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Teknik Bilimler Meslek Yüksekokulu'nda Öğrenim Gören Kız Öğrencilerin FeTeMM Kariyerine İlişkin Görüşleri

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Öz

Bu çalışmanın amacı, kız öğrencilerin Teknik Bilimler Meslek Yüksekokulu (TBMYO) öğrencisi olma konusundaki hislerini ve mezun olduktan sonra Türkiye'de (f)en, (t)eknoloji, (m)ühendislik ve (m)atematik (FeTeMM) alanlarında kariyer yapma konusunda ne düşündüklerini araştırmaktır. İstanbul'un önde gelen üniversitelerinden birinde öğrenim gören altı kız öğrenciyle bireysel ve yüz yüze yapılan yarı yapılandırılmış görüşmelerle verilerin toplandığı bu araştırmada fenomenolojik nitel araştırma yöntemi; görüşme verilerinin analizinde tümevarımsal tematik analiz yaklaşımı kullanılmıştır. Araştırmanın bulguları, katılımcıların hemen hepsinin programı seçerken kendilerine ilham veren bir rol modele sahip olduğunu göstermektedir. Katılımcıların tamamı dört yıllık programı tamamlayıp mühendis olarak FeTeMM alanında kariyerlerini sürdürmeyi istemektedirler. Ancak, bu alanlarda erkeklerin işe alınma olasılığının daha yüksek olduğu düşüncesiyle sektörde iş bulma konusunda endişe duymaktadırlar. Katılımcılar ailelerinin kız öğrenci oldukları için kendilerini meslek okuluna gönderme konusunda başlangıçta önyargı ve endişeye sahip olduklarını ama zaman içerisinde onların bu önyargı ve endişelerinin azaldığını ve bu fikrin daha fazla kabul gördüğünü ifade etmektedirler. Katılımcılar ayrıca okullarında bir kadın öğretim üyesinin olmasından da mutlu olduklarını ve bu durumun kendileri için ilham verici bir rol model olduğunu belirtmektedirler. Sonuç olarak kadın bilim insanlarının FeTeMM alanlarında kariyer yapmalarının teşvik edilmesi ve toplumun kadın bilim insanlarıyla günlük hayatlarında daha fazla karşılaşması gelecekte kız öğrencilerin FeTeMM alanında kariyer tercihi yapmalarının ve ailelerinin desteğinin sağlanması açısından önem taşımaktadır.

Anahtar kelimeler: *Cinsiyet, kadın, teknik bilimler meslek yüksekokulu, FeTeMM kariyeri.*

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Voices of Female Students Studying at Vocational Technical Sciences School of Higher Education about STEM Careers

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Abstract

This study aims to uncover female students' feelings about being students at Technical Sciences Vocational School (VTSSHE) and what they think about pursuing a career in science, technology, engineering and mathematics (STEM) in Turkey after graduation. In this study, where data have been collected through semi-structured interviews conducted individually and face-to-face with six female students studying at one of the leading universities in Istanbul, the phenomenological qualitative research method is used; the inductive thematic analysis approach is used to analyse the interview data. The study's findings show that almost all participants have a role model that inspires them when choosing the program. All participants want to complete the four-year program and continue their careers in the STEM field as engineers. However, they are worried about finding a job in the sector because they think men are more likely to be employed in these fields. The participants state that their families initially have prejudice and concerns about sending them to vocational schools because they are female students. However, these prejudices and concerns have decreased over time, and the idea has become more accepted. The participants also have stated that they are happy to have a female faculty member at their school and that this situation is an inspiring role model for them. As a result, encouraging female scientists to pursue careers in STEM fields and ensuring that society encounters female scientists more in their daily lives are important in encouraging female students to choose a career in STEM in the future and ensuring the support of their families.

Keywords: *Gender, women, vocational school of technical sciences, STEM careers.*

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Introduction

In recent years, there has been a growing recognition of the importance of STEM education for the future of our world. STEM education has experienced rapid development since 1990 (Martín-Páez, Aguilera, Perales-Palacios & Vílchez-González, 2018). Various factors, including global economic issues, results from international exams like PISA and TIMSS in science and mathematics, the increasing demand for 21st-century skills, and recent advancements in space research, initiated with Sputnik, may have contributed to the rise of STEM education (Gokcul, 2022). STEM, in its most general definition, refers to science and mathematics (Bybee, 2010). By extending this to include technology along with the fields of science, mathematics, and engineering, STEM encompasses the creation of new products and gaining multiple perspectives on problems (Sanders, 2009). Sanders (2009) condensed this perspective into the acronym SMET. The term STEM was first introduced by Judith A. Ramaley, the former director of the division at the National Science Foundation, in 2001 (Koonce, Zhou, Anderson, Hening & Conley, 2011). The term STEM was officially adopted by the National Science Foundation (NSF) (Bybee, 2013). STEM education encompasses multiple definitions and is formed from the initials of the words 'science', 'technology', 'engineering', and 'mathematics', representing the convergence of these disciplines in a common area (Bybee, 2013). STEM education allows students to establish connections between the fields of science, technology, engineering, and mathematics, providing practical experience (Thomas, 2014). The purpose of STEM is to unify disciplines: (a) to enable students to learn deeply, (b) to broaden understanding socially and culturally, and (c) to increase interest in STEM fields. STEM-educated students exhibit technologically literate behaviors, are problem-solvers, self-reliant, inventors, innovators, and can relate their history and culture (Morrison, 2006). With STEM education, students can develop methods to solve problems they encounter in their social lives. STEM is about the integration of its constituent disciplines (Wang, Moore, Roehrig & Park, 2011). The combination of STEM fields ensures meaningful and enduring learning (Wicklein and Schell, 1995). STEM enables students to generate creative and applicable solutions to the problems they encounter by integrating their engineering-based thinking skills with other disciplines (Rogers & Portsmore, 2004). STEM fields play a critical role in driving innovation and addressing global challenges, ranging from climate change to health issues. The contemporary world calls for more interdisciplinary studies, responding to the growing need for educated individuals in STEM-related fields.

