DETERMINANTS OF HIGH ACHIEVING STUDENTS' CAREER CHOICES IN STEM FIELDS

by

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ABSTRACT

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One of the most important educational improvements of the 21st century has occurred in the Science, Technology, Engineering and Mathematics (STEM) fields (Bybee, 2010). STEM means the integration of disciplines into the real life experiences (Labov *et al.*, 2010; Sanders, 2009). Motivated by the need to meet the deficit in the STEM workforce, experts has worked on improving the STEM education (TUSIAD, 2014) Particularly along with the increasing number of university students who choose STEM fields, an urge to improve the quality of the education in such fields has arisen. That's why, it is firstly essential to understand which factors play a role in the choices of students, who get high scores in the University Entrance Exam to pursue a career in such fields.

To this end, the main purpose of the present study was to investigate the factors affecting high-achieving students' career choices in STEM fields. In the literature, factors are classified into five different categories: STEM self-efficacy, gender, parental variables, career selection, and high school STEM score. The study examined the reasons behind the choices of students in a certain state university, which requires relatively higher University Entrance Exam scores. Participants consisted of 314 preparatory students who would study either in a STEM or in a Non-STEM field. A 26-item questionnaire including both open-ended (N=12) and likert-type (N=14) questions were used to in the study. The resutls revealed that there were no significant differences between STEM and Non-STEM students regarding their gender and high school STEM scores. Students who chose STEM departments as a major were found to have significantly higher STEM self-efficacy scores and parents with higher interest in STEM than students choosing Non-STEM fields. This might be because the university where the questionnaire was applied is one of the high-ranking universities accepting only students who get high points in the University Entry Exam.

ÖZET

YÜKSEK BAŞARILI ÖĞRENCİLERİN FeTeMM ALANLARINDAKİ KARİYER TERCİHLERİNİ BELİRLEYEN FAKTÖRLER

FeTeMM (Fen, Teknoloj, Mühendislik ve Matematik, *İng. STEM*) 21. yüzyılın eğitim alanında en önemli gelişmelerinden biridir (Bybee, 2010). FeTeMM sadece fen, teknoloj, mühendislik ve matematiğin kısaltması değil aynı zamanda bu alanların bütünleştirilerek gerçek hayat tecrübelerinde kullanılması anlamına gelmektedir. (Labov *ve ark.*, 2010; Sanders, 2009). FeTeMM alanlarında olan iş gücü ihtiyacının karşılanması için Türkiye'deki uzmanlar FeTeMM eğitimini geliştirmek için çalışmalar yapmaktadır. (TUSIAD, 2014). Bu işgücü ihtiyacını ortadan kaldırmak için FeTeMM alanlarını seçen öğrencilerin sayısının artması amaçlanmaktadır. Bunun yanı sıra, FeTeMM alanlarını seçen üniversite öğrencilerinin niteliklerinin artması da önem taşımaktadır. Bu bağlamda, Üniversite Giriş Sınavı'nda yüksek puan alan öğrencilerin FeTeMM kariyerlerini seçmesini etkileyen etmenleri bilmek önemlidir.

Bu çalışmada, 5 kategoride farklı etmenler incelenmiştir: FeTeMM özyeterlik, cinsiyet, ailesel değişkenler, kariyer seçimi, lise FeTeMM notları. Bu bağlamda, üniversite giriş sınavından yüksek puan almayı gerektiren bir üniversitede FeTeMM veya FeTeMM-dışı alanlarda okumakta olan öğrencilerintercihlerini etkileyen etmenler araştırılmıştır. Bu üniversitede 16 farklı STEM bölümü ve 16 farklı STEM-dışı bölüm vardır. Araştırma kapsamında hazırlık sınıfında okuyan öğrencilere ulaşılmış ve 314 kişi gönüllülük esasına göre çalışmaya katılmışlardır. Araştırmada kullanılan ankette, FeTeMM bölümlerinin seçilmesini etkileyen etmenleri değerlendiren 12 açık uçlu ve 14 likert olmak üzere toplam 26 farklı soru sorulmuştur. Elde edilen sonuçlara göre, FeTeMM ve FeTeMM-dışı bölümleri seçen öğrenciler arasında cinsiyet ve lise FeTeMM notları arasında bir fark olmadığı görülmüştür. Ancak, FeTeMM bölümlerini seçen öğrenciler, FeTeMM dışı bölümleri seçen öğrencilere göre daha yüksek FeTeMM özyeterliğe ve FeTeMM konularına daha fazla ilgili olan ailelere sahip olduğu bulunmuştur.

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LIST OF SYMBOLS

M	Mean
Md	Median
N	Number
SD	Standard Deviation

LIST OF ACRONYMS/ABBREVIATIONS

STEM	Science, Technology, Engineering, Mathematics
FeTeMM	Fen, Teknoloji, Mühendislik ve Matematik
MEB	Milli Eğitim Bakanlığı / Ministry of National Education
TUSIAD	Türk Sanayicileri ve İş İnsanları Derneği
NSF	National Science Foundation
NGSS	The Next Generation Science Standards
PISA	Programme for International Students Assessment
OECD	The organisation for Economic Co-operation and Development

1. INTRODUCTION

Critical thinking, problem solving, communication and collaboration, creativity and innovation, information literacy, and Information and Communication Technologies (ICT) literacy are among the most crucial 21^{st} century skills (Framework for 21^{st} Century Learnings, 2007). In today's world, students are expected to improve themselves in science, technology, engineering and mathematics to adopt these skills for solving the complexity of life and trying to make it easier. The abbreviation STEM stands for Science, Technology, Engineering and Mathematics but it also means integrating these disciplines into real-life experiences (Labov *et al.*, 2010; Sanders, 2009).

However, in recent years, a big gap between existing workforce in STEM fields and the actual need in these areas has emerged (National Science Board, 2004; National Science Foundation, 2013). In order to close this gap, governments have invested millions of dollars to the field of STEM (Obama, 2013). It is seen that students do not choose STEM fields as a major. Two main reasons behind the increasing amount of money spent on STEM education are specifically stated as follows:

- To prepare not only males and but also females to be qualified in the STEM-related fields,
- To inspire all students to study in STEM fields (Holdren *et al.*, 2010).

In Turkish setting, newspapers and research done by Turkish Industry and Business Association, TUSIAD (Turkish, *Türk Sanayicileri ve İş İnsanları Derneği*) have indicated a huge gap in STEM majors in that context. Also, technical reports have validated that situation. For instance, TUSIAD (2014) documented that the number of people who graduated from STEM fields was not neccessary to meet the lack of workforce in these areas. In addition to this, graduates of STEM-related fields preferred other areas in their working life (TUSIAD, 2014).

According to Zhang (2011), the initial thing to do is to understand the factors affecting students in choosing or not choosing STEM majors before trying to solve the problems in producing strong manpower in these fields and strengthening economy. Therefore, the aim of present study was to investigate factors affecting students' preferences for choosing or not choosing STEM fields. Students in this study all took high scores in the University Entrance Exam. Therefore, they can be regarded as high achieving students. When the scores that the students got in the University Entrance Exam are considered, it is apparent that they were able to choose either STEM or Non-STEM majors as a career choice. Besides, their scores were adequate for choosing most of the departments in STEM and Non-STEM areas. Therefore, the investigation of other reasons why they chose STEM or Non-STEM departments could provide valuable insights into the factors affecting their choices. In light of previous studies, the present study specifically investigated the differences in STEM-self-efficacy, gender, parental involvement and interest in STEM, parents' educational level, students' high school STEM scores and their choice of STEM field.

2. REVIEW OF LITERATURE

This chapter presents a brief review of the literature. It begins with previous studies on the definitions of STEM and STEM education. Then, it includes research the factors affecting students' choice of STEM as a major. Such factors having an impact on the career choices of students are investigated under five sections as follows: STEM self-efficacy, gender, parental variables, which are parental involvement, parental STEM occupation and parents' educational level, career selection and achievement.

2.1. Science, Technology, Engineering, and Mathematics (STEM)

STEM, which is the abbreviation for Science, Technology, Engineering and Mathematics, is a kind of educational movement. In history, even if there were these kinds of movements in mathematics and science, STEM was labeled as one of the most important improvements of the 21st century (Bybee, 2010). Indeed, it was originally SMET; however, due to the difficulties in its pronunciation, it was later renamed and SMET was changed into STEM. Initially, SMET was talked by the U.S. National Science Foundation (NSF) (Holmegaard *et al.*, 2014; Perna *et al.*, 2009).

Although STEM is one of the most important educational reformations of the 21st century, people do not know the meaning of it properly. Most people think that STEM is only related to mathematics and science. In fact, it is not only related to science and mathematics but also related to engineering and technology. The main goal of STEM is referred to as integrating the disciplines, which are science, technology, engineering and mathematics, by using one title, as an acronym. However, it is far from being just a title. It is the integration of science, technology, engineering and mathematics into the real-life situations (Bybee, 2010). For example, Breiner, Harkness, Johnson, and Koehler (2012) stated that in the U.S., 72.5% of the faculty members defined STEM as the integration of science, technology, engineering and mathematics. Important to mention, within this percent, there were faculty members of both STEM and Non-STEM departments. It was found that faculty members in the STEM disciplines had neutral or positive attitudes towards the STEM education; while Non-STEM faculty members had negative attitudes (Breiner *et al.*, 2012). This result showed that faculty members knew the meaning of STEM, but they did not have positive attitudes towards it. In addition to the meaning of STEM as the integration of Science, Technology, Engineering and Mathematics, it also means integrating disciplines into real life experiences (Labov *et al.*, 2010; Sanders, 2009). For example, engineers are required to know all science, mathematics and technology very well to design or produce machines, tools, goods and etc. (Bennett and O'Neale, 1998).

In recent years, a scarcity in the number of workers in science, technology, engineering and mathematics fields has appeared (National Science Board, 2004; National Science Foundation, 2013). The main reason of that could be the inadequate numbers of students choosing these areas to study in higher education. Along with the changing world, that deficit in the workforce has even increased. In the 21st century, there has been an urgent need in productive workers endowed with multifaceted skills, and analytic thinking. If a country aims to be among the world leaders in economy, it should have productive, well-trained workers for future (National Science Board, 2004; National Science Foundation, 2013). For example, Skillen (2016) highlighted a change towards mathematics and technology in today's world. Therefore, STEM is essential to keep pace with this changing world. To produce manpower, societies need to constantly focus on innovation. Cataldo (2014) indicated that people could access all resources of the information through the Internet along with the third industrial revolution, which brought computer and automation into today's world. That's why; a current K-12 curriculum in a country needs to be reformed to train students with high-tech problem solving and ICT skills (Cataldo, 2014). Even now, the world is witnessing the fourth industrial revolution, which is characterized by a cyber physical system (Jazdi, 2014). Aforementioned 21^{st} century skills, namely critical thinking, problem solving, communication and collaboration, creativity and innovation, information literacy, and ICT literacy play a key role in adopting this new cyber physical system age (Framework for 21st Century Learnings, 2007; Jazdi, 2014). Therefore, students are expected to improve themselves in science, technology, engineering and mathematics (i.e., STEM fields) to adopt these skills for solving the complexity of life and trying to make it easier. Along with the increase in workforce requirements, an urgent need for qualified scientists, technologists, engineers, and mathematicians has appeared as a current concern. As might be expected, training qualified scientists, technologists, engineers, and mathematicians could only be done through education. Further, noticing and emphasizing the relationship among the fields of science, technology, engineering and mathematics is very likely to yield an increase in the workforce, which is urgently needed by societies. Therefore, STEM is regarded as one of the most crucial elements for countries such as U.S., Japan, South Korea, Germany and China to maintain and improve their economic and technological conditions (STEM Akademi, 2014). In the case of Turkey, some steps taken for improving STEM education can be mentioned. For example, there is a STEM centerconstructed by Aydın University (Akgündüz *et al.*, 2015). In addition, there is a STEM laboratory in Hacettepe University (H-STEM, 2014). As for other addressed countries, the United States considers STEM education a tool to solve the manpower requirements. Therefore, the U.S. spends nearly $1 billion per year for STEM education. The reason behind this increasing amount of money spent on STEM education is two-fold. The first one is to prepare not only males but also females to be qualified in the STEM-related fields. The second one is to inspire all students to study in STEM subjects such as physics, chemistry, mathematics, and etc. (Holdren *et al.*, 2010).

In addition, National Research Council (2011) reported that STEM education focused on three purposes. Specifically,

- to encourage students to choose a career life in the fields of STEM,
- to produce workforce in the areas of science, technology, engineering and mathematics,
- to develop STEM literacy.

Although thepurposes of STEM education seem to vary, indeed the expectations of it are quite similar. To make prompting improvements in STEM education could be one of the ways in achieving these goals. Actually, countries experience common problems such as the need for strengthening economy, increasing qualification in manpower, and improving technology. It is clearly seen that to adopt STEM education in K-12 may help to solve these problems, and so countries can more easily keep up with the fourth industrial revolution (Framework for 21st Century Learnings, 2007; Jazdi, 2014; Holdren *et al.,* 2010).

2.2. STEM Education

Assefa and Rorissa (2013) argued that STEM was used not only in career development literature but also in the field of education. Indeed, when STEM is adopted in K-12 curriculum, it refers to STEM Education. Czerniak and Johnson (2007) stated that STEM education is not the sole collection of science, technology, engineering and mathematics butit is a kind of interdisciplinary reform. That is, it combines science and mathematics with mathematical thinking, scientific inquiry, engineering design and technological investments in curriculum.

Shanahan, Carol-Ann Burke, and Francis (2016) asserted that science and mathematics dominated the STEM education while technology and engineering parts of STEM remained neglected aspects in the STEM education. As a consequence of that situation, some researchers tend to emphasize only the real life application of STEM rather than its integrative effects. Along with different opinions about STEM, it has been realized that the idea of STEM and its application into practice have just fallen apart. Approaches towards STEM could be different according to societies, that is it could be formed in education with respect to societies' needs. Therefore, the integration of STEM into curriculum could change based on these needs. For example, in the curriculum of Canada, it is possible to see that STEM, gathers different concepts, areas and groups in the same basket sinceSTEM takes its power from collaboration in that context. Shanahan, *et al.* (2016) pointed to the possibility of seeing the integration meaning of STEM in the Canada curriculum. Therefore, people from different areas could come together and develop new approaches to reach objectives in curriculum. In Turkey, new curriculum, which will be applied in the first semester in 2018, was prepared based on STEM education. Engineering and desing skills were also added to the objectives of the secondary school education. In addition, science and engineering applications gained considerable importance within the scope of this new curriculum. Furthermore, the importance of technological skills in mathematics was increased (Milli Eğitim Bakanlığı [MEB], 2018). The Next Generation Science Standards (NGSS) published in 2013 was also important in STEM education. It was constructed with three dimensions, which were crosscutting, practices and core ideas. Each dimension works collaboratively and covers the science content standards. For example, the dimension of practices consists of Science and Engineering Practices (Next Generation Science Standards, 2018). However, because of the difficulties in the applicability of the curriculum and the need for extra financial power, it hasnot been applied by most of the states (Akgündüz *et al.* 2015).

