



# Analysis of the female student profiles who consider choosing STEM careers

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## Abstract

In this research, it was aimed to analyze the profiles of secondary school female students considering STEM (science, technology, engineering and math) careers at university by collecting information such as education status of the parents, number of siblings, monthly income of the household, their favorite courses at school and the departments they intend to choose at the university. The research addressed the following question: “What is the profile of secondary school female students who consider choosing STEM careers?” This study is structured according to instrumental case study design, one of the qualitative research designs. The research data were collected from 210 female students studying in Anatolian high schools by a form in which the students' information was requested. After collecting the forms applied to a wider workgroup, female students' data were separated and the departments they intend to choose at the university were analyzed. Originally, the form has been applied to a larger sample, following the collection of the data, the data of female students was analyzed separately to see the departments that they consider at the university. The departments stated by female students were coded as STEM careers and non-STEM careers. The results obtained from the evaluation of the data are given as frequency and percentage. Regarding female students who consider preferring STEM careers, it was found that the education level of their parents is high; the number of siblings and therefore the number of people in their household is low; the monthly household income is moderate or high; and the students who like the courses directly related to STEM fields are more interested in choosing STEM careers. It is seen that more than half of the female students who want to choose STEM careers want to pursue a career in medicine.

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**Keywords:** STEM career; student profiles; career choice; gender; socio-demographic status

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## 1. Introduction

### 1.1. Introduce the problem

Today we are experiencing the industrial revolution called “industry 4.0”, which is the name of the digital industry technology that has been first introduced in 2011. “Industry

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4.0” is the transformation process that enables the production of high-quality products via faster, more flexible and more efficient processes at low cost. Over time, this transformation will increase the productivity, change the economy, change the labor profile and change the competitiveness of countries and sectors. In this context, technology pioneers such as the US and Japan have begun to shape their future goals in line with “Industry 4.0”. However, Turkey has not shifted to "Industry 4.0" yet. It is thought that this phase will be started in 10-15 years. For Turkey to come to a position to compete in the global level, achieving a more skilled workforce and “Industry 4.0” technologies are gaining importance (BCG, 2019; Kuscu, 2018). To take part in this competition, firstly an importance should be assigned to “Industry 4.0” technologies and careers and professions derived from these technologies and the participation of the labor force in these fields should be improved.

That are basically nine technologies that are the building blocks of “Industry 4.0”. These are; autonomous robots, simulation, system integrations, industrial internet of things, cyber security, cloud, production with the addition of materials, augmented reality, big data and analytics technologies (BCG, 2019). These nine technological innovations point out the professions and sectors of the future, which can be listed as; programmer, industrial data analyst, information systems and internet of things solution provider, robot coordinator and repairer, production technology specialist, smart city planner, product designer (Kuscu, 2018). These professions and technologies basically indicate STEM (science, technology, engineering and math) careers and professions. Regarding the STEM professions mentioned in the 2015 report of the UK Commission for Employment and Skills (UKCES), it is seen that the professions covering “Industry 4.0” technologies and future professions parallel to it were included in the report. Some of the STEM professions included in the report were the followings; programmers and software development specialists, aircraft pilots and flight engineers, web design and development specialists, design and development engineers, information technology and telecommunications managers (UKCES, 2015). In the light of technological developments emerged with “Industry 4.0” and parallel to it, STEM areas, especially engineering areas, where technology is at the core, have become male-dominated. In the society, it is assumed that these professions are incompatible with the characteristics of women (KPMG, 2019). For example, in a survey on women working in the technology sector, most of the respondents stated that men are more advantageous in computer and technology. In addition, most of the participants stated that society does not associate technology with the image of women (Deloitte-TUBISAD, 2018). Thus, regarding the STEM careers in Turkey, men have started to be represented more, whereas women have begun to take place as a minority. The results of many studies have shown that women are less involved in STEM careers.

First of all, it should be said that the overall labor force participation rate of women in Turkey is quite low. Women's labor force participation rate is 30% in Turkey (YOK,

