ORIGINAL ARTICLE

High School Students that Consider Choosing Science, Technology, Engineering, and Mathematics (STEM) Fields for their University Education#

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ABSTRACT

The purposes of this study were to determine whether the departments that high school students consider choosing for their university education belong to science, technology, engineering, and mathematics (STEM) fields or not and to reveal the relationship between their choice and gender, grade, and type of institution. The research was conducted during the second semester of 2016–2017 academic year with 2129 students from five public schools located in the Kocasinan and Melikgazi districts of the Kayseri Province in Turkey. Data were collected through a survey instrument requesting students' demographic information and the departments that they selected for university education. Afterward, the departments mentioned by the students were coded as STEM-related and STEM-unrelated departments. Data analysis was conducted using SPSS 22.0 Statistic Software and frequencies, percentages, and Chi-square analysis were employed. Significant relationships were found between grade, gender, type of institution, and considering STEM-related department for university education. As a result, this study recommends that informative and stimulating activities involving STEM departments of universities should be organized for senior high school students to promote STEM fields.

KEY WORDS: science, technology, engineering, and mathematics fields; gender; university preference; high school students; profession selection

INTRODUCTION

Nowadays, professionals who specialize in science, technology, engineering, and mathematics (STEM) fields are seen as one of the most important factors for a country's innovation and economic development (Carnevale et al., 2018; PwC Turkey and TUSIAD, 2017). The individuals who are able to keep pace with the progresses and changes of today's digital era, which is very rich in terms of information and technology, are expected to be STEM employees who possess the 21st century skills. These skills are namely innovation, creativity, communication, problem solving, and critical thinking (Beers, 2018; NCREL and Metiri Group, 2003; P21, 2016; World Economic Forum, 2015).

Many occupations are likely to emerge or are even expected for the future. Research has noted what constitutes STEM field professions such as programming and software development, nuclear engineering, aerospace engineering, digital archaeologist, brain signal decoding, augmented reality architecture, financial technology expertise, wind turbine service technician, robot consulting, synthetic life engineering, cyber city analyst, and digital tailoring (Bakhshi et al., 2017; Frey, 2011; Hejazi, 2011; Pring et al., 2017; Talwar and Hancock, 2010; UKCES, 2014; U.S. Bureau of Labor Statistics, 2018; Wagner, 2011). Therefore, we would argue that many of the professionals who will be working in future occupations would be composed mostly of STEM field related professionals. However, in Turkey, the workforce involved in STEM fields and the number of students who prefer these fields is insufficient.

In Turkey, the employment in STEM fields and the number of students who prefer these fields is quite low. The review of the occupational distribution of STEM fields in Turkey reveals that the employment in professions such as physics, mathematics, engineering, and software development is quite low (Ercan, 2011; ISKUR, 2017a; 2017b). These results are similar for the students who are enrolled in the university for these subjects. An analysis of new students to higher education shows that the number of students who are registered in the science, mathematics, statistics, information and communication technologies, and engineering departments is quite low (OECD, 2017; YOK, 2017). Moreover, the attendance to these fields is also low in terms of the number of current students (YOK, 2017). To promote students' engagement toward STEM

fields and to increase the employment in STEM areas, further studies that provide guidance to potential activities are needed.

A review of studies conducted in Turkey indicates that there are some studies which have investigated the factors affecting university students' preferences. There are studies involving particular departments such as medicine (Genc et al., 2007), teaching (Akbayir, 2002; Kaya et al., 2013; Ozsoy et al., 2010), nursing (Citak et al., 2010), health (Ciftci et al., 2011), economics and administrative sciences (Akar, 2012), or overall preferences (Demirci, 2017; Kars et al., 2014; Korkut et al., 2012; Sarikaya and Khorshid, 2009). Among these studies, the percentage of those focusing on higher education is low. There is a dearth of studies involving the university departments that high school students tend to choose.

Similarly, this is a body of related literature about STEM careers of Turkish students (Korkut and Mutlu, 2016; Korkut and Eraslan, 2018; Koyunlu et al., 2016; Yerdelen et al., 2016). However, there is a significant gap in terms of the research focusing on the preferences of high school students' toward STEM field for the university. This study is expected to make a move toward diminishing the existing gap. Accordingly, the purpose of this study was to determine the university departments that high school students consider choosing for their university education, identifying whether they belong to STEM field, and revealing the relationships between students' preferences and gender, grade, and type of institution.

METHODOLOGY

Research Design

This research was conducted using a cross-sectional descriptive research design, which is a non-experimental quantitative research design. This design is used to describe the status of the data within a relatively short time period (Johnson and Christensen, 2014). In this research, students' STEM field preferences were analyzed through the data obtained over a short time period; therefore, cross-sectional descriptive research design was employed.