In the U.S., STEM fields are much more attractive for foreign students who come the U.S with study abroad programs. Although the U.S. tries to engage their own students to choose STEM programs at undergraduate or graduate levels, the majority of these programs consist of students coming from different countries around the world (Komura, 2013). 70 % of the foreign students continue their education in STEM fields at graduate and undergraduate level in the U.S. (Institute of International Education, 2008, as cited in Komura, 2013, p.4). It showed that a great number of students, who come from abroad to study in the U.S., choose STEM as a major field for their future career. The reason behindthis large amount of international students choosing STEM programs could be "the flexibility they offer in learning styles, depth of research experiences and quality of faculty" (Altbach *et al.*, 2005; Odin and Manicas, 2004). This scenario in the U.S. could be understood by investigating the reasons of foreign students choosing STEM. Further, to close the gap in workforce in STEM areas for other students, it is necessary to detect why students do not choose STEM fields to study as a career to pursue in the future. Therefore, much more research should be done about this situation first to get a better understanding of the issue, and then to close this huge gap.

In Turkey, it was expected that manufacturing and heavy industry companies, which have more than 150 workers, would need STEM major graduates. This was also underlined by senior executives of companies that work in the STEM field. At the same time, investments in Research and Development (R&D) triggered the need for STEM major graduates. Human Resources Directors state that 19% of workers in companies include STEM major graduates. A research conducted with 408 STEM major graduates showed that only half of them are working in STEM fields. Even if the number of STEM major graduates iss insufficient, they are still working out of the STEM field (TUSIAD, 2014). When it is examined the literature, it is seen that there are relatively higher integration of STEM studies and STEM education at schools. However, in Turkey, it iss not common yet (Gulhan and Şahin, 2016). TUSIAD arranged a meeting, which is called "STEM Summit" in 2014. The aim of that meeting was to increase the awareness of STEM and STEM workforce. At the end of the meeting, the importance of STEM education in strengthening economy and raising the quality of life was emphasized (Sarac, 2018). As such, workforce in STEM fields has been found in an important position to get the better of global competitiveness and to provide consistency in economy. To this end, Zhang (2011) argued that to know the factors affecting the choices of STEM majors could allow to understand the problems in producing strong manpower in these fields, and it allows to strengthening economy by solving such problems.

Johnson (2014) stated that STEM education is not a short-term reform. It is a kind of challenge in which millions of dollars have been invested. If people in different areas come together to work on STEM education, the sustainability of it could be better ensured. To make a strong continuity plan, people in the education and business fields should spare lots of time to develop STEM education. Otherwise, it may turn into one of the short-term projects (Johnson, 2014). Therefore, there is a need to focus on two aims of STEM education as mentioned before. One of them is to prepare all students including boys and girls to be qualified in the fields that are STEM-related. The second one is to inspire all students to study in STEM subjects (Holdren *et al.*, 2010). Actually, when these two purposes are combined, it addresses two important points, the quality of the people who choose to follow a STEM career along with the number of people who choose STEM career. For example, in Turkey, between 2000-2014, students who choose science and mathematics as an area, were in the first thousand ranks in the University Entrance Exam when analyzed. It was found that the number of students who chose STEM departments decreased within those years. In 2000, there were 85.63% of students who chose STEM departments. This ratio was 27.88% in 2012, and 38.23% in 2014 (Akgündüz *et al.*, 2015). Therefore, in order to reach the goals that Holdren *et al.* (2010)

stated, factorsaffecting people to choose STEM fields should be investigated. In this research, factors were examined under five different categories; STEM self-efficacy, gender, parental variables, career selection and achievement based on the literature.

2.2.1. STEM Self-efficacy

Self-efficacy is a kind of belief about to be able to achieve something in specific situations (Bandura, 1986). The importance of the variable self-efficacy for the achievement comes from the positive effects of students' motivation and learning (van Dinther *et al.*, 2010). For example, to achieve mathematics, self-efficacy plays major role. Bandura's (1986) claim is that academic results could be shaped by self-efficacy beliefs. Ayotola and Adedeji's study (2009) supported Bandura's claim for mathematics.

In his study, Bandura (1977) defined self-efficacy depending on four sources, which are mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states. Mastery experiences are the major one that affects a person's self-efficacy. It was shaped by experiences and performances. Vicarious experiences develop by observing others. When people observe other people's performance on a task, how they overcome the difficulties or what reactions they exhibit on different situations, self-efficacy beliefs develop spontaneously. Verbal persuasions depend on constructive feedbacks. When other people encourage one or engage one for a task, positive self-efficacy beliefs come into existence. Mental states, emotions and physical abilities that affect people's self-efficacy are in the source of physical and emotional states (Bandura, 1977).

In a similar vein, the results of Lusby's (2012) study showed that self-efficacy is a factor to increase students' achievement. Therefore, Lusby (2012) stated that for every classroom and level, to improve students' positive self-efficacy will help future academic career of students. Therefore, there can be a relation between self-efficacy and the choice of STEM fields. However, there are only a few studies about detecting the relation between self-efficacy and STEM choices as a career (Moakler and Kim, 2014). For example, Concannon and Barrow (2009) asserted that self-efficacy is one of the main factors for academic achievement and career choices of students. People choose their career according to some reasons. One of the reasons is to believe completing the responsibilities of that career. This is called self-efficacy beliefs. In two subsequent studies, a strong positive relationship between self-efficacy and selecting engineering as a career was found (Lent *et al.*, 2005, 2007 as cited by Concannon and Barrow, 2009, p. 164). That's why, it is argued to be important to investigate the relationship between self-efficacy and approaches towards STEM courses, STEM activities and STEM career in different school levels.

Furthermore, Britner and Pajares (2006) investigated 319 middle school students who were higher science achievement than otherstudents at that school. Data was analyzed quantitatively, and the results revealed that there was a relationship between science self-efficacy and achievement in science. Students, who had more science self-efficacy, were found to be more volunteer to attend high-level science courses and to make extra science activities.

Regarding the relationship between self-efficacy and STEM choices, Brown, *et al.* (2016) also conducted a study with 206 (91 males, 115 females) suburban middle school students. The participants took an earth science course at the sixth-grade level during the research. There were multiple project-based learning activities during the course to increase students' motivation in STEM. One of the results showed that there was an increase in students' interests in STEM subjects and STEM self-efficacy after teaching them science, technology, engineering and mathematics. Another result was that students' self-efficacy beliefs were significantly related with students' approaches towards STEM. It was possible to say that students' intentions in persistence of STEM were predicted by students' self-efficacy beliefs not only before the STEM instruction but also after the STEM instruction. In addition, the results of the study of Brown *et al.* (2016) showed that self-efficacy is not the best predictor of choosing STEM as a major, but there is a positive relationship between self-efficacy and STEM choice as a career.

Participants in both the study by Britner and Pajares (2006) and by Brown *et al.* (2016) were from middle school, and both studies were analyzed by using regression analyses. However, the types of students were different. As such, participants in the study of Britner and Pajares (2006) were higher science achievers while students in the other study were from suburban middle school. Despite having differences in terms of student profile, they both indicated that science self-efficacy and self-efficacy are positively correlated with attending STEM activities and following a STEM career.

Also, similar results were found for mathematics self-efficacy. Hackett and Betz (1989) stated that there was a strong relationship between choosing mathematics-based career and self-efficacy beliefs. There were subjects related with mathematics in STEM. Therefore, it can be possible to say that self-efficacy is a predictor of choosing STEM subjects. Hackett and Betz (1989) asserted that students who have strong mathematics self-efficacy become more enthusiastic about choosing science-based departments.

A longitudinal study, which is done by Ocumpaugh *et al.* (2016) showed that 76 high school students, who were able to solve mathematics problems easily, were more confident in mathematics and had high self-efficacy. On the other hand, students who had difficulties in solving problems in mathematics were found to have less confidence in their STEM skills. Therefore, they did not show any interest in STEM fields as a future major. This study also showed that there is a positive relationship between the number of correct answers in mathematics and career development choice in STEM. On the other hand, Wagstaff (2014) investigated the relationship between science self-efficacy and STEM career plan with the participants from the high school longitudinal study of 2009. Data were collected from a total of 21.440 9^{th} grade students. It was revealed that there was no association between science self-efficacy and making plans about STEM career (Wagstaff, 2014). So, this longitudinal study's results were inconsistent with the previous one by Ocumpaugh *et al.* (2016). While one study found a relationship between mathematics self-efficacy and choosing STEM career, the other indicated no relationship between science self-efficacy and choosing STEM career for high school students. Another difference between these two studies was sample size, that is, the sample size of Wagstaff's (2014) study was much larger compared to the other study. Since there were some studies that have different results according to their participants, STEM self-efficacy for the specific participants in this present research should be investigated.

According to responses from 335.842 students from universities and public institutions in the U.S., 67.2% of all students showed above average confidence in their academic ability. This number was 42.7% for confidence in their mathematics ability. Academic confidence and mathematics confidence was found as a significant positive indicator that affect students' tendency for studying STEM. However, when the academic confidence and mathematics confidence of students who chose STEM fields were compared, mathematics confidence was more influential to choose STEM fields. To be more specific, mathematic confidence played a crucial role in students' decisions whether they choose STEM majors, or not. Even if academic confidence showed overall status of students in the school, mathematic confidence was the key for STEM majors (Moakler and Kim, 2014).

2.2.2. Gender

In addition to STEM self-efficacy, another factor could be a gender gap for some of the occupations. That is, some jobs are more attracting for females; while others are more attracting for males. That holds true for STEM fields. The number of females choosing STEM fields is less than males. Therefore, mentioned above, one of the aims of STEM was to prepare all students including males and females to be qualified in the fields that are STEM-related (Holdren *et al.*, 2010).

Female students who attend STEM were nearly half of the male students in the U.S. 39.6% of females were engaged in STEM departments. The number was 14.9% for girls (My College Options, 2012). In Turkey, 64% of total STEM workers was men and only 34% was women (TUSIAD, 2014).

Ing (2014) stated that there was a gender gap between making STEM career or not. The number of females choosing STEM career was less than the males. When students who choose science and mathematics as an area in the University Entrance Exam were analyzed descriptively, it was found that only 18.61% of students in STEM fields were female, and the remaining part consisted of males. Even if the medicine included as a STEM department in the analyses, 28.68% of students in STEM fields were female

(Akgündüz *et al.*, 2015). In addition to this, the number of female students was less not only in choosing STEM career but also in choosing STEM courses (Halpern *et al.*, 2007).

Furthermore, there were other studies that had similar results. Abovementioned Wagstaff's (2014) study investigating the relationship between gender and STEM career plan with using the participants from the high school longitudinal study of 2009 showed that there was a negative relationship being female and making plan about STEM career. To be more specific, male students' STEM career plans were 59% more than female students.

Another longitudinal study analyzed 355.688 secondary female and male students by using frequency tables. Results revealed that female students less frequently attend the higher level of STEM courses than male students (Bergeron and Gordon, 2017). The participants of the studies had different grade levels and came from different countries. However, all of the studies above showed that females are less volunteer to take STEM courses at the secondary level or to choose STEM career after graduation from high school. That's why, it is important to investigate why STEM was less attractive for females, namely what the reasons are behind it. Ybarra (2016) pointed that there could be historical, educational, biological, cultural, and social reasons. To make a comment about the situation, first it is needed to indicate the potential reasons in a detailed way.

Firstly, Kulturel-Konak, D'Allegro and Dickinson (2011) asserted that social and educational factors affected female students' interests in STEM fields. They investigated learning types of females and males. According to results, women and men were found to have different learning preferences. Learning types of women were more intuitively. They learnt using their feelings. However, men approached more analytically and critically. They learnt more logically. Analytic approach and problem solving was important for STEM courses. Therefore, learning types may be an obstacle for female students and they did not tend to STEM career. In Turkey, 2012 Programme for International Students Assessment (PISA) results also showed similar findings. In problem solving, boys had better performance than girls. In addition, the number of best performance of boys was much more than girls (The organisation for Economic Co-operation and Development [OECD], 2012).

Secondly, academic and mathematics confidence could be the reasons behing low ratios of females choosing STEM fields. Moakler and Kim (2014) pointed that the governments' attempts to engage female students to choose STEM career were not enough. It was found that there is a correlation of female students with low confidence in mathematics and low STEM major choice. Along with this relation, first it was needed to develop female students' self-efficacy in mathematics to solve this issue. During the middle school years, especially female students need to improve in academic and mathematics skills. Moaklar and Kim stated that (2014) to increase female students' tendency of studying STEM, first it is necessary to develop their academic and mathematics confidence. If their confidence levels are increased during the primary or middle school years, then their performance in mathematics and science will not become unsuccessful. Therefore, STEM subjects will be more attracted for girls. Along with this reason, their levels of choosing STEM fields as a career will increase, too. Moaklar and Kim (2014) discussed these results, and they asserted that being women negatively affected students' tendency of studying STEM.

On the other hand, 91 male and 115 female students at 6^{th} grade level participated in the study of Brown, Concannon, Marx, Donaldson, and Black (2016). Their results showed that there was no difference in STEM scores between men and women. Furthermore, it was found no difference between self-efficacy beliefs between male and female students in that study (Brown *et al.*, 2016). Therefore, further studies should be conducted to understand the reasons why females are less interested in STEM fields.

Thirdly, job satisfaction and the types of STEM jobs could play a role in females' low ratios of choosing STEM fields as a major. Ginder (2016) investigated 119 females and 92 males, with 55.9% of the total participants worked at STEM fields. The purpose of the research was to understand the potential reasons of gender discrimination in STEM fields. One of the reasons of the difference between females and males in STEM fields was argued to be job satisfaction, which was measured by the feelings of the workers about the work environment, co-workers and etc. The results showed that male workers had lower job satisfaction than females, which indicated that they were not happy about working with their female partners

Another study about gender discrimination in STEM fields, particularly against women, was carried out by Heilman, Wallen, Fuchs, and Tamkins (2004). They stated that when women were recruited in STEM fields, which were defined as male oriented, there was an unfair approach towards the women. Because of the bias of people, female workers' successes were less valued and appreciated in these fields. Not surprisingly, when there are both females and males in the same department in a STEM workplace, females have been regarded as less qualified than their male colleagues.

Based on the literature, it could be said that there are different reasons for female students not to choose STEM career such as having lower problem-solving and critical thinking skills, having less self-efficacy and having less job satisfaction due to gender discriminations. What should be done to solve this problem and to achieve the goals of STEM are well stated as in the following quote: "Women's interest in STEM-related majors may be increased by developing their self-image, promoting early STEM career-linking strategies, interacting with female role models and mentors in STEM career fields, developing confidence in mathematics abilities through group activities and capstone projects, and providing female STEM- related scholarships for higher education" (Fouad, 1995; Lee, 1998, 2002; Turner *et al.*, 2004 as cited by Moakler and Kim, 2014 p.139).

That's why; gender is addressed as another critical factor in the present research study. However, it was assumed that for the participants in the present research, differences in these kinds of gender-related variables between males and females was minimum since both female and male students were high achievers in this research. Therefore, to investigate whether there is a gender gap even between this specific group of participants is important to make generalizations about the gender issues

2.2.3. Parental Variables

There are several parental variables that affect students' educational life. In this section parental variables are divided into three categories, which are parental involvement, parental education level and parental STEM occupation. Some of the studies, which investigated the effects of each parental variable on choosing STEM fields, are presented in this section.

