EXPLORING THE STEM READINESS LEVEL OF HIGH SCHOOLS IN ANKARA

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ÜMRAN YIĞIT

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submitted by **ÜMRAN YIĞIT** in partial fulfillment of the requirements for the degree of **Master of Science in Mathematics and Science Education Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** ________________

Prof. Dr. Ömer Geban
Head of Department, **Math. and Sci. Edu.** ________________

Assist. Prof. Dr. Gökhan Öztürk
Supervisor, **Math. and Sci. Edu., METU** ________________

Examining Committee Members:

Assoc. Prof. Dr. Ömer Faruk Özdemir
Mathematics and Science Education, METU ________________

Assist. Prof. Dr. Gökhan Öztürk
Math. and Sci. Edu., METU ________________

Assist. Prof. Dr. Mustafa Tüysüz
Mathematics and Science Education, Van Yüzüncü Yıl Uni ________________

Date: 08.08.2019

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Surname: Ümran Yiğit

Signature:

ABSTRACT

EXPLORING THE STEM READINESS LEVEL OF HIGH SCHOOLS IN ANKARA

Yiğit, Ümran
Master of Science, Mathematics and Science Education
Supervisor: Assist. Prof. Dr. Gökhan Öztürk

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In order to exist in the economic race in the rapidly changing and developing world, technology is not only required to be used but also produced. This is only possible through the production of qualified manpower in different disciplines. STEM education, occurs with abbreviation of words Science, Technology, Engineering and Mathematics, enhances the capacity of students to develop innovation by developing critical, analytical thinking and problem-solving skills, has been an interdisciplinary approach. At this point, it is a very important step for the development of our country with the qualified manpower it will provide. In order to integrate STEM education into the existing education system, it is necessary to be prepared for this. In this context, the purpose of this study was to determine the readiness level of high schools in Ankara for STEM education. For this purpose, interview questions were prepared according to NYCDOE STEM framework and interviews were conducted with teachers and administrators in 4 different schools. The readiness levels of the schools were evaluated by analyzing the obtained data. In addition, the themes that emerged as a result of the study will shed light on future studies.

Keywords: STEM, STEM Education, STEM Readiness

ÖZ

ANKARA’DAKİ LİSELERİN STEM HAZIRLIK SEVİYELERİNİN ARAŞTIRILMASI

Yiğit, Ümran
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Hızla değişen ve gelişen dünyadaki ekonomik yarışta var olabilmek için, teknolojiyi sadece kullanmak değil üretmek de gerekmektedir. Bu da sadece farklı disiplinlerde üretilen nitelikli insan gücü ile mümkün olabilir. Science, technology, engineering ve mathematics kelimelerinin baş harflerinden oluşan ve disiplinler arası bir yaklaşım olan STEM eğitimi, öğrencilerin eleştirel, analitik düşünme ve problem çözme becerilerini geliştirerek onarın inovasyon geliştirme kapasitelerini arttırmaktadır. Bu noktada, sağlayacağı nitelikli insan gücü ile ülkemizin gelişmesi için çok önemli bir adımdır. STEM eğitimini mevcut eğitim sistemine dahil etmek için bunun için hazırlık yapılması gerekmektedir. Bu bağlamda, bu çalışmanın amacı, Ankara’daki liselerinin STEM eğitimine hazır olma düzeyini tespit etmektir. Bu amaçla, NYCDOE STEM çerçevesine göre görüşme soruları hazırlanmış ve 4 ayrı okulda öğretmen ve idarecilerle görüşmeler yapılmıştır. Elde edilen veriler analiz edilerek okulların hazırlık düzeyleri değerlendirilmiştir. Ayrıca, çalışma sonucunda ortaya çıkan temalar gelecekteki çalışmalara ışık tutabilecektir.

Anahtar Kelimeler: STEM, STEM Eğitimi, STEM Hazırlığı

To my beloved family…

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LIST OF ABBREVIATIONS

B.S: Bachelor of Science

CCM: Constant Comparative Method

MoNE: Ministry of National Education

NYCDOE: The New York City Department of Education

PISA: The Programme for International Student Assessment

OECD: Organiation for Economic Co-operation and Development

STEM: Science, Technology, Engineering and Mathematics

UK: The United Kingdom

USA: The United States of America

CHAPTER 1

INTRODUCTION

1.1. Background of the Study

In the last century, with the scientific, economic and technologic development of the world, the countries are in race for global power in the fields of economy, technology and defense industry. The development of these fields depends on a scientific literate population of the country and a highly-educated workforce in the field of science, technology, engineering and mathematics (Chachashvili-Bolotin, Milner-Bolotin & Lissitsa, 2016). These four disciplines; science, technology, engineering and mathematics are represented by an abbreviation that is STEM (Farina, Weinberg, Commitante & Curtis-Bey, 2016).

STEM education has emerged through some historical events such as the Morrill Act of 1862, World War 2 and the launch of the Sputnik (White, 2014). In accordance with Morrill Act, states were given land for agricultural practices by the government in United States. With this income, institutions for agricultural and technological education were created, then science and engineering programs were developed in every states (Butz et al., 2004). These steps were the baby steps of STEM education because interdisciplinary studies had begun.

In addition to Morrill Act, the technology, invented and applied by engineers, mathematicians and scientists to win the 2nd World War, was a demonstration of the future STEM education. This showed that America continued to evolve in the technological field in 1940s (White, 2014).

In 1957, thanks to the Russian satellite, Sputnik, Americans put their competitive spirit on the path to technology and innovation because it was very important for them to become leaders in science, technology, engineering and mathematics (Marick Group, 2016). National Aeronautics and Space Administration (NASA) was founded in 1958 in order to prove the presence of the United States in the space race, and many STEM education initiatives were carried out within NASA (White, 2014). Today, NASA aims to cross the boundaries of STEM by 'bringing STEM education from space to class', so there are different STEM engagement programs and projects for both students and educators (Ramji, 2019).

All of these developments have been followed by many initiatives related to STEM as a result of the increasing power and leadership race in Europe and America. In 1996, a curriculum focusing on inquiry-based learning in science courses was prepared under National Science Education Standards in United States. This initiative continued with some other reports and meetings (Business Roundtable in 2005, NAS and BHEF in 2007) to improve STEM education (Kennedy & Odell, 2014). National Science Education Standards and the National Council of Teachers of Mathematics were guides for U.S. educators to integrate STEM in their classes and curricula in the 1990s (Marick Group, 2016). In 2000s a new curriculum was introduced and developed for STEM education and in 2013 a new revised curriculum was announced for all schools (Banks & Parlex, 2014).

Countries' current education systems have an important role for them to gain power in the future. According to Obama (2010), the quality of the education of today's students in science, technology, engineering and mathematics (STEM) is very important for them to become the leaders of tomorrow. STEM is the common name of a model related with science, mathematics and production, originally proposed and supported by the government in the United States in 2009. The purpose of this model is to produce the sufficient human power needed in rapidly developing a competitive economy.

According to Figure 1.1, the expected growth in all STEM areas between 2010 and 2020 is expected to be 14%. With the importance given to STEM and STEM specialized schools, the US is expected to continue its leadership in the 21st century (U.S. Department of Education, 2015).