Despite the increasing demand for STEM professionals, women remain underrepresented in these fields. Wang & Degol (2017) stated that US women's underrepresentation in STEM fields. Gender is one of the factors affecting the choice of career in STEM, and the presence of implicit gender bias may be one of the reasons why girls do not choose a career in STEM (Smeding, 2012). Moreover, there is a meaningful relationship between gender equality and girls' attitudes towards STEM (Stoet & Geary, 2018). Girls require more teacher support to participate in mathematics and science, while boys show more interest in mathematics and science when deciding to pursue a career in STEM fields (Fredricks et al., 2018). Dubetz and Wilson (2013) also indicated the lack of representation of girls in engineering, mathematics, and science in the United States. Swafford and Anderson (2020) examine and identify perceived barriers women face in the pursuit of STEM careers. Merayo & Ayuso (2023) note that women are still under-represented in STEM fields, with female students showing a preference for education and health professions, while male students tend to prefer computer science and engineering. Teachers and families tend to encourage STEM activities more for male students than female students (Merayo & Ayuso, 2023). Bamberger (2014) listed possible reasons why girls feel fear in choosing a career in STEM, such as cognitive or developmental gaps, and cultural context. Cultural factors can be an important factor affecting girls' choices in STEM. Socio-cultural context including social interactions and cultural symbols influence one's perceptions of professions (Vygotsky, 1978). In addition, Osborne et al. (2003) listed possible reasons for the underrepresentation of girls in STEM, including factors related to parents, teachers, and gender differences in learning styles.

Despite improvements in girls' representation in STEM fields in recent years, they remain underrepresented in STEM careers (NSF, 2021). Various factors contribute to the underrepresentation of girls in STEM fields. Based on the reviewing the last 30 years of research in the fields of psychology, sociology, economics, and education, Wang & Degol (2017) listed several reasons why U.S. women are underrepresented in STEM fields as domain-specific ability beliefs, relative cognitive strengths, cognitive ability, lifestyle values or work-family balance preferences, vocational interests or preferences, gender-related stereotypes, and prejudices. Dasgupta and Stout (2014) stated that certain learning environments, peer relationships, and family characteristics are effective in girls' interest in STEM. One of the significant factors is the lack of role models. Girls may not see many women in STEM fields, making it challenging for them to envision pursuing careers in these areas. This lack of representation can also lead

to stereotypes and biases, making it more difficult for girls to be taken seriously in STEM fields. Additionally, working mothers become role models by demonstrating that education and working life lead to a happy life (Skolnik, 2015). Another factor contributing to the underrepresentation of girls in STEM is the gender gap in education. Girls are less likely than boys to pursue STEM subjects in school, placing them at a disadvantage when it comes to pursuing STEM careers. This gap can be attributed to various factors, including cultural norms and expectations, lack of access to resources, and insufficient support from teachers and peers. Finally, girls in STEM also face challenges related to workplace culture. Women in STEM fields may encounter discrimination and bias, including lower salaries and fewer opportunities for advancement. These challenges can make it difficult for women to succeed and thrive in these fields, and potentially discourage girls from pursuing STEM careers in the first place (Jean et al., 2015). Moreover, many women and men still adhere to stereotypes, believing that science is most suitable for men. This is because women, especially women of minority ethnic origin, struggle to excel in STEM courses (Skolnik, 2015).

STEM education should be inclusive so that all students, especially those in groups that are underrepresented in STEM studies in terms of socioeconomic level, ethnicity, and gender, can access the STEM experience (Jackson et al., 2021). The fact that the families of the students or the region they live in have a low socioeconomic level affects their career goals, and this situation negatively influences the rates of continuing their careers, especially in STEM fields (Gore et al., 2015). Increasing the participation of women in STEM fields is not only important for promoting equality and social justice, but it also has many benefits for the fields themselves. Research has shown that increasing diversity in STEM fields can lead to (Harris et al., 2023):

Innovation: Diverse teams are more likely to generate new and innovative ideas, which can help to drive progress and address complex challenges.

Increased productivity: Diverse teams are more productive and efficient, as they are better able to leverage the strengths and perspectives of all team members.

Improved problem-solving: Diverse teams are better able to identify and address complex problems, as they can draw on a wider range of experiences and expertise.

Greater creativity: Diverse teams are more creative and adaptable, as they are better able to think outside the box and explore new approaches.

Overall, increasing diversity in STEM fields is not only the right thing to do from a social justice perspective, but it also has many practical benefits for these fields themselves (Botella et al., 2019).