Parents have an important role on students' educational life. In 2009, there was a positive relationship between PISA results of 15 years old students and parental engagement. For example, students whose parents read book regularly during their children's first year of school got higher scores in PISA. In this respect, Gonzalez-DeHass *et al.* (2005) asserted that parental involvement affects students' motivation positively. Students whose parents are involved in their educational life are more engaged with achievement in courses. Furthermore, Cotton and Wikelund (2005) discussed that parents' involvement affects students' achievement in a positive way. When parents encourage their children to participate in school activities, make plan for them, help their lessons, and work with their teachers in collaboration, then students become more engaged with school, and their school performance gets higher.

Interestingly, Ing (2014) investigated the mediating role of students' gender in the effect of parental involvement on their achievement. He stated that there was a positive relationship between parental support and mathematics achievement for male students but not for females. The participants in the study of Ing (2014) were taken from the Longitudinal Study of American Youth. The study lasted for 19 years, starting with 7th grade of the students. For both males and females, science achievement wasnot found to be related with parental support. This showed that according to participants and courses, the direction of the relation between parental support and achievement could change. However, it is also important whether there is any relation between parental support and choosing STEM career or not.

Another longitudinal study investigated the relationship between parental support and STEM career plan with using the participants from the high school longitudinal study of 2009. Data collected from 21.440 9th grade students showed that there was no association between parental support and students' tendencies to career in STEM fields (Wagstaff, 2014)

Furthermore, in the study of Flecha (2012) nearly half of the 515 rural high school students stated that their career choices were not affected by their parents. Small parts of the participants proposed that their parents had an impact on their STEM career choice (Flecha, 2012). Both studies of Wagstaff (2014) and Flecha (2012) were done with high school students, and they were analyzed with quantitative methods. They emphasized that parents had no effect on high school students' choice of STEM career. However, students could be affected by their parents implicitly. According to Eccles's model, there are two different task values; intrinsic value and utility value. Utility value is taken place for a person since his/her other part of life has a direct relationship with it (ECCLES, 2009). This model shows the effects of parents' approach about children's future and values. Parents can lead their children to take STEM course according to what they think is the best for their children. Parents' behavior effects children's approach of utility value about STEM courses. Harackiewicz *et al.* (2012) provided supporting evidence for this result with 188 parents. Their study showed that increasing the conversation about utility of STEM courses increases the number of students who take STEM courses during high school. That's why; it is not possible to say parents did not affect students' approach to STEM courses or STEM career at all.

Second aspect of parental variables is how parents' education level affects students' approaches to STEM. The education level of parents had a direct relationship with the number of STEM courses their children took. Parents' education level affected students' motivation about taking STEM courses. Highly educated parents' children studied more mathematics and science courses in high school (Harackiewicz *et al.*, 2012). 1966 Coleman report stated that the family background is the most important thing which affects student achievement (Ornstein, 2010) In another research, which was done with high school students, the purpose was to investigate whether a relationship between students' specific subjects' achievement such as mathematics, English etc., and their parents' education level. For the research, mathematics course was divided in two parts, the first one was about college mathematics and the second one was about preparation for the work life. It was found that there was a relationship between students' mathematics achievement and their mothers' educational level (Signer and Saldana, 2001). All studies mentioned above are similar according to the grade level of participants. It was possible to say that high school students' mathematics achievement and their approaches towards the STEM courses were affected by their parents' level of education in a positive way. However, there was no result about their choices of STEM fields as a career. That's why, in the present study, the relationship between the choices of the participants who were preparatory students in a high-ranking university and their parents' educational level was quantitatively analyzed.

Thirdly, another aspect of parental variables was parents' STEM occupation. Moaklar and Kim's research (2014) indicated that "parental STEM occupation, and minority status" were significant positive factors that affected students' tendency of studying STEM. This study was applied to 335.842 students in the U.S. from universities and public institutions. If parents have occupations related with STEM, the ratio of students to choose a STEM field as a career gets increased. IT was seen that the involvement of parents was playing an important role in children's choices of STEM majors. Students with "parental STEM occupation" tended to choose STEM fields 50% more than others. Interaction between parents and children was argued to be the key part for this flow. It can be said that children understand the importance of STEM thanks to parents' mentoring to children for STEM-related occupations. In order to direct children to STEM majors, "role models, mentorships" and coaching are to be used (Moakler and Kim, 2014). For students, parents are one of the most vital parts in order to create motivation in choosing STEM careers even if their knowledge about STEM is not enough to persuade them in a proper way (Hill and Tyson, 2009). On the other hand, a longitudinal study of Staniec (2004) showed that there is no relationship between parents' STEM occupation and students' choices of STEM. Therefore, regarding this aspect of parental variables, there was no consensus between studies. That's why, it is important to quantitatively investigate parents' STEM occupation factor for the specific high achieving prep year studentsin the present study.

2.2.4. Career Selection

Profession can be described as the collection of activities which a person performs via information and talent obtained through an education to make money. Choosing a profession is one of the most important things in people's lives. A person who chooses a profession does actually decide a life style. His/her goal in his profession is to prove himself/herself as a successful person. When a person chooses his/her profession according to his/her abilities, interests and wishes, s/he has a chance to be successful, efficient and happy. Otherwise, his unhappiness and poorness is inevitable. Therefore, people need to take into consideration their characteristics in the process of choosing a profession (Yanıkkerem *et al.*, 2004).

Unfortunately, the current situation of a country hinders students from choosing a profession according to their abilities and interests, which is though an ideal way of choosing a profession. Nowadays, future anxiety of young people affects their decision about profession. It can be said that their unhappiness and dissatisfaction in segments continues after graduation. There are a limited number of studies examining reasons, which are effective in the process of choosing a profession for students. One of the researches done with 216 university students in Turkey showed that the process of choosing a profession was affected by various factors. Data was analyzed by Analytic Hierarchy Process (AHP). Employment guarantee, high salary and social security guarantee are found among the most effective three factors while choosing career. The most preferred professions by students are researchers, civil servant and running own company consecutively (Göktolga and Gökalp, 2012). College students make their decision for their education and careers according to economic situation (Melguizo and Wolniak, 2011; Wells *et al.*, 2013; Xu, 2013). Job satisfaction which has no correlation with money earned, working hours etc., and people's self-assessment is playing a crucial role in the process of deciding a job-related issue in career (Rosser, 2004; Smart *et al.*, 1986). These are the factors that affect university students' career choices. These factors could change according to different countries, universities and departments. For the present study, it is important to explore what factors have an impact on the students' choices of STEM or Non-STEM departments.

A research conducted in Ege Univeristy, Turkey (Sarikaya and Khorshid 2009) investigated the factors by dividing students into two categories, which were studying in social departments. In the study, there were 1000 preparatory students and data was analyzed by using chi-square analysis. The reasons of students who choose social studies while attending the university were found to being more talented and more interested in these fields, making their dreams come true, and being happy. The reasons of students who choose science-based departments appeared as to be having an occupation, advising of others, and their scores in University Entrance Exam. If people do not choose their jobs according to their abilities and skills, they may be unhappy while working, they may want to change their job, they may not open to new ideas and they may have resistance to their jobs. However, it is not possible to make generalizations about factors. These factors can show a change according to the specific participants and years. That's why, the present research was conducted with a certain group, namely university students in prep year. Therefore, their ideas do not begin to change about the departments yet.

One of the career selection reasons of students in science-based departments is advising of others according to Sarıkaya and Khorshid's study (2009). It is possible to find deeper information about advising of others while choosing career in Falco's article (2017). Falco (2017) indicated that early childhood period the guidance and directions of other people affectstudents' career choice. Especially, school counselors had an impact on students' career choice of STEM implicitly and explicitly. School counselors could support and engage their students to attend STEM career. Furthermore, they could encourage girls to choose STEM fields while telling and showing areas and workplaces. Therefore, school counselors were playing important role while their students choosing STEM fields as a career (Falco, 2017). That's why, in the present research, advising of others was investigated deeply for the specific high achieving students.

Furthermore, it is also important to analyze STEM graduated people and STEM workers. Human Resources Directors in Turkey stated that 19% of workers in companies is STEM major graduates. A research with 408 STEM major graduates showed that only half of them were working in STEM fields. Even if the number of STEM major graduates was insufficient, they were still working out of STEM fields. Reasons which push STEM major graduates to work outside their fields were job satisfaction and salary as well as career opportunities and status in the society. If demanded salary is met for STEM major graduates, the number of them working in their own areas will increase (TUSIAD, 2014). This may be a way to attract students who tend to choose STEM career. However, solving this problem is very tiring for Turkey. Since among the OECD countries, the average of employment rate in STEM graduates was 86%. The rate was below 80% for Turkey (OECD, 2017).

In Turkey, 64% of total STEM workers were men and only 34% was women (TUSIAD, 2014). Males who work in a job, which has low relation with theirmajors, were more dissatisfied even if they were in STEM fields. Wage satisfaction level was very low if males work in a field, which is unrelated to their major. On the other hand, working in unrelated jobs with their majors created more problems for females. If females had jobs related to major, then they were generally more satisfied with wages than males. People who graduated from STEM fields had a better chance for employment. Nevertheless, females were still not taking STEM majors (Xu, 2016). Along with these solutions, to know the factors that affect students' choice of STEM career is important. To investigate the factors affecting high achieving students helps to increase the qualification of STEM workers.

2.2.5. Achievement in STEM Areas

Despite the efforts, initiatives and projects, science and mathematic scores of Turkish students in domestic and international tests are very low. University Entrance Exam and PISA-the Programme for International Student Assessment (OECD) is an example for these tests and statistics, even if the Ministry of Education made important changes in curriculum and testing methods, research showed that in the last 6 years, students have only 7,8 net in 40 mathematic questions, and 4,74 net out of 40 science questions in University Entrance Exam. According to the results of PISA-the Programme for International Student Assessment test, Turkey's score is below average and even one of the worst among OECD countries. Turkish students scored 463 in science test where the average score of OECD Countries was 501, and 448 in mathematics test where the average score of OECD Countries was 494. Test scores in domestic and international level indicated that Turkish students are not successful in main two disciplines of STEM; Science and Mathematics (Akgündüz *et al.* 2015).

According to Skillen (2016), the world has undergone a change towards mathematics and technology. Indeed, STEM permeats every part of our daily life experiences, and mathematics is a core for all the STEM areas. Chubb (2014) asserted that quantitative skills are the key point for all the STEM subjects from science to mathematics. Critical thinking, problem solving, and making inferences all requiringmathematics, are crucial for all jobs today. That's why; mathematics is based on all the STEM fields (Chubb, 2014 as cited by Skillen, 2016, p.2)

SAT and ACT are kinds of university entrance exams in the U.S. SAT and ACT scores are also other indicators for students to choose STEM as well as GPA. High numbers in these three scores are in favor of STEM majors. It means that, if students work hard, do their homework on time and regularly, they can end up with STEM majors (Moakler and Kim, 2014).

According to responses from 335.842 students in the U.S; high school GPA, weekly hours spent studying or doing homework and SAT scores were found to have a significant positive effect on students' tendency towards studying in STEM-related fields. Students with higher GPA were most likely choosing a STEM area as well (Moakler and Kim, 2014).

Ing (2014) also used data that was taken from the Longitudinal Study of American Youth (LSAY). Participants in LSAY were 7th grade students when the longitudinal study began. Data collection lasted for 19 years. Ing (2014) investigated the effects of mathematics and science achievement on STEM career for both male and female students. The results showed that there was a positive relationship between science and mathematics achievement and students' approaches towards STEM career both in females and males. Even if Moakler and Kim (2014) and Ing (2014) studies' participants had different profiles, both studies emphasized that there is a positive relationship between achievement and choosing STEM as a career.

On the other hand, Olitsky (2014) indicated a gender difference. He mentioned that even if female students had high academic achievement level, the rate of choosing STEM of them as a major was low. The reason of it could be that the benefits of STEM related jobs was not enough for high achieving women. They may earn much more money while working in Non-STEM jobs. Köller, Baumert, and Schnabel (2001) studied the relevance of academic interest, academic achievement, and subsequent course selection. Mathematics grade of students in 10^{th} grade plays important role over course selection. On the other hand, the interest of students in subjects also affects course selection. Depending on interests of students and self-efficacy, achievement may not have proportional relationships with course selection.

Similarly, Flecha (2012) stated that there was no relationship between mathematics achievement and career related to mathematics. There were 515 high school students in the study of Flecha. In addition to this, despite finding no relationship, the majority of students whose mathematics scores were low were less tended to STEM career in the study. Most of them chose their career with the help and guidance of other people.

In the literature, generally high school students were included as participants in the studies. In the present research, there were university students in prep year, but their high school grades were also used similar to the literature. The important part is the profile of the students, which was high achieving. In the literature, there is no study especially done with high achieving students. For high achieving students whether a difference between students choosing STEM and Non-STEM departments or not regarding to high school STEM grades was aimed to be addressed. To know the factors affecting high achieving students career choices may help to achieve one of the goals of STEM which was to train qualified manpower.

3. SIGNIFICANCE OF STUDY

Along with the changing world, the deficit in the science, technology, engineering, and mathematics workforce has increased (Cataldo, 2014; National Science Board, 2004; National Science Foundation, 2013). There has been a need for citizens who have 21st century skills, such as critical thinking, problem solving, communications and collaboration, creativity and innovation, information literacy, Information and communication technologies (ICT) literacy (Framework for 21st Century Learnings, 2007). Most of the countries like USA, Japan, South Korea, Germany and China give importance STEM to maintain and improve economic and technologic conditions (STEM Akademi, 2014). For example, The United States spends nearly $1 billion per year for STEM education (Holdren *et al.,* 2010). Turkey also makes an investment for STEM education. To meet workforce need, experts in Turkey work for improving STEM education (TUSIAD, 2014). As Johnson (2014) mentioned to support STEM education to be long-term reform, experts in the education and business should spare time to develop STEM education. The purpose of increasing money that is spent on STEM education is two-fold. The first one is equality, preparing all students (including boys and girls), to be qualified in the STEM fields. The second one is inspiring all students to study in STEM subjects (Holdren *et al.*, 2010). Therefore, along with the increase of the number of students who choose STEM fields, increase in the quality of the students who choose STEM fields is also important. In Turkey, when students in the first thousand ranks of the University Entrance Exam were analyzed, most of these students who did not choose STEM departments choose medicine as a career (Akgündüz *et al.* 2015). Therefore, in order to increase in the quality of students in STEM fields, firstly it is important to know which factors affect STEM career choices of students who got in high scores in the University Entrance Exam. Zhang (2011) stated that to know the factors affect the choice of STEM majors showed that how could be solved the problems in producing strong manpower in these fields, strengthen economy.

This study will investigate the factors affecting high achieving students' career choices in a certain university. To choose the university, where the study was applied, students need to take high scores in University Entrance Exam. When it was look their scores in University Entrance Exam, it may be considered that these students could choose either STEM or Non-STEM majors as a career. In other words, their scores were appropriate to choose most of the departments in STEM or Non-STEM areas. Investigating why they chose STEM or Non-STEM departments may provide information about the factors affecting their choices. The factors affecting students' choice of STEM major were investigated in the present study. Based on the literature, the determinants of high achieving students' choice were investigated in five parts, which are STEM self-efficacy, gender, parental variables, (parental involvement, parental STEM occupation and parents' educational level), career selection and high school STEM score. (Hackett and Betz, 1981; Ybarra, 2016; Moakler and Kim, 2014; Harackiewicz *et al.*, 2012; TUSIAD, 2014).

