and their belief that these professions are related to Science and Mathematics are also among the reasons why they are inclined towards STEM professions. Supporting this result, Koyunlu-Ünlü and Dökme (2020) reported that students' interest in Science and Mathematics courses increased in direct proportion to their interest in STEM professions. Students dream of having a STEM profession in the future, thinking that they will make new inventions, products, projects, experiments, and research. In addition, students discovering that they have a talent for such professions and stating that there are professions related to their interests show that they are interested in STEM professions. Similarly, Bozkurt-Altan et al. (2019) also stated that students' vocational orientations are shaped according to their interests and good courses in that field. In his study, Razali (2021) stated that middle school students' interest in STEM professions varies according to their interests and that students' interest in science also affects their interest in STEM professions. Dönmez and İdin (2020), in their study with middle school students, stated that self-efficacy, interest in science and personal inputs are effective in middle school students' STEM career interests. Robnett and Leaper (2013) also stated in their study that student groups with an interest in science are more likely to prefer STEM professions. Wiebe et al. (2018) reported that students' awareness of their abilities and interests led to changes in their interest in STEM professions. This result proves that students' abilities and interests affect their interest in STEM professions.

Students who do not want to choose a STEM profession in the future stated that they want to work in other professions because these profession groups do not belong to their interests, do not match with their hobbies and do not have the talent for such professions. In addition, students in this opinion characterize STEM professions as feel stressful, boring and unhappy professions. Hacıoğlu and Gülhan (2021) stated in their study that students developed awareness of these professions even though they would not choose STEM professions thanks to STEM activities. This situation emphasizes the necessity of STEM education for the new generation to give due importance to these professional groups. In addition, Chen et al. (2024) argue that by increasing students' self-perceptions and promoting STEM professions more widely, the number of students who will be oriented towards these professions in the future will increase.

Most of the students who want to have a STEM profession in the future want to become computer software developers, programmers or engineers, while many others plan to become doctors, nurses or pharmacists in the healthcare field. In addition, various engineering programs are also among the students' preferences. In this regard, Karakaya et al. (2018), in their study with middle school students, determined that students mostly focused on technology-related professions and their findings support this study. Hacıoğlu and Gülhan (2021) while, in their semi-structured interviews with students, stated that students frequently focus on engineering fields and make career plans in these fields.

Students state that in order to have a STEM profession, they need to be educated in related schools and faculties, they need to have knowledge and skills specific to the profession they will acquire, and even they need to develop themselves and gain awareness in this regard. In addition, there are students who state that in order to have these professions, it is necessary to strive hard, work hard, not give up, get higher education and graduate from a good institution with a degree. Most of the students stated that they learned this information about professions by hearing it from their parents or teachers, not by researching it themselves. In this context, it is understood that in addition to their interest and skills in that profession, the suggestions and opinions of their families and teachers play an important role in students' vocational orientations. Koyunlu-Ünlü and Dökme (2020) obtained the same result in their study with middle school students. Similarly, Bozkurt-Altan et al. (2019) stated that the family was effective in the vocational preferences of students in their studies with middle school students. Razali's (2021) study also supports this result. In addition, Dönmez and İdin (2020), in their study with middle school students, concluded that if students are oriented towards STEM professions, state that their families will be satisfied with this. Abe and Chikoko (2020) also stated in their study that the family factor was more dominant than other factors in students' career planning.

Students think that people in STEM professions may face difficulties such as being subjected to bullying and restrictions by society and not being rewarded for their labor. Students believe that these professions require people to be patient and resilient due to the challenging, intense, tiring working hours and constant communication with people. In addition, students state that since risky and rare situations can be encountered in these professional groups, people should do everything carefully and in detail, and follow innovations and developments.

Finally, the majority of the students characterize STEM professions as difficult occupations, stating that these professions contain memorize and a lot of information, with determined work and intensive research, and that they are professions that require labor, effort and cannot make mistakes. In addition, the fact that the majority of STEM professions are related to Science and Mathematics is one of the reasons why students find these professions difficult. In support of this information, Vela et al. (2020) reported that students with higher perceptions of science, mathematics and engineering had better perceptions of STEM careers.

Recommendations

Considering the importance of raising qualified individuals in STEM professions for countries, studies should be conducted to investigate the level of knowledge of students on STEM professions and to evaluate their preferences for STEM professions in terms of the type of school they attend and the characteristics of the school. In addition, in these studies, it may be suggested to try to determine the effect of students' ethnicity, gender or friend circle on their preferences for STEM professions. It is also important to increase the number of qualitative studies on this subject.

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Ethics Committee Permission Statement

The Ethics Committee Approval of this study was approved by the decision of Uşak University Science and Engineering Sciences Scientific Research and Publication Ethics Committee (Date: 16/02/2022, Number: 2022/02). Informed consent was obtained from the parents of the students participating in this study.

Conflict of Interest Statement

The second author of the article is the university advisor of the first author and neither of them has any conflict of interest to disclose. As the authors, we have determined the order of signature and the submission of the article in this form by common decision.

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