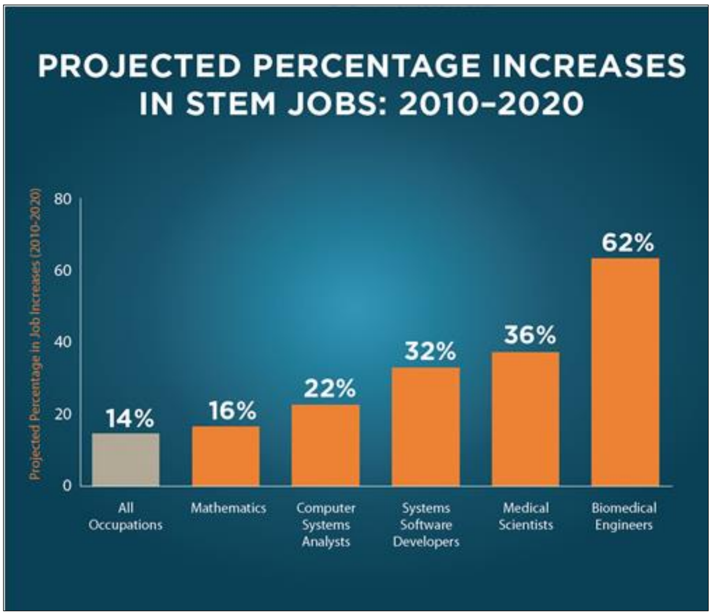

Figure 1.1. Expected Growth Percentages in STEM Areas: 2010-2020 (U.S. Department of Education, 2015)

According to Science Education Now: A Renewed Pedagogy for the Future of Europe Report, which was published by the European Commission in 2007, the interest of young people in science, technology and mathematics in Europe has significantly decreased in recent years (Rocard et al., 2007). This report emphasized the importance of using inquiry-based approaches in science education and then, teaching approaches used in science and technology education began to be renewed throughout Europe (Akgündüz, Ertepınar, Ger, Kaplan Sayı & Türk, 2015).

The ratio of graduates from science, computer science, mathematics and engineering fields by countries in 2011 is seen by the Figure 1.2 below. According to records from The Conference Board of Canada (2016), countries' focus on leadership race in research & development and innovation helps students choose courses in STEM fields and improve their STEM careers. This is clearly seen in Finland in Figure 1.2.

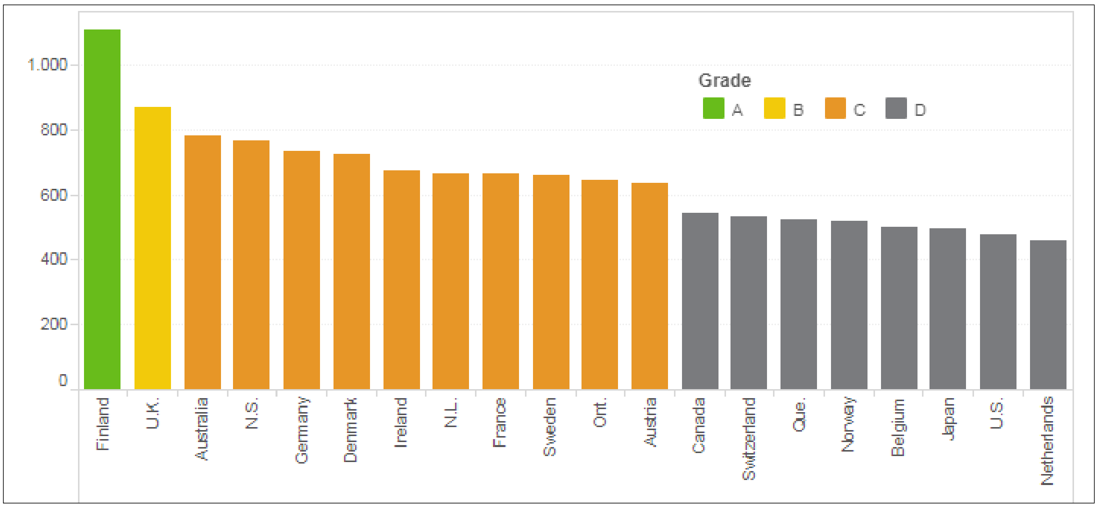

Figure 1.2. Science, Math, Computer Science and Engineering graduates, Provinces and International Peers, 2011

1.2. STEM Education in Turkey

Studies in Turkey show that the future generations' attitudes towards creative thinking and science are at a low level (Şahin, Ayar & Adıgüzel, 2014). In order to increase the innovation capacity of Turkey, there is a need for individuals who are well-equipped in the fields of science, technology, engineering and mathematics, and who think creatively about scientific processes. Within the framework of this requirement, the STEM study report has been described by the Ministry of National Education. According to this report, STEM education has become essential for students, teachers and schools in Turkey (Ministry of National Education, 2016). Turkey needs economic growth to keep up with world countries and STEM is an important chance to get this competition.

Turkey needs an educational culture that gives responsibility to students, makes them critical thinkers, and equips them with technological knowledge to develop an entrepreneurial, innovative and creative generation in schools. Without such an educational culture, it is impossible for Turkey to compete in the 21st century global economic order. Only innovation-oriented growth has the potential to create added value jobs and industries (Organization for Economic Co-operation and Development [OECD], 2010a). Because innovations are mainly obtained from progress in scientific, technological and mathematical (STEM) fields, STEM expertise is required for a growing amount of employment at all stages (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2011). STEM knowledge is very important for Turkey as well as for the whole world, because it supports a new model of production and develops problem solving, critical thinking and creativity for students. It also supports individuals who develop cooperation between systems and people, take initiative, communicate effectively and learn continuously (Wagner, 2008).

STEM education is directly related to the economic developments in the world, so the integration of STEM education into the Turkish education system is vital. According to STEM Education Report (2016), Turkey does not have a direct STEM action plan but there are some strategical goals to strength STEM education until 2019. These goals include technology and design courses, robotics lectures, projects and competitions to enhance the engagement of students and teachers in STEM. Today, in addition to STEM studies of MoNE, private schools, universities and companies have many studies on STEM education and approach (Altunel, 2018). At this point, it is necessary to pay attention to the following while studying on STEM education; STEM is not an activity, a teaching technique, nor a study in science experiments or robotics; and coding does not mean applying STEM education (Akgündüz, 2016).

Turkey needs to transform its education systems in accordance with the technological developments in order to be able to develop its economic power. According to the TIMMS 2011 report, Turkey was below the average for both mathematics and science (Oral & Mcgivney, 2013). In addition to that, according to PISA 2012 report (Anıl, Özkan & Demir, 2015), Turkey was the 44th among 65 countries and 31th among 34 OECD countries (Demir, 2015). Besides, while the average scores in the field of science literacy in PISA 2015 is 465, Turkey's average is 425; and the average score of Turkey in mathematics literacy field is 420, while the other countries' average is 461 (PISA National Report, 2015). According to these results, it is obvious that Turkey needs reforms in teaching STEM disciplines in all levels of education.