4. STATEMENT OF THE PROBLEM

The present study aims to investigate in what degree the factors -STEM self-efficacy, gender, parental variables which are parental involvement, parents' STEM occupation, parents' educational level, career selection and high school STEM score- affect high achieving students' choice of STEM major. For this purpose, the researcher adopted an instrument from various sources that assesses factors affecting thechoice of STEM.

4.1. Variables

The five main variables in this study are stated as STEM self-efficacy, gender, parental variables, career selection and high school STEM scores. However, parental variables are aldo divided into three parts that are parental involvement, parental STEM occupation and parents' educational level. The operational definitions of these variables are as follows:

- *STEM Self-efficacy* is defined as self-efficacy towards STEM..The variable STEM self-efficacy is students' beliefs to be able to achieve in STEM related activities. In this research STEM self-efficacy measures "students' confidence and self-assurance in completing STEM related activities." (Brown *et al.*, 2016, p.29). It was measured by the adaptation of the CIRP Freshman Survey (2009) and students' self-efficacy subscale (Brown *et al.*, 2016) to this study.
- *Gender* varies from male to female to identify people's biological characteristics.
- *Parental variables* are defined self-report of students' thought about their parents. It will be investigated in three categories, which are parental involvement, parents' educational level and parents' STEM occupation. Parental STEM involvement measures in what degree a participant perceive his/her parent's encouragement their children in school activities (making plan for them, helping

their lessons, and working their teachers with collaboration) (Cotton and Wikelund, 2005). Parental Involvement Survey (Voydanoff and Donnelly, 1999) was adaped to this study to measure parental STEM involvement. The school which parents graduated shows parents' educational level. Parental STEM occupation is the field that parents work to earn money.

- *Career selection* is defined as the reasons of choosing the STEM major or not in the university. It was measured by the factors affecting choosing department survey of Owen *et al.* (2012) which is adapted to this study.
- *High school STEM score* is defined as self-report of students about scores in high school mathematics and science courses.

4.2. Research Questions

This study aims to investigate the following 5 research questions for high achieving prep year university students:

(i) Is there a statistically significant difference in *STEM self-efficacy* between high achieving prep year students who choose STEM and Non-STEM major as a career?

(ii) Is there a statistically significant difference in choosing STEM or Non-STEM major as a career between *female and male* students?

(iii) (a) Is there a statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding the *parental involvement of STEM*? (b) Is there a statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding *the parents' educational level*? (c) Is there a statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding *the parents' STEM occupation*?

(iv) What are the factors reported by high achieving prep year students (studying STEM or Non-STEM career) for their career selections?

(v) Is there a statistically significant difference in high school STEM scores between high achieving prep year students who choose STEM and Non-STEM major as a career?

4.3. Statement of Research Hypotheses

In this study, the null hypotheses are the followings:

(i) There is no statistically significant difference in STEM self-efficacy between high achieving prep year students who choose STEM and Non-STEM major as a career.

(ii) There is no statistically significant difference in choosing STEM or Non-STEM major as a career between males and females.

(iii) (a) There is no statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding the parental involvement of STEM. (b) There is no statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding the parents' educational level. (c) There is no statistically significant difference between high achieving prep year students who choose STEM and Non-STEM as a major regarding the parents' STEM occupation?

(iv) There is no statistically significant difference in high school STEM scores between high achieving prep year students who choose STEM and Non-STEM major as a career.

5. METHODOLOGY

This chapter provides detailed information about the methodology. Within this context, it includes research design, participants and setting, procedure, data collection, and data analysis.

5.1. Research Design

The type of this quantitative research is causal-comparative. Causal-comparative research design helps to determine the cause of existing difference between the variables. However, the variables were not controlled by researchers in this type of reseach design (Brewer and Kuhn, 2010). The reason of using causal comparative research design is to better understand the causative differences in STEM self-efficacy, gender, parental involvement, parental STEM occupation and parents' educational level between participants who choose STEM or Non-STEM major as a career in the university. There is also a descriptive component of this research. Descriptive part of the research will be to investigate the factors reported by participants for career selections as a STEM or Non-STEM. However, in general the design of the study can be said to be causal-comparative because the majority of research questions are causal-comparative.

5.2. Participants and Setting

The participants of the present study were 328 undergraduate students attending to the preparatory program at a public university, School of Foreign Languages in İstanbul, Turkey.Purposeful sampling method was used while choosing university since the purpose of this research was to investigate the factors affecting high achieving students' career choices. That's why, the study was done in one of the top-ranking universities in Turkey. The background of the university is older than 150 years in education. There are six campuses and thirty-two undergraduate departments. Students in the university took high scores in the University Entrance Exam. Therefore, there are high achieving students who enrolled STEM departments and Non-STEM departments. For STEM departments there are 16 different departments categorizing Science, Technology, Engineering, Mathematics that are physics, chemistry, mathematics, molecular biology and genetics, teaching physics, teaching chemistry, teaching mathematics, undergraduate program in science education, undergraduate program in mathematics education, computer education and educational technology, civil engineering, industrial engineering, electrical and electronic engineering, chemistry engineering, mechanical engineering, computer engineering.

For Non-STEM departments, there are also 16 different departments that are economics, management, political science and international relations, psychology, undergraduate program in preschool education, sociology, guidance and physchological counseling, tourism administration, international trade, management information systems, turkish language and literature, department of translation and interpreting studies, english language education, western language and literature philosophy history.

In the present research, there were students who enrolled both STEM departments and Non-STEM departments. For STEM departments there were 801 students categorizing Science, Technology, Engineering, Mathematics. For Non-STEM departments there were 1137 students. To determine the number of participants in each group, convenience-sampling method was applied. The participants were chosen among preparatory students in two different campuses of Boğaziçi University. Two weeks were spent on data collection. It was the last days of the semester for preparatory students. Therefore, some of the students were not in the lessons. The survey was applied the volunteer students in the campuses. They filled in the survey in their break time.

There were 1623 preparatory students at The School of Foreign Languages in 2015-2016 academic years (Boğaziçi University, 2016). The exact numbers of students in 2016-2017 academic years were not published yet. However, it was expected to be more than 1500 students enrolled undergraduate programs.

328 preparatory students participated this research, but some of the students did not give the answer for some items in the survey. Therefore, they were excluded from the sample and the sample size became 314. 47% (n=148) of participants are male, 53% (n=166) of participants are female.

Table 5.1. The number and the percentages of the students in STEM and Non-STEM departments

	Sample Size	**%**
STEM	184	58.5%
Non-STEM	130	41.5%

This table shows that, 58.5% of participants (n=184) were registered to STEM departments. 41.5% of participants (n=130) were registered to Non-STEM departments in Boğaziçi University.

The mean age of the participants was 19.65. The mother tongue of all of the students was Turkish. Therefore, the survey is administered in Turkish.

The school background of 44% participants were Anatolian High School, 17% of participants were from Science High School, 10% of students are from Teacher Training High School, 5% of them were from vocational school, 9% were from private high school, and 12% were from other high schools like religious vocational high school, military high school and etc. There was only one student from Foreign High School.

5.3. Procedure

In the Boğaziçi University, students enrolled English preparatory class if they do not have required English proficiency. In preparatory classes, there are students from different departments. Classes are in two different campuses. Data collection took place during the second semester of the 2016-2017 school year.

All required permissions were given from Coordinator of the School of Foreign Languages in order to apply survey to preparatory students. Coordinator sent an email to all lecturers to inform them. Then, lecturers informed students about the survey. Students filled the survey in break and free time in two different campuses. Researcher gave necessary information to the students before participating the study. They were told what the aim of survey is. They all were informed that they are free to not fill the survey. It is also pointed out that all information will be kept confidential and all students can withdraw whenever they want. After all these process, volunteers took the survey.

5.4. Instruments

In order to investigate determinants of high achieving students' career choices in STEM fields, the researcher adapted *Factors Affecting Students' STEM Choices as A Major Test* in Appendix A. The instrument was administered spring term of 2016-2017 school year preparatory students in Boğaziçi University.

Table 5.2. The number of items related with each variable.

Variables	Question number
Gender	1
STEM self-efficacy	10 (7 items) 12 (8 items)
Parents' education level Parents' STEM occupation Parental STEM involvement	14 15, 16 17 (12 items)
Career selection	24 (19 items)
High school STEM score	7

In the instrument, there are 26 questions, some of them are demographic questions, others that were selected or adapted about investigating factors affecting choosing STEM major. These factors were chosen as STEM self-efficacy, gender, parental variables, career selection and high school STEM score based on the literature. There are both open-ended and likert-type questions. Likert-type items were designed as a 3-point rating or a 5-point rating scale according to type of the questions. Sample items from the instrument were included in Table 5.2.

To calculate reliability of *Factors Affecting Students' STEM Choices as A Major Test*, Cronbach's alpha was used. Cronbach alpha was found as .832 for 55 items in the present research. The 55 items used from *Factors Affecting Students' STEM Choices as A Major Test* have good internal consistency. To assess the reliability of each variable, cronbach alpha was computed for STEM self-efficacy, parental STEM involvement, career selection and high school STEM score separately.

To measure STEM self-efficacy, items of questions 10 and 12 were selected from Brown, Concannon, Marx, Donaldson and Black 's (2016) and the national freshman survey from the Cooperative Institutional Research Program (CIRP) of the Higher Education Research Institute (HERI) at the University of California, Los Angeles (The CIRP Freshman Survey). Then items were adapted to this research. Question 10 in the survey was prepared to investigate the STEM and Non-STEM students' high school perspectives and feelings about STEM courses. The items were designed as a 3-point Likert scale, which are never, sometimes, and often. They were coded as point 1, 2 and 3 respectively. Question 12 in the survey was prepared to investigate the STEM and Non-STEM students' STEM self efficacy. The sub-items in 13 were designed, as 5-point Likert scales, which are strongly disagree, disagree, neither, agree, strongly agree. They were coded as point 1, 2, 3, 4 and 5 respectively.

"*STEM self-efficacy* is a domain-specific self-efficacy measure of students' confidence and self-assurance in completing STEM related activities" (Brown *et al.*, 2016, p.29). The items measured academic, mathematics, social and intellectual beliefs about the skills in the learning environments (Eagan *et al.*, 2016). The reliability of STEM self-efficacy was found .848 with using cronbach alpha. The internal consistency reliability is good for STEM self-efficacy with 8 items.

Parental variables are divided three categories, which are parental education level, parental STEM occupation, and parental involvement. Items in first two categories were asked by the researcher. They measured exactly the school which parents graduated and the field that parents work to earn money is related with STEM departments or not. Parental involvement items were selected and adopted from Parental Involvement Survey (Voydanoff and Donnelly, 1999). The items in question 17 were designed, as 3-point Likert scales, which are never, sometimes, and often. They were coded as point 1, 2 and 3 respectively. It measures the self-reports of students about how their parents involve sons' or daughters' academic life during the high school and how they encourage them in STEM activities. The reliability of parental STEM involvement was computed .835 with using cronbach alpha. Parental STEM involvement with 6 items has good internal consistency.

Question 7 measured high school STEM score was asked by the rearcher. It was measured exactly asking the physics, chemistry, biology and mathematics scores of students above five during the high school. Since, these are the courses about STEM in the high school curriculum of Turkey. Technology scores were collacted but then ignored, because a small part of participants claimed that they have took technology courses during the high school. There is no course about engineering in the high school curriculum. Cronbach alpha coefficient is .879 for reliability of high school STEM score. It consists of 4 items and it shows good internal consistency.

To measure career selection items, factors affecting choosing department survey of Owen *et al.* (2012) were adopted to this research. This survey was formed by thinking possible factors that affect the choice of career. The stages advised by Büyüköztürk (2005) about the factors were discussed before the survey was created. Then the survey was examined 4 people who took measurement and evaluation courses. Therefore, content and validity of the survey was provided. According to feedbacks, necessary correction was made. After the pilot study, it has been proven the comprehensibility of the survey. The factors that affect the choice of career were divided into 4 parts consisting personal, social, systemic and chance. The reliability of factors affecting career selection was computed with using crobbach alpha. Cronbach alpha coefficient is. 824 (19 items). The coeeficient shows good internal consistency for this variable.

In order to modify the instrument, expert opinions were consulted to examine content validity. Factors Affecting Students' STEM Choices As A Major Test and its evaluation form were sent via e-mail. Two assistant professors in teaching chemistry and teaching mathematics, a post graduated student who works about STEM and a master's degree students who made research about STEM was examined the instrument. It was revisited according to feedbacks. The order of items and questions were changed. Demographic questions took place in the beginning of the survey. The expanded name of STEM was written in the questions. Information about definition of STEM was added to consent form.

Then, the instrument was piloted with 31 second year students in Boğaziçi University. The pilot study was done in spring 2017. After pilot study was conducted, only small word mistakes were corrected. The duration of the survey was checked. It last almost 10 minutes and no item was removed the survey. Data of pilot study were coded. To calculate reliability of pilot study, Cronbach's alpha was used. Cronbach alpha was found as .813 for 55 items in the pilot study.

5.5. Data Collection and Analysis

In this study, there are five main variables, which are STEM self-efficacy, gender, parental variables, career selection and high school STEM scores. However, parental variables divided in three parts that are parental involvement, parental STEM occupation and parents' educational level. To analyze all research questions, appropriate tests were used.

In the present study, data was analyzed by quantitative methods by using software of Statistical Package for Social Sicences (SPSS) (Pallant, 2010). Data was analyzed by using descriptive statistics and Mann-Whitney U test. Chi-Square test was used to investigate the difference among categorical variables.

Firstly, descriptive statistics of the study were done for STEM self-efficacy, gender, parental variables, career selection and high school STEM score. Means, medians, standard deviations were calculated. In addition, the percentage distribution was found for all items in each variable. To investigate the difference in participants' STEM self-efficacy, parental STEM involvement, high school STEM score between the ones who choose STEM and Non-STEM major as a career in the university, and high school STEM scores between the ones who choose STEM and Non-STEM major as a career in the university, using t-test was assumed. However, the distribution of the data was deviated from normal. Then non-parametric Mann-Whitney U test was used.

The difference between participants who choose STEM and Non-STEM as a major regarding the gender was analyzed by Chi-Square. Furthermore, Chi-Square was used to detect the difference between participants regarding the parents' STEM occupation and parents' educational level. Descriptive statistics were computed to investigate the factors reported by participants for career selections as a STEM or Non-STEM.

6. RESULTS

This chapter provides detailed information about the results of the study. The findings were given in five parts. All parts include one of the main variables, which are STEM self-efficacy, gender, parental variables, career selection and high school STEM scores. In the section parental variables, the results for parental involvement, parents' STEM occupation and parents' educational level were given.

6.1. STEM Self-efficacy

Question 10 in the survey was used to investigate the STEM and Non-STEM students' high school perspectives and feelings about STEM courses.

