T.C.

YEDITEPE UNIVERSITY

INSTITUTE OF EDUCATIONAL SCIENCES

MASTER’S PROGRAM IN CURRICULUM AND INSTRUCTION

INVESTIGATION OF STUDENTS’ ATTITUDES TOWARDS STEM AND THE RELATIONSHIPS WITH CAREER PREFERENCES

BY

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ABSTRACT

INVESTIGATION OF STUDENTS' ATTITUDES TOWARDS STEM AND THE RELATIONSHIPS WITH CAREER PREFERENCES

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The purpose of this study is to investigate the influence of some variables on high school students' attitudes towards STEM and the relationship between the high school students' attitudes towards STEM and STEM-related career choices.

The research was conducted across ten high schools in five different types on 1161 students in those schools. The data were gathered by the "STEM Attitude Scale" developed by Faber et al. (2013) and the "STEM Career Interest Form" according to the courses in Turkish universities, developed by the researcher. In this study, quantitative research methods were used. Arithmetic Mean, Standard Deviation, Frequency, Percentage, One-Sample T-Test, ANOVA, and Correlation were employed to analyze the data of the research.

It was seen that high school students' attitudes towards STEM are generally "positive". Furthermore, attitudes for all students towards 21st-century skills and engineering components are more positive than science and mathematics components. Overall, male students had higher attitudes towards STEM than female students. In engineering component, male students had higher; while in 21st-century skills component, female students had higher scores. In STEM Career Interest Survey, the STEM professions were written in 12 groups. It was found that; overall the most preferred occupational groups are Engineering and Space Sciences and the least preferred occupational groups are Agriculture & Aquaculture and Energy. It was found that the areas of male students' preferences significantly higher are Computer Sciences, Energy, Ship-Aircraft, and Engineering; while the areas of female students' preferences significantly higher are Biology, Livestock & Veterinary, and Medical Sciences.

Keywords: STEM, STEM Education, STEM Attitude, Career, STEM Career

ÖZET

ÖĞRENCİLERİN STEM'E İLİŞKİN TUTUMLARI VE KARİYER TERCİHLERİ İLE İLİŞKİLERİNİN İNCELENMESİ

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Bu araştırmanın amacı, bazı değişkenlerin lise öğrencilerinin STEM'e yönelik tutumlarına etkisi ve lise öğrencilerinin STEM'e yönelik tutumları ile STEM'le ilişkili kariyer tercihleri arasındaki ilişkiyi araştırmaktır.

Araştırma 10 okulu kapsayan 5 farklı okul türünde okuyan 1161 öğrencide yürütülmüştür. Veriler, Faber ve diğ. (2013) tarafından geliştirilen "STEM Tutum Ölçeği" ve araştırmacı tarafından Türkiyedeki üniversitelerin bölümleri dikkate alınarak geliştirilen "STEM Meslekleri İlgi Ölçeği" ile toplandı. Bu çalışmada nicel araştırma yöntemleri kullanılmıştır. Araştırmanın verilerini analiz etmek için Aritmetik Ortalama, Standart Sapma, Frekans, Yüzdelik, Tek Örneklem T-Testi, ANOVA ve Korelasyon kullanılmıştır.

Lise öğrencilerinin STEM'e yönelik tutumları genel olarak "olumlu" olduğu görülmüştür. Ayrıca, tüm öğrencilerin "21.yüzyıl becerileri" ve "Mühendislik" bileşenlerine yönelik tutumu, “Fen” ve “Matematik” bileşenlerinden daha pozitif görünmektedir. Genel olarak, erkek öğrencilerin STEM tutumları kız öğrencilere göre daha yüksektir. "Mühendislik" bileşeninde erkek öğrenciler kız öğrencilere göre daha yüksek tutuma sahip iken, "21. yüzyıl becerileri" bileşeninde kız öğrencilerin erkek öğrencilere göre puanı daha yüksek çıkmıştır. “STEM Meslekleri İlgi Ölçeği”nde, STEM meslekleri 12 gruptan oluşmaktadır. Bütün öğrenciler arasında en çok tercih edilen meslek grupları Mühendislik ve Uzay Bilimleri'dir. En az tercih edilen meslek grubları ise Tarım ve Su Ürünleri ile Enerji'dir. Erkek öğrencilerin tercihlerinin önemli ölçüde daha yüksek olduğu alanlar Bilgisayar Bilimleri, Enerji, Gemi-Uçak ve Mühendislik; kız öğrencilerin tercihlerinin anlamlı derecede yüksek olduğu alanlar ise Biyoloji, Hayvancılık ve Veterinerlik ve Sağlık Bilimleri olduğu bulunmuştur.

Anahtar Kelimeler: STEM, STEM Eğitimi, STEM Tutumu, Kariyer, STEM Kariyeri

DEDICATION

To My Mother, Nedime Ocak

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LIST OF ABBREVIATIONS

4C Creativity, Critical thinking, Communication, and Collaboration

AHS: Anatolian High School

BLS: U.S. Bureau of Labor and Statistics

CTE: Career and Technical Education

FHS: Fundamental High School

G-20: Group of 20 (International forum for the governments from 20 major economies)

IBP: The Institute for Broadening Participation

MEB: Milli Eğitim Bakanlığı

METU: Middle East Technical University

MoNE Minister of National Education

N Sample size

NAE: National Academy of Engineering in the USA

NAS: National Academy of Sciences in the USA

NASA National Aeronautics and Space Administration

NRC The National Research Council

NSF: The National Science Foundation

NSSE: National Survey of Student Engagement

NSSES: National STEM School Education Strategy

OECD: Organisation for Economic Co-operation and Development

ÖSYM: Central Examination System in Turkey

P21: Partnership for 21st Century Learning

PHS: Private High School

PISA:	Programme for International Student Assessment
RIASEC:	Realistic; Investigative; Artistic; Social; Enterprising; Conventional
SAS:	STEM Attitude Scale
SCIF	STEM Career Interest Form
SHS:	Science High School
SOC:	Standard Occupational Classification
SOCPC:	Standard Occupational Classification Policy Committee
STEM	Science, Technology, Engineering, Mathematics
TIMSS:	Trends in International Mathematics and Science Study
TUBITAK:	Scientific and Technological Research Council of Turkey
TÜSİAD:	Turkish Industrialists and Businessmen Association
VTHS:	Vocational and Technical High School
WWII:	World War II
YEĞİTEK	General Directorate of Innovation and Education Technologies

1. INTRODUCTION

There has been growing interest in STEM (Science, Technology, Engineering, and Mathematics) education over the last decade**.** Literacy in STEM areas is becoming more important both for the personal well being of each citizen and for a nation's competitiveness in the global economy (The National Research Council [NRC], 2011), because STEM education has many potential benefits for individuals and for a nation as a whole (NRC, 2011).

Students who graduate from a school in the STEM field possess many qualifications. STEM, for all students, is an important component of multidisciplinary education that provides entry to science, social studies, literature, arts, physical education and health, and the opportunity to learn an additional language (STEM-2026, 2016). The process of learning and practicing the STEM disciplines can instill in students a passion for inquiry and discovery and fosters skills such as persistence, teamwork, communication, and the application of gained knowledge to new situations (Bailey et al., 2015; Betrus, 2015; STEM 2026, 2016). STEM education is a multifaceted educational approach that develops students in the field of science and social science and moreover enhances their abilities in social life.

A strong STEM education results in the acquisition of the skills and mindsets that open the door for lifelong learning (STEM 2026, 2016). The term "lifelong learning" recognizes that learning is not confined to childhood or the classroom, but takes place throughout life and in a range of situations (Coşkun, Demirel; 2010). From this perspective, STEM education starts as early as preschool, is culturally responsive, employs problem- and inquiry-based approaches, and engages students in cooperative activities offering opportunities to interact with STEM professionals (STEM 2026, 2016). On the other hand, STEM-based learning and disciplines are also accepted as essential to support effective learning in non-STEM areas and to become competent and capable citizens in a technology dependent society and globalized world (The International Bureau of Education [UNESCO IBE], 2015). Many countries around the world are aware of the importance of STEM education and are therefore working to integrate STEM into their education systems. Therefore, the fundamental rules of education should also be taken into account in STEM education.

1.1. STEM

In this section, since STEM is an educational approach, literature researches on education, the importance of STEM, STEM education, and the reasons for countries to adopt STEM education into their curricula have been discussed.

1.1.1. Education

Education is one of the common words we often come to encounter in everyday life. We emphasize the importance of education whenever we face certain problems in daily life, such as traffic violation, environmental pollution, or communicational problems. In fact, with schools and universities and other countless educational institutions in the center, education maintains a pivotal place in our life.

There is no standard definition of education. Among the definitions of education, some are comprehensive. One definition given by Tyler is: “Education is a process of changing the behavior patterns of people” (Tyler, 1949, p.5). Education, in the broadest sense, is defined as the process of bringing change in behavior through individual experiences (Erden M, 2012). Erden (2012) emphasizes the following three fundamental features of education:

1. Education is a process.
2. As a result of the education, individual behavior change occurs.
3. Behavior change occurs through individual's experiences.

Process, the first of the three emphasized features of education, is defined as a series of events and movements that are repeated, progressing, and developing over time (Kıroğlu, 2014). As learning continues in every phase of life and at every stage, there is no beginning and end in education. STEM Education is also a process that starts in pre-school education and continues until the end of the university, even including Ph.D. education (Sanders, 2012). This process ensures that individuals have the necessary qualities and capabilities for the 21st-century science and business world. The way in which individuals are required to be in the desired qualifications and skills is through a well-planned curriculum. The curriculum is defined as a set of learning experiences provided through planned activities at the school, and outside the school (Demirel, 2015). In this context, as Senemoğlu (2014) emphasizes, planning has three basic characteristics in the entire teaching process. Planning a) gives emotional confidence to teachers; b) ensures that the items to be used in teaching are organized to provide learning; c) allows teachers to monitor, evaluate and correct their teaching activities, in other words, to consider on reflective thinking (Senemoğlu, 2014).

The second fundamental feature of the definition of education is the behavior changes which are the objectives (learning outcomes) in education. Behavior, which is subsequently acquired, must have three characteristics in order to be regarded as behavior in education. These features should be a) observable, b) measurable, and c) desired/requested (Kıroğlu, 2014). Behaviors that do not have all of these three characteristics are not considered as behavior with regard to education (Kıroğlu, 2014). Critical thinking and problem solving, communication, collaboration and creativity and innovation, known as 4C in 21st-century skills, are important objectives in STEM Education (Partnership for 21st-Century Learning [P21]).

The third fundamental characteristic of the definition of education is that behavior change occurs as a result of an individual's experiences. The expression of experience as Ertürk (1972) defines is the effect of one's interaction with other individuals and the environment. John Dewey's famous quote "Relate the school to life, and all students are of necessity correlated" (Dewey, 1910, p.32) serves to place the problems that are taken from life into educational programs. STEM education is student-centered education, beyond typical teacher-centered classroom education (Morrison, 2006). In the projects made with the topics taken from the life, the students are carrying out their projects by questioning and producing new ideas within the group. When viewed from this angle, STEM education is an educational approach through the experiences of life.

1.1.2. STEM

STEM is an educational approach in the agenda of mainly developed countries. It has begun to become a state policy in countries such as Australia, China, South Korea, Taiwan, Norway, Netherlands, France, and primarily the United States (STEM Education Report of Turkish Ministry of National Education [MoNE], 2016). The educators of these countries are shaping K-12 education programs according to STEM education as integrative cross-disciplinary approaches in each STEM discipline (Fan & Ritz, 2014; Baran et al. 2016). In the STEM education that has begun to appear from the year 2000 on, as countries plan their education systems, they attach importance to the educational approaches that young people can reach in a full and well-equipped manner. STEM education has got a significant status in the 21st-century as it allows the development of the country's economy, the development of the quality of life, the formation of new industries and the creation of new business opportunities (Yıldırım, 2016).

According to the leaders and politicians, STEM education will play an essential role in educating young people as future engineers, scientists, and mathematicians. Therefore, STEM education will contribute to the development of technology and economy continuously. If young people can use science, technology, engineering, and mathematics effectively, they will come up with innovations (Yıldırım, 2016). Young people will continuously improve themselves on the skills and knowledge needed for innovation. Increasingly the knowledge and skills of the youth will allow the rapid emergence of innovation. With the increase of innovation, countries' economies will be strengthened, new business areas will emerge (Fan & Ritz, 2014), and they will make progress in the field of technology. STEM education reform was initiated due to the impact of technological development and economic demands (Yıldırım, 2016; Banks & Barlex, 2014; Bybee, 2013; Williams, 2011).

STEM education has a significant place in the development of education today (Berlin and Lee, 2005; Kuenzi, 2008, Reiss and Holmen, 2007; Ceylan, 2014). In this sense, STEM is regarded as the greatest educational movement in the last decade and supports many educational movements being carried out today (Cavanagh and Trotter, 2008; Daugherty, 2013). STEM education emphasizes an interdisciplinary approach to increasing the number of secondary and high school graduates who will be better prepared for STEM disciplines and who will choose STEM professions (Ceylan, 2014). This shows that the abbreviation of STEM accounts for more than the name of the four disciplines integrated (Ostler, 2012).

1.1.3. STEM Definition

The STEM abbreviation, which is made up of Science, Technology, Engineering, and Mathematics, is a meta-discipline (Ejiwale, 2013). In the early 1990's, as Ostler (2012) states, the National Science Foundation (NSF) in the USA formally coined the STEM abbreviation we use today to refer to the individual content disciplines of Science, Technology, Engineering, and Mathematics. Initially, this abbreviation was formed with no intention of integrating the four subjects in schools formally. It was a strategic decision made by scientists, technologists, engineers, and mathematicians to unite forces and create a stronger political voice (Innovate, 2014). As an educational term, STEM Education was first introduced by Judith A. Ramaley, Director of The National Science Foundation in 2001, and has been spreading rapidly since then (Yıldırım, Altun, 2014). In order to distinguish the STEM abbreviation in education from the stem cell which is used in biology and medicine, STEAM was intended to be abbreviated by adding the letter A, the first letter of the art. However, the inclusion of art into STEM which was already complex teaching concept was not widely accepted (Mobley, 2015).

Since some countries in the world want to teach and implement another area with STEM, which universities or educational institutions consider important, they add another letter to STEM abbreviation. As mentioned in the previous paragraph, some organizations have added the letter A, the first letter of the art. In Turkey, for example, Bahçeşehir Schools use the abbreviation of STEM-A as A stands for ‘Art’ (Bahçeşehir Schools). Some of the abbreviations that are used together with STEM are:

STEM-A: by adding ‘A’ as the first letter of Art to STEM. There are also people and organizations that use this abbreviation as STEAM (STEAM Education; EDUCATION CLOSET; STEM to STEAM).

B-STEM: by adding ‘B’ as the first letter of business to STEM. It aims to educate students who can work together with STEM knowledge especially for girls to be active in the business area (B-STEM PROJECT).

C-STEM: by adding ‘C’ as the first letter of communication or computing to STEM (C-STEM; CHANGE THE EQUATION).

D-STEM: by adding ‘D’ as the first letter of design to STEM. The aim in D-STEM is to apply “design thinking” to STEM in academia and industry (SILICON REPUBLIC).

Some other letters of the alphabet are also used with STEM. Another way of using a letter with STEM is that first letter of a city name can be added to STEM. For example, the researchers and educators in Texas use “T-STEM” abbreviation in order to describe the STEM activities and organizations in their respective states, universities, schools by adding the letter T as a prefix to STEM (EDUCATE TEXAS; Oner, Capraro, Capraro, 2014). As a result, it can be specified that there are various forms of STEM abbreviation use by being added some letters as a prefix or suffix to STEM.

FeTeMM abbreviation, on the other hand, is also employed in Turkey as FeTeMM is the abbreviation of Science (Fen), Technology (Teknoloji), Engineering (Mühendislik) and Mathematics (Matematik) in Turkish Language (STEM Education Report of MoNE, 2016). Despite being called FeTeMM, its widespread use is still in STEM form in Turkey.

1.1.4. STEM Education

There are many definitions of STEM education. Although it is composed of initials of four disciplines, STEM education does not have a clear definition. In the whole of the definitions made, it is thought that the implementation of these four disciplines is better, when integrated with each other.

There are some definitions of STEM which are widely accepted. These are:

“STEM Education includes the knowledge, skills, and beliefs that are collaboratively constructed at the intersection of more than one STEM subject area” (Corlu, 2014)

“STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy” (Tsupros, 2009).

"STEM education is an intentional, metadisciplinary approach to teaching and learning, in which students uncover and acquire a cohesive set of concepts, competencies, and dispositions of science, technology, engineering, and mathematics that they transfer and apply in both academic and real-world contexts, in order to be globally competitive in the 21st-century" (Rider-Bertrand, 2015).

1.1.5. Reasons for Adopting STEM Education into National Curricula

The two main reasons why countries want to adopt STEM education are the developing technology competition and the economy. Some historical events have pushed the competition for technology and STEM education to grow and flourish (White, 2014). According to White (2014) two such events were World War II, and then the launch of the Soviet Union’s satellite, Sputnik. From different types of weaponry especially the Atomic Bomb to many types of vehicles for both land and water, the technologies invented and implemented during World War II are almost immeasurable. (White, 2014). After the WWII, Sputnik was the first satellite to be launched into space by Soviet Russia in 1957. The launch of this satellite has been a turning point for technology. On this point, "Space Race" between Soviet Russia and America started (Yildirim, 2016; White, 2014). The launch of Sputnik, the Russian satellite, caused the United States to fear of falling behind in the field of technology and the race for space and this situation created a great stir that had been fueled by the competitive nature of the United States. (Mohr-Schroeder MJ, Cavalcanti M, and Blyman K, 2015).

The launch of Sputnik has changed the technological aspects of the United States and other countries. This success of Soviet Russia attracted the attention of the world and caught America as an opponent unprepared (National Aeronautics and Space Administration [NASA], 2008). As a result, the United States gave importance to national defense and established NASA in 1958 (Dick, 1980). After the establishment of NASA, space racing and STEM education became important (White, 2014). Since the creation of NASA as an agency in 1958, it remains committed to advancing and promoting science, technology, engineering and mathematics (STEM) in several capacities: concepts, careers, and awareness for learners, educators and institutions (NASA, 2015). When it comes to 2010, President Obama emphasized that STEM education will be the main factor in the economic, technological and scientific development of the country and started “Science Fair” in the White House in order to encourage students for the STEM areas (WHITE HOUSE).

On the other hand, the need for STEM education is based on economics. The STEM educational movement is a reform movement initiated by leaders and politicians (Yıldırım, 2016). While many countries suffer from the effects of global economic difficulties such as rising unemployment and rising public debt, the role of labor entry in the 21st-century economy is diminishing (Corlu, 2012). According to Corlu (2012), only innovation-driven growth has the potential to create value added jobs and industries. As innovation is mainly derived from the development of science, technology, engineering and mathematics disciplines, the increase in the number of professions at each level is based on STEM knowledge (Corlu, 2012). Recent STEM education initiatives have been driven by global economic downturns and promoted by institutional, commercial, industrial, governmental and strategic market developments in the US, as Krug (2012) emphasized the economic effect of STEM. In order to be competitive in the 21st century, as Corlu (2012) states, nations need an innovative STEM workforce.

1.2. STEM and Curriculum

In this section, since STEM is an educational approach, the issues related to STEM and education, i.e. curriculum, STEM models, and STEM schools have been searched. Additionally, 21st-century skills have been included in the study as an important part of STEM education.

1.2.1. Curriculum

The curriculum has multifaceted, dynamic, changing and evolving features. Therefore, defining curriculum has several aspects. If we look at the origin of the curriculum, it is a Latin word that refers to a 'course' or 'track' to be followed (van den Akker et al., 2005). Its contemporary meaning is that of "courses offered by an educational institution or a set of courses constituting an area of specialization" (Merriam – Webster's Dictionary). Tyler (p.79, 1957), for instance, described curriculum as "All of the learning of students which is planned by and directed by the school to attain its educational goals". Along the same line, Wheeler (p.15, 1967) proposed that "by curriculum, we mean the planned experiences offered to the learner under the guidance of the school". In a schooling context, Skilbeck (p.21, 1984) sees the curriculum as "...the learning experiences of the students, insofar as they are expressed or anticipated in goals and objectives, plans and designs for learning and the implementation of these plans and designs".

Ornstein and Hunkins (2017) specified five basic definitions of the curriculum:

1. Curriculum as **a plan**. It has been popularized by Tyler and Taba. It is a typical example of a linear view of curriculum. It involves a sequence of steps. Today, most behavioral and some managerial and systems people agree with this definition.
2. Curriculum as **learner's experiences**. It is almost anything planned in or outside of school as part of the curriculum. It is rooted in Dewey's definition of experience and education. Humanistic curricularists and elementary school curricularists subscribe this definition which textbook writers have interpreted more broadly over the years.
3. Curriculum as **a field of study** with its own foundations, knowledge domains, research, theory, principles, and specialists. In this definition, rather than practical terms, theoretical terms are discussed. The supporters of this definition are concerned with broad historical, philosophical, or social issues. This view of curriculum is often subscribed by academics.
4. and 5. Curriculum in terms of **subject matter** (math, science, English, history, and so on) or **content** (the way we organize and assimilate information). We can also talk about subject matter or content regarding **grade levels**. People who adopt this definition emphasize the facts and concepts of particular subject areas.

Given simple definition from Taba (1962) that is “*plan for learning*”, van den Akker et al. (p.5, 2010) state that “a differentiation between various levels of the curriculum has proven to be very useful when talking about curricular activities (policy-making, design and development, evaluation, and implementation)”. van den Akker et al. (2010) made the following distinction that appears to be helpful:

- Supra Level: international or comparative
- Macro Level: system, society, nation, or state such as national syllabi or core objectives
- Meso Level: school, institution, or program such as school-specific curriculum
- Micro Level: classroom, group, or lessons such as textbooks and instructional materials
- Nano Level: individual or personal.

Curricula, on the other hand, can be represented in various forms. Van den Akker et al. (2010) stated that clarification of these forms is especially useful when trying to understand the problematic efforts to change a curriculum. He states that a common broad distinction is between the three levels of the ‘*intended*’, ‘*implemented*’, and ‘*attained*’ curriculum. A more refined typology (van den Akker et al., 2010) is outlined in the able below.