1.3. Statement of the Problem

We are in the age of innovation, and because of this, countries' educational systems must adapt to innovations to have economic power and to stay in the race (Fensham, 2008). The increase in the number and quality of the STEM teachers helps the students to adapt to the requirements of today's skills and innovation. (Corlu, Capraro & Capraro, 2014).

According to Turkish Academy of Sciences (2010), the integration of STEM disciplines in the education system can be critical for the economic competitiveness of Turkey, because Turkey has an insufficient improvement in terms of innovative productivity of workers (Turkish Academy of Sciences, 2010). The main issue here is whether Turkey is ready or not for STEM education. There are not many students who meet the international standards in STEM disciplines in Turkey yet, and the implementation of education in STEM disciplines in Turkey differs from school to school.

The fact that a school is ready for STEM education means that students, teachers, administrators and physical conditions are also ready for STEM education. One of the most important factors that affects students' STEM success in Turkey is school type (Alacaci & Erbaş, 2010) and only a limited number of students studying in private schools have the chance to meet the international standards in STEM disciplines (Corlu, Capraro & Capraro, 2014). To increase the number of students who will meet the international standards in STEM disciplines, readiness of schools for STEM is the first important step. Teachers' characteristics, attitudes of administrators, willingness of students and families, curriculum, timetables and textbooks are all important parts of a successful preparation process. Therefore, there is a need for research on the readiness of schools in Turkey for STEM education.

1.4. Purpose and Research Questions

The initials of science, technology, engineering and mathematics constitute the word 'STEM'. In STEM education, students are active participants as a result of the inquiry and project-based lecture strategies, in contrast to the traditional lecture-based teaching strategies (Brainer, Harkness, Johnson & Koehler, 2012). STEM education is very important for students, because they can solve the problems creatively and use logic to establish cause and effect relationships between the natural phenomena in the world (Morrison, 2006). In this context, STEM education includes an educational movement from preschool to beyond university (Gonzales & Kuenzi, 2012).

According to TUSIAD Report (2017), integration of STEM education into the Turkish education system is vital for not falling back in the global economy race. STEM Education Report (2016), shows that Turkey does not have a direct STEM education curriculum, but there are some strategic goals such as courses in technology and design to strengthen STEM education until 2019. Turkey needs to transform its education systems in accordance with the technological developments in order to be able to develop its economic power. According to PISA 2015 report, Turkey was the 52nd in science and 49th in mathematics among 70 countries (BBC, 2016). Based on these results, Turkey needs reforms in teaching STEM disciplines in all levels of education, because failing in exams is a major problem for future. Therefore, the main aim of this study is to determine whether schools are ready or not in Turkey for STEM education. More specifically, the purpose is to determine the factors that affect readiness of schools for STEM education. The factors to be investigated in this study are teachers' and administrators' perceptions of STEM education, students' encouragement for STEM education and schools' conditions.

The main research question and related two sub-questions addressed in this study are as follows:

1. Are the high schools in Çankaya, Ankara ready for STEM education?

2. What are the teachers' and school principals' opinions about STEM education in their schools?

2.1. What are the barriers that school teachers and principals think about STEM?

2.2. What are the needs of school teachers and principals about STEM?

1.5. Significance of the Study

According to results of international student assessments, the science and mathematics achievements of Turkish students are rather low compared to other countries (Cetin & Balta, 2017). The cause of this failure is not fully solved, but different techniques are always tested such as curriculum reform and smart boards. However, engineering and technology topics have not been integrated successfully into the science and math curricula (Balta, Yerdelen-Damar & Carberry, 2017). At this point, despite its limitations, STEM education can be a good choice to enhance the Turkish educational system. Engineering and technology topics can be integrated into the science and math curricula with some projects, because STEM education with project-based learning is more efficient for low performing students to increase their performance compared with high performing students (Han, Capraro & Capraro, 2014).

According to Sanders (2009), while STEM practices in schools give students the chance to learn by wondering, experimenting, and with trial and error method; it also allows teachers to combine more than one. Integrative STEM education is grounded on the principles of constructivism and the results of the developments in the cognitive science. STEM education is undoubtedly very useful for students and also teachers, but there is a significant issue about how it is applied in the schools. To apply STEM successfully in classes, schools should be ready for STEM education with their teachers, students and conditions like smart classes or laboratories. The aim of the STEM education is to raise the new generation with a capacity to innovate, and teachers are one of the important parts of this process. Schools should provide some programs for their teachers in order to prepare them for STEM in their preparation process. Teacher education is very important to increase the number of students who have innovation capacities and skills, so teachers should be equipped with the knowledge, skills and beliefs to integrate the STEM in their classes (Cuadra & Moreno, 2005).

As Einstein said, ‘We cannot solve our problems with the same thinking we used when we created them’. We should change our perspective and we should learn to think different. STEM education is a guide to gain new perspectives about science, math, technology, engineering and also life. To have these perspectives, teachers and students should be ready both mentally and physically. It is significant to show the preparation process of schools to be sure if the process is sufficient or not. This study, investigating the readiness of high schools in Çankaya, Ankara, holds potential to get a general idea about the readiness of schools in Ankara for STEM education. It may be a guide for the future studies in terms of showing what is missing to be ready for STEM education.

1.6. Definition of Key Terms

STEM has the four different fields that are science, technology, engineering, and mathematics. Their first letters form STEM (Cetin & Balta, 2017).

STEM Education is known as an interdisciplinary approach. During this approach, students can apply science, technology, engineering, and mathematics to the real world with the new economy completion skill (Tsupros, 2009).

Innovation is defined as the implementation of new and useful ideas. Creativity is the seed of innovation that is intended to produce new and useful ideas, but it is still only an idea if it is not implemented and scaled (Burkus, 2016).

CHAPTER 2

LITERATURE REVIEW

In this chapter, ‘STEM education’, ‘Readiness for STEM education’ and ‘STEM education in Turkey’ concepts are explained in order to provide clear information about them.

Implementation of STEM education in the classrooms can be difficult because of some reasons and this problem can affect the readiness of schools for STEM education. Teachers may not be well-educated, may not trust themselves in teaching subjects that require expertise or may not have enough teaching materials and laboratories (Ramli et al., 2017). This study will examine the current situation in selected schools, and it will help to have an idea about the readiness of schools for STEM education. Thus, this study is important in terms of shedding light on future STEM integration studies in schools.

2.1. STEM Education

STEM education has a crucial role in education because it provides opportunities to transform knowledge into practice. It also has an important role in the educational systems of countries to stay in the economic competition in the world. STEM especially emphasizes technology and engineering and starts from early childhood and extends to the future with sustainable innovativeness. Its disciplines like science, mathematics, technology and engineering cannot be considered apart from each other. STEM education enhances students’ creativity, higher order thinking skills, motivation, problem solving skills and achievements when integrated the lectures correctly. In this context, inquiry-based learning, digital learning, computer programming and robotics courses help teachers and students to enhance STEM education usability in lectures.