Table 6.1. Means, standard deviations, and medians of the each item in question 10

	STEM			Non-STEM		
	M	SD	Md	M	SD	Md
I was bored during STEM topics.	2.29	0.59	2.00	2.02	0.58	2.00
I used to do peer tutoring on STEM topics	2.28	0.54	2.00	1.88	0.64	2.00
I used to study with other students on STEM topics	2.05	0.58	2.00	2.04	0.68	2.00
I used to feel that I can overcome all STEM related task.	2.47	0.57	3.00	1.97	0.73	2.00
I used to feel uncomfortable in STEM courses.	2.67	0.48	3.00	2.29	0.62	2.00
I used to attend out of class STEM activities	1.77	0.65	2.00	1.51	0.59	1.00
After STEM courses, I used to ask questions to my teacher.	2.21	0.59	2.00	2.05	0.65	2.00

Table 6.1. showed that means, standard deviations and medians of each item in question 10 that assesses the STEM and Non-STEM students' high school perspectives and feelings about STEM courses. "I used to feel that I could overcome all STEM related task." was rated by Non-STEM students *(M=1.97, SD=0.73)* and by STEM students *(M= 2.47, SD=0.57)*. Besides, the median of STEM students is 1 higher than the median of Non-STEM students for this item. "I used to attend out of class STEM activities" was rated by Non-STEM students *(M= 1.51, SD=0.59)* and by STEM students *(M= 1.77, SD=0.65)*. The mean of Non-STEM and STEM students are similar even if the mean of STEM students is a little bit higher. The median of Non-STEM students is twice times bigger than the median of Non-STEM students; 2.00 to 1.00 respectively.

When the items were analyzed in Appendix B, 10.83% of the participants stated that they were never bored during STEM topics. This ratio is 17.69% for students in Non-STEM, 36.41% for students in STEM departments. 55.41 % of the participants said that they used to feel uncomfortable in STEM courses never. This ratio is 37.69 % for students in Non-STEM, 67.93 % for students in STEM departments. 8.46 % of students registered to Non-STEM departments stated that they often used to feel uncomfortable in STEM courses. 25,48 % students *(n=80)* proposed that they often used to help other students to learn STEM subjects. 20 of them are from Non-STEM departments, 60 of them are from STEM departments. 50.54% of students in STEM departments stated that they used to feel that they could often overcome all STEM related task. This ratio is 24.62% for students in Non-STEM departments. Only 0.54% of students registered to STEM departments stated that they often used to feel uncomfortable in STEM courses.

Question 12 in the survey was used to investigate the STEM and Non-STEM students' STEM self efficacy.

Table 6.2. Means, standard deviations, and medians of the each item in question 12

	STEM			Non-STEM		
	M	SD	Md	M	SD	Md
I am sure I can do well on science tests	3.91	0.74	4.00	3.02	1.05	3.00
I usually give up when I do not understand a STEM concept.	3.97	0.87	4.00	3.50	0.97	4.00
I have good problem-solving skills.	3.98	0.76	4.00	3.85	0.92	4.00
I cannot understand STEM even if I try hard.	4.29	0.84	4.00	3.89	0.89	4.00
I am confident that I can be successful in STEM.	4.22	0.69	4.00	3.49	0.94	4.00
If I work hard enough, I can learn difficult STEM concepts	4.39	0.64	4.00	4.08	0.72	4.00
Science is easy for me.	3.74	0.87	4.00	2.92	0.95	3.00
I am good at solving problems.	4.17	0.68	4.00	3.89	0.91	4.00

Table 6.2. showed that means, standard deviations and medians of each item that assesses the STEM and Non-STEM students' STEM self-efficacy.

The median of STEM students is 4.00 for the items "I am sure I can do well on science test" and "Science is easy for me" was rated for STEM students *(Md=4.00)* and for Non-STEM students *(Md= 3.00)*. The mean of STEM students is higher than the mean of Non-STEM students.

Furthermore, when the items in question 12 were analyzed in Appendix C, 72.30% of these students proposed that they can understand STEM if they try hard. Then 55.39% of them stated that they are confidents that they can be successful in STEM. However, 54.62% of students are not sure that they can do well on science tests. They are in indecision. Since, 69.23% of these students stated that science is not easy for them.

In addition to this, 91.71% of STEM students stated that they can understand STEM if they try hard. Then 89.67% of them are confident they can be successful in STEM. The percentage of the students in STEM proposed these two items higher than Non-STEM students. 77.71% of STEM students are sure they can do well on science tests. Since 61.41% of them stated that science is easy for them. In addition, 94.03% of STEM students proposed that if they work hard enough, they could learn difficult STEM concepts.

The first research question aims to investigate whether there is a statistically significant difference in STEM self-efficacy between university students who choose STEM and Non-STEM departments as a major. Associated with the research questions, STEM self-efficacy mean scores of STEM and Non-STEM students were compared by using Mann-Whitney U test.

Table 6.3. Means, standard deviations, minimum and maximum scores of STEM self-efficacy of STEM and Non-STEM students.

		M	***SD***	**Min**	**Max**
STEM self-efficacy	**STEM**	32.6739	3.89369	22.00	40.00
	Non-STEM	28.6538	5.20690	13.00	40.00

The data was collected from 314 university preparatory students. 184 of them were registered from STEM departments and 130 of them were from Non-STEM departments. In Table 6.3, mean scores, standard deviations, minimum and maximum scores of students were mentioned. Mann-Whitney U test results showed that there is a statistically significant difference between in STEM self-efficacy of participants ($z=-6.996$, $p< .001$).

Students who choose STEM departments as a major have significantly higher STEM self-efficacy *(Md=32,67, n=184)* than students who choose Non-STEM departments *(Md=28,65 n=130) U = 6429, z = -6.996, p < .001, r = .4*. Moreover, the r-value indicates medium effect using Cohen (1988) criteria.

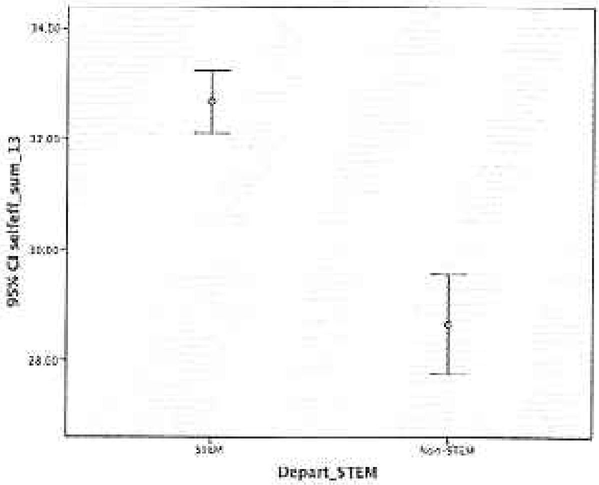

Figure 6.1. Confidence intervals of STEM self-efficacy for STEM and Non-STEM students.

Graphical represantation of the data by comparing confidence intervals (95%) of students who choose STEM and Non-STEM departments was stated in figure 6.1.

The error bar chart in figure 6.1 showed that confidence intervals for students who choose STEM departments *(95% CI [32.11, 33.24])* and students who choose Non-STEM *(95% CI [27.75, 29.56])* do not overlap. This proposed that there is a statistically significant difference between groups. In addition, there is a distance between the upper bound of CI for Non-STEM *(29.56)* students and the lower bound of CI for STEM students *(32.11)*.

6.2. Gender

There are 314 university preparatory students participated this research. 47.1% *(n=148)* of the data collected from participants are male, 52.9% (n=166) of participants are female. 51.1% of STEM students are female and 48.9% of STEM students are male. 55.4% of Non-STEM students are female and remainings are male.

Table 6.4. The number and the percentage of female and male students in STEM and Non-STEM departments

	STEM	Non-STEM
Female	51.1% (n= 94)	55.4% (n= 72)
Male	48.9% (n= 90)	44.6% (n= 58)
Total	100% (n=184)	100% (n=130)

Chi-Squre was conducted to analyze whether there is a difference between males and females who choose STEM major as a career. A Chi-Square test for independence indicated no significant association between gender and choosing STEM or Non-STEM departments, χ^2 *(1, n = 314) = .41, p = .52, phi = –.04.*

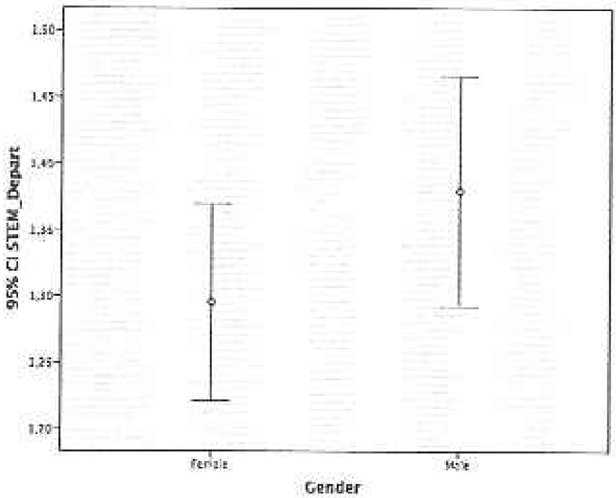

Figure 6.2. Error bar chart of the STEM and Non-STEM departments according to gender.

Graphical represantation of the data by comparing confidence intervals (95%) of females and males was stated in Figure 6.2. The error bar chart in Figure 6.2 showed that confidence intervals for female *(95% CI [1.22, 1.37])* and students who choose Non-STEM *(95% CI [1.29, 1.47])* do not overlap. This proposed that there is no statistically significant difference between groups.

6.3. Parental variables

In this part, there are findings about self-report of students' thought about their parental involvement, parents' educational level and parental STEM occupation.

Table 6.5. The percentage distribution of STEM and Non-STEM students in each item in question 18

	STEM			Non-STEM		
	Never	Sometimes	Often	Never	Sometimes	Often
Talked to a teacher about my progress in school.	16.30	51.09	32.61	14.62	58.46	26.92
Attended a parent-teacher meeting or other school meeting.	9.78	35.87	54.35	10.00	29.23	60.77
Attended a school play, concert, sporting event, or other school activity.	48.91	38.59	12.50	47.69	39.23	13.08
Helped with a special school project, school trip, or other school activity	48.37	38.59	13.04	49.23	36.92	13.85
Helped me with my homework.	41.30	38.59	20.11	46.92	36.15	16.92
Supported me while preparing for my exams	14.67	32.61	52.72	16.15	30.00	53.85
Supported me in the study about STEM topics.	31.52	36.41	32.07	40.77	33.08	26.15
Encouraged me to study STEM topics.	11.96	34.24	53.80	26.15	29.23	44.62
Had expectations about doing the best in STEM topics.	9.24	24.46	66.30	19.23	36.15	44.62
Gave importance in STEM topics.	9.78	30.43	59.78	14.62	38.46	46.92
Supported me attending STEM activities out of class.	15.76	46.74	37.50	30.00	37.69	32.31
Supported me doing career in STEM areas.	13.59	26.63	59.78	36.15	33.08	30.77

Table 6.5. shows that the percentage distribution of STEM and Non-STEM students indicated how often their parents involve during the high school. For first six items results are relatively similar for both Non-STEM and STEM students. For example, 53.83% of Non-STEM students, 52.72% of STEM students proposed that their family supported them while preparing exams. These six items were designed to measure general parental involvement. The other items were prepared to give a result for parental involvement in STEM subjects. 44.62% of students in Non-STEM departments stated that their parents had expectations about doing the best in STEM topics. This percentage is 66.30% for students in STEM departments.59.78% of students in STEM departments proposed that their parents gave importance in STEM topics.

30% of students' in Non-STEM departments' parents did not support their children on STEM activities. Only 15% of STEM students' parents did not support their children on STEM activities. 59.78% of students in STEM departments and 30% of students in Non-STEM departments stated that their parents supported them doing career in STEM areas.

According to participants' family background. 285 students' mother and father are alive and married. The family of 12 students is divorced. 17 of participants said that one of them their mother and father or both of them are died.

To investigate whether there is a statistically significant difference in STEM parental involvement between university students who choose STEM and Non-STEM departments as a major, parental STEM involvement means scores of STEM and Non-STEM students were compared by using Mann Whitney U test.

Table 6.6. Mean scores, standard deviations, minimum and maximum scores of parental STEM involvement.

		M	SD	Min	Max
Parental STEM involvement	**STEM**	14.21	3.03	6.00	18.00
	Non-STEM	12.58	3.65	6.00	18.00

The data that again collected from 184 STEM students and 130 Non-STEM students were analyzed. In Table 6.6., descriptive statistics (mean scores, standard deviations, minimum and maximum scores of students) of parental STEM involvement that students reported were mentioned.

Mann-Whitney U test results showed that there is a statistically significant difference between in parental STEM involvement of participants *(z=-3.90, p< .001).* Students who choose STEM departments as a major have significantly higher parental STEM involvement *(Md=15.00, n=184)* than students who choose Non-STEM departments *(Md=12.00 n=130) U = 8886, z = -3.90, p < .001, r = .22.* Moreover, the r-value indicates medium effect using Cohen (1988) criteria.

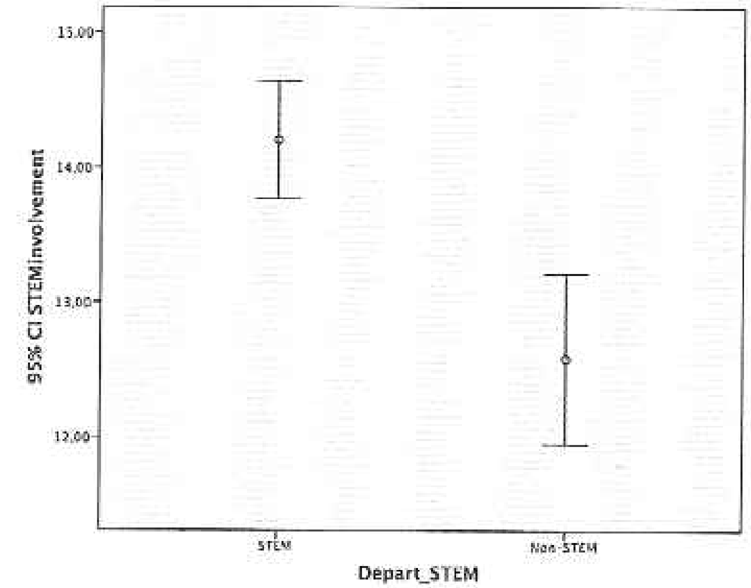

Figure 6.3. Confidence Intervals of Parental STEM Involvement for STEM and Non-STEM Students.

Graphical represantation of the data by comparing confidence intervals (95%) of students who choose STEM and Non-STEM departments was stated in Figure 6.3. The error bar chart in figure 6.3 showed that confidence intervals for students who choose STEM departments *(95% CI [13.77, 14.65]) and* students who choose Non-STEM *(95% CI [11.95, 13.22])* do not overlap. This proposed that there is a statistically significant difference between groups. In addition, there is a small distance between the upper bound of CI for Non-STEM *(13.22)* students and the lower bound of CI for STEM students *(13.75)*.

According to education background of family, mothers of 4% percent of students did not graduate any school. 27% graduated from primary school. 12% graduated from secondary school. 25% graduated from high school. 27% graduated from a university. 3% post graduated. Fathers of only 1% percent of students did not graduate from any school. 14% graduated from primary school. 9% graduated from secondary school. 26% graduated from high school. 38% graduated from a university. 7% post graduated.