Table 1.1
Typology of Curriculum Representations

INTENDED	Ideal	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/Written	Intentions as specified in curriculum documents and/or materials
IMPLEMENTED	Perceived	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also: curriculum-in-action)
ATTAINED	Experiential	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

Note. Retrieved from Van den Akker et al., (2010). A curriculum Perspective on Plurilingual Education. SLO (Netherlands Institute for Curriculum Development)

Balance and consistency between the various components of a curriculum improvement is a challenge. For Walker (1990), curriculum includes three major planning elements: content, purpose, and organization of learning. However, van den Akker, Fasoglio, and Mulder, (2010) stated that curriculum design and implementation problems have taught that it is wise to pay attention to a more detailed list of components. They listed curriculum components as “rationale or vision, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time, and assessment”.

1.2.2. STEM Curriculum

Besides STEM education, which is discipline-integrated and student-centered, STEM curriculum and instruction promotes active, collaborative, and meaningful learning, which supports mastery of skills and expands horizons (Innovate, 2014). One of the aims of STEM education is to increase the STEM interest of students. The question that comes to mind when to start is early enough in preschool education years to increase STEM interest and to choose STEM courses when arising the opportunities (The Institute for Broadening Participation [IBP], 2016). According to Innovate (2014), researches indicate that a relationship exists between early exposure to science and mathematics careers and long-term success in the STEM circuit (Oakes 1990; Museus et al. 2011). Early interest in science is positively related to students' desire to major in science in college (Museus et al. 2011). To support this, the NRC (2011) advises that curriculum and instruction in elementary education should focus on generating interest in the STEM disciplines by exposing all children to engaging applications in STEM areas, building on what they know and on their interests. According to Larmer and Mergendoller (2012), the ideal secondary school learning environment would engage students in interdisciplinary work and project-based learning using real-world contexts.

1.2.3. STEM Models

The issue of how to apply STEM education is still being discussed. There is no consensus on how scientists and educators teach science-centered and mathematics-centered STEM disciplines. In fact, the development of STEM programs is consistent with the existing political goals for education (Breiner et al., 2012), such as the understanding of teachers who will teach STEM, how to procure materials to be used in STEM classes, and how to implement it in STEM Education. Today, widely used STEM models, as Mobley (2015) states and explains, are 'multidisciplinary', 'transdisciplinary', 'interdisciplinary' and now 'integrated'. Although the meanings and practices are different, these terms are sometimes used interchangeably (Mobley, 2015, Dyer, 2003, Rosenfield, 1992).

The first model is multidisciplinary STEM education. Multidisciplinary STEM education which is described as a "mixture" of disciplines is accepted as one of the earliest approaches to STEM education (Mobley, 2015). Lederman and Niess (1997) described “multidisciplinary” as chicken soup. The "multidisciplinary" definitions are similar to chicken soup and made in such a way that each item (chicken, noodles, peas, carrots) maintains its unique identity. In an educational paradigm, it is implied that students could distinguish "doing" from science by "doing mathematics" or "doing another discipline", as suggested by Lederman and Niess (1997). In other words, each discipline maintains its own distinct identity despite other disciplines simultaneously taught throughout the course (Mobley, 2015). In such a scenario, a science teacher may include a single mathematics and/or engineering and/or technology discipline, but each will remain a distinct content and curriculum focus (Mobley, 2015). Multidisciplinary STEM education may require different team members working on different aspects of a problem, or even each team member to allocate a discipline-centered contribution (Wall & Shankar, 2008).

The second model is Transdisciplinary STEM education. Transdisciplinary STEM education, as the "trans" prefix implies, seeks to rise a common discipline that is focused on solving a larger world problem and rising on a single discipline (Morrison, 2006, Park & Son, 2010). This model is defined as a focus on issues that are between and outside learning areas to deepen new, wider perspectives and the interconnectedness of complex issues (Mobley, 2015). Wall and Shankar (2008) also pointed out that transdisciplinary approaches to education as valuing knowledge and skill contributions of individual team members, requiring sensitivity to blurred boundaries in terms of disciplinary importance, and requiring intense collaborative organization on the part of the teacher to ensure each student has a defined role. Mobley (2015) states that blurring boundaries between disciplines is a primary goal of transdisciplinary approaches to education in order to achieve disciplinary authenticity (Park & Son, 2010).

The third one is interdisciplinary STEM education. Although interdisciplinary STEM education can be defined as a separate entity by students participating in learning activities of each discipline, it is broader in relation to other disciplines than multidisciplinary and interdisciplinary (Frykolm & Glasson, 2005; Morrison, 2006). Interdisciplinary learning focuses on the level of participation that determines learning outcomes and the production of information produced in a participatory manner. Because interdisciplinary learning does not have any of the knowledge necessary to be precisely suited to a given research question, it places students in a collaborative and student-focused on information (Park & Son, 2010). Interdisciplinary learning is based on the social construction of knowledge, so its activities lead students to cooperate and communicate individual findings and integrate these findings into a final product using multidisciplinary knowledge and practices (Wall & Shankar, 2008).

The fourth model, which is widely used in the world, is integrated STEM education. In the early times when STEM education was being implemented, it was focused on the development of science and mathematics as isolated disciplines (Breiner et al. 2012; Sanders 2009; Wang et al. 2011) with little integration and attention given to technology or engineering (Bybee 2010). Moreover, STEM subjects are often taught disconnectedly from the arts, creativity, and design (Hoachlander and Yanofsky, 2011).

Developing a well-defined integrated STEM education is a challenge. Integrated STEM education aims to combine science, technology, engineering and mathematics into a single class that focuses on the connections between subjects and real-world problems (Wang, Moore, Roehrig and Park, 2011; Stohlmann, Moore and Roehrig, 2012; Mobley, 2015). Such an integration has multiple ways in the K–12 education: it may include different combinations of STEM disciplines, emphasize one discipline more than another, be presented in a formal or informal setting, involve a range of pedagogical strategies (Sanders, 2009), occur in one or several class periods, or throughout a curriculum, be reflected in the organization of a single course or an entire school, be presented in an after- or out-of-school activity. The definition of integrated STEM education is even more complex due to the fact that connections can be reflected on multiple levels at the same time: in the thinking or behavior of the student, in the instruction of the teacher, in the curriculum, between (mainly maths and science) and among teachers themselves, or in larger units of the education system, such as the organization of an entire school (National Academy of Sciences [NAS], 2014). For example, one model suggests that "integrative" STEM education must include technological or engineering design as a basis for creating connections to concepts and practices from mathematics or science (or both) (Sanders 2009).

Integrated STEM definition is as follows:

“Integrative STEM education refers to technological/engineering design-based learning approaches that intentionally integrate the concepts and practices of science and/or mathematics education with the concepts practices of technology and engineering education. Integrative STEM education may be enhanced through further integration with other school subjects, such as language arts, social studies, art, etc.” (Sanders & Wells, 2006).

According to the report "STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research" which is a joint work of the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE), each variant of integrated STEM education suggests different planning approaches, resource needs, implementation challenges, and outcomes. In this report, the committee developed a descriptive framework. The reason the committee prepared the framework is to provide a common perspective and vocabulary for researchers, practitioners, and others to identify, discuss, and investigate specific integrated STEM initiatives within the K-12 education system of the United States (NAS, 2014). General features and subcomponents of integrated STEM education are shown in this descriptive framework which is given in Figure1.1.

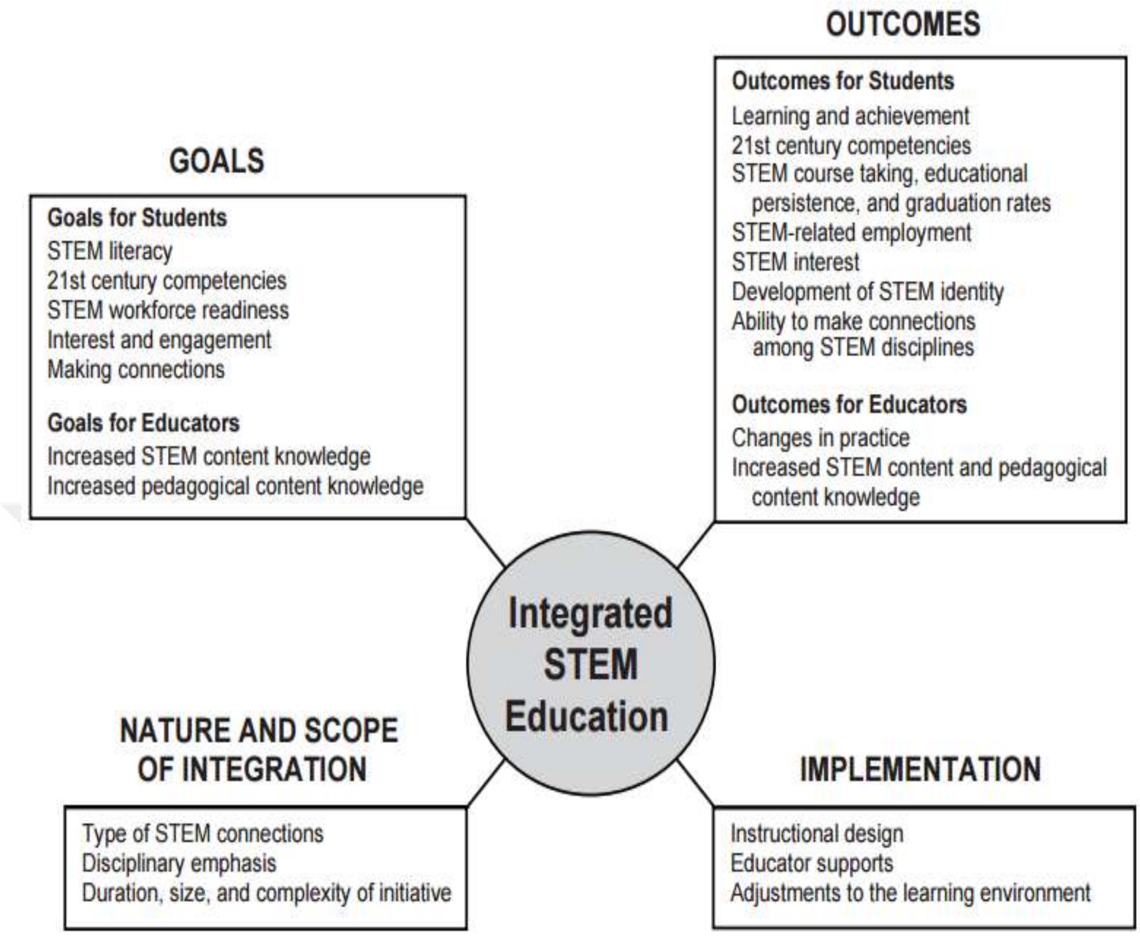

Figure 1.1. Descriptive Framework Showing General Features and Subcomponents of Integrated STEM Education. Taken from NAS (2014).

1.2.4. 21st-Century Skills as Student Outcomes in STEM

Twenty-first-century skills, which are included in STEM education, stand out not only in science but also in various branches of social sciences. The Partnership for 21st Century Skills in the United States, however, assess the skills under four main headings (P21).

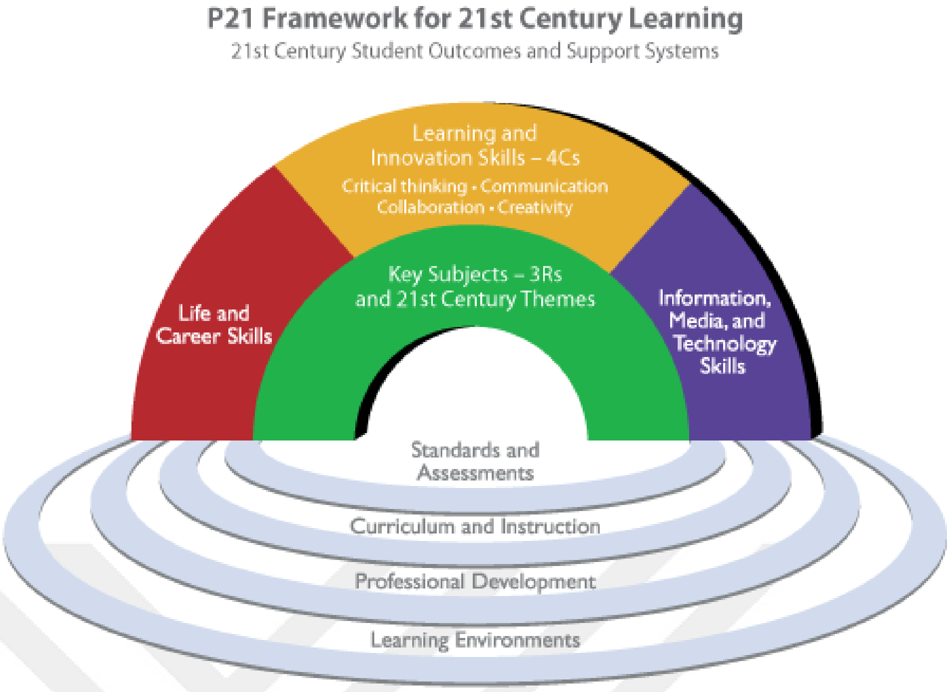

Figure 1.2. Framework for 21st Century Learning. Retrieved from http://www.p21.org/our-work/p21-framework.

In the 21st-century, there has been a rapid development in technology and the world has become a global village. Therefore, it has been tried to describe the knowledge, skills, and expertise that a 21st-century student should have. These are (P21):

1. Content Knowledge and 21st-Century Themes: Apart from fundamental subjects which are "Mathematics, English as reading or language arts, Science, Economics, World languages, Arts, Geography, History, Government and Civics"; schools must move beyond these subjects and promote the understanding of academic content at much higher levels by weaving 21st-century interdisciplinary themes into curriculum: "Global awareness, Financial, Economic, Business and Entrepreneurial Literacy, Civic Literacy, Health Literacy, and Environmental Literacy".

2. Learning and Innovation Skills: These skills known as 4C are being recognized as the skills that should be taught in schools as a priority to distinguish between those who are ready for life and work environments in the 21st-century, and those who are not. “Creativity and Innovation, Critical Thinking and Problem Solving, Communication, and Collaboration”.

3. Information, Media, and Technology Skills: Today, we live in an environment enriched by technology and media with 1) access to information abundance; 2) rapid changes in technology tools; and 3) individual contribution and collaboration on an unprecedented scale. Therefore, students should have the skills that are: “Information Literacy, Media Literacy, and ICT Literacy”.

4. Life and Career Skills**:** include “Leadership & Responsibility, Flexibility & Adaptability, Social & Cross-Cultural Skills, Productivity & Accountability, and Initiative & Self Direction”.

One way for individuals to have the 21st-century skills is through STEM education. With STEM education, individuals will have sufficient skills related to their business areas (Yıldırım, 2016). Yıldırım (2016) emphasized the benefits of STEM education given below:

1. Providing students with problem-solving skills
2. Preparing for life, critical thinking, and helping to solve problems in everyday life

3. Playing an important role in enhancing the academic achievement of the students as the integrated STEM approach provides rich learning contents to the students

4. Change students' attitudes towards STEM fields positively

5. STEM education prepares students for the skills and challenges necessary for the economy of the 21st-century besides prepares for careers to become scientists

6. Ensure the development of scientific process skills

In this context, STEM education is an important part of gaining 21st-century skills that all countries want their citizens to have. With STEM education, individuals can have these skills (Yıldırım, 2016).

The starting point of STEM education is to teach mathematics and science lessons with the technology and engineering understandings, and the ability to design. On the other hand in STEM education, students will improve their ability to solve problems in situations they may face in life. In addition to the need for the scientists of the future world, workforce and citizens who are able to produce solutions to problems at every stage of life will also be needed. STEM is an educational approach that prepares students with the ability of critical thinking, problem-solving, and scientific process skills as future economists, scientists, and workers. In this respect, STEM education is, in fact, an educational approach that every student should take.

1.3. STEM Implementations

The forms of STEM implementation are quite extensive. Just as each country has a different cultural structure, each city and every school has its own cultural difference.

For this reason, countries that have started applying STEM education have been mentioned first, and then STEM education and its implementations in Turkey have been discussed.

1.3.1. STEM Education in the World

According to the leaders and politicians, STEM education will play an essential role in educating young people as future engineers, scientists, and mathematicians (Yıldırım, 2016). Therefore, STEM is an educational approach in the agenda of mainly developed countries. It has begun to become a state policy in countries such as Australia, China, Malasia, South Korea, Taiwan, Norway, Netherlands, France, and primarily the United States (STEM Education Report of MoNE, 2016; Ceylan, 2014). The educators of such countries are shaping K-12 education programs according to STEM education as integrative cross-disciplinary approaches in each STEM discipline (Fan & Ritz, 2014; Baran et al. 2016). In the STEM education that emerged from the year 2000, as countries plan their own education systems, they attach importance to the educational approaches that young people can reach in a full and well-equipped manner. In The United States of America, for example, STEM education is seen as one of the most important elements in maintaining the present economic and technologic status (STEM Education Report of MoNE, 2016). Therefore, a high number of STEM centers in the USA have been established within many universities and schools. According to STEM Education Report of MoNE (2016), many elements such as project based learning, inquiry-based learning, STEM activities, design and innovation activities, team work, creativity and creative drama, robotics, maker, coding and workshops for preparing STEM course plan are included in these centers. There is growing interest in STEM disciplines and STEM education in European countries as well (Corlu, Capraro & Capraro, 2014). Most European countries have published reports on STEM Education, beyond which Norway has issued a strategy plan for STEM education in 2002, the Netherlands in 2004, France in 2011, Malta in 2011 and Croatia in 2014 (STEM Education Report of MoNE, 2016). Recent reports in Turkey have shown that students need to improve their STEM knowledge and skills and increase the STEM workforce (Corlu, 2012).

1.3.2. STEM Education in Turkey

STEM education comprises four main disciplines, which are mathematics, science, engineering, and technology. In Turkey, mathematics is taught in all classes of K12. Science lesson, which constitutes the most important discipline of STEM education, has undergone some changes from the establishment of the Turkish Republic till now. After the proclamation of Turkish Republic on 29 October 1923, the first primary school curriculum was established in 1926 (Altınok, Tunc, 2013). In this primary curriculum, there were two courses named “Nature Studies” (Tabiat Tetkiki) including the subjects of biology, agriculture, and livestock and “The Lessons on Scientific Objects” (Eşya Dersleri) including the subjects of physics and chemistry (Altınok, Tunc, 2013). Altınok and Tunc (2013) stated that these courses might be considered as a correspondence to “Science and Technology” course nowadays.

In the curriculum that was established in 1936, “Nature Studies” and “The Lessons on Scientific Objects” courses which were taught in 1926 curriculum have been combined under the title of “Nature Knowledge” (Tabiat Bilgisi) (Altınok, Tunc, 2013; Tunç & Akçam, 2008). In 1948 Curriculum, science and technology topics were placed in “Social Studies” (Hayat Bilgisi) units in first level classes and in

“Nature Knowledge” (Tabiat Bilgisi), and “Agriculture – Work” (Tarım-İş) courses in second level classes and have been taught under the name of “Nature Knowledge” (Altınok, Tunc, 2013). In 1968 Curriculum, “Nature Knowledge”, “Family Knowledge” and “Agriculture – Work” courses in 1948 curriculum have been united under “Science and Nature Knowledge” (Fen ve Tabiat Bilgileri)(Altınok, Tunc, 2013).

Science education which is under the name of “Science Knowledge” in elementary schools in Turkey has been replaced by a change made in 2005 under the name of "Science and Technology" course. A constructivist approach advocating that knowledge is constructed by the student has been adopted, and the content has changed much more than the name of the science program (Doğan, 2012; Eskicumalı et al. 2014). In the 2005 Science and Technology Program, students were given the necessary knowledge, understanding, skills, attitudes, and values regarding science and technology literacy (Eskicumalı et al. 2014). This curriculum, while rejecting other learning theories, emphasized the constructive learning approach (STEM Education Report of MoNE, 2016). “Technology and Design” (Teknoloji ve Tasarım) course has been put into practice in Turkey since 2005, and it is seen that the objectives of STEM overlap with the aims of "Technology and Design" course to some extent. It can be said that the studies carried out in the 7th and 8th-grade levels within the scope of “Technology and Design” course are related to STEM (STEM Education Report of MoNE, 2016). In order for the results of exams such as TIMSS and PISA to be improved, STEM education in our country needs to be considered as a priority (STEM Education Report of MoNE, 2016).

"Science Applications" course has been put into an elective course by all levels of junior high schools from 2012-2013 education year by MoNE. The aim of the course of science applications is to train individuals who are scientificly literate in the context of achievements in science courses. Thus, the students will research the fields of science and develop themselves by reading books and texts related to this field. Students who know how to obtain information will understand the nature of science and it will be easier for them to conceive the scientific bases of the problems they encounter in their lives (Milli Eğitim Bakanlığı [MEB], 2013a).

In Turkey, science curriculum which was updated in 2013, with knowledge, skill, sense, and the Science-Technology-Society-Environment (STSE) learning area, it is aimed that the students acquire the general science concepts as well as the skills, emotions and STSE relationships and train them as science literate individuals (Baran et al. 2015). Although the importance of interaction with science and technology and society is emphasized in the curriculum, STEM integration and engineering are not directly involved (Gülhan & Şahin, 2016). Bybee (2010) noted that one of the major challenges in implementing STEM education is the integration of technology and engineering knowledge into teaching programs.

In the 2016-2017 educational year, the courses that are related to STEM does not seem adequate in Turkey. The Table 1.2. shows the primary and the secondary level weekly timetable for MoNE schools in Turkey. Besides mathematics and science, the mandatory courses related to STEM are “Technology and Design” (Teknoloji ve Tasarım), “Information Technologies and Software” (Bilgi Teknolojileri ve Yazılım). The elective courses related to STEM are “Science Applications” (Fen Uygulamaları), "Mathematics Application" (Matematik Uygulamaları), and "Science and Environment" (Bilim ve Çevre) (MEB, 2014).

Table 1.2
Weekly Timetable for All Primary Schools from MoNE for 2016-2017 Educational Year

PRIMARY AND SECONDARY SCHOOLS WEEKLY TIME-TABLE								
	GRADES (Lessons per week)							
	PRIMARY				SECONDARY			
MANDATORY COURSES	G-1	G-2	G-3	G-4	G-5	G-6	G-7	G-8
Mathematics	5	5	5	5	5	5	5	5
Social Science	4	4	3					
Science			3	3	4	4	4	4
Technology and Design							2	2
Information Technologies and Software					2	2		
ELECTIVE COURSES								
Science application					2	2	2	2
Mathematics application					2	2	2	2
Environment Education							2	2
Information Technologies and Software							2	2
TOTAL LESSONS PER WEEK	9	9	11	8	11+4	11+4	11+8	11+8

Note: Retrieved from http://ttkb.meb.gov.tr/www/haftalik-ders-cizelgeleri/dosya/6 The table above was published on 01.04.2014. Only STEM related courses are listed.