2.1.1. Definition of STEM Education

STEM is an acronym of science, technology, engineering and mathematics. It may appear that it is a simple acronym, but it is not. In STEM education, more inquiry and project-based lecture strategies are used instead of traditional lecture-based teaching strategies (Brainer, Harkness, Johnson & Koehler, 2012). It makes students good problem solvers, creative thinkers, innovators and inventors (Morrison, 2006). In order to achieve advances in engineering and technology, STEM education should increase the conceptual knowledge of the science and mathematics among students (Hernandez et al., 2014). In this context, STEM education can be defined as an interdisciplinary educational approach with educational activities extending from preschool to university education. (Gonzales & Kuenzi, 2012).

2.1.2. Disciplines of STEM Education

A good understanding of the disciplines of STEM and the relationship between these disciplines is the first step to achieve STEM literacy, because STEM literacy means the capacity to distinguish, apply, and coordinate ideas from science, technology, engineering and mathematics (Balka, 2011). The development of STEM literacy prepares students to integrate the necessary knowledge, skills and attitudes with the technological world. It also allows students to graduate from schools as they are ready for the technological world. (McDonald, 2016). In this manner, different disciplines are very important to enhance students' STEM career. STEM education is interested in four main disciplines; science, technology, engineering and mathematics.

It is not easy to make science possible, but without science modern societies will leave their functions and cannot develop. Mathematics is the one of the most important 'enabling' science that engages research innovation and advancement in science and technology (Australian Academy of Science, 2006). Mathematical knowledge is fundamental to understand other disciplines and professions, and competitions about math have a big importance on both national and global areas (Martin, Anderson, Bobis, Way, & Vellar, 2012).

Science helps students to understand the natural world in terms of application of facts, principals and concepts related to disciplines like physics, chemistry and biology, but it is not limited to that (National Research Council, 2012).

> "[Science] is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world..."
>
> — President Barack Obama, March 23, 2015

Thanks to technology and engineering, learning students develop relationships between STEM concepts by enhancing their creativity and higher order thinking skills. In addition to that, the practices in the field of engineering and technology provide deeper learning of the concepts and increase the motivation and success of the students. (Cunningham & Lachapelle, 2014). According to Moore, Tank, Glancy, and Kersten (2015) engineering practices improve students' interest in STEM disciplines and career by enabling students to work together on a problem, manage the process patiently and produce solutions using 21st century technology.

2.2. STEM Integration in Lectures

2.2.1. Inquiry-Based Learning

Inquiry-based teaching is not a completely new approach, but because of its differences from traditional teaching methods that are used in schools, it can be known as a new technique. In inquiry-based learning, the teacher often acts as an observer and educational guide (Gunn, 2018). The learning atmosphere created based on inquiry in STEM classes allows students to have curiosity about a topic, ask questions and discover the answers by gathering information, interpret findings and design meaningful activities (McDonald, 2016). In this manner, to create groups and to engage students in collaborative groups in classes are very important for students to communicate their findings, to think in multiple ways, and to make discussions on scientific problems (Linn & Hsi, 2000; Clark & Linn, 2003). Some practices for students like investigation plans and providing evidence for claims are the productions of an inquiry-based science curriculum and it is directly related to STEM education's necessities (McNeill, Pimentel, & Strauss, 2013).

2.2.2. Digital Learning

Digital classrooms, which are modern learning environments, enable students to increase their level of information literacy and develop critical thinking skills. (Kong, 2014). Having only the combination of portable innovations, for example, PCs, tablets and smart phones into the educating and learning procedure is not sufficient, yet in addition, having the option to utilize them to help the learning of relevant content is necessity (Chan, 2010). STEM classes should be designed according to students' needs to improve critical thinking skills and to get meaningful learning. Digital game-based learning and computer simulations are digital learning technologies that provide meaningful learning in STEM classes (McDonald, 2016). According to Byrd (2016), digital game-based learning is achieved through computer-based tools which enables students to develop problem-solving skills and creativity beyond the curriculum. In addition, students can have the chance to show their potential without fear because they perform learning by 'playing', not under the name 'lecturing'. The other computer-based tool is computer simulations and it offers real-life problem-solving demos to children, with visual opportunities (Smetana & Bell, 2012).

2.2.3. Computer Programming and Robotics

Integrating of computer programming and robotics into the lectures is an important pedagogical approach for STEM education (Israel, Pearson, Tapia, Wherfel, & Reese, 2015). Engaging students in computer programming and robotics helps students to develop computational thinking, enhance their motivation, change their attitude positively towards lectures and have meaningful learning (Lambert & Guiffre, 2009). Thanks to the computer programming and robotics, it is possible to improve some abilities like problem-solving and critical thinking skills (Fessakis, Gouli, & Mavroudi, 2013).

2.3. Readiness

Readiness is the important key element to complete a case successfully since it is crucial to provide what is necessary to achieve a purpose. According to Merriam-Webster's collegiate dictionary (1999), readiness is ‘a state of preparation’. This is a very general definition for readiness. So, at this point, it is important to know what preparation is for. Hersey and Blanchard (1988) mentioned the need for a specific task to perform willingly while defining the readiness. If this specific task is accepted as STEM education, the readiness of teachers and students for STEM should also be taken into consideration.

According to Lynch and Smith (2016), if necessary conditions are ready for school members to deal with change, it indicates that they are ready for improvement. The readiness level of teachers and students are important for success in new configurations of science, technology, engineering and mathematics education.

2.3.1. Readiness of teachers

‘I have come to a frightening conclusion. I am the decisive element in the classroom. *It is my personal approach that creates the climate. It is my daily mood that makes the weather (...).” (Ginott, 1976, Teacher and Psychologist).’*

Teachers and students are the most important parts of the learning community and are like puzzle pieces complementing each other. They spend a significant amount of time in school and the effective use of time facilitates their work during the learning process. Teachers’ readiness is very important to create a positive and effective learning environment (Ernesty, 2018). According to The Progressive Teacher (2015), having an uncluttered mind, openness, motivation, willingness and ability are the most crucial elements for teacher readiness.

The teaching process starts by learning the subject in depth. Thus, having an uncluttered mind helps teachers to create a positive learning environment by using different methods to get to teach deeply (The Progressive Teacher, 2015). STEM applications can also include new and different methods for many teachers. In this context, in addition to having an uncluttered mind, teacher openness is also important because it allows students to become risk-takers and open-minded individuals by creating an environment for creative thinking (Crane, 2017). Teacher openness is also important for motivating teachers to share knowledge with each other and work interdisciplinary. Motivation makes teachers energetic, willing to learn and teach, and it allows teachers to use their full potential to go the extra mile in the teaching process (Sinclair, 2008).

2.3.2. Readiness of Students

In the learning process, the student readiness is as important as the teacher readiness because they affect each other. According to Schunk (2012), readiness is the thing that students can do or learning at different focuses being developed. Prior learning, interests, attitudes and abilities of students determine their level of readiness (Çetin, 2016). Tabrani Rusyan, et al (1994: 8) defines (as cited in Arozaq & Sunarhadi 2017, p.86) learning as a process of behavior change, and the duration of this process is determined by the level of readiness of the student (Harman & Çelikler, 2012). The high level of readiness of the students enables the activity performances to be successful and make them feel happy. According to Thorndike’s Law (Harman & Çelikler, 2012);

- If the individual is ready to perform the activity, it makes him/her happy to do the activity.