Table 6.7. The percentage distribution of educational level of STEM and Non-STEM students' parents

	Mother Education Level %		**Father Education Level %**	
	STEM	**Non-STEM**	**STEM**	**Non-STEM**
Not graduated any school	4.35	3.85	1.63	0.77
Primary school	30.98	22.31	15.22	14.62
Secondary school	13.04	10.77	11.96	10.77
High school	24.46	26.15	27.17	24.62
University	23.91	33.08	36.41	41.54
Post graduated	3.26	3.85	7.61	7.69

The research question which investigates whether a statistically significant difference between participants who choose STEM and Non-STEM as a major regarding the parental educational level was analyzed by using chi-square test. A Chi-square test for independence indicated no significant association between mother educational level and choosing STEM or Non-STEM departments, χ^2 *(5, n = 314) = 4.93, p = .42, phi = .13.* A

Chi-square test for independence indicated no significant association between father educational level and choosing STEM or Non-STEM departments, χ^2 *(5, n = 314) = 1.27, p = .94, phi – .06.*

According to occupation of the family members, only 2.5% of students' mother work the job related with STEM. This number is 6% for fathers. Majority of students' family's jobs is not related with STEM departments such as police, civil servant, soldier, tourism professional etc.

Again, the research question which investigates whether a statistically significant difference between participants who choose STEM and Non-STEM as a major regarding the parental STEM occupation was analyzed by using chi-square test. A Chi-square test for independence indicated no significant association between mothers' STEM occupation and choosing STEM or Non-STEM departments χ^2, *(1, n = 314) – .00, p =1.00, phi – -.013.*

For both departments the number of parents' job whose job is related from Non-STEM is higher. A Chi-Square test for independence indicated no significant association between fathers' STEM occupation and choosing STEM or Non-STEM departments, χ^2 *(1, n = 314) – .00, p = 1.00, phi – -.004.*

6.4. Career Selection

The 24th question in the survey was prepared to investigate why STEM and Non-STEM students choose their departments as a major in the university. The means, standard deviations and medians of each item included in Question 24 presented in Table 6.8.

Table 6.8 shows that descriptive statistics of each item that assess the reasons of STEM and Non-STEM students choosing their departments as a major.

In Table 6.8. guidance and recommendation of other people are not playing important role for STEM and Non-STEM students while choosing their departments.

Both STEM and Non-STEM students chose their department with respect to items "Interest in the profession", "Being suitable for their personality", "Being suitable for future plans" and "Having a reputable profession". Furthermore, in what degree these items affect students' choice was analyzed. Firstly, 52.31% of Non-STEM students proposed that their interest in the profession totally affected their choice. This percentage ratio was 39.67% for STEM students. This percentage ratio was 39.67% for STEM students. However, 43.95% of Non-STEM students, 42.39% of STEM students stated that their ability through the profession was totally affected choosing their departments in the university. This ratio is nearly same for that Non-STEM students' interest was more effective than their abilities while choosing their departments.

Table 6.8. Means, Standard Deviations, and Medians of the each Item in Question 24

	STEM			Non-STEM		
	M	SD	Md	M	SD	Md
My interest in the profession	2.26	0.69	2.00	2.41	0.69	3.00
My university entrance exam score is enough to choose this department	2.11	0.73	2.00	2.12	0.74	2.00
Being suitable for my personality	2.39	0.67	2.00	2.54	0.62	3.00
High employment opportunities	2.04	0.73	2.00	1.90	0.84	2.00
Being suitable for my future plans	2.39	0.75	3.00	2.54	0.66	3.00
Being under the influence of people working on this area	1.99	0.81	2.00	2.08	0.83	2.00
Making a good profit	2.00	0.74	2.00	1.84	0.80	2.00
Having a reputable profession	2.06	0.76	2.00	1.90	0.78	2.00
The choice of area in high school	1.93	0.78	2.00	1.65	0.77	1.00
My ability through the profession	2.23	0.75	2.00	2.30	0.70	2.00
Being suitable for my gender	1.62	0.76	1.00	1.61	0.75	1.00
Being suitable to improve myself	2.35	0.72	2.00	2.58	0.67	3.00
Guidance of my family	1.54	0.67	1.00	1.41	0.62	1.00
Guidance of my teacher	1.47	0.65	1.00	1.32	0.55	1.00
Guidance of school counselor	1.36	0.64	1.00	1.30	0.57	1.00
Having better career in the occupation	1.95	0.80	2.00	2.02	0.81	2.00
Recommendatiton of family friend	1.37	0.64	1.00	1.24	0.51	1.00
Recommendation of relatives	1.26	0.57	1.00	1.17	0.45	1.00
Recommendation of my friends	1.42	0.63	1.00	1.35	0.57	1.00

Again, the number of Non-STEM students selecting the totally affected was higher than STEM students for the item which being suitable for their personality characteristics. 60.77% of Non-STEM students and 48.91% of STEM students stated this.

63.08% of Non-STEM students proposed that their choice was totally affected their future plans. 54.89% of STEM students indicated that being suitable for their future plans totally affected their choice of STEM. However, Non-STEM students' future plans were not making good profit. Since, making a good profit never affected 40.77% of Non-STEM students' choice of departments. Only 27.17% of STEM students stated making a good profit never affected their choice of STEM. 67.69% of Non-STEM students were totally affected for being suitable to improve themselves while choosing their departments. This ratio is 49.46 for STEM students.

6.5. High School STEM Score:

In this part, there are results about high school STEM score of STEM and Non-STEM students descriptively and inferentially.

Table 6.9. The percentages of minimum and maximum score in the courses and means, medians, standard deviations of the course scores.

	STEM			Non-STEM			TOTAL				
	M	Md	SD	M	Md	SD	Min%	Max%	M	Md	SD
Mathematics	4.70	5.00	0.57	4.45	5.00	0.98	0.96	71.06	4.56	5.00	0.86
Physics	4.38	4.00	0.67	4.08	4.00	1.06	0.73	46.91	3.75	4.00	1.61
Chemistry	4.54	5.00	0.70	4.19	5.00	1.03	1.09	59.27	3.87	5.00	1.67
Biology	4.55	5.00	0.61	4.21	5.00	1.01	0.00	50.32	3.88	5.00	1.64
Technology	3.12	4.00	2.24	4.75	4.00	2.29	2.12	69.31	2.74	4.00	2.32

The percentages of the students who get min and max score in the courses and means, medians, standard deviations of the course scores respectively for Non-STEM and STEM students and all students were indicated in Table 6.9.

In Turkey, according to assessment for high school, the maximum score is 5 and the minimum score is 1. The maximum score ranged from 85 to 100. The minimum score ranged from 0 to 44.

According to the data collected from participants, 3 students reported that they did not take the mathematics courses during the high school. However, in high school curriculum all students have to take mathematics courses during the high school at least at 9^{th} grade. Therefore, these 3 students were not included. In Table 6.9, mathematics scores were given Non-STEM students $(M=4.45, SD=0.98)$ and STEM students $(M=4.70, SD=0.57)$. 0.96% of all students, who took mathematics course in the high school, had minimum score, which is 1 (between 0-44). 71.06 % of all students, who took mathematics course in the high school, had maximum score that is 5 (between 85-100) $(M=4.56, SD=0.86)$.

There are 3 science courses in high school curriculum physics, chemistry, and biology. 39 students reported that they did not take these courses during high school. Again, in high school curriculum all students have to take science courses during the high school at least at 9^{th} grade. Therefore, these 39 students were excluded from the data. In Table 6.9, physics scores were given Non-STEM students $(M=4.08, SD=1.06)$, STEM students $(M=4.38, SD=0.67)$, and all students $(M=3.75, SD=1.61)$ For physics, 0.73% of all students got minimum score. 46.91% of them got maximum score.

In Table 6.9, chemistry scores were given Non-STEM students $(M=4.19, SD=1.03)$, STEM students $(M=4.54, SD=0.70)$ and all students $(M=3.87, SD=1.67)$. 0.96% of all students took minimum score in chemistry. 51.91% had maximum score.

In Table 6.9., biology scores were given Non-STEM students $(M=4.21, SD=1.901)$, STEM students $(M=4.55, SD=0.61)$ and all students $(M=3.88, SD=1.64)$. There is no student who took minimum score 1 in the course biology. 50.32% of all students took maximum score.

In technology courses, scoring is similar with mathematics. The range of the maximum score and minimum score is similar too. In Table 6.9, technology scores were given Non-STEM students $(M=4.75, SD=2.29)$, STEM students $(M=3.12, SD=2.24)$ and all students *(M=2.74, SD=2.32)*. 42.36% of all students did not take any technology courses during the high school. 2.12 % of students, who took course about technology in the high school, had minimum score. 69.31 % of students, who took technology course in the high school, had minimum score.

During the high school, only 12% of participants (n=39) attended the project about science, mathematics, technology or engineering. A huge amount of majority has never attended these kinds of projects in high school.

The research question 5 aims to investigate whether there is a statistically significant difference in high school STEM score between university students who choose STEM and Non-STEM departments as a major. Associated with the research questions, high school STEM score mean scores of STEM and Non-STEM students were compared by using Mann-Whitney U test.

Table 6.10. Means, standard deviations, minimum and maximum STEM scores of STEM and Non-STEM students.

		M	*SD*	Min	Max
High school STEM score	**STEM**	18.18	2.05	8.00	20.00
	Non-STEM	16.92	3.62	5.00	20.00

In Table 6.10, mean scores, standard deviations, minimum and maximum scores of high school STEM courses scores of 182 STEM students and 91 Non-STEM students were mentioned.

A Mann-Whitney U Test revealed no significant difference in the high school STEM score of STEM students *(Md = 19.00, n =182)* and Non-STEM students *(Md = 18.00 n = 91)*, *U = 7171.50, z = −1.87, p = .06, r = .11*. Since the r-value is .03, this showed a small effect size using Cohen (1988) criteria of .1=small effect.

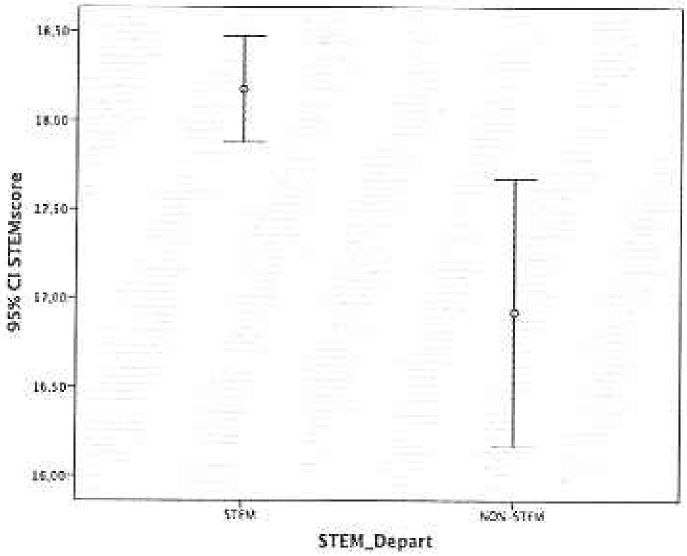

Figure 6.4. Confidence Intervals of High School STEM Score for STEM and Non-STEM students.

Graphical represantation of the data by comparing confidence intervals (95%) of students who choose STEM and Non-STEM departments was stated in Figure 6.4. The error bar chart in Figure 6.4. showed that confidence intervals for students who choose STEM departments *(95% CI [17.88, 18.48])* and students who choose Non-STEM *(95% CI [16.17, 17.68])* do not overlap nearly. This proposed that there is a statistically difference between groups but not significant. In addition, there is a small gap between the upper bound of CI for Non-STEM *(17.68)* students and the lower bound of CI for STEM students *(17.88)*

Figure 6.4. showed that Non-STEM students STEM scores differs in the group largely; there is a large gap between upper and lower bounds of Non-STEM students. So, a deeper examination of Non-STEM students scores revealed that there are 35 students in Non-STEM departments who took maximum scores both mathematics and science courses. Therefore, Mann-Whitney U test was applied to compare high school STEM score mean scores of STEM and Non-STEM students (excluding 35 students) again.

A Mann-Whitney U Test revealed significant difference in the high school STEM score of STEM students *(n =182)* and Non-STEM students (excluding 35 students) *(n = 56), U = 2026.50, z = -6.94, p = .00, r = .45.* Since the r value is .45, this showed almost large effect size using Cohen (1988) criteria.

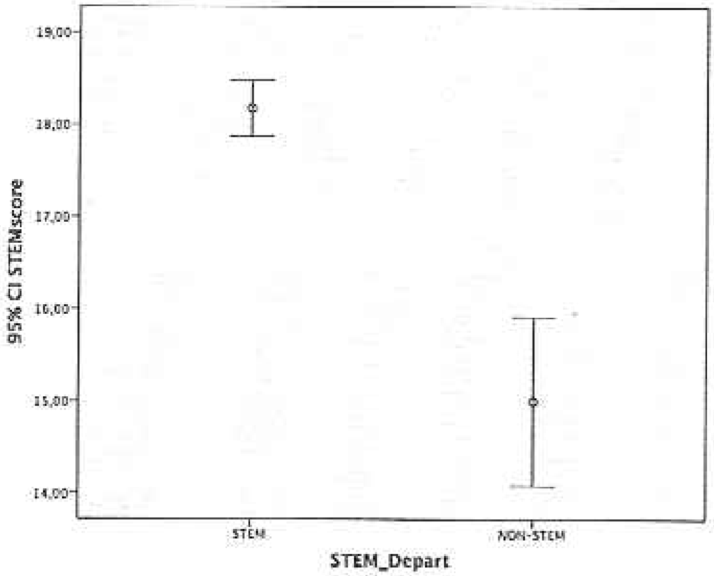

Figure 6.5. Confidence intervals of high school STEM score for STEM and Non-STEM students (excluded 35 students).

Graphical represantation of the data by comparing confidence intervals (95%) of students who choose STEM and Non-STEM departments (excluded 35 students) was stated in figure 6.5.

The error bar chart in figure 6.5 showed that confidence intervals for students who choose STEM departments and students who choose Non-STEM (excluding 35 students) do not overlap. This proposed that there is a statistically significant difference between groups. In addition, there is a gap between the upper bound of CI for Non-STEM students and the lower bound of CI for STEM students.

7. DISCUSSION AND CONCLUSION

The aim of this research is to investigate the factors affecting students STEM or Non-STEM choices. Based on the literature, five variables that could affect students' choices were identified. The variables investigated in this study are gender, self-efficacy, parental variables (i.e., parental STEM involvement, parents' educational background and parents' occupation), career selection factors and academic score (Hackett and Betz, 1981; Ybarra, 2016; Moakler, and Kim, 2014; Harackiewicz *et al.*, 2012; TUSIAD, 2014).

In this chapter, the results are discussed in three main parts. These parts are organized by combining the variables, which yielded similar findings in the results section. That is, the first one is Gender and Career Selection, the second one is STEM Self-Efficacy and Parental Variables, and the last one is High School STEM Score.

7.1. Gender and Career Selection

In the literature, the number of girls choosing STEM fields is usually less than boys. For example, in the U.S. female students who attend STEM departments are nearly half of the male students (My College Options, 2012). Not only in the U.S. but also in Turkey the sitation is almost the same. 64% of total STEM workers is men, and only 34% is composed of women (TUSIAD, 2014). One of the aims of the present study is to understand whether gender is a factor that affects students' choice of STEM or Non-STEM, or not.

In this research, 47.1% (n=148) of the participants are male, 52.9 % (n=166) of the participants are female. 51.1% of STEM students are female and 48.9% of STEM students are male.