When it comes to high-school, there are five types of schools that are related to STEM: Science High School, Anatolian High School, Private High School, Vocational and Technical Anatolian High School, and Fundamental High School (Temel Lise). In those five types of schools, overall mandatory lessons that are related to STEM are mathematics and science lessons (physics, chemistry, and biology); and the elective courses are advanced mathematics, advanced physics, advanced chemistry, advanced biology, astronomy and space science, and information and communication technology (MEB, 2014). Additionally, as elective courses, Science High Schools have two more courses. These courses are two-lesson Mathematics Applications (Matematik Uygulamaları) and three-lesson Science Applications (Fen Uygulamaları) in Grades 10, 11, and 12 (MEB, 2014).

Table 1.3
Weekly Timetable for All High Schools from MoNE for 2016-2017 Educational Year

HIGH SCHOOLS WEEKLY TIME-TABLE				
MANDATORY COURSES	Grade 9	Grade 10	Grade 11	Grade 12
Mathematics	6	6		
Physics	2	2		
Chemistry	2	2		
Biology	3	3		
ELECTIVE COURSES				
Mathematics			2	2
Advanced Mathematics			6	6
Advanced Physics			4	4
Advanced Chemistry			4	4
Advanced Biology			3	3
Astronomy and Space Sciences	1 or 2	1 or 2	1 or 2	1 or 2
Information and Communication Technology	1 or 2	1 or 2	1 or 2	1 or 2
TOTAL LESSONS PER WEEK	**13+2**	**13+2**	**0+21**	**0+21**

Note: Retrieved from http://ttkb.meb.gov.tr/www/haftalik-ders-cizelgeleri/dosya/6 The table above was published on 01.04.2014. Only STEM related courses are listed.

There are many studies related to STEM, but no attempt has been made yet to the level of curriculum addition in Turkey. The first two STEM areas are combined under the name of "Science and Technology" (Fen ve Teknoloji), and Mathematics is given as a separate course. Engineering is not involved at all (Büyüköztürk, Çakan, Tan and Atar, 2014a; Gülhan & Şahin, 2016).

Entrance to the university in Turkey is through the central examination system (Öğrenci seçme ve Yerleştirme Merkezi [ÖSYM]). Since all the questions in this examination system are in multiple-choice form, the multiple-choice exams are considered important. Therefore, the lessons are processed from this point of view and the transition stages of the theoretical knowledge into practice are not implemented sufficiently. Excluding 12th graders who are studying for university exams; some activities may accelerate the transition to STEM education. As examples of such activities a) more applied mathematics and science courses for grades 9, 10 and 11 should be added; b) students should spend more time in the labs; c) students should be more active in project works; and d) additional points should be provided in the university entrance exams for students participating in project competitions in school, province, national or international project competitions.

1.3.3. STEM History In Turkey

The name of STEM education in Turkey has started to be heard in the last few years. The first studies started with Tufan Adıgüzel, Sencer Çorlu, Cihat Ayar and Serkan Özel who were working at Bilkent University (Adıgüzel, Ayar, Çorlu & Özel, 2012; Yıldırım, 2016). Then, a limited number of pilot schools were selected by Kayseri Provincial National Education Directorate starting from 2013 and then STEM project was started. The first STEM center in Turkey was established by Kayseri Provincial Directorate of National Education. After that, studies on STEM education in many state universities were started (Yıldırım, 2016). Recently, a STEM center was opened by the governor of Urfa in the Southeast Anatolia region of Turkey in October 2016. In this center, students from preschool to high school may take STEM education. The center where the schools may visit with their teachers and students by appointment is six floors and consists of two conference rooms, nine classrooms, and three individual study design classes. For the teacher training program in 2016, 160 teachers have been recruited for the training opened within the scope of the project and the teachers were able to study at the new STEM Center every week. (Sanliurfa MEB, 2017).

A STEM laboratory was established in Muş Alparslan University during the fall semester of 2013-2014. Within the scope of this laboratory, candidates for science teaching have started to be educated. A STEM center was also established in METU (Middle East Technical University). Many studies have been carried out in this context and continue to do so. On the other hand, STEM studies have been carried out in some private universities like Bahçeşehir and Istanbul Aydın Universities. In short, in recent years, many researchers in Turkey have been working on the STEM issue and writing articles and reports on this area (Yıldırım, 2016).

Although STEM is new in Turkey, many documents from education and business world provide political support for STEM education. These documents include the Ministry of National Education Strategic Plan, Higher Education Strategic Plan, Vision-2023 Study, National Science, Technology and Innovation Strategy 2011-2016, Lifelong Learning Strategy Document, Turkish Industrialists and Businessmen

Association Vision-2050 Turkey Report, and the reports published by the Turkish Academy of Sciences (Corlu, 2014). Recently, significant initiatives have been taking place regarding STEM education in Turkey. One is the Turkey STEM Labor Force Report (TÜSİAD, 2014) published by the Turkish Industrialists and Businessmen Association in 2014 and the other is the STEM Education Turkey Report (Akgündüz et al., 2015) published by Istanbul Aydın University in 2015. Another study is the STEM Education Report (2016) published by the Ministry of National Education General Directorate of Innovation and Education Technologies (YEĞİTEK). While the STEM Labor Force Report emphasizes the strengthening of the university's STEM areas and the enhancement of the qualified STEM workforce, Istanbul Aydın University's STEM Education Turkey Report underlines the introduction and implementation of a qualified STEM education into the K-12 curriculum (Akgündüz ve diğ., 2015). The STEM report of the Ministry of National Education, on the other hand, pointed out that the establishment of STEM Education Centers for the transition to STEM education in Turkey, the establishment of STEM Education Researches, the training of STEM teachers and the STEM Education of Instructional Programs were taken into consideration (STEM Education Report of MoNE, 2016).

In recent years there has been an increase in the number of projects and researches related to STEM education in Turkey. Within the scope of the project "STEM for Disadvantaged Students especially Girls" conducted by Istanbul Aydın University, it is aimed to educate both teachers and students in STEM fields and to create appropriate programs (Akgündüz et al., 2015).

Other opportunities include education projects supported by the Scientific and Technological Research Council of Turkey (TUBITAK) that aim to empower STEM education with activities for students and teachers. For example, in a project funded by TUBITAK, 5th-grade students used a design-based methodology for STEM education, designed solar robots and kaleidoscopes, and created graphs with motion detectors and these activities helped develop positive attitudes towards science (Yamak, Bulut, & Dündar, 2014). In the engineer project, students were encouraged to think like engineers by using simple and inexpensive materials (Çavaş, Bulut, Holbrook, & Rannikmae, 2013).

STEM projects also focused on training preservice and in-service teachers. Gül & Marulcu (2014) focused on the engineering discipline, worked with preservice and in-service science teachers on engineering design processes and activities using robots and Legos.

Corlu, Capraro, and Capraro (2014) stated that, in the result of their work, teachers in our country only have the knowledge of teaching in their field of expertise and will not be enough to raise the qualified human power needed. Gencer (2015) stated that the STEM effectiveness he applied to Grade 7 students will help students to develop career awareness in the field of science, that the knowledge and skills related to this field will develop, and that their attitudes toward the field will be positive. Şahin, Ayar, and Adıgüzel (2014) emphasize that the STEM activities in the United States have helped students improve their skills and learn from each other. Yamak, Bulut, and Dündar (2014) point out that the STEM activities they have implemented have improved students' attitudes towards science and scientific process skills. When studies at the national level are examined, it is seen that there is an increase in the number of studies related to STEM education. These studies seem to have been conducted with students and teacher candidates. This presents the need for measurement tools that can be used for students, prospective teachers, and in-service teachers (Hacıömeroğlu & Bulut, 2016).

Since 2003, PISA exams have been applied in Turkey. In this test, which measures students' mathematics, science and reading skills and is repeated every three years, Turkey can not meet the performance expected from students. According to the PISA exam results in 2015, Turkey is below the OECD (Organization for Economic Cooperation and Development) average score (OECD, 2015). While OECD averages in Science, Reading, and Mathematics are 493, 493, and 490 respectively, the averages of Turkey in Science, Reading and Mathematics are 425, 428, and 420 respectively. It may be useful to apply STEM education to improve science, mathematics and reading skills in our country (Yıldırım, 2016). Another data supporting this claim is the high PISA exam results in the countries where STEM education is applied. PISA exam scores of Japan, UK, Korea, Australia, China, and Germany, which are applying STEM education, are above the average score of OECD countries (OECD, 2015).

In the STEM Education Report (2016) published by the Ministry of National Education, it is stated that the Ministry of National Education needs to prepare a strategy document regarding national policies under the heading "Recommendations and Steps for Adaptation of STEM Education in Turkey”. In this strategy document, it is stated that STEM is what it is, how it can contribute to schools and how it can be activated in lessons. In the STEM Education Report published by MoNE, it expresses the appropriate updating of teaching programs in Turkey to STEM education as follows (2016, p.43):

> "Instead of a direct revision of curriculum, a step by step update in curriculum for STEM education is necessary (Özdemir, 2016). Firstly, exciting activities can be included in the curriculum for initiating scientific inquiry based activities. In this way, students can gain awareness of scientific inquiry. While conducting studies about curriculum, it important to consider in which stage STEM education will be used. The method in STEM education should be "tinkering method" which includes learning by doing. While adaptation of STEM education into primary and secondary school curriculum, appropriate engineering skills into these school levels should be identified. Then, especially coding should be adapted to STEM curriculum. After completing these two steps for STEM education, theoretical courses supporting the STEM applications in science and mathematics courses should be determined. It is not possible to handle only mathematics and science or only Engineering and Technology courses in the new curriculum. The STEM curriculum program should be more than the total of all pieces (Davison, Miller, & Metheny, 1995; Honey, Pearson, & Schweingruber, 2014)".

Within the framework of these specifications, it is stated that it would be appropriate for the STEM Education Action Plan to be led by Ministry of National Education. This Action Plan consists of the following steps (STEM Education Report, 2016):

1. Establishing STEM Education centers,
2. Conducting STEM education researches for the integration of STEM education into school programs,
3. Training teachers in a way they can adopt STEM education approach,
4. Updating curriculum in a way that it could involve STEM education,
5. Creating teaching environments for STEM education and providing course materials to schools.

One of the important objectives of STEM education is that students make career choices in the STEM field. In Turkey, there is a belief that career choice is primarily concerned with the department of university education. Therefore, the faculty that students choose is an important step in the career path. There are some factors that affect the vocational decision-making processes of individuals. It is also important for the young people who are considering university education to decide which departments to go because of the central examination system in Turkey (Çapan & Owen 2017). According to some researches conducted in Turkey, factors affecting the career/department preference of high school students are a) interest in the field, b) the score taken from the central system, c) suitability to personality traits, d) the high level of employment opportunities (Korkut-Owen et al., 2012), e) liking the area, f) ease of finding a job when graduating (Sahin, Zoraloğlu and Şahin, 2011), g) job and scholarship opportunities, (Hacettepe University Psychometry Application and Research Center, 2014; Çapan & Owen 2017). As a result, it is important to be considered that the career preferences of high school students are part of STEM education.

1.4. Career and STEM

One of the important aims of STEM education is to guide students choose one of the STEM fields for their career choices. For this reason in this section, career related terms have been reviewed, and career theories and STEM career issues have been discussed.

1.4.1. Career

Developments in the field of science and technology, which started in the last quarter of the 20th-century and increased at an unexpectedly rapid rate from the 21st-century, were not something anyone could guess. Today, these scientific and technological developments are continuing to increase rapidly. Especially developed countries are in a race to keep up new developments in order not to be left behind, even to lead. Naturally, new business areas are emerging as a result of technological developments. For these new business areas, experts and workers open to innovation are being sought. Over the last decade, in particular, the increase in business areas related to STEM is three times higher than in other business areas (Langdon, 2011). It also takes time for people to become ready for these new business areas. Therefore, people must have knowledge of career development and be prepared for these new business areas. Some organizations or institutions that are related to education are involved in career development. For example, people from various professional groups are being invited to schools to introduce their own professions; or career specialists are being invited to introduce various professions in which students may want to pursue a career are towards this aim.

The meaning and definition of career are still perceived differentially. Developing a theoretical understanding of career is difficult because the lack of conceptual clarity preserves uncertainty (Patton and McMahon, 2014). From the time of Parsons (1909), the terms career, vocation, and occupation have generally been used synonymously (P Sharma, 2016; Patton and McMahon, 2014). Traditional definitions have been criticized in different areas. One criticism about definitions is for their restriction of career to a professional work life and other life roles and contexts (Patton and

McMahon, 2014). Another criticism for career is for its western middle-class focus and the lack of its applicability across cultures and less developed countries (P Sharma, 2016).

Gysbers & More (1981) have stated that the term ‘career’ encompasses various roles, circumstances and places that one encounters in a lifetime (Chen, 1998). According to Chen (1998), in order to reflect the nature of such a comprehensive and complex self-development through the life span of a person, it is better replaced by the expression 'life career development' instead of 'career'.

Some of the career definitions are as follows:

“The sequence of major positions occupied by a person throughout his preoccupational, occupational and post occupational life; includes work related roles such as those of student, employee, and pensioner, together with complementary vocational, familial and civil roles” (Super, 1957).

“The evolving sequence of a person’s work experiences over time” (Arthur, Hall & Lawrence, 1989).

“We define a career as an individual’s work-related and other relevant experiences, both inside and outside of organizations that form a unique pattern over the individual’s lifespan” (Sullivan and Baruch, 2009).

“Subjectively, a career is the moving perspective in which the person sees his life as a whole and interprets the meaning of his various attributes, actions, and the things which happen to him” (Hughes, 1937).

“A career is a succession of related jobs, arranged in a hierarchy of prestige, through which persons move in an ordered (more-or-less predictable) sequence” (Wilensky, 1961).

“A pattern of work experiences comprising the entire life span of a person and which is generally seen with regard to a number of phases or stages reflecting the transition from one stage of life to the next” (Weinert, 2001).

From the definitions, as could be seen above, we can emerge some commonalities about career definitions. Career choice which may continue throughout life falls on the individual (P Sharma, 2016); can change over time; can move to higher positions or another field as work experience increases; have different roles; and may engage in all phases of life.

1.4.2. Career Theories

Although the terms career and career development became popular in the 1960’s (Gysbers, 1988), the definition for career has begun in the earlier period. Some of the career and career development theorists and their theories are given below:

1.4.2.1.Parsons: Trait Theory of Career Development

Frank Parson is often perceived as the founding father of modern career and vocational psychology (P Sharma, 2016). He developed the "talent matching" approach which was subsequently developed into the trait and factor theory of occupational choice within the evolving discipline of differential psychology (Gikopoulou, 2008). Parsons' core concept was "matching". He (1909, p.5) suggested that occupational choice occurs when people have achieved:

> "First, a clear understanding of yourself: your aptitudes, abilities, interests, resources, limitations and other qualities;
>
> Second, knowledge in different lines of work: the requirements and conditions of success, advantages and disadvantages, compensation, opportunities, and prospects;
>
> Third, matching: a rational and objective judgment about the relationship between these two groups of facts."

According to Gikopoulou (2008), a key assumption is that it is possible to measure both individual talents and the attributes required for particular jobs, which can then be matched to achieve a 'good fit'.

1.4.2.2.Donald Super: Life Career Stages

Super was a doctoral student of Ginzberg and developed many of Ginzberg's ideas (Gikopoulou, 2008). Ginzberg's theory consisted of fantasy stage (up to 11 years old), tentative stage (11-17 years old), and realistic stage (17-onwards). Since he thought that Ginzberg's work had weaknesses, he extended Ginzberg's three life stages to five with slightly different sub-stages (Gikopoulou, 2008). Super (1957) proposed a life stage developmental framework with the following stages: growth, exploration, establishment, maintenance (or management), and disengagement (P Sharma, 2016).

Super’s five stages and their substages are:

Growth: This stage is up for individuals up to the age of 15. This stage has three substages:

- Fantasy stage (4 to 10 years)
- Interest stage (11 to 12 years)
- Capacity stage (13 to 14 years)

Exploration: This stage is between 15-24. This stage has three substages:

- Tentative stage (15 to 17 years)
- Transition stage (18 to 21 years)
- Trial stage (22 to 24 years)

Establishment: This stage is between 25-40. This stage has three substages

- Trial stage (25 to 30 years)
- Stabilisation stage (30 to 40 years)

Maintenance: This is a stage where individuals continue to develop their skills and abilities in their careers. The ages for this career are 40-64

Decline: This is the stage after the age of 65 where an individual begins to exit the work force and adjust to their world outside of work.

1.4.2.3.Holland’s Theory: Vocational Personalities in Work Environment

Career interest assessment has internationally been guided by the theory of Holland (1985, 1997) in the past few decades. (Leung, 2008). According to Leung (2008), the theory by Holland offers a simple and easy-to-understand typology framework on career interest and environments that could be used in career counseling and guidance. Holland described six occupational themes of RIASEC Model (Prescod, 2014). Those themes are explained below (Prescod, 2014, p.34-35):

- **Realistic-R:** This group is comprised of DOERS. They prefer to deal with things rather than people. They are described as honest, persistent, shy, modest and practical. Careers: Automotive Engineer, Construction Worker, Police Officer
- **Investigative-I:** This group is comprised of THINKERS. They enjoy solving abstract problems and understanding the physical world. They are described as curious, introverted, rational, critical and intellectual. Careers: Anesthesiologist, Biologist, Computer Analyst, Electrical Engineer
- **Artistic-A:** This group is comprised of CREATORS. They like to work in settings that offer opportunities for self-expression. They are described as complicated, emotional, impulsive, intuitive and nonconforming. Career: Actor, Dancer, English Teacher, Graphic Designer
- **Social-S:** This group is comprised of HELPERS. They are sociable and responsible and have little interest in machinery or physical skills. They are described as friendly, generous, understanding and insightful. Careers: Counselor, Homemaker, Occupational Therapist, Schoolteacher
- **Enterprising-E:** This group is comprised of PERSUADERS. They enjoy leading, speaking and selling. They are described as ambitious, domineering, popular, optimistic and risk-taking. Careers: Banker, Industrial Engineer, Lawyer, Stockbroker
- **Conventional-C:** They are comprised of ORGANIZERS. They prefer highly ordered activities that characterize office work. They are described as careful

obedient, orderly and self-controlled. Careers: Accountant, Librarian, Legal Secretary, Computer Operator.

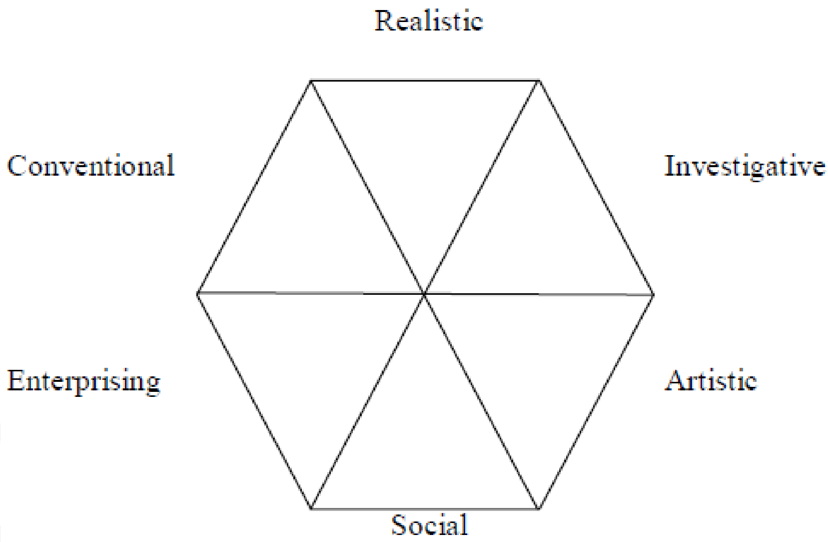

Figure 1.3. Holland's Hexagon about Personality Types. Taken from: Doctoral Dissertation by Prescod (2014).

Differentiation which is another concept in Holland's theory is the degree to which high and low-interest types are distinguishable (Prescod, 2014). According to Prescod (2014) when there is low differentiation, high and low types are not distinct, but in high differentiation, there are distinctions between high and low types. In sum, as Prescod (2014) states that Holland's typologies provide a starting point for individuals exploring their career options.

1.4.2.4.Driver (1982): Career Pattern

According to the report of Debono and his friends (Malta MoE**,** 2007), Driver (1982) formulated a theory of career patterns which has strongly influenced contemporary definitions of career. He identified four patterns of employment:

1. Transitory: in this pattern, a person often changes employment without any stability period.

2. Steady-state: in this pattern, the individual chooses a profession in the early stages of life and continuously follows it.
3. Linear: in this pattern, a field is chosen in early life, and upward movement plan is developed and carried out.
4. Spiral: in this pattern, the individual develops for a long time on a specific area and then moves to another related or unrelated area on a cyclical basis.

1.4.2.5.Gottfredson: Circumscription and Compromise

A more recent contribution is accepted as Gottfredson's theory of career development. She attempts to describe how career choice develops in young people. There are four developmental processes that are vital to the vocational choice process in her theory: cognitive growth, self-creation, circumscription, and compromise. Gottfredson (2002) suggests that perceptions of the world of work and vocationally relevant decision making begin at early ages. For this reason, although the majority of the vocational selection process takes place during adolescence and early adulthood, cognitive growth during childhood also has a large impact on this process and must be taken into account (Junk, 2008). Gottfredson states that the career aspirations of children are influenced more by the public (e.g., gender, social class) than private aspects of their self-concept (e.g., skills, interests) (Leung, 2008). Gottfredson (2002) proposed a developmental model consisting of four stages of circumscription:

1. The first stage is called "orientation to size and power" for ages 3–5, and the child perceives occupations as roles taken up by big people (adults).
2. The second stage is called "orientation to sex-roles" for ages 6–8, and in this stage sex-role norms and attitudes emerge as defining the aspect of a child's self-concept.

3. The third stage is called "orientation to social valuation" for ages 9–13, as social class and status become salient to a child's developing self-concept.
4. The fourth stage is called "orientation to the internal, unique self" for ages 14 and above, in which internal and private aspects of the adolescent's self-concept, such as personality, interests, skills, and values, become prominent.