While there are many challenges faced by girls in STEM, there are also numerous steps that can be taken to increase diversity in STEM. One of the most important steps is to provide girls with access to role models and mentors in STEM fields. Mentors can also provide guidance and support to help girls navigate the challenges of pursuing a career in STEM (Cimpian et al., 2020). Having a role model enables them to receive valuable advice, aiding in overcoming the challenges associated with pursuing STEM careers (Warsito et al., 2023). Similarly, González-Pérez et al. (2020) found that girls' aspirations in STEM increased while gender stereotypes decreased as a result of the role-model intervention. Another key step is to provide girls with access to quality STEM education. This includes offering resources and support to girls interested in STEM subjects and addressing biases and stereotypes that may discourage girls from pursuing these fields. Such efforts can be implemented through various programs, including after-school clubs, summer camps, and mentorship programs (Cimpian et al., 2020). College-run STEM career days for high school students have been one of the effective examples for promoting students' STEM career interests (Kitchen, Williams, Sonnert & Sadler, 2024). Warsito et al. (2023) stated that girls' early exposure to STEM fields can significantly influence their interests. Finally, it is important to address workplace culture in STEM fields to ensure that women can succeed and thrive.

This involves promoting diversity and inclusion in hiring and promotion practices, as well as providing training and resources to help employees recognize and address bias and discrimination. By creating a more welcoming and supportive workplace culture, we can help more women to succeed in STEM fields (Cimpian et al., 2020).

STEM education has become an economic factor, especially in developed and developing countries (Kennedy & Odell, 2014). Türkiye is one of the countries that paid more attention to STEM education in recent years (Akgunduz et al. 2015). However, Turkiye still falls behind many OECD countries such as Germany, Mexico, the United Kingdom, Poland, Denmark, Israel, the USA, and Australia in terms of the percentage of STEM graduates (EAG, 2023). According to the report of the Higher Education Council, only %17 of graduates are STEM majors (YÖK, 2023). Many research studies have also been conducted to investigate students' career interests in STEM in Turkiye. Demir Guldal, Alp & Altın (2024) state that comparing the numbers of female and male academics working

in ten state universities during this process and findings reveal that the ratio of female academics in STEM disciplines is 42%, which is lower than the general ratio of female academics in universities. Kılıc & Ozturk (2014) studied that women in Turkey try to take part in the labor market, but this effort is met with poor working conditions and low wages. Ergun (2019) analyzed data coming from 400 middle school students through the STEM career interest survey to identify the effect of gender on students' STEM career interests. She has found that male students have higher levels of STEM career self-efficacy and interest than female students do. It has been found that male students have higher self-efficacy levels in the areas of technology and engineering while female students have higher self-efficacy levels in the area of mathematics. Similarly, Balcın et al (2018) studied middle school students' attitudes and career interests toward STEM and found that male students have more career interests related to both technology and engineering than female students. Semerci & Ozcelik (2023) studied middle school student's interest in STEM professions in terms of gender, grade level, and types of parents' occupations. The findings have indicated that male students have more interest in the areas of physics, energy, and mathematics professions than female students. In terms of grade levels, the sixth graders have more interest in chemistry and environmental studies than students in other grade levels. There was no difference between students' interest in STEM in terms of mothers' jobs but there was a statistical difference in terms of fathers' jobs in biology, zoology, and earth science. Yıldırım & Turk (2018) also state that girls do not have less interest in STEM than boys but they suggest that girls' interest in STEM can be increased as a result of STEM activities. Although these studies focused on female students' interest in STEM careers, none of them has studied vocational technical science schools of higher education students' interest in STEM careers. Vocational technical sciences schools train vocational-technical staff in the fields needed by the industry. It is an undeniable fact that the number of vocational-technical staff (intermediate staff) is low in our country. The need for vocational technical staff can be reduced only if women start to work in the industry. Therefore, the current study has focused on views of female students studying at the VTSSHE in one of the largest universities in Istanbul since the school plays a major role as a bridge between industry and academia for both preparing students toward further STEM careers and preparing immediate technical personnel in industry.

Purpose of the Study and Research Questions

The purpose of the research is to explore the views of female students studying at the Vocational Technical Science School of Higher Education (VTSSHE) regarding pursuing a career in STEM fields in Türkiye. The following research questions guided the study:

1. How do female students feel about being a student at the VTSSHE?
2. How does the family approach educating female students and encouraging them to pursue STEM careers?
3. What do female students think about continuing their careers in the STEM field after graduation from the VTSSHE?

Methodology

Qualitative research was chosen for this study as it allows for an in-depth exploration of participants' feelings, motivations, and experiences regarding their education and career aspirations in STEM fields (Merriam, 2018). This study employs a qualitative research design based on the phenomenological approach. Phenomenology is based on the assumption that 'we can only know what we experience' by attending to perceptions and meanings that awaken our conscious awareness. Phenomenology focuses on meaning making as the essence of human experience (Patton, 2018). This approach is well-suited to answer our research questions which focus on understanding how female students at the Vocational Technical Science School of Higher Education (VTSSHE) perceive their experiences and make decisions about their futures.

Context of the study

This research was conducted with female students enrolled at the Vocational Technical Science School of Higher Education (VTSSHE) at a large university in Istanbul, Turkey. Established in 1985, the VTSSHE initially offered a single program in Computer Programming. Today, the school boasts 22 departments, encompassing a wide range of specializations from traditional areas like Computer Programming to cutting-edge fields like Virtual and Augmented Reality.