Table 7.1. The number and the percentage of female and male students in STEM and Non-STEM departments

	STEM	Non-STEM
Female	51,1% (n= 94)	55,4% (n= 72)
Male	48,9% (n= 90)	44,6% (n= 58)
Total	100% (n=184)	100% (n=130)

U.S. National Science Foundation, National Center for Science and Engineering Statistics (2013) stated that females are not interested in the STEM fields as a career. Bergeron and Gordon (2017) analyzed 355.688 secondary female and male students. They proposed that female students less frequently attend the higher level of STEM courses than male students. Ybarra (2016) also investigated the reasons of lack of interest of girls in STEM fields in the high school. There can be some historical, educational, biological, cultural, and social reasons for females' low ratios of tending to STEM fields. However, in the present study, no gender gap was found between choosing STEM departments as a major or not. The percentages of female and male students choosing STEM are close to each other.

Moreover, the results showed that there is no significant difference between gender and choosing STEM or Non-STEM departments contradict to the literature. This may be because the university in this study is one of the high-ranking universities and only students who get high points in the University Entry Exam can get accepted. So, participants in the present research consist of high achieving students. In this research, high achieving students mean that the students who took high scores in the University Entrance Exam. It may be concluded that considering the profile of learners such as high achieving students, females do not less frequently tend to STEM departments than males.

The inconsistent results between the literature and the present study might be that previous studies were not conducted with only high achieving students. Indeed, these were done with all types of students attending secondary and high schools. However, the present study was done only with high achieving students who are already graduated from high school in Turkey and get accepted for a high-ranking state university. This may explain why there is no significant association between gender and choosing STEM or Non-STEM departments in this study. For high achieving females, there is no problem in entering STEM departments. In high school or maybe before the high school, the problem might come into existence. Moakler and Kim (2014) pointed that to increase the number of females choosing STEM departments, it is necessary to encourage, motivate and help them to improve their self-efficacy in mathematics during the high school. Therefore, this present research calls for further research to investigate what is needed in the high school for female students to encourage them to choose STEM fields.

In addition to gender factors, this study also aimed to investigate the effect of the factors reported by students for their career selections as a STEM or Non-STEM. It was noticed that STEM and Non-STEM students' reports about which factors affect their choices are similar. In present research, STEM and Non-STEM students reported that "guidance and recommendation of family and other people" do not play an important role in their choice of future departments. When a person chooses his/her profession according to her/his abilities, interests and wishes, s/he has a chance to be successful, efficient and happy. Therefore, people need to take into consideration their own characteristics in the process of choosing a profession (Yanıkkerem *et al.*, 2004). In similar vein, Sarikaya and Khorshid (2009) conducted a research in Turkey with 1000 preparatory students in Ege University. The reasons of students who choose social studies to attend the university were being more talented and more interested in these fields, making their dreams come true, being and being happy. However, the reasons of students who choose science-based departments were stated as having an occupation, advising of others, and their scores in University Entrance Exam. This finding is contradicting to the present research. In this study, both STEM and Non-STEM students chose their departments with respect to items "Interest in the profession", "Being suitable for their personality", "Being suitable for future plans" and "Having a reputable profession". Furthermore, not only preparatory students in social studies but also preparatory students in science-based departments proposed that the reasons of their choice are their interest and personality rather than the guidance of others or just the sake of getting an occupation. When the reason why they chose this university and department is asked to them, students' answers are similar both for STEM and Non-STEM students.

Taken together, the present research revealed that gender and career selection factors mentioned by the participants did not significantly affect their major choices as either STEM or Non-STEM. Participants in this study were composed of high-achieving studentswho took high scores in the University Entrance Exam. Before the research, one of the requirements of being a participant was to be able to choose either STEM or Non-STEM majors as a career. While investigating the factors affecting the choice of STEM or Non-STEM departments, there was no difference between STEM and Non-STEM students regarding to gender and career selection factors. Therefore, to understand why some of the students choose STEM or Non-STEM departments in present study, the other variables that are STEM self-efficacy, parental variables such as parental occupation, parental educational level, and involvement and academic score were examined.

7.2. STEM Self-Efficacy and Parental Variables

Another aim of this research was to investigate whether there is a statistically significant difference between students who choose STEM and Non-STEM majors as a career in terms of their STEM self-efficacy. Bandura (1977) asserted that self-efficacy is a kind of belief about to be able to achieve something in specific situations. Concannon and Barrow (2009), and Lusby (2012) stated that there could be a relation between self-efficacy and career choosing of students. In addition, Hackett and Betz (1989) stated that there was a strong relationship between choosing mathematics-based career and self-efficacy beliefs. Parallel to the literature, in present research, students who chose STEM departments as a major were found to have significantly higher STEM self-efficacy than students who choose Non-STEM departments.

Aforementioned Bandura's self-efficacy definition depends on four different sources; mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states. Mastery experiences are shaped with experiences and performances. According to the present research, the number of STEM students was almost two times of the number of Non-STEM students who stated that they got never bored during STEM topics. Similarly, they never used to feel uncomfortable in STEM courses. Therefore, their experiences about the high school STEM courses and STEM topics may be an explanation of why Non-STEM students' STEM self-efficacy is lower than STEM students' STEM self-efficacy. STEM students' STEM self-efficacy may be developed during the pre-college STEM course experiences.

As for the parental variables, 1966 Coleman report stated that the family background is the most important thing that affects student achievement (Ornstein, 2010). Similarly, Harackiewicz, Rozek, Hulleman and Hyde (2012) proposed that education level of parents has a direct relationship with the number of STEM courses their children take. As such, parents' education level affects students' motivation about taking STEM courses. Highly educated parents' children study more mathematics and science courses in high school (Harackiewicz *et al.*, 2012). Inspite of these findings, in this research, Chi-square test for independence indicated no significant difference between mother and father educational level and choosing STEM or Non-STEM departments. There may be two explanations of that finding, the first one could be that the educational level of parents is not important for high achieving students. The second one could be that the data from parents' educational level is not normally distributed enough to draw conclusions. According to education background of family, mothers of only 4% percent of students did not graduate from any school, while 27% graduated from primary school, 12% graduated from secondary school, 25% graduated from high school, 27% graduated from a university, and 3% continued with postgraduate studies. Fathers of only 1% percent of students did not graduate from any school, while 14% graduated from primary school, 9% graduated from secondary school, 26% graduated from high school, 38% graduated from a university, and 7% continued with post-graduate education.

Moakler and Kim (2014) claimed that if parents have occupations related with STEM, the ratio of students to choose a STEM field as a career gets increased. Students with "parental STEM occupation" tend to choose STEM 50% more commonly than others. Children understand the importance of STEM with parents' mentoring to them for STEM related occupations (Moakler and Kim, 2014). On the other hand, study of Staniec (2004) showed that there is no relation between parental STEM occupation and students' choices of STEM. Therefore, in this perspective, there is no consensus on studies. In the present research, one of the aims was to investigate whether there is a difference between chosing STEM and Non-STEM departments with respect to parental STEM occupation. No significant difference between mothers' and fathers' STEM occupation and choosing STEM or Non-STEM departments was found. However, in this research, most of the students' family's jobs do not related with STEM areas. Most of them is police, civil servant, soldier, tourism professional etc. For example, only 2.5% of students' mothers work in a job related with STEM. This number is 6% for fathers. Due to the fact that those numbers are low for the sample, it will be hard to compare statistically. It was found that there is no difference between choosing STEM and Non-STEM departemants regarding parental education level and parental STEM occupation because of some of the limitations.

As naturally expected, parents have an important role on students' educational life. Cotton and Wikelund (2005) discussed that parents' involvement affect students' achievement positively. When parents encourage their children in school activities, make plan for them, help their lessons, and work with their teachers in collaboration, then students become more engaged with school, and their school performance gets high. The 13^{th} and 18^{th} items in Appendix F showed that guidance of family and relatives do not play an important role for STEM and Non-STEM students while choosing their departments. Their means are low when compared with the other items affecting choosing departments for both STEM and Non-STEM students. According to this study, parents' educational level, parental STEM occupation, and guidance of parents did not affect students' choice of STEM or Non-STEM departments as a major explicitly. However, implicitly, parents were found to guide students to STEM areas. Since, in the present research, it was found that there is a statistically significant difference between parental STEM involvement of participants. Students who choose STEM departments as a major have significantly higher parental STEM involvement than students who choose Non-STEM departments. These results mean that actually parents affect students' choice of STEM, but not explicitly. They encourage, motivate, and offer experience to their children. This may be better explained with Eccles' model (ECCLES, 2009). According to Eccles' model, there are three different task values; intrinsic value, utility value and attainment value. Utility value is taken place for a person since his/her other part of life has a direct relationship with it (Eccles, 2009). This model shows the effects of parents' approach about children's future and values. Parents can lead their children to take STEM course according to what they think is the best for their children. Parents' behavior affects children's approach of utility value about STEM courses. Morever, in the present study, 30% of students in Non-STEM departments' parents did not support their children on STEM activities. Only 15% of STEM students' parents did not support their children on STEM activities. 59.78% of students in STEM departments and 30% of students in Non-STEM departments stated that their parents supported them doing career in STEM areas. Therefore, even though they reported guidance of their family, educational level of parents and parental STEM occupation are not effective while choosing their departments actually their parents affect their choice implicitly.

7.3 High School STEM Score

Lastly, one of the aims of the present research was to investigate whether there is a statistically significant difference between students who choose STEM and Non-STEM major as a career in terms of their high school STEM score. STEM score was defined as the score taken in mathematics and science courses during their high school education.

According to the results of PISA, Turkey's score is below average, and it is among the worst OECD countries. Test scores in domestic and international level indicated that Turkish students are not successful in main two discipline of STEM; Science and Mathematics (Akgündüz, *et al.* 2015). However, in the present research, the average of the Non-STEM students' mathematics score is 4.45 and STEM students' is 4.70 out of 5. These scores do not reflect a big difference for the science courses. This indicates that both STEM and Non-STEM students got high grades in mathematics and science courses in high school. That's why, these students in this research were called high achievers. Moakler and Kim (2014) stated that according to the responses from 335.842 students in the U.S; high school GPA and SAT score was found to be a significant positive indicator that affects students' tendency of studying STEM. Students with higher GPA are most likely to choose a STEM area as well. However, in the present research, there is no significant difference between STEM students and Non-STEM students with respect to theirSTEM scores at high school.

Graphical represantation of the data by comparing confidence intervals (95%) of students who choose STEM and Non-STEM departments was stated in Figure 7.1.

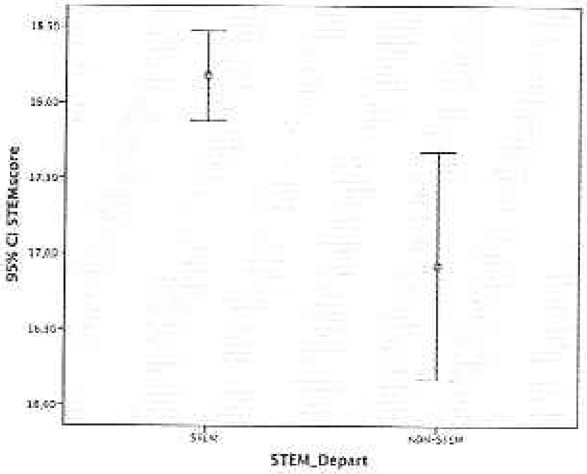

Figure 7.1. Confidence intervals of high school STEM score for STEM and Non-STEM students.

Not significant difference may be explained by large interval of Non-STEM students. In order to examine further these non-difference participants, STEM scores were depicted to see distribution. Figure 7.1 shows that Non-STEM students STEM scores differs in the group largely; there is a large gap between upper and lower bounds. So, a deeper examination of Non-STEM students scores revealed that there are 35 students in Non-STEM departments who took maximum scores both mathematics and science courses. When it was examined the departments of these students only three of them chose Non-STEM departments without mathematics, namely; philosopy and history. The others (n = 32) chose the departments, which are management, economy, international trade and etc. In other words, they chose mathematics related departments. When they were excluded from the data, paralel to the literature, there is a significant difference between STEM and Non-STEM students regarding to high school STEM score. Furthermore, these students' answers about the factors affecting their departments' choice was examined which found to be similar to Non-STEM students. However, some items such as "My university entrance exam score is enough to choose this department", "High employment opportunities", "Making a good profit" and "Being a reputable profession" were selected by these 35 students much more than Non-STEM students. They were different from Non-STEM students with respect to these items. This may be an explanation of why these 35 students chose Non-STEM departments.

The aim of this research was to investigate the factors affecting students STEM or Non-STEM choices. In this chapter, these factors were discussed in three main parts. To know the factors is important to increase the number of students who choose STEM departments. According to Zhang (2011), the initial thing to do is to understand the factors affecting students in choosing or not choosing STEM majors before trying to solve the problems in producing strong manpower in these fields and strengthening economy. Then, governments, teachers and families work together to increase the number of students in STEM fields by knowing these factors.

As a conclusion, because no differences in gender were found in the present study, governments should still continue to encourage not only females but also males to study in the STEM fields. In addition to this, to encourage parents to motivate their children to choose STEM fields may be another way to increase the number of students who choose STEM career.

8. LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

In this part, the limitations of the present study and suggestions for further research will be presented. The present reseach was purposefully conducted with the students from one of the high-ranking public universities in Turkey. Therefore, making a generalization may not be possible for other students and other universities in Turkey. That's why, in future, a research could be done with both public and private universities including all types of students.

One of the aims is to investigate whether there is a difference between chosing STEM and Non-STEM departments with respect to parental STEM occupation or not. However, in this research, most of the students' family's jobs were not related with STEM areas. Only 2.5% of students' mothers work in a job related with STEM. This number is 6% for fathers. In addition, there is no spread distribution for parents' educational level to compare this factor in statisctical terms. Therefore, it may be found that there is no difference between choosing STEM and Non-STEM departments regarding parental education level and parental STEM occupation because of this limitation. Therefore, it could be good if the number of participants gets increased in further studies. In addition, to get a better understanding of non-significant differences in this study, qualitative research and mixed study designs may be carried out.

While investigating the relationship between parental involvement and choosing STEM departments, parental involvement data was self-reported of the students. Students answered the parental involvement items in the survey. So, the given information may not completely reflect the reality. It more reflected the perspective of students. Actually, for parental involvement, parents' ideas should have been also taken into consideration. This was another limitation of this sudy.

Also, another limitation of this study is that again self-reported of students in high school STEM score was taken. While answering the questions, it is possible that students may not remember their scores or may give wrong information about their scores.

Moreover, to collect the data about high school STEM score, it may be good also to analyze the STEM scores in University Entrance Exam.

In this research, 35 students whose grades were maximum appeared, but they did not choose STEM departments, so a post-study of that research may investigate why these types of students choose Non-STEM departments using qualitative methods. To sum up, this kind of a study may be administered in all the universities in Turkey to obtain a more holistic picture of the factors affecting students' choice of STEM.