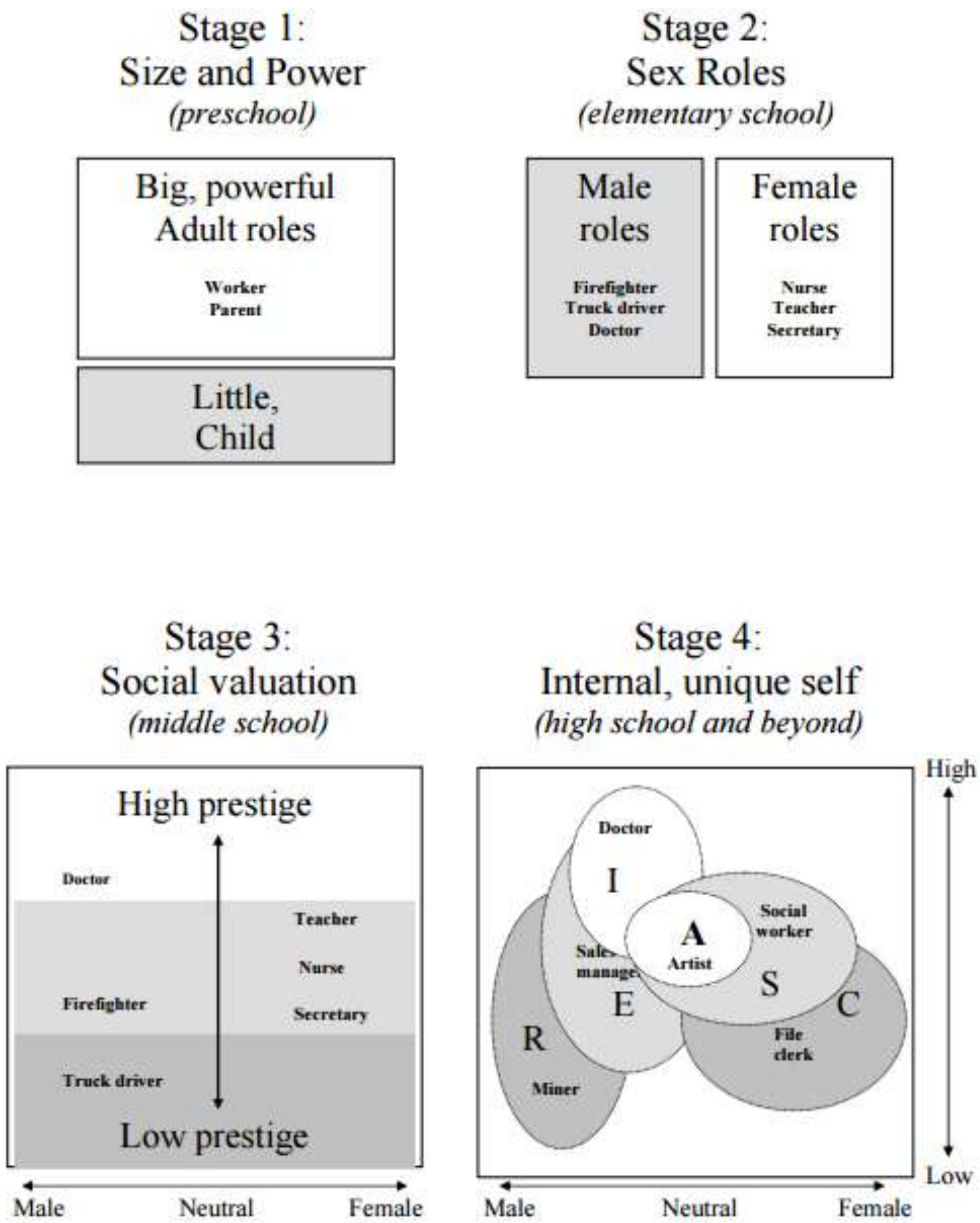

Figure 1.4. The Four stages in the Circumscription of Vocational Aspirations. (Note: I=Investigative; E=Enterprising; R= Realistic; C=Conventional; S=Social; A=Artistic;)

As it can be seen, there are many theories and models about career development. Each of the career theorists and their theories has dealt with a different aspect of the career. While Parson focused on matching one's own talents and the professions that fit those skills, Super (1957) emphasized the age-related stages of the career. While Holland (1985, 1997) working on personalities, Driver (1982) emphasized the career pattern. Gotfretson is one of the most contemporary theorists, focusing on the career roles starting from the childhood. All of these theories are pieces of a whole that complement each other.

1.4.3. STEM Career

STEM has received a considerable attention over the past several years. This attention, according to Oleson (2014), is believed to play a central role in creating new industries as the history of renewal in these areas. On the other hand, David Langdon and his friends, the economists in Economics and Statistics Administration (ESA), published a report about STEM entitled “STEM: Good Jobs Now and for the Future”. In this report, there are some comparisons between STEM jobs and non-STEM jobs or STEM jobs now and future. According to Langdon (2011) in this report, “over the past ten years, growth in STEM jobs was three times as fast as growth in non-STEM jobs. STEM workers are also less likely to experience joblessness than their non-STEM counterparts. Science, technology, engineering and mathematics workers play a fundamental role in the sustained growth and stability of the U.S. economy, and are a critical component to helping the U.S. win the future”. In this report, some information is emphasized. For example, STEM professions will grow by 17.0 percent from 2008 to 2018 compared to 9.8 percent growth for non-

STEM professions; STEM employees are charging higher fees than their counterparts outside of STEM with a 26% higher fee; and STEM grade holders earn higher profits regardless of whether they work in STEM or non-STEM professions. (Langdon, 2011).

An important question that rises is what the STEM professions are. Experts about STEM professions have different views. According to Oleson (2014), in the case of STEM professions in the near or above the list of many experts who make good payments in the 21st-century, depending on which experts are dependent on policy makers, educators or students, they will produce very different conclusions about their policies, curricula, and future career choices. According to Standard Occupational Classification Policy Committee (SOCPC), STEM occupations are generally consist of two domains: Core and Related (Jones, 2014; SOCPC, 2012).

For defining STEM occupations in 2012, the SOCPC determined that STEM occupations can be divided into two domains with two subdomains each. (Oleson, 2014). The primary domains and their subdomains can be expressed as follows:

1. Core STEM Domain: the science, engineering, mathematics, and information technology domain. The subdomains within STEM domain which are considered to contain the “core” STEM occupations (Jones, 2014) are:
   A. Life and physical science, engineering, mathematics, and information technology occupations,
   B. Social science occupations.
2. STEM-Related Domain: the science- and engineering-related domain. The subdomains within the science- and engineering-related domains are:

A. Architecture occupations,

B. Health occupations (SOCPC, 2012).

SOC Policy Committee (2012) detailed 184 occupations in STEM area. For NSF, on the other hand, science and engineering occupations typically require a bachelor’s degree in an S&E field, while the S&E-related occupations may not require a bachelor’s degree in an S&E field (NSB, 2014).

Some organizations classified the STEM jobs. For example, SOCPC specified 184 STEM jobs in seven categories. The Occupational Information Network (O*NET) specified 170, The Georgetown University Center on Education and the Workforce (CEW) specified 85, and NSF specified 62 STEM jobs. These classifications of STEM jobs are given in Table 1.4 below.

Table 1.4
Classifications of STEM jobs

	SOCPC	O*Net – STEM Career Cluster	NSF	CEW at Georgetown
SOC	184 detailed occupations	170 detailed occupations	62 detailed occupations	85 detailed occupations
SOC major groups	**7 Major Groups** 1. computer & mathematical 2. architecture & engineering 3. life, physical, & social science 4. management 5. education, training, & library 6. healthcare practitioner & technical 7. sales & related	**10 Major Groups** 1. computer & mathematical 2. architecture & engineering 3. life, physical, & social science 4. management 5. education, training, & library 6. healthcare practitioners & technical 7. business & financial operations 8. office & administrative support 9. community & social services 10. arts, design, entertainment, sports, & media	**3 Major Groups** 1. computer & mathematical 2. architecture & engineering 3. life, physical, & social science	**3 Major Groups** 1. computer & mathematical 2. architecture & engineering 3. life, physical, & social science

Note: Classification of STEM occupations by agency (Oleson, 2014) (Retrieved from http://wcer.wisc.edu/docs/working-papers/Working_Paper_No_2014_02.pdf)

On the other hand, SOCPC and the NSF compared the STEM occupations as "core" and "related". It can be said that they are relatively similar (Oleson, 2014).

As time passes, new professions emerge. The increase in new professions is notably higher in STEM fields because STEM fields are open to creativity and innovation. On the other hand, no consensus has yet been reached as to which professions are directly related to the STEM field and which are indirectly related. When professions are generalized, separating the professions related to STEM as core and related makes it easier to reach consensus on this issue.

Table 1.5
Comparisons between "Core STEM" and "STEM-Related" occupations

	SOCPC	NSF
STEM/ S&E	**STEM Occupations:** Life and physical science Engineering Mathematics Information technology Social science (Includes the following types: Research, development, design, or practitioner; technologist and technician; postsecondary teaching; managerial; and sales)	**S&E Occupations:** Biological, agricultural, and environmental life scientists Computer and mathematical scientists Physical scientists Social scientists Engineers S&E postsecondary teachers
STEM/ S&E Related	**S&E-Related Occupations:** Architecture Health (Includes the following types: Research, development, design, or practitioner; technologist and technician; postsecondary teaching; managerial; and sales)	**S&E-Related Occupations:** Health S&E managers S&E precollege teachers S&E technicians and technologists Architects Actuaries S&E-related postsecondary teachers

Note. Comparisons between "Core STEM" and "STEM-Related" occupations for the SOCPC and the NSF (Oleson, 2014)

Due to the interest of the public policy towards STEM skills, there is a significant amount of research on STEM graduates' labor market and career goals (Hooley et al., 2012). Hooley et al. (2012) states these key findings as: a) STEM graduates can be found throughout the economy in various professions and sectors. With a few exceptions, most STEM degrees do not automatically direct graduates to working in a particular occupation or group of occupations. b) On average, STEM graduates earn more than non-STEM graduates, even when they work in non-STEM sector jobs.

c) The STEM graduates are demanded across the economy, at least not because of the aging of the current STEM workforce and because this demand is expected to rise in the medium to long term.

1.5. Reports Related to STEM in Turkey

Three important institutions in Turkey can contribute to STEM education. These are Ministry of National Education (MoNE), universities and business world. These three institutions have also published reports at different times that emphasized the importance of STEM education, determined the needs, and investigated what needs to be done. When these reports are examined, the similarities among the demands are in the foreground. The issue they all share in common is the individuals that should be trained in STEM fields.

The first one is STEM Education Turkey Report prepared by Devrim Akgündüz and his friends in Istanbul Aydın Üniversity (Akgündüz et al. 2015). This report is important to be the first in this field in Turkey. At first, it reviews the reform movements in the world in the field of STEM. After being informed about the STEM school system and STEM institutions in the United States, which are leading in the field of STEM, the activities towards STEM education in the European Union have been mentioned. After discussing the importance of integrated STEM education and 21st-century skills, the relationship between these two is examined. After giving general information about STEM, it focuses on the need for STEM in Turkey. In this report, it is observed that the percentage of the placement of top thousand students in STEM areas in Turkey decreased from 2000 to 2014 (Akgündüz, 2016). The STEM placement rate, which was 85.63% in 2000, declined to 27.88% in 2010 and was

38.23% in 2014. This situation suggests that urgent measures should be taken in selecting the professions of STEM fields in Turkey and that the STEM career should be encouraged. Another finding determined in this study is that those who are in the first 1000 and do not prefer STEM fields prefer especially the faculty of medicine. Another important point is that the average placement rate of STEM fields for males is 81.39% and that of females is 18.61%. There is a big difference between the placement rates of STEM areas for boys and girls. After focusing on the different interpretations of STEM in Turkey, then the road map and proposals related to STEM education in Turkey were emphasized. Some of these proposals are: the system supporting the STEM schools in the US should be adapted to the Turkey; establishing science centers in all cities and increasing communication with schools are necessary; education faculties of universities should work on STEM education and develop projects; the skills of STEM education of teachers should be increased through the training that teachers will receive in education faculties under in-service teacher training; there is a need for the establishment of a large number of high schools in Turkey where advanced STEM education is given; collaboration between the industry and the schools can be increased; national standards on how to integrate STEM education into existing curriculum needs to be established.

The second important report supporting the first one is the STEM Education Report prepared by the Ministry of National Education (MoNE, 2016). After reviewing the countries that implement STEM education, this paper reviews recommendations and steps for STEM education in Turkey. The recommendations are examined in five main sections. These recommendations are establishment of STEM education centers, conducting STEM education researches, training STEM teachers, updating teaching programs, and finally creating STEM education environments and providing necessary laboratory materials to primary and secondary schools. At the end of this report, action recommendations have been made regarding the transition of STEM education in Turkey. These recommendations consist of (MoNE, 2016, p.78):

1. Creating a STEM education working group.
2. Establishing STEM education centers by collaboration with other related institutions.
3. Conducting research studies in STEM centers to generalize STEM education in Turkey.
4. Preparing a STEM action plan for the transition to STEM education according to the results of the researches conducted in STEM education centers.
5. Organizing seminars about STEM education by STEM centers to the personnel work in MoNE education units, board of education, provincial directorates of MoNE, school administrators and teachers.
6. Decreasing content load in Science and Mathematics courses in schools so that there will be enough time for STEM course activities and updating centralized content based examination system accordingly to measure students' inquiry, researching, developing products and inventing skills.
7. Renewing science laboratories of schools and providing new laboratory equipment for the transition to STEM education in primary and secondary schools.
8. Launching STEM teacher training programs within the faculties of education at universities.
9. Preparing and implementing in-service STEM education programs for science, mathematics, technology, etc. teachers who want to be STEM teacher.

Another important report is published by the Turkish Industry and Business Association (TUSIAD, 2017), the largest business group in Turkey. This report, titled "STEM Requirements in Turkey Towards 2023" describes the benefits and necessity of giving importance to STEM fields of education and of business. The opportunity to become a country that determines the future for improved innovation and productivity with well-equipped workers will contribute to economic development. Turkey, which is one of the G-20 countries, is in the process of follow-up and adaptation of the latest technological developments in order to sustain the projected growth rates of the economy towards 2023. Therefore, the skills of creativity, productivity, and lifelong learning should be paid attention. Consequently, increasing the need for specialists in the field of STEM is emerging as an inevitable phenomenon. It was emphasized that the expectations of the business world and the individuals who will follow the digital age should be trained by STEM education and that the trained individuals should be employed in STEM fields. It is anticipated that the 21st-century ‘savior talents’ that support STEM will be subject to the demand. Examples of ‘savior talents’ include critical thinking and problem solving, developing cooperation and leadership between systems and people, entrepreneurship and initiative taking, effective verbal and written communication, analytical skills, continuous learning, curiosity, and creativity. Another important point to mention is that those with STEM skills are able to adapt more easily to desired qualities in business life. It has been stated that companies are looking for individuals capable of creativity and innovation and it is difficult for these individuals to be found. CEOs of large enterprizes state that innovation, human capital, and technological and digital skills are the first three fields that they want to develop in business life. Considering the effects of Industry 4.0 and digital transformation, it is expected that some professions and business areas will be destroyed by this transformation, while at the same time some new occupation areas will emerge as a result of human needs. Improvements in the curriculum, teaching methods, and teacher training will be beneficial for educating highly creative, innovative, analytical and critical thinking, and problem-solving individuals. Cooperation between the university and industry should be increased. Orientation of STEM graduates to STEM fields as much as possible is important in terms of meeting the qualified workforce needed in the field of technology and innovation. For STEM employment requirement analysis studies, the sectors in Turkey were grouped under six main sectors as "manufacturing, construction, distribution and transportation, primary sector and public services, commercial and other services, and non-market services". In the light of the statements made by TUSIAD, it can be concluded that the public, education and business world must come together to provide the necessary support and contribution to the STEM fields in order to be able to compete as a country in technology, innovation, and digital transformation.

1.6. The Purpose and Significance of the Research

Developments in the field of science and technology are advancing at an incredible speed in the last two decades. Countries have to keep up with these developments. For this, they are seriously taking the young generation to be creative, innovative, collaborative and cooperative. On the other hand, discoveries in STEM fields drove huge advancements in human society in the 20th-century, and a similar trend in the coming decades is anticipated (National Academy of Engineering [NAE], 2008). As a result of this, accelerating job-growth in these fields is predicted by researchers and economists (United States Department of Commerce, 2012). Therefore, countries need experts in mathematics, science, engineering, and technology. Orientation of students to these areas is one of the important objectives of a country. Therefore, educational reforms are needed to do this orientation.

STEM education is one of the most significant educational reforms in the last decade. Therefore, the subject of this research is STEM education and the career choices in the field of STEM which are not yet understood enough in our country.

The overall purpose of this study presented as to investigate the influence of some variables on high school students' attitudes towards STEM and their relation with career preferences. For this purpose, the contents of the STEM, STEM education, curriculum, career, and career theories within the scope of this thesis were discussed. In this direction, research problem statement and sub-problems are structured in the following way.

1.7. Research Questions

The problem being addressed in this study is "What is the influence of some variables on high school students' attitudes towards STEM?"

Sub-problem 1: What are the high school students' attitudes towards STEM?

Sub-problem 2: How do the attitudes of high school students towards STEM vary by

a. gender

b. school type

c. grade level

d. academic achievement

Sub-problem 3: What are the high school students' STEM career preferences?

Sub-problem 4: How do the STEM-related career choices of high school students vary by

a. gender

b. school type

c. grade level

d. academic achievement

Sub-problem 5: What is the relationship between the high school students' attitudes towards STEM and their STEM-related career choices?

1.8. Assumptions of the Study

The research is based on the following proposition:

It was assumed that all participants provided honest and accurate information during the filling "STEM Attitude Scale" and "STEM Career Interest Form".

1.9. Definitions

STEM Education: "The term STEM education refers to teaching and learning in the fields of science, technology, engineering, and mathematics. It typically includes educational activities across all grade levels— from pre-school to post-doctorate—in both formal (e.g., classrooms) and informal (e.g., afterschool programs) settings" (Gonzalez, H.B. & Kuenzi J. (2012).

Career: "The sequence of major positions occupied by a person throughout his preoccupational, occupational and post occupational life; includes work related roles such as those of student, employee, and pensioner, together with complementary vocational, familial and civil roles" (Super, 1957)**.**

2. METHOD

This part presents information about methods and procedures that have been taken in this study. It involves information about research design of the study, demographic characteristics of the study group, measuring instruments, data collection, and quantitative data analyses.

2.1. Research Design of the Study

In this study, the descriptive quantitative research method has been used. The primary purpose of this study is to investigate the influence of some variables on high school students' attitudes towards STEM and the relationship between the high school students' attitudes towards STEM and their STEM-related career choices. In order to investigate the research questions, quantitative research method has been used. To investigate main and joint effect of variables, the data has been examined through descriptive statistics. In addition, the correlational research design has been chosen in order to investigate the strength of the relationships between STEM attitude and STEM career interest of high school students.

2.2. Study Group: Demographic Characteristics of the Study Group

Participants of this study have been selected from high schools in Kadiköy district of Istanbul. Overall, there are 1231 high schools including public or private in Istanbul while there are 55 high schools in Kadiköy district (MoNE, 2014, istanbul.meb.gov.tr). Since the target population was too large, it was hard to reach all high school students in Istanbul. Therefore, the high schools in Kadıköy district were chosen for this study. When choosing the target schools, no criteria has been used and they are chosen randomly. However, science high school was not chosen randomly because there is only one science school in Kadıköy district. Totally 1266 students participated in this research. Since 39 of the students didn't complete the forms and 66 of them didn't write the information about their gender, grade level or academic achievement, 105 survey forms from these students were taken out of the research. Therefore, the remaining 1161 forms have been taken into account.

Table 2.1
Demographic Characteristics of the Study Group

Demographic characteristics of the study group	f	%
Gender		
Female	530	45.7
Male	631	54.3
Total	1161	100.0
Schools Types		
Anatolian High School	354	30.5
Science High School	142	12.2
Vocational and Technical High School	306	26.4
Private high School	140	12.1
Fundamental High School	219	18.9
Total	1161	100,0
Grade Level		
Grade 9	319	27.5
Grade 10	325	28.0
Grade 11	366	31.5
Grade 12	151	13.0
Total	1161	100.0
First Term GPA of Current Grade Level		
High-Honor (85-100)	444	38.2
Honor (70-85)	330	28.4
Average (50-69)	362	31.2
Poor (0-49)	25	2.2
Total	1161	100.0

Table 2.1 shows the descriptive statistics of the high school students participated in this study with respect to school type, gender, and academic performance. With regard to school type, 354 (30.5 per cent) of the students are from Anatolian High School, 142 (12.2 per cent) of them are from Science High School, 306 (26.4 per cent) of them are from Vocational and Technical High School, 140 (12.1 per cent) of them are from Private High School, and 219 (18.9 per cent) of them are from Fundamental High School.

Moreover, male participants of the study are slightly more than female participants. For instance, 530 (45.7 per cent) female and 631 (54.3 per cent) male students have participated in this study.

As seen in Table 2.1 with respect to academic performance, 444 (38.2 per cent) of the students did high performance and obtained High-Honor Certificate, 330 (28.4 per cent) of the students did academically well and obtained an Honor Certificate, 362 (31.2 per cent) of the students did “average” performance, whereas 25 (2.2 per cent) of the students had poor academic performance and obtained below 50.

When it comes to grade level, 319 (27.5 per cent) of the students who filled STEM Attitude Scale and STEM Career Interest Form are in grade Grade 9, 325 (28.0 per cent) of students are in Grade 10, 366 (31.5 per cent) of the students are in Grade 11, and 151 (13.0 per cent) of students are in Grade 12. The reason why the number of Grade 12 students are less than other grades is that Grade 12 students were preparing for Universities, and for that reason, some of the Grade 12 students didn’t either attend or want to fill the forms.

2.3. Instruments

The main purpose of this research is to investigate the influence of some variables on high school students' attitudes towards STEM and the relationship between the high school students' attitudes towards STEM and their STEM-related career choices. In this study, there are three measuring instruments which are "Personal Information Form", "STEM Attitude Scale" (SAS) and "STEM Career Interest Form". The details of each form will be explained below.

2.3.1. Personal Information Form

In order to better understand the differences between or among the groups, a personal information form has been prepared. This personal information form includes some information about students such as gender, type of schools, first term academic achievement, and grade level (See APPENDIX A).

2.3.2. STEM Attitude Scale (SAS)

The main purpose of this research is to investigate the influence of some variables on high school students' attitudes towards STEM and the relationship between the high school students' attitudes towards STEM and their STEM-related career choices. For this purpose, The STEM Attitude Scale (SAS) developed by Faber et al (2013) and adapted to Turkish by Yıldırım and Selvi (2015) as a means of data collection in the research was used to determine the attitudes of high school students towards STEM. STEM Attitude Scale is structured as 5 point likert scale. Answer choices for the items in the scale are organized as "5= I certainly agree", "4= I agree", "3= I am neutral", "2= I do not agree" and "1= I certainly disagree" (Faber et al., 2013).