Students gain admission to these programs through annual nationwide exams (YKS) conducted by the Student Selection and Placement Center (OSYM) under the Higher Education Council (YÖK). However, graduates from Technical High Schools receive bonus points on the YKS, incentivizing them to pursue further

technical education at the VTSSHE. The VTSSHE operates as a two-year pre-undergraduate program. Its mission is twofold: to prepare students for immediate technical careers in industry and to equip those who wish to continue their education with the foundation for success in four-year undergraduate STEM programs. Upon graduation from the VTSSHE, students can take the Vertical Transfer Exam (DGS) administered by OSYM. Strong performance on this exam allows students to pursue undergraduate degrees in engineering or science at various universities across Turkey. For many years, the VTSSHE student body has been predominantly male. According to the 2023 report by the Council of Higher Education (YÖK), only 41% of graduates were women in that year. Given this gender imbalance, the current study specifically focuses on the experiences and perspectives of female students at the VTSSHE.

Participants

Purposive sampling has been used in the study. Purposive sampling involves selecting a sample that the researcher wants to investigate to gain insight and in-depth knowledge and hence must select a sample from which the most can be learned (Merriam, 2018). Only six participants out of 40 students were purposefully selected based on three main criteria: (a) voluntariness (b) being a female student and (c) studying at VTSSHE in one of the largest universities in Istanbul, as the school plays a significant role in preparing students for further careers in STEM. In the research group, there were only 6 female students. Pseudonyms were used instead of the students' real names (Table 1).

Table 1

Participants

Name	***Graduated high school***	***Age***
Ada	*Technical chemistry of high school*	*20*
Banu	*Technical chemistry of high school*	*21*
Canan	*Religious-based high school*	*19*
Deren	*Technical chemistry of high school*	*18*
Ela	*Technical chemistry of high school*	*18*
Ferah	*Regular high school*	*21*

Data Collection

Semi-structured, face-to-face interviews were chosen as the primary method for data collection in this study. In these interactive interviews, the researcher asks questions designed to elicit rich and detailed responses from participants (Glesne, 2015). A semi-structured format allows for flexibility in exploring topics based on

the participant's unique experiences while still ensuring the interview addresses the core research questions (Merriam, 2018). The interview guide (not shown here) covered themes related to the participants' experiences as female students in a STEM program, their perceptions of family support for STEM careers, and their aspirations for future careers in STEM fields. The interview guide includes questions on demographic information and STEM careers. The questions include the female students' opinions about STEM education, their feelings about being a female student in STEM, and their views on being a female student in STEM from a societal perspective. The guide was developed based on relevant literature and feedback from a faculty member with expertise in qualitative research methods. Experts are right; adding side questions based on participants' answers can be very valuable. These side questions help you delve deeper into unexpected but interesting insights that emerge during the interview. Semi-structured interviews were conducted in two sessions. Each interview lasted approximately 20-25 minutes and was conducted in two sessions. After analyzing the initial interviews, a decision was made to conduct follow-up interviews with all participants to clarify their responses and gain deeper insights. With the participants' permission, all interviews were audio-recorded and transcribed for analysis.

Data Analysis

An inductive thematic analysis approach was employed to analyze the interview data. This method involves identifying codes within the transcripts, then grouping these codes into categories and ultimately organizing them into broader themes (Braun & Clarke, 2006). The analysis was iterative, with researchers moving back and forth between the data and emerging themes.

Each participant's responses were analyzed in relation to the research questions, focusing on distinct time periods: before, during, and after their studies at the VTSSHE program. To answer the first research question ("How do female students feel about being a student at the VTSSHE?"), researchers compared participants' responses about the factors influencing their program choice and how these preferences may have evolved before starting the program. During their studies, the analysis focused on participants' experiences regarding the quality of education and their feelings about being a female student in a male-dominated program. For the second research question ("How does the family approach educating female students and encouraging them to pursue STEM careers?"), student experiences were examined from various perspectives, including family, friends, and society.

Finally, to address the third research question ("What do female students think about continuing their careers in the STEM field after graduation from the VTSSHE?"), researchers analyzed participants' plans for the immediate future, including their willingness to pursue a four-year engineering program and their perceived challenges of finding employment as a female technical professional in the industry. An illustrative example of this process could be seen in how initial codes related to feelings of isolation or lack of confidence (e.g., "There weren't many girls in my classes," "Sometimes I felt like I wasn't taken seriously") might be grouped into a category of "gendered program experience," which could then contribute to a broader theme of "challenges faced by female students in STEM programs." In order to provide trustworthiness and credibility of findings of the study, there have been several methods used. First of all, member checking (Merriam, 2018) was done with the participants after all data were transcribed and sent to the participants for the confirmation. Secondly, interviews were made until data saturation. After preliminary analysis of the first interviews was done, the second interviews were conducted in order to clarify any missing points and gain in-depth understanding. Thirdly, two researchers' triangulations were used in order to ensure that the findings of the study were consistent with the collected data (Merriam, 2018). Data were independently analyzed and cross-checked by the researchers. During the data analysis process, any conflicts were discussed and clarified until the agreement was made. Since interviews were made in Turkish, all of the quotations were translated into English. Translations of interviews were also cross-checked by a language expert. Finally, to provide transferability, the context of the study and participants' backgrounds were described in detail so that readers can transfer the findings of the research to a similar context.