2017). In this participation, women are generally employed in non-STEM careers. Regarding the proportion of female researchers in 2017, it is seen that the proportion of women in the field of engineering and technology was approximately 26% and the proportion in science was 36%. Regarding the proportion of female graduates in Turkey according to the fields, the proportion of women graduating from the engineering is 25%, whereas the proportion of female graduates from the fields of science is 48% (YOK, 2017). In a research conducted with R & D companies, the proportion of female technicians was found to be 20% and that of experts and engineers was 22% (Oztan & Dogan, 2017). In another study conducted with women working in companies, participants were asked about the most successful sectors for women employment. According to the results, education, banking, insurance and media sectors took the first places among the most successful sectors in women's employment (Deloitte-TUBISAD, 2018). In a study involving female agricultural engineers, the proportion of men and women in various engineering disciplines in 2014 was given. Regarding the proportions, it is seen that the proportion of men registered to the chambers of engineers is considerably higher than that of women (Mart, n.d.). Regarding the vocational high schools in Turkey, it is seen that engineering, manufacturing and construction fields are often preferred by men students with a high margin compared to females. A similar result is observed in the number of students in associate degree regarding the classification of education and training fields. It was found that the number of associate degree female students studying in natural sciences, mathematics and statistics, information and communication technologies, engineering, manufacturing and construction is lower than the number of male students (YOK, 2017). A study analyzed the number of women and male faculty members in 272 computer programming and technology departments in Turkey, and it was found that the number of female faculty members constitutes 20% of the total number of faculty members in the field (Yazagan, 2017). In the 2018 report of World Economic Forum involving global gender inequality, Turkey was ranked as 130th among 149 countries in terms of global gender gap index. The gender gap in labor force participation of Turkey was ranked 133. A difference was found in the labor force participation rate in favor of men. The same report also shows that the proportion of men was higher than women among the graduates of engineering, construction, information and communication technologies. The percentages among the graduates of social sciences and journalism was in favor of women (World Economic Forum, 2018). As a result of the results revealed in the researches, some activities were started in Turkey regarding the STEM careers of women.

The project "Girls Let's Go Coding", initiated within a holding, aims to pave the way for the children of men and women blue-collar workers to become scientists, engineers and information processors. Thanks to the project, the girls were raised, while their mothers are motivated to stay in work-life (SKD Turkey, n.d.). "Engineer Girls of Turkey Project" was carried out by United Nations Development Program (UNDP). The project

aims to increase the number of female engineers by taking different aspects of women's participation in engineering profession (UNDP, 2018). "Women's Internship Program in Technology" carried out by a company operating in the field of telecommunication has been initiated for young women in engineering faculties of universities, to increase the number of women working in the field of technology. Students who successfully complete the internship period are planned to be employed in the company (SKD Turkey, n.d.). "The Girls in Science and Technology" project aims to eliminate gender inequality in the fields of science, technology, engineering and mathematics and to direct girls to positive sciences (Web 1).

### *1.2. The purpose of the research and the research question*

Regarding the results discussed above, it is seen that in Turkey the proportion of female students and women in STEM careers is very low and this is mostly due to the social factors. In this respect, the studies to be carried out on female students considering STEM careers are important. With this research, it was aimed to analyze the profiles of secondary school female students considering STEM (science, technology, engineering and math) careers at university according to some socio-economic variables by collecting information such as education status of the parents, number of siblings, monthly income of the household, their favorite courses at school and the STEM careers they intend to choose at the university. The research addressed the following question: "What is the profile of secondary school female students who consider choosing STEM careers? In this way, the socio-demographic factors that may affect the STEM career choice of female students will be examined.

## **2. Method**

### *2.1. Research model*

This study is structured according to instrumental case study design, one of the qualitative research designs. In instrumental case studies, the case is analyzed to draw a more general conclusion (Butun, 2014). In this research, it was aimed to make generalization based on the analyzed case and the profiles of female secondary school students were analyzed in terms of STEM careers. Therefore, the research was structured according to instrumental case study model.

### *2.2. Workgroup*

The research data were obtained from 210 female students studying in Anatolian high schools. Table 1 shows the distribution of the students by grade level.

Table 1. Distribution of female students in the workgroup by grade level

Demographic Characteristics		Number of Students (N)	Percentage of Students (%)
Grade Level	9	62	29.5
	10	79	37.6
	11	49	23.3
	12	20	9.5
Total		210	100

### 2.3. Data collection tool and data analysis

Research data were collected through a form in which the students' information was requested. The education status of the parents, number of siblings, monthly income of the household, students' favorite courses at school and the departments they intend to choose at the university were asked in the form. After collecting the forms applied to a wider workgroup, female students' data were separated and the departments they intend to choose at the university were analyzed. The departments written by the students were coded as STEM careers and non-STEM careers using the detailed Table of STEM departments in the report prepared by Noonan (2017) and the STEM professions expressed in the report of the UK Commission for Employment and Skills (UKCES, 2015). The data of the students considering making a career in STEM fields were separated and analyzed within the scope of the research. The results obtained from the evaluation of the data are given as frequency and percentages.