The Turkish version of the STEM Attitude Scale consists of four components (Mathematics, Science, Engineering, 21st Century skills) and a total of 37 items. The science and engineering components are nine items, the 21st-century skills component is 11 items, and the mathematics component is eight items (See APPENDIX B).

The STEM Attitude Scale reliability test results and the scores for each component of SAS for the different groups of students that were done in other researches together with the students in this research are given in the table below:

Table 2.2
Cronbach's Alfa Results from Other Researches

Results from Cronbach's Alfa

Researchers and Year	Study Group	f	SAS	Math	Science	Engineering	21. Centrury Skills
Faber et al. (2013)	Grade 4-12	9880	0,83	0,83	0,83	0,83	0,83
Yıldırım, Selvi (2015)	Grade 6-8	1360	0,94	0,89	0,86	0,86	0,89
Yenilmez, Balbağ (2016)	Grade 1 of University	128	0,88	0,87	0,91	0,83	0,92
Ocak (2017)	Grade 9-12	1161	0,93	0,89	0,93	0,89	0,88

2.3.3. STEM Career Interest Form (SCIF)

Faber et al. (2013) added 12 areas including "Physics, Environmental Works, Biology and Zoology, Veterinary Works, Mathematics, Medicine, Earth Science, Computer Science, Medical Science, Chemistry, Energy and Engineering" to the second part of SAS in order to learn towards which careers the students are interested in. In this part of the scale, 4 point likert scale was used to determine students' interest in the professions specified. Answer choices for the items in the scale are organized as "1= I am not interested at all", "2= I am not interested", "3= I am interested" and "4= I am very interested" (Faber et al., 2013).

In Turkey, however, high school students perceive career or future plan in accordance with the courses given in the universities. For this reason, "STEM Career Interest Form" has been prepared according to the courses in the universities in Turkey. STEM Career Interest Form which is related to STEM jobs includes Computer Sciences, Biology, Energy, Ship and Aircraft, Livestock and Veterinary, Mathematics, Engineering, Medicine, Agriculture & Aquaculture, Fundamental Sciences, Space, and Earth Sciences. Answer choices for the items in the scale, just like in the original Future Plan by Faber et al. (2013), are organized as "1= I am not interested at all", "2= I am not interested", "3= I am interested" and "4= I am very interested".

The number of departments related to STEM in universities in Turkey are more than ninety. However, it is determined that the number of the most preferred departments are 86. These departments are identified as 12 occupational groups. The explanations are made about every occupation group, like Faber at al (2013) did, and the university departments about these occupation groups were specified. These groups and related departments are given as follows:

Computer Sciences: This area consists of the development and testing of computer systems, designing new programs and helping others to use computers. (Software engineering, computer engineering, informatics systems, digital game design, informatics technology, computer-informatics.)

Biology: involves the study of living organisms like plants and animals and the processes of life. (Bioengineering, biosystem engineering, bioinformatics and genetics, biotechnology, molecular biology, genetics and life sciences.)

Energy: involves the study and generation of power or energy such as heat and electricity. (Mining engineering, energy systems engineering, electrical engineering, energy and materials engineering, petroleum and natural gas engineering, nuclear energy engineering.)

Ship and Aircraft: includes jobs or departments that involve designing, testing, and manufacturing new products of ship and aircraft through the use of science, math, and computers. (Aircraft engineering, aircraft body-engine, aircraft electric-electronics, ship-yacht design, ship and marine technology engineering, shipbuilding, deck.)

Livestock and Veterinary: involves departments and professions that obtain animal-related products and that produce treatments and solutions for animal diseases. (Veterinary, zoo-technology, dairy technology, animal production and technology, poultry breeding.)

Mathematics: is the science of numbers and their operations. It involves computation, algorithms, and theory used to solve problems and summarize data.

(Actuarial, statistics, mathematics, accounting, economics, financial analysis, mathematical engineering, and statistics & computer.)

Engineering: involves designing, testing, and manufacturing new products (like machines, bridges, buildings, and electronics) through the use of math, science, and computers. (Construction, machinery, electrical-electronics, material science, mechatronics, industry, industrial design, optics and acoustics, electronic communication, agricultural machines, manufacturing.)

Medicine: This area involves the protection and continuation of human health, the investigation and treatment of diseases, and the production of solutions to human health problems. (Doctor, dentist, midwifery, pharmacy, nursing, nutrition and dietetics, pharmacology, physiotherapy and rehabilitation, audiology, food engineering, biomedical engineering, gerontology, orthotics- prosthesis.)

Agriculture and Aquaculture: includes crops produced from soil and aquatic products and the use of technology related to these areas. (Farm plants, agricultural structures and irrigation, agricultural biotechnology, soil science and plant nutrition, agricultural genetic engineering, aquatic products engineering, fishery technology and engineering, garden plants.)

Fundamental Sciences: This area includes departments that bring up scientists, provide the basis for other sciences and enable scientific researches in these fields. (Physics, chemistry, mathematics, biology.)

Space: This area includes the studies of space-related science, activities, and technologies. (Astronomy and space science, space science and technology, aviation electricity and electronics, aviation and space engineering, air traffic control.)

Earth Sciences: is the study of earth, including the air, land, and ocean. (Environmental engineering, geology, archeology, map engineering, geophysical engineering, geomatics engineering.)

The Turkish version of "STEM Career Interest Form" for Turkish students is given in APPENDIX C and the English version is given in APPENDIX D.

2.4.Data Collection

Data collection procedures were started and completed between April 3 and April 28, 2017, upon the approval of Yeditepe University Rectorship Ethics Committee (See APPENDIX E) and the approval for the implementation from the Provincial Directorate of Education of Istanbul (See APPENDIX F).

The data collection stages were as follows:

1. The school administrators in Kadıköy district high schools were informed about the research topic, the content of the scales and the process of filling the scales. In order to ensure that the implementation process continue in coordination with the teaching process, the researcher followed the dates and times reported by the principal to be eligible.
2. Research data were collected during the class hours. The scales were applied by the researcher or class teachers for each classroom (40 minutes).

3. Schools were visited at specific dates and times. The researcher attended classes with classroom teachers. Necessary information was provided on the purpose of the research to ensure that the students respond correctly to the scales. Then it was explained how to respond to the scale questions.
4. Students were not asked to write their names on the forms to enable them to express their opinions freely.

2.5.Data Analyses

All the statistical analyses were done by using the Statistical Package for Social Sciences Version 23 (SPSS 23). The significance level was set p<.05 unless otherwise indicated. Frequencies and percentages of the demographic variables of the sample were displayed. For data analysis, statistical techniques were employed and the specific places where each was used have been detailed given below.

This study has employed these statistical calculations in measuring STEM Attitude Scale (SAS) and STEM Career Interest Form, and their relations with respect to gender, academic achievement, school types, and grade level of high school students;

1. Descriptive Statistics
   a. Arithmetic means
   b. Standard Deviation
   c. Variation
   d. Independent Samples T-Test
   e. Comparisons
2. Correlation

3. RESULTS

In this chapter, the results of this study are explained in five sections. In the first section, the results of descriptive statistics of the high school students' attitudes towards STEM are presented. In the second section, the results of the attitudes of the high school students towards STEM by gender, school type, grade level, and academic achievement are explained. In the third section, high school students' STEM career preferences are examined. In the fourth section, the STEM-related career choices of high school students by gender, school type, grade level, and academic achievement are explained. In the last section, the relationship between the high school students' attitudes towards STEM and their STEM-related career preferences is examined.

3.1. Findings of Subproblem 1: Descriptive Statistics for High School Students' Attitudes Towards STEM

The problem statement of this research has been determined as "What is the influence of some variables on high school students' attitudes towards STEM?". To answer this problem, STEM Attitudes Scale has been used.

The STEM Attitude Scale consists of four factors which are Science, Engineering, 21st-Century skills, and Mathematics and a total of 37 items. The science and engineering factors are nine, the 21st-century skills factor is 11, and the mathematics factor is eight. First, minimum, maximum, means, standard deviations, and variance for each of the sub factors and overall STEM attitudes were given. The results were taken from SPSS version 23.

Table 3.1
Descriptive Statistics for High School Students' STEM Attitude Scores

	N	Min.	Max.	Mean	Sd.	Variance
Mathematics	1161	8	40	24,07	3,38	11,48
Science	1161	9	45	27,28	7,64	58,40
Engineering	1161	9	45	30,84	7,81	61,10
21st Century Skills	1161	11	55	42,71	7,11	50,64
STEM (Overall)	1161	54	173	124,91	18,27	333,87

According to the data obtained from Table 3.1, when all attitude questions have been analyzed as a whole, the mean of STEM attitudes of high school students has been found as $\bar{x}$ = 124.91 (Sd=18.27, min=54, max=173). When it comes to components of STEM Attitudes of high school students, the mean of mathematics attitude scores has been found as $\bar{x}$ = 24.07 (Sd=3.38, min=8, max=40), the mean of science attitude scores has been found as $\bar{x}$ = 27.28 (Sd=7.64, min=9, max=45), the mean of engineering attitude scores has been found as $\bar{x}$ = 30.84 (Sd=7.81, min=9, max=45), and the mean of 21st-century skills attitude scores has been found as $\bar{x}$ = 42.71 (Sd=7.11, min=11, max=55).

3.2. Findings of Subproblem 2: STEM Attitudes Based on Gender, School Type, Grade Level, and Academic Achievement

a. Findings of STEM Attitudes Scores Based on Gender

In table 3.2, the STEM attitudes scores and STEM components based on gender are analyzed.

Table 3.2
Descriptive Statistics for STEM Attitude Scores Based on Gender

	Gender	N	Mean	Sd
Mathematics	Female	530	24,03	3,33
	Male	631	24,10	3,43
Science	Female	530	27,26	8,02
	Male	631	27,30	7,31
Engineering	Female	530	28,10	7,48
	Male	631	33,14	7,33
21st Century Skills	Female	530	43,46	6,79
	Male	631	42,08	7,32
STEM Total	Female	530	122,85	17,59
	Male	631	126,62	18,66

For mathematics attitudes, the mean score of female students has been found as $\bar{x}$ = 24.03 (Sd=3.33) and of male students has been found as $\bar{x}$ = 24.10 (Sd=3.43). For science attitudes, the mean score of female students has been found as $\bar{x}$ = 27.26 (Sd=8.02) and of male students has been found as $\bar{x}$ = 27.30 (Sd=7.31). For Engineering attitudes, the mean score of female students has been found as $\bar{x}$ = 28.10 (Sd=7.48) and of male students has been found as $\bar{x}$ = 33.14 (Sd=7.33). For 21st-century skills attitudes, the mean score of female students has been found as $\bar{x}$ = 43.46 (Sd=6.79) and of male students has been found as $\bar{x}$ = 42.08 (Sd=7.32).

The Independent Samples T-Test was performed to examine whether the STEM attitudes of the high school students differed with respect to gender. The results of the analysis were given in Table 3.3.

Table 3.3
Independent Samples T-Test for STEM Attitudes of the High School Students Based on Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mat	E.v.a.*	,95	,32	-,31	1159	,75	-,06	,19	-,45	,32
	E.v.n.a.**			-,32	1134	,74	-,06	,19	-,45	,32
Science	E.v.a.*	10,68	,00	-,07	1159	,93	-,03	,45	-,91	,84
	E.v.n.a.**			-,07	1082	,94	-,03	,45	-,92	,85
Engineering	E.v.a.*	2,59	,10	-11,54	1159	,00	-5,03	,43	-5,89	-4,18
	E.v.n.a.**			-11,52	1116	,00	-5,03	,43	-5,89	-4,18
21. Century Skills	E.v.a.*	2,37	,12	3,31	1159	,00	1,38	,41	,56	2,20
	E.v.n.a.**			3,33	1147	,00	1,38	,41	,56	2,19
STEM TOTAL	E.v.a.*	,24	,62	-3,50	1159	,00	-3,75	1,07	-5,85	-1,65
	E.v.n.a.**			-3,52	1143	,00	-3,75	1,06	-5,84	-1,66

* .Equation variance assumed

** .Equation variance not assumed

According to Table 3.3, significant differences have been found in engineering attitudes (p<.00, t= -11,54), 21st-century skills (p<.00, t= 3,31), and STEM Attitudes (p<.00, t= -3,50) on statistical basis.

The engineering attitude are quite high for male students. In the 21st-century skills, the score of female students is higher than male students. In the STEM attitudes scores, it has been found to be slightly higher for male students than female students.

b. Findings of STEM Attitudes Scores Based on School Type

In table 3.4, the STEM attitude scores with respect to school types have been analyzed. In order to make these tables more coherent, the short forms of school types have been written as follows:

- Anatolian High School (AHS)
- ScienceHigh School (SHS)
- Vocational and Technical High School (VTHS)
- Private High School (PHS)
- Fundamental High School (FHS)

Table 3.4
Descriptive Statistics for STEM Attitudes Scores Based on School Type

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min.	Max.
Anatolian HS	354	126,99	19,67	1,04	124,93	129,04	57	172
Science HS	142	132,95	13,56	1,13	130,70	135,20	97	170
Vocational and Technical HS	306	119,86	17,11	,97	117,93	121,78	59	173
Private HS	140	122,45	17,55	1,48	119,51	125,38	72	161
Fundamental HS	219	124,98	18,31	1,23	122,54	127,42	54	165
TOTAL	1161	124,91	18,27	,53	123,86	125,96	54	173

According to Table 3.4, the mean of STEM Attitude scores of students in Anatolian High School (AHS) has been found as $\bar{x}$ = 126.99 (Sd = 19.67), the mean of STEM

Attitude scores of students in Science High School (SHS) has been found as $\bar{x}$ = 132.95 (Sd = 13.56), the mean of STEM Attitude scores of students in Vocational and Technical High School (VTHS) has been found as $\bar{x}$ = 119.86 (Sd = 17.11), the mean of STEM Attitude scores of students in Private High School (PHS) has been found as $\bar{x}$ = 122.45 (Sd = 17.55), and the mean of STEM Attitude scores of students in Fundamental High School (FHS) has been found as $\bar{x}$ = 124.98 (Sd = 18.31).

In order to compare STEM attitudes of different types of schools, One-Way ANOVA in Table 3.5 and Tukey HSD in Table 3.6 given below have been used.

Table 3.5
One-Way ANOVA on STEM Attitudes of High School Students Based on School Types

	Sum of Squares	df	MeanSquare	F	Sig.
Between Groups	19374,195	4	4843,549	15,218	,000
Within Groups	367917,533	1156	318,268		
Total	387291,728	1160			

Table 3.6
Tukey HSD Test for Multiple Comparisons of STEM Attitude Scores Based on School Types

School Type (I)	School Type (J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
AHS	SHS	-5,96*	1,77	,01	-10,80	-1,12
	VTHS	7,12*	1,39	,00	3,32	10,93
	PHS	4,54	1,78	,08	-,32	9,40
	FHS	2,00	1,53	,68	-2,18	6,20
SHS	AHS	5,96*	1,77	,01	1,12	10,80
	VTHS	13,09*	1,81	,00	8,14	18,04
	PHS	10,50*	2,12	,00	4,70	16,31
	FHS	7,97*	1,92	,00	2,72	13,22
VTHS	AHS	-7,12*	1,39	,00	-10,93	-3,32
	SHS	-13,09*	1,81	,00	-18,04	-8,14

	PHS	-2,58	1,82	,61	-7,56	2,38
	FHS	-5,11*	1,57	,01	-9,43	-,80
PHS	AHS	-4,54	1,78	,08	-9,40	,32
	SHS	-10,50*	2,12	,00	-16,31	-4,70
	VTHS	2,58	1,82	,61	-2,38	7,56
	FHS	-2,53	1,93	,68	-7,80	2,74
FHS	AHS	-2,00	1,53	,68	-6,20	2,18
	SHS	-7,97*	1,92	,00	-13,22	-2,72
	VTHS	5,11*	1,57	,01	,80	9,43
	PHS	2,53	1,93	,68	-2,74	7,80

*. The mean difference is significant at the 0.05 level.

The results will be discussed in the Discussion section. Shortly, while Science High School students have the highest score ($\bar{x}$ = 132.95) of STEM Attitudes among all the high school types on the statistical basis, Vocational and Technical High Schools have the least score ($\bar{x}$ = 119.86) of STEM Attitudes.

c. Findings of STEM Attitudes Scores Based on Grade Level

In Table 3.7, the STEM attitude scores with respect to Grade Level have been analyzed.

Table 3.7
Descriptive Statistics for STEM Attitudes Scores Based on Grade Level

	N	Mean	Sd.	Std. Error	95% Confidence Interval for Mean: Lower Bound	95% Confidence Interval for Mean: Upper Bound	Min	Max
Grade 9	319	123,78	17,08	,95	121,90	125,66	54	165
Grade 10	325	125,18	18,36	1,01	123,18	127,18	58	170
Grade 11	366	126,89	18,48	,96	124,99	128,79	57	172
Grade 12	151	121,92	19,54	1,59	118,78	125,07	74	173
Total	1161	124,91	18,27	,53	123,86	125,96	54	173

According to Table 3.7, the mean of STEM Attitude scores of students in Grade 9 has been found as $\bar{x}$ = 123.78 (Sd = 17.08), the mean of STEM Attitude scores of students in Grade 10 has been found as $\bar{x}$ = 125.18 (Sd = 18.36), the mean of STEM Attitude scores of students in Grade 11 has been found as $\bar{x}$ = 126.89 (Sd = 18.48), and the mean of STEM Attitude scores of students in Grade 12 has been found as $\bar{x}$ = 121.92 (Sd = 19.54).

In order to compare STEM attitudes of different grade levels, One-Way ANOVA in Table 3.8 and Tukey HSD in Table 3.9 have been used.

Table 3.8
One-Way ANOVA on STEM Attitudes of High School Students Based on Grade Level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3216,47	3	1072,15	3,23	,02
Within Groups	384075,25	1157	331,95		
Total	387291,72	1160			

Table 3.9
Tukey HSD Test for Multiple Comparisons of STEM Attitude Scores Based on Grade Level

					95% Confidence Interval	
(I) SIN	(J) SIN	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Grade 9	Grade 10	-1,40	1,43	,76	-5,09	2,29
	Grade11	-3,11	1,39	,11	-6,70	,47
	Grade12	1,85	1,79	,73	-2,77	6,48
Grade10	Grade 9	1,40	1,43	,76	-2,29	5,09
	Grade 11	-1,71	1,38	,60	-5,28	1,86

	Grade 12	3,25	1,79	,26	-1,35	7,87
Grade11	Grade 9	3,11	1,39	,11	-,47	6,70
	Grade 10	1,71	1,38	,60	-1,86	5,28
	Grade 12	4,96*	1,76	,02	,43	9,50
Grade12	Grade 9	-1,85	1,79	,73	-6,48	2,77
	Grade 10	-3,25	1,79	,26	-7,87	1,35
	Grade 11	-4,96*	1,76	,02	-9,50	-,43

*. The mean difference is significant at the 0.05 level.

In the ANOVA result, no statistically significant difference has been found ($p < .22$), but Tukey HSD has been calculated anyway. A difference between Grade 11 and Grade 12 has been found ($p < .02$).

d. Findings of STEM Attitudes Scores Based on Academic Achievement

In Table 3.10, the STEM attitude scores of high school students with respect to academic achievement have been analyzed. In Turkey, academic performance is calculated as follows:

- POOR (Average between 1-49)
- AVERAGE (Average between 50-69)
- HONOR (Average between 70-84)
- HIGH-HONOR (Average between 85-100)

Table 3.10
Descriptive Statistics for STEM Attitude Scores Based on Academic Achievement

	N	Mean	Sd	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
POOR (Average between 1-49)	25	122,68	20,55	4,11	114,19	131,16	62	160

AVERAGE (Average between 50-69)	362	121,40	18,05	,94	119,54	123,27	54	172
HONOR (Average between 70-84)	330	125,10	18,12	,99	123,13	127,06	57	170
HIGH-HONOR (Average between 85-100)	444	127,76	17,98	,85	126,08	129,44	59	173
Total	1161	124,91	18,27	,53	123,86	125,96	54	173

According to Table 3.10, the mean of STEM Attitude scores of high school students with POOR achievement has been found as $\bar{x}$ = 122.68 (Sd = 20.55), the mean of STEM Attitude scores of high school students with AVERAGE achievement has been found as $\bar{x}$ = 121.40 (Sd = 18.05), the mean of STEM Attitude scores of high school students with HONOR achievement has been found as $\bar{x}$ = 125.10 (Sd = 18.12), and the mean of STEM Attitude scores of high school students with HIGH HONOR achievement has been found as $\bar{x}$ = 127.76 (Sd = 17.98).

In order to compare STEM attitudes of high school students with respect to academic achievement, One-Way ANOVA in Table 3.11 and Tukey HSD in Table 3.12 have been used.

Table 3.11
One-Way ANOVA on STEM Attitudes of High School Students Based on Academic Achievement

	Sum of Squares	df	MeanSquare	F	Sig.
Between Groups	8188,92	3	2729,64	8,33	,00
Within Groups	379102,80	1157	327,66		
Total	387291,72	1160			

Table 3.12
Tukey HSD Test for Multiple Comparisons of STEM Attitude Scores Based on Academic Achievement

(I) KK	(J) KK	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
POOR	AVERAGE	1,27	3,74	,98	-8,35	10,90
	HONOR	-2,42	3,75	,91	-12,08	7,24
	HIGH-HONOR	-5,08	3,72	,52	-14,65	4,48
AVERAGE	POOR	-1,27	3,74	,98	-10,90	8,35
	HONOR	-3,69*	1,37	,03	-7,23	-,14
	HIGH-HONOR	-6,35*	1,28	,00	-9,65	-3,05
HONOR	POOR	2,42	3,75	,91	-7,24	12,08
	AVERAGE	3,69*	1,37	,03	,14	7,23
	HIGH-HONOR	-2,66	1,31	,18	-6,04	,72
HIGH-HONOR	POOR	5,08	3,72	,52	-4,48	14,65
	AVERAGE	6,35*	1,28	,00	3,05	9,65
	HONOR	2,66	1,31	,18	-,72	6,04

*. The mean difference is significant at the 0.05 level.

In One-Way ANOVA result, statistically significant difference has been found ($p < .00$) then Tukey HSD has been calculated. The statistically significant difference between the academically AVERAGE students and the academically HONOR students (Mean difference=3.69), and the difference between academically AVERAGE students and academically HIGH HONOR students (Mean difference=6.35) have been found.

3.3. Findings of Subproblem 3: Descriptive Statistics for STEM Career Interest

The third subproblem of this research has been determined as "What are the high school students' STEM career preferences?". To answer this problem, STEM Career Interest Form has been used.