Findings

The purpose of this study was to uncover how female students feel about being students at the VTSSHE and what they think about pursuing a career in Science, Technology, Engineering, and Math (STEM) fields in Türkiye after their graduation. Initially, codes were identified from the data obtained through semi-structured interviews with the students who participated in the study. These codes were then utilized to form categories, and the categories were further organized into themes (Table 2).

Table 2

Categories and Themes of STEM

Category	***Themes***	***Codes***
STEM courses	*Practice*	*…in our program, for example we are studying plastics umm like injection machine that we do not see in reality [Ada]*
	Theoric	*I would have wanted to do more practice here, too. Rather than writing and listening [Ela]*
	Stem course competence	*I think they are not challenging enough [Deren]*
STEM gender factor	*The equality of woman and man*	*I wished that more girls would be here but like that… [Ferah]*
	choose the Stem area	*in Türkiye, since girls did not generally study engineering or science, it seems that these programs are only for men in society…. Electrical engineers or mechanical engineers are always men that I have known [Ada]*
	Advantages / disadvantages of gender factor	*I think that is a good thing [thinking] umm even I am proud of myself [laughing] because I already believe that women can do this kind of work [Banu]*
STEM role model	*Effect of role model*	*I felt as if no one was around me and I shouldn't be here. I felt that I did not belong here since even professors were men, but this was the case until I saw my professor was a woman. [Deren]*
STEM business opportunity	*Chance of business opportunity by gender factor*	*Less likely compared to men because especially some departments such as production preferred specifically men because it is shift work and requires labor but women can be preferred mostly at the quality control department [Ferah]*
STEM social overview	*Cultural impact*	*For example, I have not ever known any women electrical engineers. Electrical engineers or mechanical engineers are always men that I have known. [Ada]*
	Family view	*My family never has any problem with the*

	program I entered. [Banu]
Nearing environment	*React negatively, what I mean when they ask me my program they say 'what, what is it?' People don't know the program but they think that women cannot do it but I believe they think wrong [Ferah]*

The findings of the study were described in terms of the research questions.

RQ1-How do female students feel about being a student at the Vocational Technical Science School of Higher Education?

The first research question was analyzed under three categories including the priority of preferences to enter their program, views about the quality of education that they studied, and feelings about being a female student in a male-dominant program.

Acceptance to the program

All of the participants were happy about being students in their program since the program they were studying was a high priority of their preferences. All of them were placed in their program as the top tenth of their preferences on the nationwide university entrance exam. Ela's program choice was her number one preference, and she was successfully placed there. Ada and Deren entered their program from the reserve list since they were not placed in any program at the first placement. However, they were happy that they eventually were able to enter the programs that they already wanted. The program that Ferah and Canan studied was Ferah's eighth choice while Canan's tenth choice. Although both Ferah and Canan initially preferred studying at programs related to health majors such as pharmacy and nursing rather than their current programs, they were happy with their programs soon after starting their programs.

Except for Ferah, all participants had a role model that inspired them to study STEM careers. Ada and Deren were inspired by a female engineer at the company where they were having internships in their high school years. Banu's role model was her older sister who was studying at the program of construction engineering. Ela's role model was her mathematics teacher at her high school. Canan found her role model as a result of searching the internet. Ferah said that she had no role model that inspired her to choose the program she was studying.

Content of Courses

In terms of the quality of education that they studied, all of the participants agreed that they wanted to take more practical courses rather than theoretical ones. Especially Ada complained about the theoretical content of the courses by saying that *"in our program, for example we are studying plastics umm like injection machine that we do not see in reality I wish there is a machine that we can see in our school or that use for learning purposes so we can learn more but we see them just virtually."* Like Ada, Ela also indicated that *"when I was at the high school, we were making more practices such as in chemistry we were doing experiments. I would have wanted to do more practice here, too. Rather than writing and listening, I can keep the things in my mind when I see since I am a visual learner."* Although they criticized the theoretical nature of courses in their program, four of the participants generally met their expectations and found the program sufficient for their professional development. On the other hand, Deren and Ferah did not find the content of the courses sufficient enough. Ferah believed that courses were not sufficient enough because of the two-year program. She thought that they would add more knowledge if they continued on the four-year program. Deren believed that the courses were not challenging enough. She said *"I think they are not challenging enough. When a tougher student is challenged, she/he would study harder and improve herself/himself but I think we are not challenged. Like a high school, since we are not challenged, we are not competently developed."*

Being a female student

All of the participants stated that they enjoyed the program that they were studying and that they were happy to be there. However, they wished that there would be more female students. Ferah expressed her feelings about being the only female in her classes as *"[laughing] pretty nice actually...I wished that more girls would be here but like that, I am feeling more valued [laughing again]…. since I am the only girl, I have been appreciated by my classmates, this is one thing."* Moreover, she added *"I mean, I think that it is proof that women can do anything. There is no such thing that cannot be done. Anyone can work anywhere. I want to be here knowing that. It is my priority."* Although Ferah felt happy in her studies and respected by her classmates, she thought that the only disadvantage of her program was the lack of female students. She said *"In the past, there had been more girls in the program but it is not the case for me. This is the only negative side; there is nothing negative in the program."* She added that *"men cannot understand women sometimes [laughing]. Other than that, there is no such discrimination. I think a nice class, nice school, and nice program."* Ada was also