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APPENDIX A: A SURVEY OF FACTORS AFFECTING STUDENTS' STEM CHOICES AS A MAJOR

1. Cinsiyetiniz

KADIN	ERKEK

2. Yaşınız ....

3. Anadiliniz ....

4. Okuduğunuz bölüm: ....

5. Liseden mezun olduğunuz yıl: ....

6. Mezun olduğunuz lise türünü belirtip ismini yazınız.

Lise Türü	Lise Adı
Fen Lisesi	
Anadolu Lisesi	
Meslek Lisesi	
Yabancı lise	
Azınlık lisesi	
Özel lise	
Diğer	

7. Liseden mezun olurken ortalamanızın kaç olduğunu yazınız.

	Bu dersi almadım	Başarısız 0-44	Geçer 45-54	Orta 55-69	İyi 70-84	Pekiyi 85-100
a) Liseden mezun olurken Matematik ortalamanız kaçtı?		1	2	3	4	5
b) Liseden mezun olurken Fizik ortalamanız kaçtı?		1	2	3	4	5
c) Liseden mezun olurken Kimya ortalamanız kaçtı?		1	2	3	4	5
d) Liseden mezun olurken Biyoloji ortalamanız kaçtı?		1	2	3	4	5
e) Liseden mezun olurken Türkçe ortalamanız kaçtı?		1	2	3	4	5
f) Liseden mezun olurken teknoloji ile ilgili derslerden ortalamanız kaçtı?		1	2	3	4	5

8. Daha önce fen veya matematik projelerinde görev aldınız mı?

Evet	Hayır

Cevabınız evet ise kısaca açıklayınız

....
....
....

Figure A.1. 26 Questions in The Survey of Factors Affecting Students' STEM Choices As A Major

9. Aşağıdakilerin herhangi birinden destek (özel ders, dersane vb.) aldınız ya da dersi tekrarladıysanız belirtiniz.

	Destek aldım	Dersi tekrarladım
Türkçe		
Matematik		
Sosyal Bilimler		
Fen Bilimleri		
Yabancı Diller		

10. Lisede aşağıdaki durumların hangilerinde ve ne kadar sıklıkla bulundunuz.

	Hiçbir zaman	Ara sıra	Sık sık
FETEMM derslerinde sıkılırdım.			
FETEMM konularında başka öğrencilere ders anlatırdım.			
FETEMM konularında başka öğrencilerle beraber çalışırdım.			
FETEMM ile ilgili yaptığım her işte üstesinden gelebileceğimi hissederdim.			
FETEMM derslerinde kendimi kötü hissettim.			
Ders dışı FETEMM etkinliklerine katıldım.			
FETEMM derslerinden sonra öğretmene bir şeyler sorardım			

11. Aşağıdaki yeteneklerde kendinizi nasıl gördüğünüzü belirtiniz.

	Çok kötü	Kötü	Orta	İyi	Çok iyi
Akademik beceri					
Sanatsal beceri					
Bilgisayar becerisi					
Grup halinde çalışma					
Yaratıcılık					
Başarıya ulaşmak					
Duygusal sağlık					
Matematik yeteneği					
Fen yeteneği					
Mühendislik yeteneği					
Toplum önünde konuşabilme					
Entelektüel özgüven					
Sosyal özgüven					
Diğerlerini anlama					

Figure A.1. 26 Questions in The Survey of Factors Affecting Students' STEM Choices As A Major (cont.)

12 Aşağıdaki durumlara katılım durumunuzu belirtiniz.

	Hiç katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Tamamen katılıyorum
Fen testlerini iyi yapabileceğime eminim					
Bir FETEMM kavramını anlamadığımda genelde vazgeçerim.					
Benim için fen kolaydır.					
Çok denememe rağmen FETEMM konularını anlayamıyorum.					
FETEMM konularında başarılı olabileceğim konusunda kendime güveniyorum.					
Eğer yeterince çalışırsam , zor FETEMM kavramlarını öğrenebilirim.					
İyi bir problem çözme yeteneğine sahibim.					
Problem çözerken iyiyim.					

13. Aile durumunuzu belirtiniz

Hayatta ve evli	
Hayatta ve boşanmış	
Birisi ya da ikisi de hayatta değil	

14. Ailenizin eğitim durumunu belirtiniz.

	Anne	Baba
Herhangi bir okul mezunu değil		
İlkokul mezunu		
Ortaokul mezunu		
Lise mezunu		
Üniversite mezunu		
Yüksek lisans veya doktora mezunu		

15. Annenizin mesleğini yazınız. ....

16. Babanızın mesleğini yazınız. ....

Figure A.1. 26 Questions in The Survey of Factors Affecting Students' STEM Choices As A Major (cont.)

17. Ailenizin lise döneminde aşağıdaki durumlara katılımını belirtiniz

	Hiçbir Zaman	Ara Sıra	Sık Sık
Benim gelişimim hakkında öğretmenlerimle konuşur.			
Okul görüşmelerine ve veli toplantılarına katılır.			
Okulun sosyal aktivitelerine (konser, tiyatro, spor etkinlikleri vb.) katılır.			
Okulda düzenlenen etkinliklere (projeler,geziler, konser, tiyatro ve spor) yardımcı olur.			
Ev ödevlerimi yaparken bana destek olur.			
Sınavlarıma hazırlanırken bana destek olur.			
FETEMM konularındaki çalışmalarımda bana destek olur.			
FETEMM konularında çalışmam için beni cesaretlendirir.			
FETEMM konularında en iyisini yapmamı bekler.			
FETEMM konularına önem verir.			
Ders dışı FETEMM etkinliklerine katılmamı destekler.			
FETEMM alanında kariyer yapmak için beni destekler.			

18 Daha önce başka bir üniversitede veya bölümde bulundunuz mu? Bulunduysanız üniversite adını ve bölümünü yazınız.

....

19 Üniversitede okuduğunuz bölüm kaçıncı tercihiniz olduğunuzu yazınız.

....

20 Üniversiteye girdiğiniz puan türünüzü ve puanınızı yazınız.

....

21 Bölüm ya da üniversite değiştirmek istiyorsanız belirtiniz.

Evet istiyorum	Hayır istemiyorum

22 Çalışmayı planladığınız alan/meslek/sektör okuduğunuz bölümden farklı ise nedeni ile birlikte belirtiniz.

23 Ulaşmayı hedeflediğiniz eğitim derecesini seçiniz.

Lisans	
Lisansüstü	
Doktora	
Diğer	

Figure A.1. 26 Questions in The Survey of Factors Affecting Students' STEM Choices As A Major (cont.)

24 Bu bölümü seçmenizde etkili olan faktörleri ve derecelerini belirtiniz.

	Tamamen etkili	Kısmen etkili	Etkili değil
Mesleğe olan ilgim			
Üniversiteye giriş sınav puanımın bu bölüme yetmesi			
Bu alanın benim kişilik özelliklerime uygun olduğunu düşünmem			
İş bulma olanağının yüksek olması			
Gelecekle ilgili amaçlarıma uygun olması			
Bu alanda çalışan kişilerden etkilenmem			
İyi bir kazanç sağlayabileceğini düşünmem			
Prestijli bir meslek olması			
Lisedeki alan tercihim			
Mesleğe olan yeteneğim			
Cinsiyetime uygun olması			
Alanın kendimi geliştirmeme olanak tanıması			
Anne/babamın yönlendirmesi			
Öğretmenlerimin yönlendirmesi			
Okul psikolojik danışmanı/rehber öğretmenimin yönlendirmesi			
Meslekte yükselme olanaklarının fazla olması			
Aile dostlarımızın tavsiye			
Diğer akrabalarımın tavsiye			
Arkadaşlarımın tavsiye			

25 Bu üniversiteyi seçmenizde etkili olan faktörleri ve derecelerini belirtiniz.

	Tamamen etkili	Kısmen etkili	Etkili değil
Üniversiteye giriş sınav puanımın bu üniversiteye yetmesi			
Bu üniversitenin benim kişilik özelliklerime uygun olduğunu düşünmem			
Üniversitenin kendimi geliştirmeme olanak tanıması			
Üniversitenin ailemle yaşadığım yere yakın olması			
Bu şehirde yaşamanın cazip gelmesi			
Üniversitenin eğitsel, sosyal ve kültürel olanakları			
Üniversitenin popülerliği			
Üniversitenin yabancı dil eğitimi vermesi			
Üniversitenin burs olanakları			
İş bulma olanağının yüksek olması			
Anne/babamın yönlendirmesi			
Öğretmenlerimin yönlendirmesi			
Okul psikolojik danışmanı/rehber öğretmenimin yönlendirmesi			
Aile dostlarımızın tavsiye			
Diğer akrabalarımın tavsiye			
Arkadaşlarımın tavsiye			

26 ÖSYS sonucuna göre kazanabileceğiniz diğer bölümler yerine bu bölümü tercih etme sebebinizi belirtiniz.

....

....

TEŞEKKÜRLER...

Figure A.1. 26 Questions in The Survey of Factors Affecting Students' STEM Choices As A Major (cont.)

APPENDIX B: THE PERCENTAGE DISTRIBUTION OF ALL, STEM AND NON-STEM STUDENTS FOR EACH ITEM IN QUESTION 10

Table B.1. The Percentage Distribution of All, STEM and Non-STEM Students for Each Item in Question 10 in the Survey

	ALL			Non-STEM			STEM		
	Never	Sometimes	Often	Never	Sometimes	Often	Never	Sometimes	Often
I was bored during STEM topics.	10.83	60.51	28.66	17.69	66.15	16.15	36.41	56.52	7.07
I used to do peer tutoring on STEM topics	13.69	60.83	25.48	26.92	57.69	15.38	4.35	63.04	32.61
I used to study with other students on STEM topics	16.88	61.46	21.66	20.77	54.62	24.62	14.13	66.30	19.57
I used to feel that I can overcome all STEM related task.	13.69	39.81	46.5	27.69	47.69	24.62	3.80	45.65	50.54
I used to feel uncomfortable in STEM courses.	55.41	40.76	3.82	37.69	53.85	8.46	67.93	31.52	0.54
I used to attend out of class STEM activities	42.99	48.09	8.92	53.85	41.54	4.62	35.33	52.72	11.96
After STEM courses, I used to ask questions to my teacher.	13.06	59.24	27.71	18.46	57.69	23.85	9.24	60.33	30.43

APPENDIX C: THE PERCENTAGE DISTRIBUTION OF ALL STUDENTS FOR EACH ITEM IN QUESTION 12

Table C.1. The Percentage Distribution of All Students for Each Item in Question 12 in the Survey

	ALL				
	Strongly disagree	**Disagree**	**Neither**	**Agree**	**Strongly agree**
I am sure I can do well on science tests	4.46	9.87	25.16	47.77	12.74
I usually give up when I do not understand a STEM concept.	20.38	49.68	19.11	8.60	2.23
I have good problem solving skills.	0.64	6.37	15.29	55.10	22.61
I cannot understand STEM even if I try hard.	36.94	46.50	10.51	4.46	1.59
I am confident that I can be successful in STEM.	1.27	6.05	17.20	50.64	24.84
If I work hard enough, I can learn difficult STEM concepts	0	1.27	10.19	49.68	38.85
Science is easy for me.	3.18	13.06	37.90	31.85	14.01
I am good at solving problems.	0.96	2.55	15.29	52.55	28.66

APPENDIX D: THE PERCENTAGE DISTRIBUTION OF NON-STEM STUDENTS FOR EACH ITEM IN QUESTION 12

Table D.1. The Percentage Distribution of Non-STEM Students for Each Item in Question 12 in the Survey

	Non-STEM				
	Strongly disagree	**Disagree**	**Neither**	**Agree**	**Strongly agree**
I am sure I can do well on science tests	9.23	20.77	33.85	30.77	5.38
I usually give up when I do not understand a STEM concept.	11.54	47.69	22.31	16.15	2.31
I have good problem solving skills	0	12.31	13.08	51.54	23.08
I cannot understand STEM even if I try hard.	25.38	46.92	20.00	6.92	0.77
I am confident that I can be successful in STEM.	2.31	13.08	29.23	43.85	11.54
If I work hard enough, I can learn difficult STEM concepts	0.00	1.54	17.69	52.31	28.46
Science is easy for me.	6.92	23.08	46.15	18.46	5.38
I am good at solving problems.	2.31	5.38	16.92	51.54	23.85

APPENDIX E: THE PERCENTAGE DISTRIBUTION OF STEM STUDENTS FOR EACH ITEM IN QUESTION 12

Table E.1. The Percentage Distribution of All Students for Each Item in Question 12 in the Survey

	STEM				
	Strongly disagree	**Disagree**	**Neither**	**Agree**	**Strongly agree**
I am sure I can do well on science tests	1.09	2.17	19.02	59.78	17.93
I usually give up when I do not understand a STEM concept.	26.63	51.09	16.85	3.26	2.17
I have good problem solving skills.	1.09	2.17	16.85	57.61	22.28
I cannot understand STEM even if I try hard.	45.51	46.20	3.80	2.72	2.17
I am confident that I can be successful in STEM.	0.54	1.09	8.70	55.43	34.24
If I work hard enough, I can learn difficult STEM concepts	0.00	1.09	4.89	47.83	46.20
Science is easy for me.	0.54	5.98	32.07	41.30	20.11
I am good at solving problems.	0.00	0.54	14.13	53.26	32.07

APPENDIX F: THE PERCENTAGE DISTRIBUTION OF ALL, STEM AND NON-STEM STUDENTS FOR EACH ITEM IN QUESTION 24

Table F.1. The Percentage Distribution of All, STEM and Non-STEM Students for Each Item in Question 24 in the Survey

	All			Non-STEM			STEM		
	Never affected	Affected	Totally affected	Never affected	Affected	Totally affected	Never affected	Affect ed	Totally affected
My interest in the profession	13.06	42.04	44.90	11.54	36.15	52.31	14.13	46.20	39.67
My university entrance exam score is enough to choose this department	21.66	45.22	33.12	22.31	43.85	33.85	21.20	46.20	32.61
Being suitable for my personality characteristics	8,2	37.26	53.82	6.92	32.31	60.77	10.33	40.76	48.91
High employment opportunities	3.53	38.85	29.62	40.77	28.46	30.77	25.0	46.20	28.80
Being suitable for my future plans	1.38	28.34	58.28	9.23	27.69	63.08	16.30	28.80	54.89
Being under the influence of people working on this area	3.85	33.44	34.71	30.00	31.54	38.46	33.15	34.78	32.07
Making a good profit	3.80	41.08	26.11	40.77	34.62	24.62	27.17	45.65	27.17
Being a reputable profession	29.62	41.40	28.98	35.38	39.23	25.38	25.54	42.93	31.52
The choice of area in high school	42.04	34.39	23.57	53.08	28.46	18.46	34.24	38.59	27.17
My ability through the profession	16.88	40.13	42.99	13.85	42.31	43.85	19.02	38.59	42.39
Being suitable for my gender	55.10	28.34	16.56	55.38	28.46	16.15	54.89	28.26	16.85
Being suitable to improve myself	12.74	30.25	57.01	10.00	22.31	67.69	14.67	35.87	49.46
Guidance of my family	59.87	31.53	8.0	66.15	26.92	6.92	55.43	34.78	9.78
Guidance of my teacher	65.61	27.71	6.69	71.54	24.62	3.85	61.41	29.89	8.70
Guidance of school counselor	73.57	19.11	7.32	75.38	19.23	5.38	72.28	19.02	8.70
Better chance for promotion	33.44	35.35	3.21	31.54	35.38	33,08	34.78	35.33	29.89
Recommendatiton of family friend	75.16	18.15	6.69	80.00	16.15	3,85	71.74	1957	8.70
Recommendation of relatives	82.80	12.10	5.10	86.15	10.77	3,08	80.43	13.04	6.52
Recommendation of my friends	67.20	26.43	6.37	70.00	25.38	4,62	65.22	27.17	7.61