In order to find the most preferred occupation, the mean of the scores of each STEM or STEM related occupation groups given in Table 3.13 has been calculated

Table 3.13
Descriptive Statistics for STEM Career Interest

	N	Min	Max	Mean	Sd.	Variance
Engineering	1161	1	4	2,65	0,99	0,981
Space Sciences	1161	1	4	2,62	1,02	1,045
Computer Sciences	1161	1	4	2,55	1,04	1,082
Medicine	1161	1	4	2,48	1,05	1,107
Biology	1161	1	4	2,32	0,98	0,962
Mathematics	1161	1	4	2,31	0,99	0,987
Ship and Aircraft	1161	1	4	2,30	0,97	0,954
Fundamental Sciences	1161	1	4	2,18	0,93	0,865
Earth Sciences	1161	1	4	2,12	0,95	0,907
Livestock and Veterinary	1161	1	4	2,10	1,00	1,012
Energy	1161	1	4	2,06	0,85	0,726
Agriculture or Aquaculture	1161	1	4	1,73	0,80	0,651

The mean scores of each area has been found as follows: the mean score of Engineering is $\bar{x}$ = 2.65 (Sd= .99), the mean score of Space Sciences is $\bar{x}$ = 2.62 (Sd= 1.02), the mean score of Computer Sciences is $\bar{x}$ = 2.55 (Sd= 1.04), the mean score of Medicine and Medical Sciences is $\bar{x}$ = 2.48 (Sd= 1.05), the mean score of Biology is $\bar{x}$

= 2.32 (Sd= .98), the mean score of Mathematics is x̄ = 2.31 (Sd= .99), the mean score of Ship and Aircraft is x̄ = 2.30 (Sd= .97), the mean score of Fundamental Sciences is x̄ = 2.18 (Sd= .93), the mean score of Earth Sciences is x̄ = 2.12 (Sd= .95), the mean score of Livestock and Veterinary is x̄ = 2.10 (Sd= 1.00), the mean score of Energy is x̄ = 2.06 (Sd= .85), and the mean score of Agriculture or Aquaculture is x̄ = 1.73 (Sd= .80).

Generally, while the most preferred occupational groups are Engineering and Space Sciences, the least preferred occupational groups are Energy, and Agriculture and Aquaculture.

3.4. Findings of Subproblem 4: STEM Career Interest Based on Gender, School Type, Grade Level, and Academic Achievement

a. Findings of STEM Career Interest Based on Gender

In table 3.14, STEM career interests of students according to gender have been analyzed.

Table 3.14
Descriptive Statistics for STEM Career Interest of the High School Students Based on Gender

		N	Mean	Std. Deviation	95% Confidence Interval for Mean: Lower Bound	95% Confidence Interval for Mean: Upper Bound	Min	Max
Computer Sciences	Male	631	2,97	,98	2,89	3,05	1	4
	Female	530	2,05	,87	1,97	2,12	1	4
	Total	1161	2,55	1,04	2,49	2,61	1	4
Biology	Male	631	2,15	,93	2,08	2,22	1	4
	Female	530	2,52	1,00	2,43	2,61	1	4

	Total	1161	2,32	,98	2,26	2,38	1	4
Energy	Male	631	2,28	,86	2,21	2,34	1	4
	Female	530	1,79	,75	1,72	1,85	1	4
	Total	1161	2,05	,85	2,00	2,10	1	4
Ship and Aircraft	Male	631	2,57	,97	2,49	2,65	1	4
	Female	530	1,96	,87	1,89	2,04	1	4
	Total	1161	2,29	,97	2,24	2,35	1	4
Livestock and Veterinary	Male	631	1,95	,97	1,88	2,03	1	4
	Female	530	2,27	1,01	2,19	2,36	1	4
	Total	1161	2,10	1,00	2,04	2,16	1	4
Mathematics	Male	631	2,35	,99	2,27	2,42	1	4
	Female	530	2,26	,98	2,18	2,35	1	4
	Total	1161	2,31	,99	2,25	2,36	1	4
Engineering	Male	631	2,96	,90	2,89	3,03	1	4
	Female	530	2,26	,95	2,17	2,34	1	4
	Total	1161	2,64	,99	2,58	2,70	1	4
Medicine and Medical Sciences	Male	631	2,23	,98	2,16	2,31	1	4
	Female	530	2,75	1,06	2,66	2,84	1	4
	Total	1161	2,47	1,05	2,41	2,53	1	4
Agriculture or Aquaculture	Male	631	1,75	,82	1,69	1,81	1	4
	Female	530	1,70	,78	1,63	1,76	1	4
	Total	1161	1,73	,80	1,68	1,77	1	4
Fundamental Sciences	Male	631	2,19	,93	2,11	2,26	1	4
	Female	530	2,16	,92	2,08	2,24	1	4
	Total	1161	2,17	,93	2,12	2,23	1	4
Space Sciences	Male	631	2,70	1,00	2,62	2,77	1	4
	Female	530	2,53	1,03	2,44	2,61	1	4
	Total	1161	2,62	1,02	2,56	2,68	1	4
Earth Sciences	Male	631	2,19	,96	2,12	2,27	1	4
	Female	530	2,03	,93	1,95	2,11	1	4
	Total	1161	2,12	,95	2,06	2,17	1	4

The Independent Samples T-Test has been used to examine whether the STEM Career Interest of the high school students differed with respect to gender. The results of the analysis have been given in Table 3.15.

Table 3.15
Independent Samples T-Test for STEM Career Interest of the High School Students Based on Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Computer Sciences	E.v.a.*	6,50	,01	16,75	1159	,00	,92	,05	,81	1,02
	E.v.n.a.**			16,93	1155	,00	,92	,05	,81	1,02
Biology	E.v.a.*	13,70	,00	-6,50	1159	,00	-,36	,05	-,48	-,25
	E.v.n.a.**			-6,46	1092	,00	-,36	,05	-,48	-,25
Energy	E.v.a.*	12,40	,00	10,18	1159	,00	,48	,04	,39	,58
	E.v.n.a.**			10,29	1156	,00	,48	,04	,39	,58
Ship and Aircraft	E.v.a.*	35,22	,00	11,13	1159	,00	,60	,05	,50	,71
	E.v.n.a.**			11,24	1154	,00	,60	,05	,50	,71
Livestock and Veterinary	E.v.a.*	9,74	,00	-5,50	1159	,00	-,32	,05	-,43	-,20
	E.v.n.a.**			-5,47	1105	,00	-,32	,05	-,43	-,20
Mathematics	E.v.a.*	,85	,35	1,43	1159	,15	,08	,05	-,03	,19
	E.v.n.a.**			1,44	1129	,15	,08	,05	-,03	,19
Engineering	E.v.a.*	23,05	,00	12,97	1159	,00	,70	,05	,60	,81
	E.v.n.a.**			12,91	1099	,00	,70	,05	,60	,81
Medicine	E.v.a.*	6,87	,00	-8,63	1159	,00	-,51	,06	-,63	-,40
	E.v.n.a.**			-8,57	1088	,00	-,51	,06	-,63	-,40
Agriculture or Aquaculture	E.v.a.*	,98	,32	1,14	1159	,25	,05	,04	-,03	,14
	E.v.n.a.**			1,14	1142	,25	,05	,04	-,03	,14
Fundamental Sciences	E.v.a.*	,92	,33	,50	1159	,61	,02	,05	-,07	,13
	E.v.n.a.**			,51	1130	,61	,02	,05	-,07	,13
Space Sciences	E.v.a.*	2,75	,09	2,83	1159	,00	,17	,06	,05	,28
	E.v.n.a.**			2,83	1116	,00	,17	,06	,05	,28
Earth Sciences	E.v.a.*	2,89	,08	2,87	1159	,00	,16	,05	,05	,27
	E.v.n.a.**			2,88	1135	,00	,16	,05	,05	,27

* .Equation variance assumed ** .Equation variance not assumed

According to the tables given above, some of the areas of students' STEM career interest vary with respect to gender. These areas are Computer Sciences ($p<.00$, $t=16.75$), Energy ($p<.00$, $t=10.18$), Ship-Aircraft ($p<.00$, $t=11.13$), Engineering ($p<.00$, $t=12.97$), Earth Sciences ($p<.00$, $t=2.87$), Space Sciences ($p<.00$, $t=2.83$), Biology ($p<.00$, $t= -6.50$), Livestock and Veterinary ($p<.00$, $t= -5.5$), and Medical sciences ($p<.00$, $t= -8.63$).

b. Findings of STEM Career Interest Based on School Type

In Table 3.16, the career interests for STEM professions of high school students with respect to school types have been analyzed.

Table 3.16
Descriptive Statistics for STEM Career Interest of the High School Students Based on School Types

				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	Min	Max
Anatolian High School (AHS)	354	28,36	6,24	27,70	29,01	12	48
ScienceHigh School (SHS)	142	29,16	4,91	28,35	29,98	14	48
Vocational and Technical High School (VTHS)	306	27,10	5,74	26,46	27,75	12	42
Private High School (PHS)	140	24,13	5,65	23,19	25,08	12	35
Fundamental High School (FHS)	219	27,30	5,70	26,54	28,06	12	40
Total	1161	27,42	5,94	27,07	27,76	12	48

According to Table 3.16, the mean of STEM career interest scores of students in Anatolian High School (AHS) has been found as $\bar{x}$ = 28.36 (Sd = 6.24), the mean of STEM career interest scores of students in Science High School (SHS) has been found as $\bar{x}$ = 29.16 (Sd = 4.91), the mean of STEM career interest scores of students in Vocational and Technical High School (VTHS) has been found as $\bar{x}$ = 27.10 (Sd = 5.74), the mean of STEM career interest scores of students in Private High School (PHS) has been found as $\bar{x}$ = 24.13 (Sd = 5.65), and the mean of STEM career interest scores of students in Fundamental High School (FHS) has been found as $\bar{x}$ = 27.30 (Sd = 5.70).

In order to compare STEM career interest of high school students from different school types, Tukey HSD in Table 3.17 has been used.

Table 3.17
Tukey HSD Test for Multiple Comparisons of STEM Career Interest Based on School Types

(I) School Type	(J) School Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Anatolian HS	Science HS	-,80	,57	,62	-2,37	,76
	Voc.-Tech HS	1,25*	,45	,04	,01	2,48
	Private HS	4,22*	,57	,00	2,64	5,80
	Fundamental HS	1,06	,49	,20	-,29	2,42
Science HS	Anatolian HS	,80	,57	,62	-,76	2,37
	Voc.-Tech HS	2,06*	,58	,00	,45	3,66
	Private HS	5,03*	,68	,00	3,14	6,91
	Fundamental HS	1,86*	,62	,02	,16	3,57
Voc.-Tech HS	Anatolian HS	-1,25*	,45	,04	-2,48	-,01
	Science HS	-2,06*	,58	,00	-3,66	-,45

	Private HS	2,97*	,59	,00	1,35	4,58
	Fundamental HS	-,19	,51	,99	-1,59	1,20
Private HS	Anatolian HS	-4,22*	,57	,00	-5,80	-2,64
	Science HS	-5,03*	,68	,00	-6,91	-3,14
	Voc.-Tech HS	-2,97*	,59	,00	-4,58	-1,35
	Fundamental HS	-3,16*	,62	,00	-4,87	-1,45
Fundamental HS	Anatolian HS	-1,06	,49	,20	-2,42	,29
	Science HS	-1,86*	,62	,02	-3,57	-,16
	Voc.-Tech HS	,19	,51	,99	-1,20	1,59
	Private HS	3,16*	,62	,00	1,45	4,87

*. The mean difference is significant at the 0.05 level.

Among all the types of high schools, while Science High School students have statistically the highest score ($\bar{x}$ = 29.16, Sd = 4.91) of STEM career interest and Private High School have the least score ($\bar{x}$ = 24.13, Sd = 5.65) of STEM career interest among all the types of high schools. The details will be discussed in the Discussion section.

c. Findings of STEM Career Interest Based on Grade Level

In Table 3.18, the career interest for STEM professions of high school students with respect to grade level have been analyzed.

Table 3.18
Descriptive Statistics for STEM Career Interest of the High School Students Based on Grade Level

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Grade 9	319	27,57	5,68	,31	26,94	28,19	12	45

Grade 10	325	27,44	6,30	,34	26,75	28,13	12	41
Grade 11	366	27,49	5,80	,30	26,89	28,09	12	48
Grade 12	151	26,87	6,05	,49	25,90	27,84	12	41
Total	1161	27,42	5,94	,17	27,07	27,76	12	48

According to Table 3.18, the mean of STEM career interest scores of students in grade 9 has been found as $\bar{x}$ = 27.57 (Sd = 5.68), the mean of STEM career interest scores of students in grade 10 has been found as $\bar{x}$ = 27.44 (Sd = 6.30), the mean of STEM career interest scores of students in grade 11 has been found as $\bar{x}$ = 27.49 (Sd = 5.80), and the mean of STEM career interest scores of students in grade 12 has been found as $\bar{x}$ = 26.87 (Sd = 6.05).

It seems that there is not much difference between STEM career interest scores among grade levels. In order to see if there is any significant difference between any grade levels for STEM Career Interest scores, One-Way ANOVA has been calculated.

Table 3.19

One-Way ANOVA on STEM Career Interest of High School students Based on Grade Level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54,42	3	18,14	,51	,67
Within Groups	40982,45	1157	35,42		
Total	41036,88	1160			

Between any two grade levels, significantly difference has not been found.

d. Findings of STEM Career Interest Based on Academic Achievement

In Table 3.20, career interest scores for STEM professions of high school students with respect to academic achievement have been found separately. In Turkey, academic achievement is calculated as follows:

- POOR (0-49)
- AVERAGE (50-69)
- HONOR (70-84)
- HIGH-HONOR (85-100)

Table 3.20
Descriptive Statistics for STEM Career Interest of the High School Students Based on Academic Achievement

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Min	Max
POOR (0-49)	25	27,48	6,06	1,21	24,97	29,98	15	39
AVERAGE (50-69)	362	26,53	6,07	,31	25,90	27,15	12	45
HONOR (70-84)	330	27,75	6,16	,33	27,08	28,42	12	48
HIGH-HONOR (85-100)	444	27,89	5,60	,26	27,36	28,41	12	48
Total	1161	27,42	5,94	,17	27,07	27,76	12	48

According to Table 3.20, the mean of career interest scores for STEM professions of high school students with POOR performance has been found as $\bar{x}$ = 27.48 (Sd = 6.06), career interest scores for STEM professions of high school students with AVERAGE performance has been found as $\bar{x}$ = 26.53 (Sd = 6.07), career interest scores for STEM professions of high school students with HONOR performance has been found as $\bar{x}$ = 27.75 (Sd = 6.16), and career interest scores for STEM professions of high school students with HIGH HONOR performance has been found as $\overline{x}$ = 27.89 (Sd = 5.60).

Tukey HSD in Table 3.21 has been used so as to compare career interest scores for STEM professions of high school students with respect to academic achievement.

Table 3.21
Tukey HSD Test for Multiple Comparisons of STEM Career Interest Based on Academic Achievement

(I) KK	(J) KK	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
POOR (0-49)	AVERAGE (50-69)	,94	1,22	,86	-2,20	4,10
	HONOR (70-84)	-,27	1,22	,99	-3,43	2,88
	HIGH-HONOR (85-100)	-,41	1,21	,98	-3,54	2,72
AVERAGE (50-69)	POOR (0-49)	-,94	1,22	,86	-4,10	2,20
	HONOR (70-84)	-1,22*	,45	,03	-2,38	-,06
	HIGH-HONOR (85-100)	-1,36*	,41	,00	-2,44	-,28
HONOR (70-84)	POOR (0-49)	,27	1,22	,99	-2,88	3,43
	AVERAGE (50-69)	1,22*	,45	,03	,06	2,38
	HIGH-HONOR (85-100)	-,13	,43	,98	-1,24	,97
HIGH-HONOR (85-100)	POOR (0-49)	,41	1,21	,98	-2,72	3,54
	AVERAGE (50-69)	1,36*	,41	,00	,28	2,44
	HONOR (70-84)	,13	,43	,98	-,97	1,24

*. The mean difference is significant at the 0.05 level.

In order to find statistically significant difference, Tukey HSD Test has been used. The statistically significant difference between academically AVERAGE students and academically HONOR students ($p<.03$, Mean difference= -1.22); and academically AVERAGE students and academically HIGH HONOR students ($p<.00$, Mean difference = -1.36) have been found.

3.5. Findings of Subproblem 5: Correlation of High School Students' Attitudes towards STEM and STEM-Related Career Preferences

Fifth sub-problem sentence of this research has been stated as "What is the relationship between the high school students attitudes towards STEM and their STEM-related career choices?" As a statistical technique, the correlation has been used to answer this question.

Correlational studies investigate the possibility of relationships between only two variables (Farnkel & Wallen, 2010). Correlation also explains the degree of relationships between two variables or sets of scores (Creswell, 2012). To investigate the relationship between high school students' STEM attitudes scores and STEM career interest scores, correlation analysis has been utilized. There are different correlation coefficients that are used for particular situations. In this study, Pearson product-moment correlation has been used to analyze the relationship between attitudes towards STEM and STEM-related career preferences in Table 3.22 to see the strength and direction of the relationship between two variables in determined cases.

Table 3.22
Correlation Test between STEM Attitudes Scores and STEM Career Interest Scores

		Future Plan	STEM Attitude
STEM Career Interest Scores	Pearson Correlation	1	,509**
	Sig. (2-tailed)		,000
	N	1161	1161
STEM Attitude Scores	Pearson Correlation	,509**	1
	Sig. (2-tailed)	,000	
	N	1161	1161

**. Correlation is significant at the 0.01 level (2-tailed).

As shown in Table 3.22, there is a positive (r=0.509) and significant relationship between STEM Attitude scores and STEM career interest scores for STEM professions. The total of STEM Attitude scores positively and significantly correlated with STEM career interest scores for STEM professions ($r=0.509$, $n=1161$, $p<.01$). Büyüköztürk (2004) states that Pearson correlation coefficient (r) for two variables can be defined as “high” if the coefficient is between 0.70 and 1.00; “moderate” if the coefficient is between 0.70 and 0.30; and “low” if the coefficient is between 0.30 and 0.00. In this research, it can be mentioned that there is a moderate relation between scores obtained from STEM Attitude scores and STEM career interest scores for STEM professions.

4. DISCUSSIONS

This chapter presents discussions of five sections. The first section includes the discussions of descriptive statistics of the high school students' attitudes towards STEM; the second section includes the discussion of the attitudes of high school students towards STEM by gender, school type, grade level, and academic achievement; the third section includes the discussion of high school students' STEM career preferences; the fourth section includes the discussion of the STEM-related career choices of high school students by gender, school type, grade level, and academic achievement; and the fifth section includes the discussion of the relationship between the high school students' attitudes towards STEM and their STEM-related career choices. At the end of each chapter, taking into account the variables of this study, some of the results of the literature research are summarized. Some of these researches are directed towards STEM, and some are related to STEM implementations; also while some are related to variables such as gender, age, school type, others are related to STEM professions.

4.1. Discussions Related to Subproblem 1: High School Students' Attitudes Towards STEM

The main purpose of this study is to investigate the influence of some variables on high school students' attitudes towards STEM**.** For this purpose, the first sub problem is "What are the high school students' attitudes towards STEM?" and it was measured that the mean of STEM attitudes scores of high school students is $\overline{x}$ = 124.91 as seen in Table 3.1. The subcomponents of STEM Attitude Survey are Mathematics, Science, Engineering and 21st-century skills and their mean scores have been found as 24.07, 27.28, 30.84 and 42.71 respectively. According to Table 3.1, it can be said that high school students' attitudes towards STEM are generally "positive". Furthermore, when high school students' attitudes towards STEM are examined on the basis of components, it can be said that their attitudes towards 21st-century skills ($\bar{x}$ = 42.71) and engineering ($\bar{x}$ = 30.84) components are seen to be more positive than science ($\bar{x}$ = 27.28) and mathematics ($\bar{x}$ = 24.07) components.

In Turkey, the STEM Attitudes Survey by Faber et al. (2013) has been surveyed before, and their results are shown in Table 4.1.

Table 4.1
Comparison of the Averages of STEM Attitude Total Scores Concerning Other Researches

	Ocak (N=1161)	Yıldırım (N=1360)	Yenilmez & Balbağ (N=128)
	Mean	Mean	Mean
Mathematics	24,07	29,44	32,71
Science	27,28	34,66	31,87
Engineering	30,84	35,21	29,00
21st Century Skills	42,71	45,24	45,12
STEM (Overall)	124,9	144,55	138,70

In Yıldırım's research (2015), the STEM Attitude Survey was applied to 1360 students in grades 6-8. On the other hand in the research of Yenilmez & Balbağ (2016), the STEM Attitude Survey was applied to 128 prospective science and middle school mathematics teachers. While the attitudes towards math are lowest in both Yıldırm's and Ocak's results, the attitudes towards engineering in the research of Yenilmez & Balbağ (2016) is the lowest among subcomponents of STEM Attitude Survey. Furthermore, in all the researches of Ocak (2017), Yenilmez & Balbağ

(2016), and Yıldırım (2015), the highest score of the component of STEM Attitude Survey is 21st-century skills as shown in Table 4.1.

Some other scales, instruments or questionnaires have been developed by researchers in order to study out the attitudes or thoughts of students towards STEM in different grade levels. For example, Massachusetts Department of Higher Education has collected several researches and published a report (Bouvier and Connors 2011) called "Increasing Student Interest in Science, Technology, Engineering, and Math (STEM): Massachusetts STEM Pipeline Fund Programs Using Promising Practices". In this report, in order to investigate the students' interest in STEM, "STEM Pipeline Student Interest Grant Evaluation Survey Questions", "Information about the STEM Fellows Student Survey", "STEM RAYS After-School Science Program Pre- and Post-Assessment Survey", and "STEM Career Fair Student Survey" have been used. Another example, Gülhan and Şahin (2016) who aimed to investigate the effect of the integration of STEM on the perceptions and attitudes of the 5th-grade students in these fields used "STEM Perception Test" and "STEM Attitude Test" as quantitative data collecting materials.

In schools, the implementations of STEM-related studies increase the interest in STEM and STEM professions. Olivarez (2012), for example, made one of these researches. Olivarez (2012) tried to determine the impact of STEM education on the academic achievement of the students attending secondary school in her doctoral dissertation. An ex-post facto, causal-comparative research design was employed. The researcher conducted the study with 176 students who were in the 8th grade. Of these students who were in the 8th grade, 73 were the experimental group. The remaining

103 students formed the control group. In this research, teachers used Project-Based Learning (PBL), collaborative learning, and hands-on strategies. The researcher concluded that participation in a STEM academic program positively impacted eighth-grade students' academic achievement in mathematics, science, and reading. As a result of this research, it was also determined that implementations of STEM in schools improved not only the success of mathematics and science but also the success of reading.