happy to be in the program but indicated that she wished to see more girls in their school. She said *"Being among the men is a good thing, of course. Men have more tendency to do this kind of thing such as machines or computers. We can learn many things from them but for example, if there are more women at least we can share more and we can learn much more from each other."* She considered the lack of women as a limitation and added that *"since the class is full of men, sometimes it is hard to understand something that men already know. I mean you can share more things with female students and do many things together. Still, when it comes to men, it seems to me that they understand more about machines or something"*. She also emphasized that gender was not a matter for her but added that *"in Türkiye, since girls did not generally study engineering or science, it seems that these programs are only for men in society. When it comes to engineering, everybody thinks of male engineers such as electrical engineers. For example, I have not ever known any women electrical engineers. Electrical engineers or mechanical engineers are always men that I have known."* Banu also wished that more women should be there but did not consider either advantageous or disadvantageous of this situation. She said *"I think that is a good thing [thinking] umm even I am proud of myself [laughing] because I already believe that women can do this kind of work. I have been inspired by the factory where I had been for an internship. Nice thing, I mean [laughing]."* Ela also agreed with Banu's view that it was not either an advantage or disadvantage. Ela said *"There is not any negative effect on me. It doesn't matter to me but I believe that girls are more capable of doing this. I don't know what I mean... At technical work or doing experiments girls are more practical. I believe that they [girls] think more logically. For this reason, I am thinking that we are smarter than them [laughing]."* Canan and Deren wanted to see more women in their program for social and emotional reasons. Canan explained her reason why she wanted to see more women by saying that *"actually this is affecting us because there are many things that we can talk and share with women but not with the men. I mean that it would be better to support each other, we would have studied together."* and added that *"we should change the prejudice toward women. I think that women should major in engineering not men I mean."* Deren was initially disappointed and felt that she did not belong there. She said *"I felt as if no one was around me and I shouldn't be here. I felt that I did not belong here since even professors were men, but this was the case until I saw my professor was a woman."* Deren said that although she got used to this situation and was happy at the program, she wished to have more women in her classes to keep more sincere friendships since she felt bored at times.

In conclusion, although all of the participants were happy to be in the program and got used to being few women, they still wished to see more women in the program for not only academic but also emotional and social reasons. Like Deren, all of the participants indicated that they were happy to see women professors who inspired them in their program.

RQ2- How does the family approach educating female students and encouraging them to pursue STEM careers?

All of the participants were supported by their families to study at the program where they were studying. However, Ada was not supported initially by her family. She said that her family laughed and made fun of her program by asking *"what is that a tire?"* the first time they heard the program she had been placed in. However, she added that their responses had changed over time especially when they saw that she was doing her assignments by working the SolidWorks used in engineering. She stated that her family started thinking of her program as the foundation of engineering.

STEM Social Overview

Ela's family was initially hesitant about her program that she was placed in. Especially Ela's father did not want her to study at this program. Her father suggested that she could study harder for another year and take the university entrance exam (YKS) again to go to any engineering program. However, her father's concern disappeared over time since she was successful at her program. Ela stated that *"He thought it was late for engineering. I'm very happy with the program I study. He thought I couldn't, but I did it, and I succeeded. He also believes that I can enter DGS [the vertical transfer exam for transferring to the four-year undergraduate degree], can complete the engineering program, now he trusts me and he knows I can."*

Banu stated that her family supported her to study at this program. She said that *"my family never has any problem with the program I entered. On the contrary, they supported me. I came to the program by being inspired from my elder sister, working at the construction company."* Similar to Banu, Deren came to the program since she was inspired by her sister and brother-in-law, chemical engineers working at a plastic factory. Her family supported her to study at the program she studied. Canan stated that her family, especially her mother supported her to study at this program. However, the only family member who did not support was her aunt. Although her aunt's reaction did not change over time, she did not care about her view anymore. Ferah stated that her family

always supported her and was happy about the program that she studied. She added that they wanted her to go to the four-year program as well.

In conclusion, although some of their family had initially been concerned about sending her daughter to the program, their concerns disappeared over time. All of the participants' families supported them to study at the program which they entered.

Although the participants were supported by their family, it was not the case in society. Ferah stated that people reacted by saying *"what, what is it?"* when they heard the program she was studying. Ferah stated that *"react negatively, what I mean when they ask me my program they say 'what, what is it?' People don't know the program but they think that women cannot do it but I believe they think wrong."* Banu stated that *"generally when people ask about my school different reactions, they show they asked 'are you studying at this program as a woman?' sometimes even my friends make fun of me by showing a screwdriver in their hand". Banu added that "I have never thought that I cannot do it because I am a woman but people around me said that it is not a woman's job or something like that but I have never been affected by their reactions."* Ela's responses were similar to others. Ela said that *"some people said 'do not go', 'what are you going to do there', 'there would be many men', 'it is not the kind of thing you can do' such reactions that I heard. But one of my favorite teachers always told me that there is nothing such as a women job or a men job, you can do what men do."* Deren said that people were asking her questions like *"why are you studying, what are you going to be, whether you will work at the factory as a woman."* Deren added that *"they think that only men can study at the technical school not women."*

RQ3-What do female students think about continuing their careers in the STEM field after graduation from the Vocational Technical Science School of Higher Education?