- If an individual is not allowed to do the activity he / she is ready to do, this causes anger.
- If the individual is not ready to perform the activity and is forced to do the activity, this situation causes anger.

Determining the level of readiness for STEM education allows teachers to be prepared with respect to the needs of students.

2.4. NYC STEM Framework

The NYC STEM Education Framework is a tool that gives an organized way to deal with schools looking to enhance the usage of a STEM activity. The framework intends to move the teaching and learning from multidisciplinary and interdisciplinary paradigm to a transdisciplinary. (See Figure 2.1)

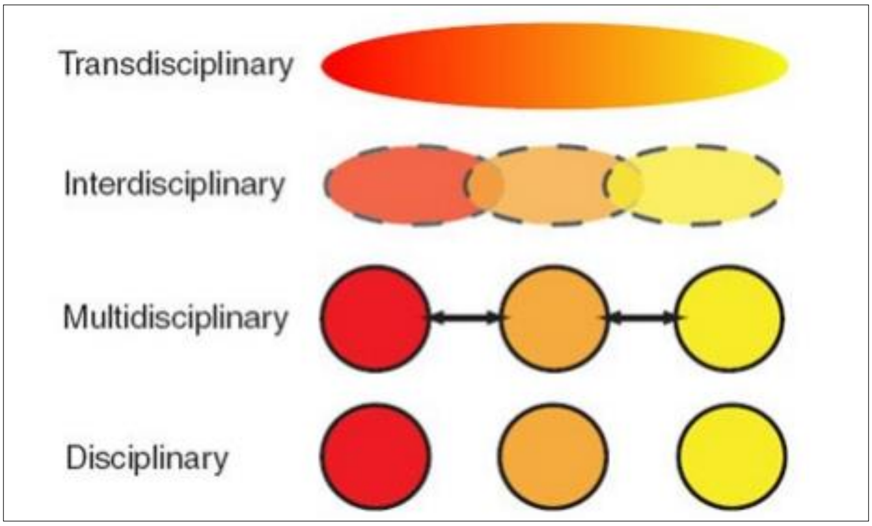

Figure 2.1. Transdisciplinarity (Darian-Smith & McCarty, 2016).

The differences among multidisciplinary, interdisciplinary and transdisciplinary are shown clearly in Figure 2.2 that is created by Kaufman, Moss, Osborn (2003). Individuals who are ready for STEM education gain the skills such as interdisciplinary and critical thinking, inquiry based and life-based learning, and take part of transdisciplinary learning process (Altunel, 2018).

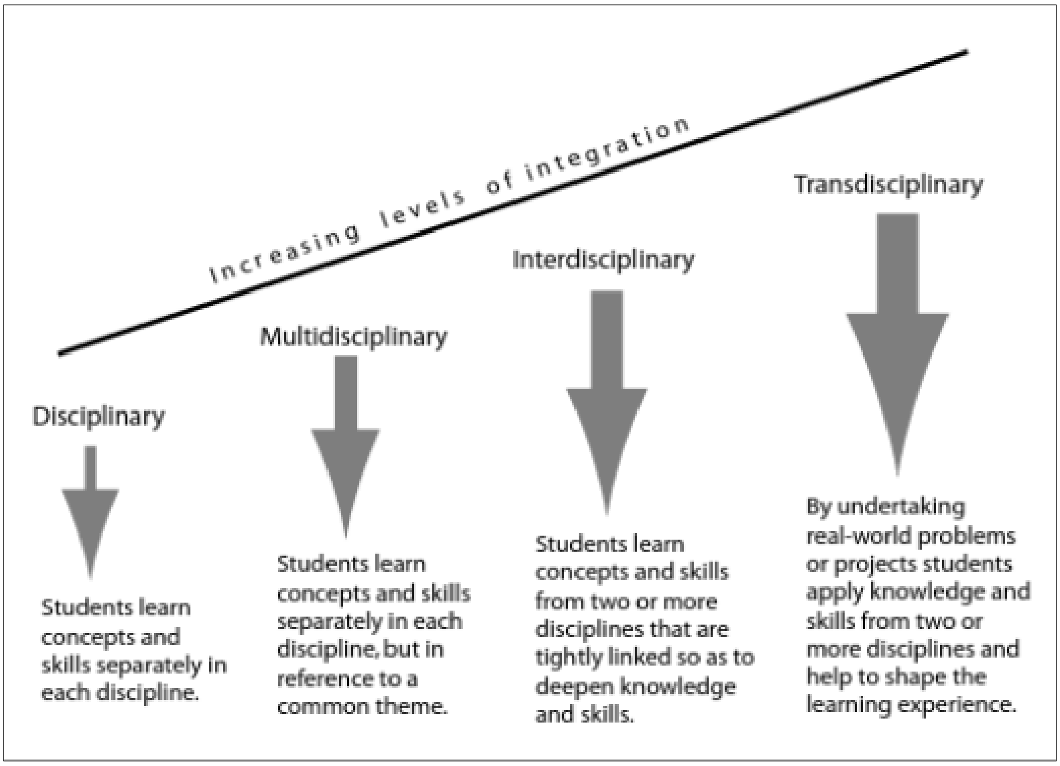

Figure 2.2. Levels of Integration (Kaufman, Moss & Osborn, 2003)

In this study, items such as socio-economic differences between schools, exam-oriented education systems, training of educators were identified as criteria to determine the readiness level of schools. At this point, the framework provided significant support to the study. It is not a tool for evaluation because it does not measure the schools' readiness level directly but shows the needs of the school in preparation process. In this study, 'readiness' refers to determining whether schools are eligible for STEM education, both financially and spiritually. In order to reveal the readiness, the framework includes many sub-headings from the formation of STEM vision in schools to career planning in this field.

The framework consists of 4 main domains and 12 indicators which include criteria showing the level of readiness from “Early” to “Emerging” to “Integrated” to “Fully integrated”. All domains and indicators are explained below in detail.

2.4.1. Domain 1: School Vision and Structures for Success

This domain expresses a rational STEM mission and vision that is obvious to all school constituents and it is effectively supported by STEM-centric culture, STEM program evaluation process and STEM budget resources.

2.4.1.1. STEM Mission and Vision

This indicator articulates the integration level of the STEM mission and vision of the school within the existing mission and vision. It also indicates the level of acceptance of the school's STEM mission and vision by school staff. In this indicator, the presence of STEM-containing education plans, meetings on STEM integration, creation and sharing of professional learning areas for STEM is expected to be evidence of STEM-infused mission and vision.

2.4.1.2. STEM-centric Culture

This indicator helps to understand whether the school atmosphere is suitable for STEM. The acceptance of student-centered inquiry, engineering practices, digital literacy, and project-based learning by all stakeholders and having sufficient number of STEM classes and laboratories are important to be fully integrated. The existence of a positive atmosphere that supports innovation and risk-taking and the adoption of transdisciplinary cooperation by all school members are also very important for the school's level of integration.

2.4.1.3. STEM Program Evaluation

The evaluation of the level of implementation of STEM education is included in this indicator. Evidence for adjustment of STEM-containing resources, and having a STEM leadership team that includes families, school administration and all stakeholders ensures full integration.