## 3. Results

### 3.1. Educational status of female students' mothers

The information on the educational status of the mothers of the female students who participated in the study and who consider preferring STEM careers is given in Table 2.

Table 2. Educational status of the mothers of the female students who consider preferring STEM careers

Educational status	Frequency	Percentage
Not attended school	1	0.5
Literate	2	1.0
Primary School	26	12.4
Secondary School	40	19.0
High school	70	33.3
University	71	33.8
Total	210	100

Regarding Table 2, it is seen that the mothers of the majority (two-thirds) of the female students who consider choosing STEM careers were high school or university graduates. This shows that the education level of the mothers of female students who consider choosing STEM careers was high.

### *3.2. Educational status of female students' fathers*

The information on the educational status of the fathers of the female students who participated in the study and who consider preferring STEM careers is given in Table 3.

Table 3. Educational status of the fathers of the female students who consider preferring STEM careers

Educational status	Frequency	Percentage
Not attended school	0	0
Literate	1	0.5
Primary School	7	3.3
Secondary School	29	13.8
High school	59	28.1
University	114	54.3
Total	210	100

Regarding Table 3, it is seen that the fathers of more than half of the female students who consider choosing STEM careers were university graduates. The proportion of high school graduates is also high. This shows that the education level of the fathers of female students who consider choosing STEM careers was high.

### *3.3. Students' number of siblings*

The information on the number of siblings of the female students who participated in the study and who consider preferring STEM careers is given in Table 4.

Table 4. Number of siblings of the female students who consider preferring STEM careers

Number of siblings	Frequency	Percentage
None	11	5.2
Has one sibling	85	40.5
Has two siblings	77	36.7
Has three siblings	27	12.9
Has four siblings	6	2.9
Has five or more siblings	4	1.9
Total	210	100

Regarding Table 4, it is seen that more than three-fourths of the female students who consider choosing STEM careers had at most two siblings. This shows that the number of siblings, and therefore the number of people in the household of female students who consider choosing STEM careers was low.

### *3.4. Students' monthly household income*

The information on monthly household income of the female students who participated in the study and who consider preferring STEM careers is given in Table 5.

Table 5. Monthly household income of the female students who consider preferring STEM careers

Monthly Household Income	Frequency	Percentage
Less than 2000 TL	39	18.6
2001-4000 TL	91	43.3
More than 4000 TL	80	38.1
Total	210	100

Regarding Table 5, it is seen that the monthly household income of a few female students who consider choosing STEM careers was low. The monthly household income of the remaining students was moderate or high. This shows that the monthly household income of female students who consider choosing STEM careers was moderate or high.

### *3.5. Students' favorite course at school*

The information on the favorite course of the female students who participated in the study and who consider preferring STEM careers is given in Table 6.

Table 6. The favorite course of the female students who consider preferring STEM careers

Favorite course	Frequency	Percentage
Mathematics	81	38.6
Biology	45	21.4
Foreign language	22	10.5
Sport, music, paint	17	8.1
Chemistry	15	7.1
Physics	13	6.2
Literature	4	1.9
Geography	4	1.9
History	3	1.4
None	3	1.4
Religion	2	1.0
Science	1	0.5

Total	210	100
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Regarding Table 5, it is seen that the favorite course of most female students who consider choosing STEM careers was mathematics. It was also found that the favorite course of most female students who consider choosing STEM careers was directly associated to STEM areas. Female students who consider choosing STEM careers do not like courses which are not directly related to STEM areas such as literature, foreign language and history. This fact is interpreted as the students who love the courses that are directly related to STEM fields consider preferring STEM careers more.

### 3.6. STEM careers that students consider choosing

The information on the STEM careers on which female students who participated in the study and who consider preferring STEM careers would like to pursue is given in Table 7.

Table 7. STEM careers that female students consider choosing

STEM carrier areas	Frequency	Percentage
Medicine	136	64.8
Architecture	24	11.4
Engineering	21	10.0
Dentistry	16	7.6
Nursing	3	1.4
Biology	2	1.0
Pharmacy	2	1.0
Physics	2	1.0
Mathematics	2	1.0
Veterinary medicine	2	1.0
Total	210	100

Regarding Table 7, it is seen that more than half of the female students who consider choosing STEM careers wanted to pursue a career in medicine. Most of the remaining students preferred a career in architecture or engineering.

## 4. Discussion, conclusion and suggestions

In this study, the profiles of secondary school female students who consider choosing STEM careers were analyzed. The study involved with various socio-demographic variables and the profiles of female students considering STEM careers were evaluated within this framework.