STEM Business Opportunity

Although all of the participants believed in their competences and had higher levels of self-esteem, all totally thought that the possibility of being hired as a woman in industry was lower than that as a man. Therefore, in order to increase the possibility of finding a job, all of them wanted to transfer to the four-year undergraduate programs at college of engineering by taking the exam (DGS). Ada stated her goal that *"my goal is to become a chemical engineer by taking the DGS exam to complete the four-year program"*. Ada added that *"the chances of women are less than men because in Türkiye for example the injection press requires weighing. I think men are already more than women in this field but more*

women need to be worked I think." Similarly, Deren also planned to study the four-year undergraduate program by taking the DGS exam. She explained her goal that *"I have a specific goal, to become an engineer at the microbiology laboratory where I have been doing my internship."* Otherwise, she thought that she had a lower chance of finding a job. She added that *"I think we are not that lucky. For example, if one of male classmates applied to the same position, he would be more likely to be hired."* Ela also said that she wanted to continue on her study at the four-year engineering program and added that *"I love doing experiments at the laboratory so if I could go to the chemical engineering program by DGS exam, I would like to work at a cosmetic company."*

In a case that if they could not go to the four-year engineering programs, they thought that it would be more possible to find a job as a woman at the quality control or laboratory departments of the company. Ferah explained the possibility of finding a job by saying that *"less likely compared to men because especially some departments such as production preferred specifically men because it is shifting work and requires labor but women can be preferred mostly at the quality control department."* Similarly, Banu stated that *"based on my observation from previous experiences during my internship, for example, I can work at the laboratory because women do not work generally at the production department requiring shift work; it is hard for me to find a job there."* Canan was the most pessimistic person about finding a job in industry. She explained her concern that *"people says that 'men can do better and know much, but what can women know?'"* Although Canan was concerned about common prejudice toward women, she believed in herself and women. She stated that *"women can do anything, they can improve themselves, and women need to be able to show their achievement more."* and added that she wanted to be either an engineer or an assistant engineer at any company.

Discussion, Conclusion and Recommendations

The purpose of this study was to uncover how female students feel about being students at the Vocational Technical Science School of Higher Education (VTSSHE) and what they think about pursuing a career in Science, Technology, Engineering, and Math (STEM) fields in Türkiye after their graduation.

Findings of the study revealed that all participants were highly interested in pursuing careers in STEM since they all preferred their program among the top ten preferences. In terms of the quality of the training they had studied, all the participants agreed that they would have liked to have taken more practical

courses rather than theoretical ones. All participants agreed that there should be more women in their school and added that they wished to see more women in their program. All the participants said that they enjoyed the programme they were studying and that they were happy to be there. However, they wished there were more female students. Except one, all participants were inspired by a role model for selecting their program as Bamberger (2014) and Broadley (2015) emphasized the importance of role models in their studies. This finding is also consistent with many studies that female role models can influence a career, especially on women in the context of the STEM profession (Quimby & DeSantis, 2006). Although women want to pursue careers in STEM, they are still under-represented in these fields as indicated in the literature (Brotman and Moore, 2008; Merayo & Ayuso, 2023). Türkiye has a very low ranking in international statistics in terms of the participation of women in the labour market (Kılıc & Ozturk, 2014). Similarly, ratio of female academics in STEM disciplines is 42% (Demir Guldal, Alp & Altın, 2024). In the current study, although participants wanted to study and pursue a career in STEM, they were few in their program. Additionally, the students noted the lack of implementation of STEM-based courses. Siew, Amir & Chong (2015) highlighted the material and time constraints faced by STEM teachers in their research. According to findings of the current study, women believe in themselves to do anything that men can do but they think that their possibility for finding a job in STEM is less than that of men. As stated by Bamberger (2014), cultural context is one of the most important factors affecting women's career in STEM. Starr & Simpkins (2021) stated that families believe that males are better at STEM than females. In the current study, although some of the families initially have concerns about sending their daughter to the VTSSHE, eventually their concerns have decreased over time and they generally support their daughter for a STEM career. Although the family support for encouraging their daughter make a STEM career is mostly provided in the current study, it is not always the case in society. Gender related stereotypes and prejudices are considered as important factors that influence women's career in STEM (Skolnik, 2015). In the current study, gender related stereotypes and bias are stated frequently by the participants. Similarly, Smeding (2012) highlights the implicit understanding of gender among students due to societal influences. Eccles & Wang (2016) explored occupational and lifestyle values, the self-concept of mathematical skills, family demography, high school classes, and how individual and gender differences influence STEM interest. Fredricks et al. (2018) conclude that girls are more connected to teacher support and personal interests when participating in mathematics and science classes. Brotman & Moore (2008)

found that despite progress in narrowing the gender gap in science over the past 30 years, girls and women remain underrepresented in areas such as physics, engineering, and technology.