2.4.1.4. Budget/Management of Resources

The existence of a STEM budget sufficient to meet the needs of students is discussed under this indicator. The limit of the budget which includes the allocation of funds used for STEM education initiatives, evidence of accurate budget records, and the fact that there is a team interested in this budget increases the integration rate. On the other hand, limited access to technology by employees and lack of other resources for STEM education reduces the level of integration.

2.4.2. Domain 2: Curriculum, Instruction, and Assessment

This domain promotes a transdisciplinary approach encouraging student-centered inquiry, project-based learning and engineering practices to STEM-centric curriculum. The quality of instruction, authentic assessments and staff capacity are other indicators that support this domain.

2.4.2.1. Academic Rigor and Instructional Quality

This indicator mentions the existence of a well-defined STEM program that encourages students to be critical thinkers, real-world problem solvers and active learners by using 21st-century skills. The addition of STEM applications to curricula, lessons and units, and the effective adaptation of teaching practices to the core mission and vision of the school in all STEM classes increase the level of integration.

2.4.2.2. STEM-centric Curriculum

This indicator shows the importance of a well-defined STEM education program including innovative and critical thinking, engineering design and scientific literacy. STEM opportunities offered to students at school and out of school, allows them to apply STEM concepts in real life and the sufficiency of time allocated to support STEM education increases integration level.

2.4.2.3. Authentic Assessments

In order to measure success, the level of effective use of authentic assessments such as projects, portfolios, presentations are focus point for this indicator. The high frequency of using learning cycle, formative and summative assessments gives students the opportunity to self-assess and receive specific feedback and increases the level of integration.

2.4.2.4. Staff Capacity

Enhancing the professional learning in STEM content and improving pedagogical knowledge of teachers are the main points of this indicator. The existence of an effective collaborative plan developed by STEM stakeholders and the influential flow of information on STEM opportunities and programs are other important points.

2.4.3. Domain 3: Strategic Partnerships

This domain is about STEM partnerships like families, universities, community-based organizations and businesses.

2.4.3.1. STEM Partnerships

This indicator focuses on purposeful and effective STEM partnerships with universities, families, local community-based organizations and businesses. The collaboration between STEM partners and educators, communication with families including STEM events are very crucial points to get fully integrated degree. The high level of cooperation with other schools of similar interest to STEM education also increases integration level.

2.4.4. Domain 4: College and Career Readiness

The main focus of this domain is students' STEM careers starting from primary school and continuing in high school.

2.4.4.1. STEM Pathway Preparation for Elementary School

Gathering information from sources like “College Talk” to have early college awareness for the STEM career is mentioned in this indicator. Evidence of the existence of opportunities in and outside the school, including guidance on STEM's career, for parents, students and teachers, are important to ensure full integration.

2.4.4.2. Access to STEM College and Career Opportunities for Middle and High School Students

This indicator is different from the previous, related to STEM career opportunities of middle and high school students. Providing guidance to students and families about the necessities such as self-discipline, homework, GPA, which play an important role in a good career readiness is an important factor that increases the level of integration.

2.4.4.3. Planning Student Outreach and Support for Pre-K–12 STEM Initiatives

The purposeful support that should be provided to students and families by the school about future STEM careers and stem related pathway is discussed under this indicator.

CHAPTER 3

METHODOLOGY

The method and the sample of this study will be explained with data collection and data analysis part in this chapter.

3.1. Method of the Study

The aim of the current study is to examine and evaluate high school teachers' and administrators' perceptions and to reveal their readiness level for STEM education. This study was carried out on the basis of the framework prepared by NYCDOE (2015) and examines the readiness level of high school in Turkey for STEM education. Although the STEM reports prepared by the Ministry of National Education included the importance of STEM for our country and the needs in the preparation process, no study examining the availability of high schools for STEM education directly was found in the literature.

The case study design was considered appropriate for this qualitative study. Before making a case study definition, it should be known that different ideas about case study are presented. Some authors argue that case study is a qualitative research type, while others argue that it is a qualitative research method. According to Creswell (2007), case study research which is a methodology takes place in a 'bounded' system, and a problem investigated in this system is studied by examining one or more cases. Chmiliar (2010) again explains case study as a methodological approach involving a detailed analysis of a particular limited scheme using various types of data compilation to collect information systematically on the way the scheme works. However, case study is not a methodology according to Stake (2005), but it means a selection of what to study in a bounded system.

Case studies have a strong ability to achieve high cognitive validity, have powerful methods to promote clear assumptions, are helpful to examine carefully the hypothesized function of causal processes in specific instances and have high potential to deal with causal difficulty (George & Bennett, 2005). All the reasons mentioned above are good reasons to choose the case study.

There are different case study types according to the literature. According to a study conducted by Subaşı and Okumuş (2017), these are exploratory, explanatory and descriptive (Yin,1994); theory-seeking and theory testing, story-telling and picture-drawing and evaluative (Bassey, 1999); disciplinary orientation, overall intent, multiple case studies (Merriam, 1998); intrinsic, instrumental and collective case studies (Stake, 2005).

For this study, instrumental case study was selected. Instrumental case study focuses not on the case itself, but on a particular problem. The situation will then become a way to comprehend the problem deeper (Stake, 1995). The focus point of this study is the readiness of the high schools and the fact that there are different schools means that there are multiple cases.

3.2. Sample

High schools in Ankara are designated as the case for this study and the STEM readiness levels of these schools are the issue. In this manner four high schools were selected. As it is seen, since there are more than one high school, a multiple case study was selected in this study. According to Baxter & Jack (2008), a multiple case study is useful for examining similarities and differences between the cases. In addition, the results obtained from multiple case studies were found to be strong and reliable (Baxter & Jack, 2008). In multiple case researches, study issues and theoretical development can be explored in greater detail (Eisenhardt & Graebner, 2007) so it takes long time to complete it. Although the issue of time seems to be a disadvantage, this problem has been eliminated by expanding this study to two years.

STEM education has become a popular approach in our country in recent years, but it is not known exactly how this education is implemented. Because of this, it makes sense to choose more than one school to understand which type of school really applies STEM education. One of the selected schools, which is a science high school, according to the results of high school entrance examination of the Ministry of Education (2018), is among the best high schools of Ankara and Turkey. Additionally, one Private High School, one Industrial Vocational High School and one Normal High School were the other selected schools for this study.

The private high school, which was one of the selected schools, was slightly different from the others with the opportunities it had and the international curriculum it applied apart from the national curriculum. The school had foreign students and teachers, and the laboratories were well-equipped. In addition, there were thematic classes, such as the geography class, which were actively used. There were three science laboratories fully equipped with experimental materials but there was no computer laboratory.

The science high school was structurally similar to the private high school, but the laboratories and equipment were older. There were 2 Physics Laboratories, 2 Chemistry Laboratories and 2 Biology Laboratories. The laboratories had enough infrastructure for students to carry out their projects and experiments. There were also 16 classrooms in the school and there was an interactive board and internet connection in the classrooms. In this school, unlike the others, 3D printers were used actively. In addition, there were 6 workshop classes which can be used for teaching and hobby studies in and out of classes.