Wyss et al. (2012) conducted research that revealed the importance of giving STEM information to secondary school students with the help of videotapes. The primary question in this research was expressed as "Does the demonstration of the videos of the interviews made with professional owners on STEM increase the involvement of students in this area?". The aim of the videos was to inform the students about STEM correctly. The study was carried out in two stages. In the first stage, interviews on STEM professions were made. In the second stage, these interview videos were shown to secondary school students for eight weeks. The students' interest in the STEM professions was obtained from the three surveys conducted at the beginning, in the middle and at the end of the eight weeks. The results of the study showed that the students of the experimental group to whom videos of STEM were shown were different from the students of the control group and sex had no effect on the fields.

Another research was performed by Yıldırım and Selvi (2017) determining the effects of STEM applications and mastery learning on the academic achievements of secondary school students, their perceptions and motivation of the inquiry learning skills, their attitudes towards STEM applications and their permanence of information. The research was carried out in three stages as pilot, orientation, and the main application. The study group of this research was the seventh-grade students who were studying in a secondary school affiliated to Muş Provincial Directorate of Education in 2015-2016 academic year. The application was carried out based on a semi-experimental study. In the analysis of the quantitative data obtained in the research, SPSS package program was used. As a result of the research, STEM applications and mastery learning were found to have a positive effect on students' motivation for academic achievement and motivation. Furthermore, STEM applications and mastery learning have also been found to have a positive effect on the permanence of learned information. It has also been observed that STEM applications and mastery learning do not have a positive effect on the inquiry learning skills perceptions for STEM attitude and science.

In a research conducted by Gülhan and Şahin (2016), it was aimed to investigate the effect of the integration of Science-Technology-Engineering-Mathematics (STEM) on the perceptions and attitudes of the 5th-grade students in these fields. The quasi-experimental design with a pretest - posttest was conducted in this research. The study group of the study was included 5th-grade students who received education in Istanbul. The control group was consisted of 27 students, and experimental group was of 28 students. ‘STEM Perception Test’ and ‘STEM Attitude Test’ were used as quantitative data collecting materials in the research. While the activities based on inquiry activities in the science books of Ministry of National Education were practiced in the control group; in the experimental group, the STEM activities developed by the researchers were practiced in addition to these activities. While for the STEM perception test, it has been determined that there is development especially in engineering, technology, and career; for the STEM attitude test, on the other hand, it has been determined that there is development especially in science, engineering and technology fields.

A study implemented by Keçeci, Alan, and Zengin (2017) was carried out to determine the effect of STEM practices consisting of fun science activities based on inquiry, coding and educational game-supported coding learning, on students' attitudes towards coding learning and the students' feelings and thoughts about the applications. The study was conducted for four weeks. The study group of the study is composed of 30 fifth-grade students. In the study, the mixed method was used. The data of the study was collected using educational computer games assisted learning coding attitude scale (ECGLCAS) and student logs. The scores obtained from ECGLCAS were analyzed using a t-test. As a result of the implemented practices, it has been found that there is a significant increase in the attitudes of the students. When students' journals on science events are examined, it is often seen that they enjoy the majority; they have done the applications again with their parents and wanted their lessons always to be entertaining.

Implementation of STEM education in schools is also related to STEM teachers. It is important for STEM teachers to be creative, open to innovations, capable of designing, and be a leader teacher. For this reason, some of the researches related to STEM are directed to teachers or teacher candidates.

Eroğlu and Bektaş (2016) aimed to reveal the opinions of science teachers about STEM and STEM-based course activities. Five science teachers working in three different secondary schools in Kayseri province participated in the study. One of the participants was female and others were male teachers. During the interviews, it has been found out that, the teachers thought that the STEM-based activities were related to the field of science especially in the field of physics and that there was a relation between science, technology, engineering, and mathematics. They also argued that they wanted to apply STEM-based lessons but could not do so because of time and material constraints. In this study, the main result obtained is that participants' negative thoughts about STEM and STEM-based course activities were not found.

Another study supports this result. Siew, Amir, and Chong (2015) aimed to establish their views in 2015 regarding the use of teacher and teacher candidates in the STEM teaching approach in science classes. According to the results obtained, participants have been found to have positive opinions about STEM applications. Science teachers are not very resilient to practice in their STEM lessons, in other words, they have a positive opinion of STEM and its activities, which is very important for future science education. The positive attitudes of science teachers about the activities that will provide meaningful learning in the students are also very important in terms of raising qualified individuals. Science teachers who are open to innovation are expected to raise their students as open, scientifically curious, inquisitive, and inquisitive learners in innovation (Siew, Amir and Chong, 2015).

Yet, another study has been performed by Yenilmez and Balbağ (2016). They wanted to examine the STEM attitudes of prospective science and primary school mathematics teachers. 128 first-year students, studying at a public university undergraduate program at the Faculty of Education, participated. The STEM Attitude

Scale by Faber et al. (2013) was used as the data collection tool in the study. For the analysis of the data, descriptive statistical values such as arithmetic mean, standard deviation, and independent samples t-test were used. As a result of the study, the STEM attitudes of prospective science and middle school mathematics teachers are generally positive, STEM attitudes of males are more positive than females with respect to engineering factor, and STEM attitudes of prospective science teachers are more positive than prospective middle school mathematics teachers. Moreover, STEM attitudes of prospective science teachers are more positive with respect to science factor and STEM attitudes of prospective middle school mathematics teachers are more positive with respect to mathematics factor.

4.2. Discussions Related to Subproblem 2: Attitudes of High School Students towards STEM Based on Gender, School Type, Grade Level and Academic Achievement

The second of the subproblems of this study is "How do attitudes of high school students towards STEM vary by gender, school type, grade level and academic achievement?". First, so as to investigate the difference of STEM Attitude Scores between male and female students, it has been found in Table 3.2 and Table 3.3 that STEM attitudes of male students ($\bar{x}$=126.62) are higher than female students ($\bar{x}$=122.85) (t= 3.5, $p<.05$). Additionally, while in engineering male students ($\bar{x}$=33.14) have been found higher attitude than female students (x=28.10) (t= 11.54, $p<.05$), female students ($\bar{x}$=43.46) have been found higher in 21st century skills than male students ($\bar{x}$=42.08) (t= 3.31, $p<.05$).

Second, in order to investigate the difference of STEM attitude scores among school types, the mean scores have been found in the Table 3.4, Table 3.5, and Table 3.6. In order to compare STEM attitudes of different school types, Tukey HSD has been used. When compared school types, Science High School has the highest ($\overline{x}$=132,95), and Vocational and Technical High School has the lowest ($\overline{x}$=119,86) scores for STEM Attitude Survey. The means of STEM Attitude Scores for the other school types are Anatolian High School ($\overline{x}$=126,99), Fundamental High School ($\overline{x}$=124,98), and Private High School ($\overline{x}$=122,45).

According STEM Attitude Scores in Table 3.4 and Table 3.6;

a) STEM attitude of Science High School students is significantly the highest.
b) STEM Attitude of Anatolian High School students is significantly lower than the students in Science High School and is significantly higher than Vocational and Technical High School; but it is not different from Fundamental and Private High Schools.
c) STEM attitude of Vocational and Technical High School students is not different from the Private high school, but significantly lower than other high schools.
d) STEM attitude of Private High School students is significantly lower than science high school, and not different from other high schools.
e) STEM attitude of Fundamental High School students is significantly lower than Science High School, however, it is significantly higher than Vocational and Technical High School but not different from other high school types.

Ranking of school types according to Total STEM Attitude scores:

1. Science High School (SHS), total STEM attitude score: $\bar{x}$=132,95
2. Anatolian High School (AHS), total STEM attitude score: $\bar{x}$=126,99

   Average of total STEM attitude score for all students: $\bar{x}$=124,91

3. Fundamental High School (FHS), total STEM attitude score: $\bar{x}$=124,98
4. Private High School (PHS), total STEM attitude score: $\bar{x}$=122,45
5. Vocational and Technical High School (VTHS), total STEM attitude score: $\bar{x}$=119,86

In Turkey, there is no official STEM school, but the implementation of STEM educational activities depends on the school type in Turkey (Baran et al., 2016). Only at private schools, a small percentage of students have access to STEM education at international standards (Corlu, 2014). The comparison of high school students' attitudes towards STEM over school types in this research is unique.

Third, in order to investigate the difference of STEM Attitude Scores among grade levels, the mean scores of grade levels have been found in Table 3.7. The mean of STEM Attitude scores of students in Grade 9 has been found as $\bar{x}$ = 123.78 (Sd = 17.08), the mean of STEM Attitude scores of students in Grade 10 has been found as $\bar{x}$ = 125.18 (Sd = 18.36), the mean of STEM Attitude scores of students in Grade 11 has been found as $\bar{x}$ = 126.89 (Sd = 18.48), and the mean of STEM Attitude scores of students in Grade 12 has been found as $\bar{x}$ = 121.92 (Sd = 19.54). In order to compare STEM attitudes scores in different grade levels, ANOVA in Table 3.8 and Tukey HDS in Table 3.9 have been used. In the ANOVA result, no statistically significant difference has been found ($p < .22$). But Tukey HDS calculation has been done anyway. No statistically significant difference has been found in the STEM attitude scores among the grade levels except between the 11th and 12th-grades ($p < .02$). Since the 12th-grade students are preparing for the university exams, 12th-grade students of Science High School have not filled the STEM Attitude Scale. The highest level of STEM attitude score among high schools has been found in the Science High School. Science High School is made up of outstanding students in Turkey. The 12th grade students of this school have not completed the scale because of their intensive course work of university entrance exam. For this reason, it is thought that grade 12 students who have not filled the forms have caused a slight difference in STEM Attitude Scores between 11th and 12th-grades of overall students.

Fourth, in order to investigate the difference of STEM Attitude Scores with respect to academic achievement, the mean scores have been found in Table 3.10. According to the table, the mean of STEM attitude scores of high school students with POOR performance has been found as $\bar{x} = 122.68$ (Sd = 20.55), the mean of STEM attitude scores of high school students with AVERAGE performance has been found as $\bar{x} = 121.40$ (Sd = 18.05), the mean of STEM attitude scores of high school students with HONOR performance has been found as $\bar{x} = 125.10$ (Sd = 18.12), and the mean of STEM attitude scores of high school students with HIGH HONOR performance has been found as $\bar{x} = 127.76$ (Sd = 17.98). In order to compare STEM attitude scores of high school students with respect to academic performance, ANOVA in Table 3.11 and Tukey HSD in Table 3.12 have been used. In the ANOVA result, statistically significant difference has been found ($p < .00$), then Tukey HSD calculation has been conducted. The statistically significant difference between academically AVERAGE students and the academically HONOR students (Mean difference=3.69); and academically AVERAGE students and academically HIGH HONOR students (Mean difference=6.35) have been found. Given the academic success status, it is seen that the STEM attitude scores of the students with AVERAGE scores (50-69) are one point lower than the students with POOR scores. Interestingly, no significant difference has been observed between students with HIGH-HONOR or HONOR and students with POOR scores.

In the research by Unfried, Faber, and Wiebe (2013), Student Attitudes Toward STEM Scale was used and 11,701 students from 4th-grade to 12th-grade attended the research. In Student Attitudes Toward STEM Scale, there were three sections, which were science, mathematics, and engineering and technology. STEM Career Interest Form was also added to this research. In this research, across all STEM subject areas, it has been found that attitudes towards STEM of older students are less positive than attitudes of younger students. Moreover, they have found that engineering attitudes have the highest construct average across all school-levels. When comparing female and male student attitudes toward mathematics, no major differences have been found. Males and females do not differ significantly in their mathematics attitudes. Results indicate that male and female students have markedly different attitudes toward engineering and technology. Female engineering and technology attitudes are consistently less positive than male attitudes.

According to research of Yenilmez & Balbağ (2016), the attitudes of prospective teachers towards STEM in general and in factors of science, mathematics and 21st century skills do not differ, but there is a significant difference between male and female students in terms of engineering component. Similarly, in this research, males students have more favorable interest on the engineering component than female students (t = 2.06, p <.05).

4.3. Discussions Related to Subproblem 3: High School Students' STEM Career Preferences

The third of the subproblems of this study is "What are the high school students' STEM career preferences?". In order to investigate the STEM career preferences of high school students, a survey about STEM career interest has been given to students. The mean scores of each STEM area in the Table 3.13 have been found as follows: the mean score of Engineering is $\bar{x}$ = 2.65 (Sd= .99), the mean score of Space Sciences is $\bar{x}$ = 2.62 (Sd= 1.02), the mean score of Computer Sciences is $\bar{x}$ = 2.55 (Sd= 1.04), the mean score of Medicine and Medical Sciences is $\bar{x}$ = 2.48 (Sd= 1.05), the mean score of Biology is $\bar{x}$ = 2.32 (Sd= .98), the mean score of Mathematics is $\bar{x}$ = 2.31 (Sd= .99), the mean score of Ship and Aircraft is $\bar{x}$ = 2.3 (Sd= .97), the mean score of Fundamental Sciences is $\bar{x}$ = 2.18 (Sd= .93), the mean score of Earth Sciences is $\bar{x}$ = 2.12 (Sd= .95), the mean score of Livestock and Veterinary is $\bar{x}$ = 2.10 (Sd= 1.00), the mean score of Energy is $\bar{x}$ = 2.06 (Sd= .85), and the mean score of Agriculture or Aquaculture is $\bar{x}$ = 1.73 (Sd= .80).

In this study, the most preferred occupational groups of high school students in Kadıköy district are Engineering, Space Sciences, and Computer Sciences. The least preferred occupational groups are Agriculture and Aquaculture, Energy, and Livestock and Veterinary.

In the study from Çapan & Owen (2017), a total of 157 students, 93 of whom are female and 64 are male, have been gathered. For the collection of data, a form has been used where students indicated their demographic information and pointed out the areas they planned to choose from the eight education areas in the university. In this research, it is seen that the first three most desirable fields are engineering, production and construction; health and social service; and social sciences, business management and law. The least desirable areas are agriculture, forestry, aquatic products and veterinary services, human sciences and arts.

4.4. Discussions Related to Subproblem 4: STEM-Related Career Choices of High School Students Based on Gender, School Type, Grade Level and Academic Achievement

The fourth of the sub problems of this study is “How do the STEM-related career choices of high school students vary by gender, school type, grade level and academic achievement?”. Firstly, the Independent Samples T-Test has been used to examine whether the STEM career interest of the high school students differed with respect to gender. The results of the analysis are given in Table 3.15.

According to Table 3.15, the areas of male students’ preference significantly higher than female students’ preference are Computer Sciences ($p<.01$, $t=16.75$), Energy ($p<.00$, $t=10.18$), Ship-Aircraft ($p<.00$, $t=11.13$), and Engineering ($p<.00$, $t=12.97$); while the areas of female students’ preference significantly higher than male students’ preference are Biology ($p<.00$, $t= -6.5$), Livestock and Veterinary ($p<.00$, $t= -5.5$), and Medical sciences ($p<.00$, $t= -8.63$).

Computer Sciences: Male students are significantly higher (p<.01, t=16.75)

Biology: Female students are significantly higher (p<.00, t= -6.5)

Energy: Male students are significantly higher (p<.00, t=10.18)

Ship-Aircraft: Male students are significantly higher (p<.00, t=11.13)

Livestock and Veterinary: Female students are significantly higher (p<.00, t= -5.5)

Mathematics: No significant difference found (p<.35)

Engineering: Male students are significantly higher (p<.00, t=12.97)

Medicine: Female students are significantly higher (p<.00, t= -8.63)

Agriculture-Aquaculture: No significant difference found (p<.32)

Fundamental Sciences: No significant difference found (p<.33)

Space Sciences: No significant difference found (p<.09)

Earth Sciences: No significant difference found (p<.08)

Secondly, Science High School students have statistically the highest score ($\bar{x}$ = 29.16, Sd = 4.91) of career interest scores for STEM professions among all the types of high schools; and Private High School students have statistically the least score ($\bar{x}$ = 24.13, Sd = 5.65) of career interest scores STEM professions among all the types of high schools.

Thirdly, the ANOVA test has been used to find a significant difference among grade levels for STEM career preferences. It has been found that there is no difference between any two grade levels.

Fourthly, in order to find statistically significant difference among the students who have different academic achievement, Tukey HSD calculation has been used. The statistically significant difference between academically AVERAGE students and academically HONOR students ($p<.03$, mean difference= -1.22); and between academically AVERAGE students and academically HIGH-HONOR students ($p<.00$, mean difference = -1.36) have been found. No significant difference between the students who are academically POOR and HONOR or POOR and HIGH-HONOR have been found.

As for research on STEM-related occupational choices, a similar research has been conducted by Çapan and Korkut (2017). In the study from Çapan and Korkut (2017), a total of 157 students, 93 of whom were female and 64 were male, were gathered. For the collection of data, a form was used where students indicated their demographic information and pointed out the areas they planned to choose from the eight education areas in the university. In the fields related to engineering, production, and construction, no significant difference has been found among the grade level while from the gender perspective, it has been found that two-thirds of males and one-third of females want to choose engineering. In the area of medicine and social services, when it comes to gender, it is seen that female students prefer to choose the area of health and social service more than male students. In this sense, when TÜİK (2009) data is taken into consideration, 28% of the employment for all sectors is female whereas this rate is 55% in the health sector. In terms of the grade level, it is understood that the 11th classes do not consider choosing the health and social service fields more than others. From the view of academic performances, it is seen that more than half of those with high GPA are more likely to choose the area of health and social services. However, no significant difference has been found between the schools.

In the research conducted with university students, the graduates of the Science High School mostly prefer the medical, dental and pharmacy faculties; and the general high school graduates are mainly engaged in faculties of science and literature, education faculties, and economics & administrative sciences (Ayık, Özdemir, and Yavuz, 2007).

In the study carried out by Korkut-Owen, Kelecioğlu and Owen (2014), education, human sciences and arts, health and social services are preferred more by female students than by male students; whereas fields of engineering, agriculture, forestry, aquaculture and veterinary are preferred more by male students than by female students.

Landivar (2013) conducted a research about a comparison of STEM employment in the USA between 1970 and 2011 in terms of gender, race, and age. According to the results of this research, in 2011, 26 percent of STEM workers were female and 74 percent were male. It was found that 13 percent of engineers, 27 percent of computer professionals, 41 percent of life and physical scientists, 47 percent of mathematical workers, and 61 percent of social scientists were women. Among the occupations with the largest representation of women is psychologist with 70 percent, while mechanical engineers with 6 percent have among the lowest female representation. The share of women in employment varies significantly depending on the detailed occupation, but its share was the lowest in engineering professions.

In the research by Unfried, Faber, and Wiebe (2013), Student Attitudes toward STEM Scale was used, and 11,701 students from 4th grade to 12th grade attended the research. In Student Attitudes Toward STEM Scale, there were three sections, which were science, mathematics, and engineering and technology. STEM Career Interest form was also added to this research. In this research, male students have higher levels of interest than females in all STEM professions but biology and zoology, veterinary work, medicine and medical sciences. Results indicate that high school male students have the least interest in veterinary work.

In another study, Cannon & Simpson (1985) have found that male students tend to have more positive attitudes toward science classes and careers than females.

4.5. Discussions Related to Subproblem 5: The Relationship Between High School Students' Attitudes towards STEM and Their STEM-Related Career Choices

Fifth sub-problem sentence of this research is stated as "What is the relationship between the high school students' attitudes towards STEM and their STEM-related career choices?". As a statistical technique, correlation has been used to answer this question.

Correlational studies investigate the possibility of relationships between only two variables (Fraenkel & Wallen, 2010). Correlation also explains the degree of relationships between two variables or sets of scores (Creswell, 2012). To investigate the relationship between students' STEM Attitudes scores and their STEM-related career choices, correlation analysis has been utilized. There are different correlation coefficients that are used for particular situations. In this study, to see the strength and direction of the relationship between two variables in determined case, Pearson product-moment correlation has been used to analyze this relationship given in Table 3.22.

As shown in Table 3.22, there is a positive and significant relationship between STEM Attitude scores and STEM Career Interest scores. The total of STEM Attitude scores positively and significantly correlated with STEM Career Interest scores ($r=0.509$, $n=1161$, $p<.01$). Büyüköztürk (2004) states that Pearson correlation coefficient (r) for two variables can be defined as high if the coefficient is between 0.70 and 1.00; medium if the coefficient is between 0.70 and 0.30; and low if the coefficient is between 0.30 and 0.00. In this research, Since Pearson Correlation score is 0.509, according to Büyüköztürk (2014), correlation between STEM attitude scores and STEM career preference of high school students is positive but has moderate relation.

5. RECOMMENDATIONS

This study has been carried out by quantitative research method. STEM Attitude Scale and STEM Career Interest Form have been used. Suggestions have been made in terms of the findings obtained in the study for further researchers and educators who will study on STEM. Firstly, some suggestions have been made about the STEM field, then about the career. These suggestions can be listed as follows:

1. This study was conducted in Kadıköy located in the center of Istanbul, the largest city in Turkey. It may be useful to make this study in smaller and disadvantaged cities and then compare the results with the results of this study.

2. As STEM education is new in Turkey and Turkish teachers do not have sufficient information about STEM education, further studies can be performed on teachers of mathematics, physics, chemistry, biology, and technology & design that are especially related to STEM fields in order to increase STEM awareness of teachers. For this, STEM Awareness Scale developed by Buyruk and Korkmaz (2016) can be used.

3. When the results of the STEM attitudes of students have been examined, it has been determined that students have higher attitudes in 21st-century skills and engineering and technology fields. During the studies carried out in the schools, it was noticable that the students who were not high academic achievement but were interested in technology asked a lot of questions related to STEM. Some of these students even said that they had technology-related

work and did not know what to do. From this point of view, some studies such as “Arduino” or “Robotics”, that will attract the interest of the students in the schools, can be useful for increasing students attitudes nad interests about STEM.

4. Interesting research topics from biology, astronomy, physics, chemistry, which are the subcomponents of science, can be selected, implemented and then examined in secondary or high schools in terms of integrated STEM applications. For example, plant structure or tissues in biology, momentum or electrostatic in physics, chemical reactions or periodic table in chemistry, direction finding or solar system in astronomy can be given as topics.

5. In this study, it has been determined that the female students have lower overall STEM attitudes and engineering components than male students. Similar results have been found in other studies as well. From there, studies about engineering for girls can be performed in order to increase the interest of female students in engineering.