Gulhan and Sahin (2018) found that an investigation of the career choices of students in the 5th grade of middle school in STEM fields. The results of this study show that female students do not want to pursue a career in technology. In addition, Urunibrahimoglu (2019) found that the interest level of male students in the science and mathematics dimensions of secondary school students was higher than that of female students. Studies indicate that younger girls exhibit a preference for and greater participation in biological rather than physical sciences, often having less extracurricular exposure to science compared to boys. Moreover, particularly among males, stereotypes persist, associating science predominantly with being 'for men.' These findings also vary based on different ethnic backgrounds. Dasgupta & Stout (2014) delved into gender inequality in STEM, illustrating how certain learning environments, peer relationships, and family characteristics hinder interest, success, and persistence in STEM during different life stages. Most of research on the gender role about women' s career has been done by using quantitative research methods (Albalate et al., 2018; Chen et al., 2023; Merayo & Ayuso, 2023; Shahin et al., 2021; Wan, So & Zhan, 2023). Kutukcu & Senturk (2018) conducted quantitative research and they found that gender roles have a significant effect on career future. Albalate et al. (2018) adopted quantitative methods in their study. In this study, students educated in STEM fields value science due to their career choices. Similarly, Chen et al. (2023) adopted quantitative methods and their studies that students taking STEM courses have a positive impact on 21st century skills. Although many research studies conducted on the role of gender on career preferences, there are few qualitative research focusing on more in-depth analysis of women's voices on their career preferences. Atkins et al. (2020) employed a qualitative research method. In this study, students participated in end-of-year interviews. Similarly, Murphy et al. (2021) conducted semi structured interviews with women academic medicine faculty members.

To summarize the findings of this study, female students are happy to be in STEM and want to pursue their careers in this field. It is also highlighted that there is a prejudice in society that only boys should be in STEM. Based on findings of the current study, some implications need to be done in order to encourage girls to pursue a STEM career. First of all, girls should be engaged in STEM activities where women scientists work so that they can find their role models that influence their decision about career in the future. Secondly, in order

to decrease gender prejudice in society, there can be many projects that could be a bridge between society and science in order to help people understand how science works and see how female scientists could be.

The current study is expected to provide new knowledge to the literature since there is little research about technical schools of higher education students' career selection in STEM. However, the current study is limited to a group of female students studying at the VTSSHE. More research can be conducted with a larger sample size at other programs of different universities in order to gain more understanding of diverse groups of students having different cultural backgrounds.

Ethical Statement

The article titled *"Voices of Female Students Studying at Vocational Technical Sciences School of Higher Education about STEM Careers"* is original research; we as the authors of the article have acted according to scientific ethics, principles, and rules at all stages of the research (preparation, literature review, data collection, data analysis, presentation); we have included all of the works used in this study in the references; we have not made any changes to the data while using the data; the research does not contain plagiarism; we state that we comply with ethical duties and responsibilities by accepting all the terms and conditions of the Scientific Research and Publication Ethics Directive of Higher Education Institutions and the Committee on Publication Ethics (COPE) Principles. We state that we will accept all moral and legal consequences in case any situation contrary to our statement regarding our research is detected.

Ethics Committee Approval

Ethical evaluation decision date: 12.09.2023

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Name of the institution that carried out the ethical evaluation: Istanbul Unıversity-Cerrahpasa, Social Science Research Ethical Committee.

Conflict of Interest Statement

There is no conflict of interest between any person, institution, organization, and its authors for the article titled *"Voices of Female Students Studying at Vocational Technical Sciences School of Higher Education about STEM Careers"*.

Author Contribution Statement

1.Idea/concept (creating an idea or hypothesis for research)

2.Design (planning the method to reach the research result)

3.Supervision/consultancy (taking responsibility for the organization and supervision of the course of the research)

4.Resources (provision of personnel, participants, venue, financial resources, equipment for the research)

5.Materials (providing materials for research)

6.Data collection/processing (collection of research data and processing of data)

7.Analysis/interpretation (analyzing and interpreting data)

8. Literature review (taking responsibility for literature review)

9. Article writing (taking responsibility for writing the whole or the main part of the research)

10.Critical review (critical review of the research not only in terms of spelling and grammar but also in terms of intellectual and academic content before submitting the research)

Table 2

Author Contribution Statement

Contributing writers	***Contribution type and contribution rate***
Meryem Demir Guldal	*1-2-4-5-6-7-8-9 %50*
Funda Savasci Acikalin	*1-2-4-5-6-7-8-9 %50 / 3-10 %100*

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Appendix-1 Interview Questions

A. Demographic Information

1. Could you give us more information about yourself?
2. How old are you?
3. Which program are you studying?
4. How do you feel about your program?
5. Which choice did you enter in your program when you took the exam (YKS)? What was your reaction when you learned that you entered the program?
6. Do you think that the courses you have been taking are sufficient in terms of numbers and the content of the courses?
7. Do you think that the number of female students studying in STEM majors is sufficient?
8. Would you like to add more about your program and yourself?

B. Questions about STEM career

1. What do you think about the education given in the fields of STEM?
2. What do you think about courses you have been taking at the program? (in terms of quality, quantity and so on)
3. What do you think about your knowledge and competence being gained at the program?
4. How do you feel about being a female student in the fields of STEM?
5. How many girls are there in your program?
6. What do you think about it? How does this situation affect you?
7. What are the advantages of having few girls at the program?
8. What are the disadvantages of having few girls at the program?
9. What do you think about having female professors at the program? How does it affect you?
10. What are your views about being a female student in STEM fields from the perspective of society?
11. What do your family think about your decision to study at the vocational technical science school of higher education?
12. What does society (friends or people around you) think about your decision to study at the vocational technical science school of higher education?
13. What are the future job opportunities of women in STEM compared to men?
14. What do you think about gender equality for finding a job and working in STEM?
15. What do you think about working in industry as a technical person after finishing your program?
16. What do you think about studying further to become engineers for a STEM career after finishing your program?