The industrial vocational high school had a large area and laboratories. There were totally 12 laboratories and workshop classes. The materials in the labs were actively using.

In the normal high school, classrooms had smart boards, but they were crowded, and no labs were used. It was totally a university entrance exam-oriented school.

Since the members of the target population of this study are easily accessible, geographically close and willing to participate the study, sampling can be referred to as convenience sampling as non-randomly (Dörnyei, 2007). In qualitative studies, purposeful sampling is used more than convenient sample (“Convenience Sampling”, 2009). In purposive sampling, research intent is quite important to choose subjects to get distinctive and high-quality data from the study (Etikan, Musa, Alkassim, 2016). From this point of view, purposive sampling method was used in this study. The study was conducted in Ankara but can be generalized according to the results obtained.

In the purposive sampling method, the focus point is 'saturation' (Miles & Huberman, 1994); it means that, the researcher continues to make interviews until no new information is available. In the light of this information, there was no exact sample size for this study. I have chosen one deputy headmaster/principal and two teachers from each school. All interviews were conducted on a voluntary basis and in some schools more than two teachers were volunteered. As the number of interviews increased, the answers were predictable by me, so it cannot be said that increasing the number of participants in same school contributed positively to the study. 9 science or math teachers and 4 deputy headmaster/principals have taken part in this study and participants were selected homogenously.

The necessary permissions obtained for interviews can be found in the Appendix A.

3.3. Preparing Interview Questions

In this study, in order to prepare interview questions, New York City (NYC) Department of Education STEM Framework Criteria was used. This framework is based on four domains and all domains include indicators with corresponding criteria. The questions were chosen according to these domains’ indicators and schools’ readiness was evaluated as early, emerging, integrated or fully integrated. The domains and their indicators can be examined in Table 3.1 and interview questions are in the part of Appendix B.

The STEM Framework was needed to be read a few times to prepare the questions. It was very important to prepare the questions carefully in order to get relevant answers. There were some artifacts for each domain, and they were an important guide for the process. While preparing the questions, some keywords that indicate the level of readiness like ‘a few, some, many, all’ were paid attention. Rather than preparing questions at once, the researcher worked by dividing them into pieces and having them checked by experts. There was a part for the elementary school in the framework, so this part was removed while preparing the questions. The questions that can be answered as short as a yes or no were not used. There were totally 30 main questions for 4 domains and also some sub-questions in addition to the main questions.

The questions for Domain 1 were created to understand the school's attitude towards STEM education and whether it had a STEM mission and vision or not. Other questions were prepared on the appropriateness of the school's educational atmosphere for STEM, focusing on whether if the school has a STEM culture and if a STEM budget is available. The questions also aimed to evaluate the STEM applications of the school. The first indicator was STEM mission and vision, and the researcher tried to reveal the participants' STEM knowledge level and their mis-understandings about STEM education. Second indicator was about STEM-centric culture and the suitability of the studies carried out in the school for STEM was tried to be found out with the questions. Interdisciplinary courses, cooperation between teachers from other disciplines, project-based learning, integration of technology into the lectures and engineering practices were the main points of the questions. Third indicator was about the evaluation of STEM programs and fourth indicator was about the school’s budget for STEM education.

In Domain 2, the first indicator was academic rigor and instructional quality. In this part, some questions were asked about the practices to encourage students in the school to implement STEM, usage of inquiry method in the lectures and the contents of school’s STEM education program. Second indicator was about the curriculum and the questions were about the opportunities for students to implement STEM in real life, school’s future plans for STEM and integration of STEM program into the courses and lesson plans. The third indicator was about assessments and in this part, the assessment methods the school had for STEM, if any, were discussed. The last indicator was staff capacity and whether the number of teachers is sufficient to implement STEM, teacher qualities for STEM education and schools’ supports to ensure teacher competence were asked.

Domain 3 was about strategic partnership and the questions were about the collaborations provided by the school to make STEM education stronger, strategic partnership with organizations, universities, families and schools' platforms for sharing news or opportunities about the STEM.

In Domain 4 there were 3 indicators about STEM career. The first indicator was about elementary school students, so it was not included in the study. The other two indicators were for high school students’ STEM career and some questions about students’ career opportunities and supports related to STEM pathways were asked to participants.

The researcher did not have to make changes for the questions because the framework was already prepared for high schools. The questions were re-checked after the preparation. It was applied as a trial in the school where the researcher worked at. The parts that need to be revised have been revised. The supervisor of the study was checked and approved, and the questions was ready for implementation.

Table 3.1. *The domains and indicators of STEM Framework*

DOMAINS		INDICATORS
Domain 1	School Vision and Structures for Success	*STEM Mission and Vision *STEM-centric Culture *STEM Program Evaluation *Budget/Management of Resources

Table 3.1 (continued)

DOMAINS		INDICATORS
Domain 2	Curriculum, Instruction and Assessment	*Academic Rigor and Instructional Quality *STEM-centric Curriculum *Authentic Assessments * Staff Capacity
Domain 3	Strategic Partnerships	* STEM Partnership
Domain 4	Collage and Career Readiness	* Access to STEM College and Career Opportunities for Middle and High School Students *Planning Student Outreach and Support for Pre-K-12 STEM Initiatives

3.4. Data Collection

The data collection process of the study, which included translating New York City (NYC) Department of Education STEM Framework criteria into Turkish from English, expert review, contacting the participants and conducting semi structured interviews have taken approximately 1 year. In order to gather useful and relevant data, a semi structured interview was conducted with the participants on a voluntary basis. The researcher, with a list of questions or a series of topics, is flexible about the question and answer period when conducting a semi-structured interview (Edwards & Holland, 2013). Therefore, there was no time limit for the participants, and the interviews lasted approximately twenty minutes. Since the interview questions were prepared meticulously according to the framework, the data collected from the participants was very purposeful.

When the participants were reached, they were first asked if they were willing to have an interview and whether they allowed them to record. All participants were eager and allowed to record. The sound recordings were very important to not miss any answer that would help the researcher. During the interview, recording the sound allows qualitative interviewees to concentrate on hearing, note taking, observing their interviewee and keeping eye connection. Therefore, voice recording is very useful not only after the interview, but also during the interview (Edwards & Holland, 2013). As Jacob & Furgerson suggested (2012), a spare recorder was always available to avoid unexpected problems. The participants were assured that the audio recordings would only be accessible by the researcher and that they would not be broadcast elsewhere without their permission. It is essential to arrange and rehearse the questioning method in depth before starting the interview. Since it was the first experience of the researcher, it was needed to be knowledgeable about the issue. Therefore, before the interviews, a lot of practices were done and questions that may come from the participants were thought.

Interviews started with warm-up questions to ease the participants and prepare them for the interview. This also helped revealing their knowledge of the issue. For example, instead of asking a question directly about STEM, they were asked if they had heard of STEM education before, and if participants requested, brief explanations were made to avoid confusion at this point.

It is very important to make eye contact with the participants as a researcher. Participants who feel that they are really listened to can share more than what you would expect (Jacob & Furgerson, 2012). The researcher did not hesitate to make eye contact and used the body language effectively to make the participants feel safe and to make them feel really listened by the researcher. The interviews were quite comfortable and nice. Beyond the answers to the questions, there was information that was noted. This information gave very good results later on in the study.