6. All the disciplines that compose the STEM play an important role in the development of twenty-first-century skills. Creativity and innovation, cooperation, collaboration, and critical thinking known as 4C are the components of Learning and Innovation Skills in 21st Century Skills. Further studies can be conducted on the relation of these components of 4C with STEM attitudes of students separately or as a whole.

7. In-service teacher training can be conducted to the teachers who can implement the STEM topics in the classes and studies of STEM implementations can be made in universities for the teacher candidates in order to increase the attention for STEM education.

8. Comparisons can be made by measuring the student's occupational tendencies and STEM attitudes.

9. As the profession interest starts at very young ages, some practical studies on STEM can be implemented in younger grades like in grade 1-4 or especially in preschool.

10. During the research, it has been observed that many students have not done any future or carrer plan. Different professions can be introduced for the idea of career choice. Differences in perceptions or interests among these students can then be examined for these students by conducting research before and after career presentations in schools.

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APPENDIX A: PERSONEL INFORMATION FORM

Kişisel Bilgi Formu

Aşağıda yazılı kişisel bilgiler sadece bilimsel araştırmada kullanılacak olup başka kişi veya kurumlarla paylaşılmayacaktır. Lütfen isimlerinizi veya sizi belirtecek e-mail, kimlik numarası, telefon numarası, banka hesap numarası gibi bilgileri bu formların herhangi bir bölümüne yazmayınız.

Cinsiyetiniz :...

Okulunuz :...

Sınıfınız :...

İlk Dönem Not Ortalamanız :...

Personel Information Form

The following personal information will be used only for scientific research and will not be shared with other persons or institutions. Please do not write your names or any information on these forms, such as e-mail, identification number, telephone number, bank account number, etc., that will identify you.

Your Gender :...

Your School :...

Your Grade Level :...

First Term GPA :...

APPENDIX B: STEM ATTITUDE SCALE IN TURKISH

Sevgili öğrenciler,

Bu ölçek sizin Fen Bilimleri dersine yönelik STEM'e ilişkin düşüncelerinizi belirlemek amacıyla geliştirilmiştir. Burada belirteceğiniz görüşler yalnızca araştırma amacıyla kullanılacak ve sonuçlar tüm grubun yanıtları göz önüne alınarak değerlendirilecektir. Bu araştırmanın güvenirliği için gerçek düşüncelerinizi belirtmeniz özel bir önem taşımaktadır. **Lütfen hiçbir maddeyi boş bırakmayınız ve her biri için tek yanıt veriniz. Vereceğiniz bu yanıtlar bilimsel bir çalışma için kullanılacak ve başka kişiler ile paylaşılmayacaktır.**
Bu çalışmaya yaptığınız katkılardan dolayı teşekkür ederim.

Yönerge: Aşağıdaki sayfalarda ifadelere dair listeler bulunmaktadır. Lütfen kendinizi her bir ifade ile ilgili nasıl hissettiğinizi cevap kağıdı üzerinde işaretleyerek belirtin.

Örneğin:

Örnek 1:	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
Mühendisliği seviyorum.	○	○	○	○	○

Cümleyi okuyunca buna katılıp katılmadığınızı bileceksiniz. Bu ifadeye ne ölçüde katıldığınızı tanımlayan yuvarlağı işaretleyin. Bazı ifadeler birbirine çok benziyor olsa da lütfen bütün ifadeler için ilgili cevabı işaretleyin. Bu seçeneklerin işaretlenmesi zaman açısından ölçülmemektedir; hızlı ancak dikkatli bir şekilde çalışın.

Hiçbir şekilde "yanlış" ya da "doğru" cevap seçenekleri söz konusu değildir! Tek doğru yanıt sizin için doğru olan yanıttır. Mümkün olduğu noktada sizin başınız gelmiş olabilecek durumların sizin tercihte bulunmanıza yardım etmesine izin verin.
Lütfen her soru için bir cevabı işaretleyin.

MATEMATİK

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Matematik benim en kötü olduğum derstir.	○	○	○	○	○
2. Matematiğin kullanıldığı bir kariyeri seçmeyi düşünebilirim.	○	○	○	○	○
3. Matematik benim için zor.	○	○	○	○	○
4. Matematikte başarılı olabilecek bir öğrenciyim.	○	○	○	○	○
5. Birçok dersle başa çıkabilirim ancak matematikle başa çıkamıyorum.	○	○	○	○	○
6. Matematik konusunda ileri seviyede çalışmalar yapabileceğimden eminim.	○	○	○	○	○
7. Matematikte iyi notlar alabilirim.	○	○	○	○	○
8. Matematikte iyiyim.	○	○	○	○	○

FEN					
	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Fen ile ilgilenirken kendimden emin davranıyorum.	○	○	○	○	○
2. Fen üzerine bir kariyer yapmayı düşünebilirim.	○	○	○	○	○
3. Okuldan mezun olduğumda fen'i kullanmayı umut ediyorum.	○	○	○	○	○
4. Fen konusunda bilgili olmam benim hayatımı kazanmama yardım edecek.	○	○	○	○	○
5. Gelecekteki çalışmalarım için fene ihtiyacım olacak.	○	○	○	○	○
6. Fen konusunda başarılı olabileceğimi biliyorum.	○	○	○	○	○
7. Hayatımdaki çalışmalarda, fen benim için önemli olacak.	○	○	○	○	○
8. Birçok dersle başa çıkabilirim ancak fenle başa çıkamıyorum.	○	○	○	○	○
9. Fen konusunda ileri seviyede çalışmalar yapabileceğimden eminim.	○	○	○	○	○

MÜHENDİSLİK					
	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Yeni ürünlerin üretildiğini hayal etmek hoşuma gidiyor.	○	○	○	○	○
2. Mühendisliği öğrenirsem, insanların günlük yaşamlarında kullandığı şeyleri geliştirebilirim.	○	○	○	○	○
3. Bir şeyleri oluşturmak ve onları tamir etmekte iyiyim.	○	○	○	○	○
4. Makinelerin nasıl çalıştığı ile ilgiliyim.	○	○	○	○	○
5. Ürünler veya yapılar tasarlamak gelecekteki çalışmalarım için önemli olacak.	○	○	○	○	○
6. Elektronik eşyaların nasıl çalıştığı konusunda meraklıyım.	○	○	○	○	○
7. Yaratıcılık ve yeniliği gelecekteki çalışmalarında kullanmak isterim.	○	○	○	○	○
8. Matematik ve Fen'i birlikte nasıl kullanacağımı bilmek bana kullanışlı şeyler icat etme şansı tanıyacak.	○	○	○	○	○
9. Mühendislik konusunda başarılı bir kariyere sahip olabileceğime inanıyorum	○	○	○	○	○

21. YÜZYILIN YETENEKLERİ					
	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Diğer bireylere bir hedefe ulaşmalarında liderlik edebileceğim konusunda kendime güveniyorum.	○	○	○	○	○
2. Diğer bireyleri ellerinden gelenin en iyisini yapmaları için cesaretlendirebileceğime inanıyorum.	○	○	○	○	○
3. Yüksek kalitede çalışmalar yapabileceğimden eminim.	○	○	○	○	○
4. Akranlarımın farklılıklarına karşı saygılı davranacağımdan eminim.	○	○	○	○	○
5. Akranlarıma yardım edebileceğime eminim.	○	○	○	○	○
6. Karar verirken başkalarının görüşlerini göz önüne alacağımdan eminim	○	○	○	○	○
7. İşler planlandığı gibi gitmediğinde değişiklikler yapabileceğimden eminim.	○	○	○	○	○
8. Kendi öğrenme hedeflerimi belirleyebileceğime inanıyorum.	○	○	○	○	○
9. Kendi başıma çalışırken zamanımı akıllıca yönetebileceğimden eminim.	○	○	○	○	○
10. Yapmam gereken görevler olduğunda hangilerinin önce yapılmaları gerektiğini seçebilirim.	○	○	○	○	○
11. Farklı altyapılara sahip olan öğrencilerle iyi bir şekilde çalışabileceğimden eminim.	○	○	○	○	○

APPENDİX C: STEM CAREER INTEREST FORM IN TURKISH

Aşağıda yazılı listelerde Fen, Matematik, Mühendislik ve Teknoloji alanları ile ilgili meslek grupları bulunmaktadır.

Bu yazılan meslek grupları aynı zamanda Türkiye'deki üniversitelerde bulunan bölümlerdir.
Bu meslek gruplarına ne kadar ilgili olduğunuzu belirtiniz.
Burada doğru yada yanlış diye bir cevap yoktur. Size en uygun olan, doğru cevaptır.

MESLEK GRUPLARI	Hiç ilgili değilim	İlgili değilim	İlgiliyim	Çok ilgiliyim
Bilgisayar Bilimleri: Bu alan bilgisayar sistemlerinin geliştirilmesi ve test edilmesi, yeni programların tasarlanması ve insanların bilgisayar kullanımlarına yardımcı olan meslek gruplarıdır. (Yazılım mühendisliği, bilgisayar mühendisliği, bilişim sistemleri, dijital oyun tasarlama, bilişim sistemleri, bilişim teknolojileri, bilgisayar-enformatik)	O	O	O	O
Biyoloji: Bu alan yaşayan organizmalar ve hayatın devamlılığı çalışmalarını içerir. (Biyomühendislik, biyosistem mühendisliği, biyoenformatik ve genetik, biyoteknoloji, moleküler biyoloji, genetik ve yaşam bilimleri)	O	O	O	O
Enerji: Bu alan ısı, elektrik gibi enerjilerin üretilmesi ile ilgili meslek gruplarıdır. (Enerji sistemleri mühendisliği, maden mühendisliği, elektrik mühendisliği, sistem mühendisliği, enerji ve malzeme mühendisliği, petrol ve doğalgaz mühendisliği, nükleer enerji mühendisliği)	O	O	O	O
Gemi ve Uçak: Bu alan matematik, fen ve bilgisayar kullanarak uçak ve gemi ile ilgili yeni ürünler ortaya çıkarma, tasarlama ve işleyişleri ile ilgili bölümleri içerir. (Uçak mühendisliği, uçak gövde-motor, uçak elektrik-elektronik, gemi-yat tasarımı, gemi ve deniz teknoloji mühendisliği, gemi inşaatı, güverte)	O	O	O	O
Hayvancılık, veterinerlik: Bu alan hayvan hastalıklarının tedavi ve çözüm yolları, yabani hayat ve hayvanlara ilişkin ürünler elde eden meslek gruplarıdır. (Veteriner, zooteknoloji, süt teknolojisi, hayvansal üretim ve teknolojileri, kanatlı hayvan yetiştiriciliği)	O	O	O	O

MESLEK GRUPLARI	Hiç ilgili değilim	İlgili değilim	İlgiliyim	Çok ilgiliyim
Matematik: Bu alan sayılar ve sayıların işlemleri ile ilgili bilimdir. Hesaplama, algoritma ve teorileri kullanarak sayılarla ilgili verileri analiz etmeye ve sorunları çözmeye yarayan alandır. (Aktüerya, istatistik, matematik, muhasebe, ekonomi, finansal analiz, matematik mühendisliği, istatistik ve bilgisayar)	O	O	O	O
Mühendislik: Bu alan matematik, fen ve bilgisayar kullanarak yeni ürünleri(makine, köprü, bina, elektronik aletler gibi) üretme, tasarlama ve test etme bölümlerini içerir.(İnşaat, makine, elektrik-elektronik, malzeme bilimi, mekatronik, endüstri, endüstriyel tasarım, optik ve akustik, elektronik haberleşme, tarım makineleri, imalat gibi mühendislikler)	O	O	O	O
Sağlık Bilimleri: Bu alan insan sağlığının korunması ve devamı, hastalıkların tedavisi, hastalıkların araştırılması ve çözümler üretilmesini içerir. (Tıp doktoru, diş hekimi, ebelik, eczacılık, hemşirelik, beslenme ve diyetetik, farmakoloji(ilaç bilimi), fizyoterapi ve rehabilitasyon, odyoloji, gıda mühendisliği, biyomedikal mühendisliği, gerontoloji, ortez-protez)	O	O	O	O
Tarım ve Su Ürünleri: Bu alan topraktan üretilen bitkiler ile su ürünlerini ve bu alanlarla ilgili teknoloji kullanımını içeren bölümlerden oluşur. (Tarla bitkileri, Tarımsal yapılar ve sulama, tarımsal biyoteknoloji, toprak bilimi ve bitki besleme, tarımsal genetik mühendisliği, su ürünleri mühendisliği, balıkçılık teknolojisi ve mühendisliği, bahçe bitkileri)	O	O	O	O
Temel Bilimler: Bu alan diğer bilim dallarına temel teşkil eden ve bu alanlarda bilim adamı yetiştiren, bilimsel araştırmalara olanak sağlayan bölümleri içerir. (Fizik, kimya, matematik, biyoloji)	O	O	O	O
Uzay: Bu alan uzayla ilgili bilimi, aktiviteleri ve teknolojileri içine alan bölümlerden oluşur. (Astronomi ve uzay bilimleri, uzay bilimleri ve teknolojileri, havacılık elektrik ve elektroniği, havacılık ve uzay mühendisliği, hava trafik kontrol)	O	O	O	O
Yeryüzü Bilimleri: Bu alan hava, toprak, denizler, okyanuslar gibi yeryüzünü ilgilendiren çalışmaları kapsar. (Çevre mühendisliği, jeoloji, arkeoloji, harita mühendisliği, jeofizik mühendisliği, geomatik mühendisliği)	O	O	O	O
Yukarıda yazılan bölümler dışında herhangi bir bölüm tercih etmeyi düşünüyorsanız bu alana yazınız:				

APPENDIX D: STEM CAREER INTEREST FORM IN ENGLISH

STEM Career Interest Form

Listed given below are occupational groups related to Science, Mathematics, Engineering and Technology (STEM) areas and lists of jobs connected to each groups.

These job lists are also the departments in the universities in Turkey as well.

You will know how interested you are in the occupational groups and the jobs, as you read the list below. Please indicate how interested you are in these profession groups.

There is no "right" or "wrong" answers. The only correct responses are those that are true for you.

Occupation Groups Related to STEM	Not at all Interested	Not So Interested	Interested	Very Interested
Computer Sciences: This area consists of the development and testing of computer systems, designing new programs and helping others to use computers. (software engineering, computer engineering, informatics systems, digital game design, informatics technology, computer-informatics)	O	O	O	O
Biology: involve the study of living organisms (such as plants and animals) and the processes of life. This includes working with farm animals and in areas like nutrition and breeding. (bioengineering, biosystem engineering, bioinformatics and genetics, biotechnology, molecular biology, genetics and life sciences)	O	O	O	O
Energy: involves the study and generation of power or energy such as heat and electricity. (Energy systems engineering, mining engineering, electrical engineering, energy and materials engineering, petroleum and natural gas engineering, nuclear energy engineering)	O	O	O	O

Ships and Aircraft: includes jobs or departments that involve designing, testing, and manufacturing new products of ship and aircraft through the use of math, science, and computers. (Aircraft engineering, aircraft body-engine, aircraft electric-electronics, ship-yacht design, ship and marine technology engineering, shipbuilding, deck)	O	O	O	O
Livestock and Veterinary: involves departments and professions that obtain animal-related products and that produce treatments and solutions for animal diseases. (Veterinary, zootechnology, dairy technology, animal production and technology, poultry breeding)	O	O	O	O
Mathematics: is the science of numbers and their operations. It involves computation, algorithms and theory used to solve problems and summarize data. (actuarial, statistics, mathematics, accounting, economics, financial analysis, mathematical engineering, statistics and computer)	O	O	O	O
Engineering: involves designing, testing, and manufacturing new products (like machines, bridges, buildings, and electronics) through the use of math, science, and computers. (Construction, machinery, electrical-electronics, material science, mechatronics, industry, industrial design, optics and acoustics, electronic communication, agricultural machines, manufacturing)	O	O	O	O
Medicine: This area involves the protection and continuation of human health, the investigation and treatment of diseases, and the production of solutions to human health problems. (Doctor, dentist, midwifery, pharmacy, nursing, nutrition and dietetics, pharmacology, physiotherapy and rehabilitation, audiology, food engineering, biomedical engineering, gerontology, orthotics- prosthesis)	O	O	O	O

Agriculture and Aquaculture: include crops produced from soil and aquatic products and the use of technology related to these areas. (farm plants, agricultural structures and irrigation, agricultural biotechnology, soil science and plant nutrition, agricultural genetic engineering, aquatic products engineering, fishery technology and engineering, garden plants)	O	O	O	O
Fundamental Science: This area includes departments that bring up scientists, provide the basis for other sciences and enable scientific researches in these fields. (Physics, chemistry, mathematics, biology)	O	O	O	O
Space: This area includes the studies of space-related science, activities, and technologies. (astronomy and space science, space science and technology, aviation electricity and electronics, aviation and space engineering, air traffic control)	O	O	O	O
Earth Sciences: is the study of earth, including the air, land, and ocean. (environmental engineering, geology, archeology, map engineering, geophysical engineering, geomatic engineering)	O	O	O	O

APPENDIX E: APPROVAL FROM YEDITEPE UNIVERSITY ETHICAL COMMITTEE

T.C. YEDİTEPE ÜNİVERSİTESİ

SAYI : 75078252-9000-0400 13.03.2017
KONU : Etik Kurul Onayı

İLGİLİ MAKAMA

Yeditepe Üniversitesi, Eğitim Bilimleri Enstitüsü, Eğitim Programları ve Öğretimi Bölümü Yüksek Lisans öğrencilerinden M. Hamdi OCAK'a ait "Milli Eğitim Bakanlığına Bağlı Okullarda Öğrenim Görmekte Olan 9-12. Sınıf Öğrencilerinin STEM Eğitimine ilişkin Tutumlarının İncelenmesi" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu, Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

Prof. Dr. Duygun YARSUVAT
Etik Kurul Komisyonu Başkanı

Prof. Dr. Servet BAYRAM
Eğitim Fakültesi, Bilgisayar ve Öğretim Teknolojileri Öğretmenliği Bölümü

Prof. Dr. Suat ANAR
İletişim Fakültesi, Gazetecilik Bölümü

Prof. Dr. Zeynep Aslı ALICI
Ticari Bilimler Fakültesi, Uluslararası Finans Bölümü

Prof. Dr. V. Necla GEYİKDAĞI
İktisadi ve İdari Bilimler Fakültesi, İktisat Bölümü

Prof. Dr. Ayla ERSOY
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APPENDIX F: APPROVAL FROM PROVINCIAL NATIONAL EDUCATION DIRECTORATE

T.C.
İSTANBUL VALİLİĞİ
İl Milli Eğitim Müdürlüğü

Sayı : 59090411-44-E.3999005 24.03.2017
Konu: Anket ve Araştırma İzin Talebi

Sayın: Muhammed Hamdi OCAK

İlgi: a) 13.03.2017 tarihli dilekçeniz.
b) Valilik Makamının 23.03.2017 tarih ve 3926970 sayılı oluru.

"Milli Eğitim Bakanlığına Bağlı Okullarda Öğrenim Görmekte Olan 9-12 Sınıf Öğrencilerinin STEM Eğitimine İlişkin Tutumlarının İncelenmesi" konulu teziniz hakkındaki ilgi (a) dilekçe ve ekleri ilgi (b) valilik onayı ile uygun görülmüştür.

Bilgilerinizi ve söz konusu talebiniz; bilimsel amaç dışında kullanmaması, **uygulama sırasında bir örneği müdürlüğümüzde muhafaza edilen mühürlü ve imzalı veri toplama araçlarının uygulanması,** katılımcıların gönüllülük esasına göre seçilmesi, araştırma sonuç raporunun müdürlüğümüzden izin alınmadan kamuoyuyla paylaşılmaması koşuluyla, gerekli duyurunun araştırmacı tarafından yapılması, okul idarecilerinin denetim, gözetim ve sorumluluğunda, eğitim-öğretimi aksatmayacak şekilde ilgi (b) Valilik Onayı doğrultusunda uygulanması ve işlem bittikten sonra 2 (iki) hafta içinde sonuçtan Müdürlüğümüz Strateji Geliştirme Bölümüne rapor halinde bilgi verilmesini rica ederim.

Harun TÜYSÜZ
Müdür a.
Müdür Yardımcısı

EK: 1- Valilik Onayı
2- Ölçekler

APPENDIX G: GOVERNOR'S APPROVAL

T.C.
İSTANBUL VALİLİĞİ
İl Millî Eğitim Müdürlüğü

Sayı : 59090411-20-E.3926970 23/03/2017
Konu: Anket ve Araştırma İzin Talebi

VALİLİK MAKAMINA

İlgi: a) 13.03.2017 tarihli dilekçe.
b) MEB. Yen. ve Eğ. Tek. Gn Md. 07.03.2012 tarih ve 3616 sayılı 2012/13 nolu gen.
c) Milli Eğitim Araştırma ve Anket Komisyonunun 22.03.2017 tarihli tutanağı.

Yeditepe Üniversitesi Eğitim Bilimleri Enstitüsü yüksek lisans öğrencisi Muhammed Hamdi OCAK'ın **"Milli Eğitim Bakanlığına Bağlı Okullarda Öğrenim Görmekte Olan 9-12 Sınıf Öğrencilerinin STEM Eğitimine İlişkin Tutumlarının İncelenmesi"** konulu tezi kapsamında, ilimiz Kadıköy ilçesinde bulunan liselerde öğrenim gören öğrencilere; kişisel bilgi formu ve anket uygulama istemi hakkındaki ilgi (a) dilekçe ve ekleri Müdürlüğümüzce incelenmiştir.

Araştırmacının; söz konusu talebi; bilimsel amaç dışında kullanılmaması, **uygulama sırasında bir örneği müdürlüğümüzde muhafaza edilen mühürlü ve imzalı veri toplama araçlarının uygulanılması, katılımcıların gönüllülük esasına göre seçilmesi, araştırma sonuç raporunun müdürlüğümüzden izin alınmadan kamuoyuyla paylaşılmaması koşuluyla, okul idarelerinin denetim, gözetim ve sorumluluğunda, eğitim-öğretimi aksatmayacak şekilde ilgi (b) Bakanlık emri esasları dâhilinde uygulanması, sonuçtan Müdürlüğümüze rapor halinde (CD formatında) bilgi verilmesi kaydıyla** Müdürlüğümüzce uygun görülmektedir.

Makamlarınızca da uygun görülmesi halinde olurlarınıza arz ederim.

Ömer Faruk YELKENCİ
Milli Eğitim Müdürü

OLUR
23/03/2017

Ahmet Hamdi USTA
Vali a.
Vali Yardımcısı

Ek:1- Genelge
2- Komisyon Tutanağı