Universe and Sample

In descriptive research, a sample is selected from the wider population. The characteristics of the sample are explored and inferences are made from the sample about the characteristics of the wider population (Johnson and Christensen, 2014). In this context, the population of the research was set as high schools students in public schools in the Kayseri Province of Turkey.

Research data were obtained from five public high schools located in the Kocasinan and Melikgazi districts of the Kayseri Province in Turkey, during the second semester of the 2016–2017 academic year. The required permissions had been granted from the Kayseri Provincial National Education Directorate and Office of the Kayseri Governor before starting data collection. After school principals were met and their consent was also obtained, data were collected from the students.

Based on the report published by the Kayseri Provincial National Education Directorate (2016), the number of students in public schools was found to be 71,221. The formula suggested by Cochran (1962 as cited in Balci, 2011) was used to determine the sample size required to represent this population. The minimum sample size for 95% confidence interval and at 0.05 tolerance level was found to be 382. This study's sample was 2129 high school students from five schools from the three institution types. Demographic characteristics of the students included in the research are given in Table 1.

Table 1 shows that 38.5% of the students were male and 61.5% were female. Most of the participants were studying at Anatolian High School. In addition, regarding the distribution of the students according to grade, the lowest participation was from 12th grade.

Data Collection Tool and Data Analysis

The gender, school, and grade information of the participating high school students were collected as demographic characteristic. In addition, students were asked to write the department that they were considering for university.

The departments that these participating students considered for their university education were coded as STEM related or STEM unrelated, according to Table 2. Noonan (2017) report compiled a standardized list of undergraduate departments for STEM-related fields of study. As such, Table 2 was used for the classification and coding of the departments that this study's participating students selected for their university education. SPSS 22 software was used for the analysis of this data. Frequencies, percentages, and Chi-square analysis were employed in data analysis.

FINDINGS

Departments that Students Consider to Choose for University Education and Preferences toward STEM Departments

The frequency and percentages of the departments that students considered for university education (from students'

Table 1: Demographic characteristics of the students included in the sample of the research

Demographic characteristics	Number of students (%)
Gender	
Male	819 (38.5)
Female	1310 (61.5)
Grade	
9	588 (27.6)
10	783 (36.8)
11	494 (23.2)
12	264 (12.4)
Institute type	
Anatolian High School	886 (41.6)
Imam Hatip High School	449 (21.1)
Vocational and Technical Anatolian High School	794 (37.3)
Overall	2129 (100)

Table 2: Undergraduate STEM departments (Noonan, 2017)

Computer departments	Mathematics departments	Engineering departments	Nature and life sciences departments
Computer science	Mathematics	Engineering	Nature sciences
Computer programming, etc.	Statistics, etc.	Engineering technologies, etc.	Astronomy
			Chemistry
			Ecology
			Zoology
			Geology
			Biology
			Botanic
			Physiology
			Physics, etc.

STEM: Science, technology, engineering, and mathematics

statements), including the classification of these departments as STEM related or STEM unrelated, are given (Table 3). For brevity, only the departments mentioned by 10 or more students are included in Table 3. This accounts for 93% of the participating students. For analysis purposes, all student responses were used.

According to Table 3, around 13% of the students preferred to study medicine at university. Approximately 9% of them declared that they want to study engineering for their university education. It was found that 6.6% of the students preferred law, 5.7% a police academy, and 5.4% were considering architecture.

The classification of the departments according to their relation with STEM fields is given in Table 4.

Table 4 indicates that the departments considered by 46.1% of 2129 participants were from STEM fields. On the other hand, the departments considered by 49.3% of them involved subjects outside of STEM fields. In addition, 3.1% of the students declared that they were reluctant to go to university, whereas 1.6% were indecisive about the department that they would choose for university education.

STEM Field Preferences of the Students According to Grade

The results of Chi-square test exploring whether the preference toward STEM-related departments differs according to grade are given in Table 5.

Table 5 shows that the percentage of the students who considered a department from STEM field for university education was 46.4% among the 9th grade students. This was 50.4% among the 10th grade students, 45.3% for the 11th grade students, and 33.7% for the 12th grade students. The difference in the consideration of STEM fields for university education according to the grade was found to be significant (χ^2 [sd = 9, n = 2129] = 37.86; $\rho < 0.05$). Accordingly, there is a significant relationship between the grade of high school students and which department they were considering for their university education.