In the study, it was found that the mothers of most female students who consider preferring STEM careers were high school or university graduates. In addition, it was seen that the fathers of more than half of the students were university graduates. This fact shows that the education level of the parents of female students who consider choosing STEM careers was high. The fact that the parents' educational proficiency is related to their children's high scores in mathematics and science, also support this finding (STEMJAM, n.d.). In another study, it was found that high school students' STEM attitudes were affected by their fathers having a postgraduate degree (Ozkurt Sivrikaya, 2019). In a study, it was concluded that primary and secondary school students' interest towards professors and architecture increased as the education level of their mothers increased. In the same study, it was found that the interest of the students, whose fathers have a university degree, towards the professions such as professors, doctors, meteorologists, chemists, mathematicians, biologists and architects were significantly high (Altay Kose & Yangin, 2015). In a study conducted with university students, it was found that the proportion of medicine students, whose mothers were high school or university graduates, was significantly higher than those of the education faculty students whose mothers was high school or university graduates. In the same study, it was also found that approximately half of the mothers of the students studying at the medicine were high school or university graduates. Similar results were observed in terms of father's educational status (Bahar, 2002). These results observed in the medical faculty, which is a STEM career, support the research findings. In another study, a research was conducted with university students studying in different departments. In the research, it was found that the parents of approximately half of the students in the fields of medicine, dentistry, pharmacy and engineering were secondary education or university graduates (Ekinci, 2011). In the research it was found that the number of siblings, and therefore the number of people in the household of female students who consider choosing STEM careers was low. In a study conducted by Bahar (2002), it was reported that students of medical faculty, which is one of the STEM careers, generally had a small number of siblings.

In the study, it was observed that the monthly household income of few female students who consider choosing STEM careers was low. This shows that monthly household income of female students considering choosing STEM careers was moderate or high. The fact that high socio-economic status for both male and female students is associated with high scores in mathematics and science supports this finding (STEMJAM, n.d.). In the study conducted by Sarikaya and Khorshid (2009), it was found that students who had less income than their expenses chose a profession based on verbal scores. Since most of the professions based on the verbal scores are non-STEM careers, this result supports the research findings. Bahar (2002), in his study, also found that the average monthly household income of the students in the medical faculty, which is a STEM career, was moderate or high. In a study conducted by Wang (2013), it was found that the socio-economic status of high school graduates who entered into STEM careers were mostly moderate or high. In a study conducted with university students, it was found that the average annual household income of students studying in pharmacy,

medicine, dentistry and engineering was higher than those of studying in education, social sciences and language (Ekinci, 2011).

In the research, it was found that the favorite course of most female students who consider choosing STEM careers was mathematics. It was also found that the favorite course of most female students who consider choosing STEM careers was directly associated to STEM areas. This fact is interpreted as the students who love the courses that are directly related to STEM fields consider preferring STEM careers more. A similar result can be seen in Wang's (2013) study, where it was found that high school graduates' exposure to mathematics and science courses were effective in their entry into STEM careers.

It is seen that more than half of the female students who consider choosing STEM careers wanted to pursue a career in medicine. Most of the remaining students preferred a career in architecture or engineering. A similar result was revealed in a study conducted by Korkut Owen, Kelecioglu and Owen (2014), where it was found that the proportion of female students in health and social services was quite high. In a study examining the scientific career interests of primary and secondary school students, it was found that female students were more interested in occupations such as doctors, veterinarians, pharmacists and dentists (Altay Kose & Yangin, 2015).

This study revealed the profiles of female students considering STEM careers. According to the result of the research, the profile of female students who consider preferring STEM careers can be set as; parents having high education level, low number of siblings, moderate or high monthly household income, liking the courses directly related to STEM fields, and preferring a career in medicine. In short, socio-demographic variables that affect STEM career preferences of female students were determined. However, the effect of different variables on the causes of choosing STEM careers was not examined. Within this framework, different variables that affect STEM career preferences of female students can be examined in future studies. Socio-demographic variables that were determined to be effective on the STEM career preferences of female students in this study could provide access to disadvantaged female students in future researches and thus, to plan activities to raise awareness among students. In the study it was found that female students who want to choose STEM careers mostly prefer to pursue a career in medicine. Future studies may investigate the reasons for this. Researches can be conducted on STEM career preferences of female students, social variables that affect these preferences and social gender.

## Note

This study was presented as an oral paper at the International Conference on Science, Mathematics, Entrepreneurship and Technology Education and its abstract was published.

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