Table 3: The departments that students consider to choose for university education

Departments	Frequency (%)	STEM related
Medicine	271 (12.7)	+
Engineering	189 (8.9)	+
Law	140 (6.6)	-
Police academy	121 (5.7)	-
Architecture	114 (5.4)	+
Physical education	99 (4.7)	-
Theology	92 (4.3)	-
Child development	80 (3.8)	-
Health fields	71 (3.3)	+
No university education	66 (3.1)	-
Preschool education	58 (2.7)	-
Psychology	50 (2.3)	-
PDR	48 (2.3)	-
Computer, data processing	46 (2.2)	+
Accounting	43 (2.0)	+
Teaching	38 (1.8)	-
Military	35 (1.6)	-
Language departments	34 (1.6)	-
Language teaching	34 (1.6)	-
Uncertain	33 (1.6)	-
Dentistry	29 (1.4)	+
Fine arts	28 (1.3)	-
Nursery	28 (1.3)	+
Business administration	27 (1.3)	+
Literature	26 (1.2)	-
Graphic	26 (1.2)	+
Public relations	22 (1.0)	-
Economy	19 (0.9)	+
History	17 (0.8)	
Aviation	16 (0.8)	+
English language and literature	15 (0.7)	-
Finance	15 (0.7)	+
Journalism, advertisement, press, radio-TV	14 (0.7)	-
Veterinary	13 (0.6)	+
Pharmaceutics	11 (0.5)	+
Arabic	10 (0.5)	-

STEM: Science, technology, engineering, and mathematics

STEM Field Preferences of the Students According to Gender

The results of Chi-square test exploring whether the preference toward STEM-related departments differs according to gender are given in Table 6.

Table 6 shows that the percentage of male students who considered a department from STEM field was 54.6%. This percentage was found to be 40.8% among their female counterparts. This difference in the consideration of STEM fields for university education between male and female students was found to be significant (χ^2 [sd = 3, n = 2129] = 57.16; $\rho < 0.05$). Accordingly, there is a significant relationship between the gender of high school students and which department they were considering for their university education.

STEM Field Preferences of the Students According to the Type of Institutions

The results of Chi-square exploring whether the preference of STEM-related departments differs according to the type of institution are given in Table 7.

Table 4: STEM-related field preference of high school students for university education

STEM-related field	STEM field	Not STEM field	None	Uncertain	Total
Total, n (%)	981 (46.1)	1049 (49.3)	66 (3.1)	33 (1.6)	2129 (100.0)

STEM: Science, technology, engineering, and mathematics

Table 7 shows that the percentage of the students who considered a department from STEM field for university education was 58.2% in Anatolian High Schools. This percentage was found to be 27.6% for Imam Hatip High School and 42.9% for the Vocational and Technical Anatolian High School. It was found that this difference in the consideration of STEM fields for university education according to the type of institution is significant (χ^2 [sd = 6, n = 2129] = 127.25; $\rho < 0.05$). Accordingly, there is a significant relationship between the type of the institution, to which high school students attend, and which department they were considering for their university education.

DISCUSSION AND SUGGESTIONS

As one of the results of this study, it was found that medicine was the most preferred profession among the participating 2129 high school students. Engineering, law, police, and then architecture followed in preference. Cakirer and Gonenc (2017) obtained similar results in a study conducted with senior high school students and found that most popular choices of their students were engineer, police, doctor, or lawyer, respectively. Similar results were reported by another study in which the departments that high school students considered the most were found to be engineering, production and construction (all engineering), and health and social services (medicine, nursery, dentistry, etc.) (Eraslan and Korkut, 2017). Similar results were also observed in a research which indicated that primary and secondary school students' major areas of interest were professions like medicine (Altay and Yangin, 2015).

Table 5: High school students' preference toward STEM-related field for university education according to grade

Grade level	STEM field	Not STEM field	None	Uncertain	Total
9, n (%)	273 (46.4)	280 (47.6)	25 (4.3)	10 (1.7)	588 (100.0)
10, n (%)	395 (50.4)	346 (44.2)	28 (3.6)	14 (1.8)	783 (100.0)
11, n (%)	224 (45.3)	254 (51.4)	10 (2.0)	6 (1.2)	494 (100.0)
12, n (%)	89 (33.7)	169 (64.0)	3 (1.1)	3 (1.1)	264 (100.0)
Total, n (%)	981 (46.1)	1049 (49.3)	66 (3.1)	33 (1.6)	2129 (100.0)

χ^2=37.86, sd=9, ρ=0.000. STEM: Science, technology, engineering, and mathematics

Table 6: High school students' preference toward STEM-related field for university education according to gender

Gender	STEM field	Not STEM field	None	Uncertain	Total
Male, n (%)	447 (54.6)	321 (39.2)	31 (3.8)	20 (2.4)	819 (100.0)
Female, n (%)	534 (40.8)	728 (55.6)	35 (2.7)	13 (1.0)	1310 (100.0)
Total, n (%)	981 (46.1)	1049 (49.3)	66 (3.1)	33 (1.6)	2129 (100.0)

χ^2=57.16, sd=3, ρ=0.000. STEM: Science, technology, engineering, and mathematics

Table 7: High school students' preference toward STEM-related field for university education according to the type of institution

Type of institution	STEM field	Not STEM field	None	Uncertain	Total
Anatolian High School, n (%)	516 (58.2)	333 (37.6)	21 (2.4)	16 (1.8)	886 (100.0)
Imam Hatip High School, n (%)	124 (27.6)	307 (68.4)	12 (2.7)	6 (1.3)	449 (100.0)
Vocational and Technical Anatolian High School, n (%)	341 (42.9)	409 (51.5)	33 (4.2)	11 (1.4)	794 (100.0)
Total, n (%)	981 (46.1)	1,049 (49.3)	66 (3.1)	33 (1.6)	2129 (100.0)

χ^2=127.25, sd=6, ρ=0.000. STEM: Science, technology, engineering, and mathematics

This study indicated that the percentages of the students who considered STEM fields and non-STEM fields were similar. In addition, a small percentage of these students did not plan to attend university as well as a similar number were not certain about the discipline that they would choose. In a study conducted by Psychometric Research and Application Center of Hacettepe University (n.d.), it was found that a small amount of senior high school students did not have a clear idea about their university preference. Similarly, Hamamci et al. (2013) reported that a small portion of high school students was indecisive about profession selection.

As this study showed, the lowest percentage of students who considered STEM fields was among the 12th grade students. It was found that relationship between the grade of the students and department they were considering for their university education was significant. In a study conducted by Eraslan and Korkut (2017), a significant difference was identified in the high school students' preference of engineering, production, and construction fields according to grade. Altay and Yangin (2015) also reported that primary and secondary school students' interest toward certain professions such as doctor, architect, or veterinary differed according to the grade.

The effect of gender on the department that students considered to choose for university education was also explored in this study. Accordingly, 54.6% of male students considered a department from STEM field, whereas this ratio was found to be 40.8% among female students. This difference among genders was significant. A significant relationship was identified between the genders of high school students and considering a department from STEM field for university education. In the study conducted by Eraslan and Korkut (2017), it was found that two-third of the males and one-third of the females chose to study engineering. Similar results to the findings of this research were also observed in the results of the university placement examination. Regarding the period between 2002 and 2012, the ratio of male students who were placed in engineering, production, and construction fields was always higher than female students (Korkut et al., 2014). In addition, Zor (2006) reported in his thesis that male students in higher education were more interested in the professions related to science, mathematics, and electric-electronic-computer engineering. In a study conducted by Yelken (2008), it was found that engineering was preferred the most among male high school students. In another study conducted with high school students, it was revealed that regarding professional plans, males were more interested in engineering topics (Sadler et al., 2012). The thesis of Bolds (2017) contained similar results, which indicated that male students chose STEM fields in the university more than females did. Another study reported that among the students of primary and secondary school, the interest of male students toward the profession such as computer technician, piloting, and civil engineering was higher (Altay and Yangin, 2015).

According to the results, the percentage of those who considered a department from STEM field for the university was higher in Anatolian High Schools, compared to the other types of institutions. The difference between the types of institutions was found to be significant. A significant relationship was identified between the type of institutions, to which high school students attended, and considering a department from STEM field for university education. Zor (2006) reported in his thesis that the professional groups that mostly attracted the students of Anatolian High Schools were mathematics and electric-electronic-computer engineering.

Overall, in this research, a significant relationship was found between grade, gender, type of institution, and considering STEM-related department for university among the students of high school. According to the research outcomes, senior high school students' ratio of considering STEM field for the university was found to be lower than other grades. In this regard, informative and stimulating activities involving STEM departments of the universities can be organized for senior high school students to promote these fields. The research indicated that female students' ratio of considering STEM field for the university was lower than males. In literature, the probable reasons of this are set as the gender perception of the society and the professions that are perceived to be appropriate for the genders. According to the prevailing gender and profession perception in the society, the occupations such as scientist, engineer, and architect are perceived as more appropriate for men (Vatandas, 2007). In this framework, it may be useful to organize activities for changing gender and profession perception of high school students. Introducing students to women from STEM professions may be beneficial in terms of providing a role model.

The purpose of this study was to determine whether the departments that high school students considered choosing for their university education belonged to STEM fields or not. Some suggestions have been made in this direction. However, the aim of the study was not to target all students to STEM areas. The research provided suggestions for students interested in STEM fields.

Undoubtedly, it is important for the future of the country that not all individuals are directed to STEM fields, but those who are interested in these areas are directed to STEM fields.

Only three institution types were covered in the study, which may be stated as a limitation of the research. The schools and students from other institution types were not included due to low number of students. Hence, more generalizable results can be obtained by including more schools and students from various institution types to future studies.

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