3.5. Data Analysis

> “Valid analysis is immensely aided by data displays that are focused enough to permit viewing of a full data set in one location and are systematically arranged to answer the research question at hand.” (Huberman and Miles, 1994, p. 432)

In the analysis part of the study, all the sound recordings were listened one by one and data obtained from two science/math teachers and one administrator from each school was written by the researcher in the form of word by word. At this point, the collected data was copied and stored in different ways (e-mail, usb storage, computer etc.). The real names of the participants and schools were not used as Creswell suggested (2007), which prevented bias during the analysis. Memos, one of the advantages of qualitative study, support the integration of codes and help the development of interpretive decisions (Denzin & Lincoln, 2005, p. 73). Also, the memos recorded by the researcher during and immediately after the interviews made the work easier when the analysis started.

In qualitative research, prepared and edited data are coded, interpreted and the themes are obtained as a result of the analysis (Creswell, 2007). If the data is considered as pieces of a multi-part puzzle, the only thing to do is to assemble pieces of similar color to complete the puzzle and to move towards the whole. Once the data is organized, frequently used words are identified, and they start to form ideas from the participants. Then, themes emerge from these ideas (Gibson and Connor, 2003). As the result of the interviews, new things or ideas that we do not expect to hear can be revealed and are called as 'rich points' (Asar, 1998). Researchers should be careful at this point because they can be valuable for the study.

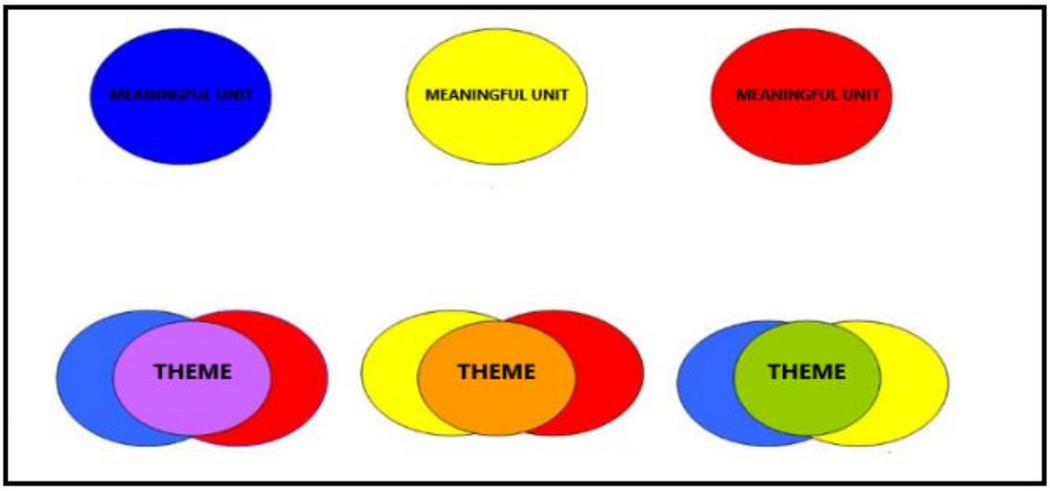

Figure 3.1. Themes emerge from meaningful units.

After audio recordings are transcribed, the written statements of the interviews were carefully read by the researcher based on the information above and the pre-coding process was done by underlining the parts. Questions were asked according to NYC STEM framework and the ideas of experts or practitioners were analyzed with a constant comparative method (CCM). CCM gives a chance to compare the information from data collection with emerging categories (Creswell, 2007), so this method was appropriate for this study. The analysis began with open coding, which included examining important words, phrases, and sentences of data from interviews. As Kolb (2012) said, data was compared by asking questions what is and is not understood. Then, data was combined in new ways by making connections between categories in the second part of analysis and finally codes were narrowed to be associated with main codes. After the analysis, some themes were revealed from practitioners' opinions about the readiness level of schools.

In the other part of the analysis, main headings were created under each domain and a total of 25 headlines were achieved. There were four different indicators under each heading and each indicator is scored between 1 and 4. For Domain 1, there were three main headings and four indicators for each heading. Each school was placed under an indicator according to the results of the interview questions. Summative approach was used in this part of the study to identify commonly used words and to find out the usage (Hsieh & Shannon, 2005). Although determining the frequencies of frequently used words for analysis seem to be a quantitative study (Kondracki, Wellman & Amundson, 2002), content interpretation is the most important focus, so it has become a qualitative study (Hsieh & Shannon, 2005). The school had some scores according to word counts obtained from interviews, and they get 1 point according to usage of 'none of', 2 for 'few', 3 for 'some' and 4 for 'all'. At this point, it was not paid attention to the fact that the word was directly the same, so close-meaning words were collected in the same category. For instance, instead of 'none of', other words such as 'never' were counted similar since they possess similar meanings. This process was repeated for all domains and for 4 schools. At the end of the scoring part, readiness level of the school with a total score of 1-25 was coded as early, 26-50 was coded as emerging, 51-75 was coded as integrated and 76-100 was coded as fully integrated.

3.6. Validity

Validity is very important in all research methods in order to achieve credibility (Pandey & Patnaik, 2014). Many views, conditions and processes have been created in the framework of qualitative research to achieve validity and reliability like internal and external validity, reliability, objectivity (LeCompte & Goetz, 1982); structural corroboration, consensual validation, referential adequacy, ironic validity (Eisner, 1991); ethical and substantive (Angen, 2000) as cited in Creswell (2007).

Study findings are validated by a procedure called as trustworthiness. According to Lincoln & Guba (1985), there are four steps to be sure the trustworthiness in a qualitative study: credibility, transferability, dependability, and confirmability.

Credibility interests in that whether the study is suitable for reality or not (Merriam, 1985). It seeks an answer to the question of whether the findings are purposeful and appropriate to reality (Merriam, 1998). To promote credibility in this study, the prolonged engagement was created between the researcher and the participants. In doing so, as Pandey and Patnaik (2014) suggested, the environment in schools were observed in various ways, and there was enough time to engage in trust-based interviews with teachers and administrators. Triangulation was another method to be ensure credibility. The use of various information sets is involved in a triangulation in order to create a higher knowledge (Merriam, 1995). In this context, in addition to teachers, interviews were conducted with administrators to increase data sources and to provide deeper understanding about the issue.

Transferability measures to what extent the result of the study is possible to be used in other studies (Merriam, 1985). In qualitative studies, it is difficult to generalize findings because they are generally applicable to small groups (Pandey & Patnaik, 2014). To construct transferability, this study included detailed information about participants, data collection methods and time period of the interviews. This detailed description, called as ‘thick description’ which was first used by Ryle (1949) as cited in Pandey& Patnaik (2014), helps to transfer results to other times, situations and participants.

Dependability investigates whether comparable results would be generated by applying the same study using the same methods and participants (Merriam, 1985). To conduct dependability in the study, a consultant who was not involved in the study was selected to follow the process and examine whether the results were supported by the data. This method, called the external audit (Creswell, 2007), provides more powerful results by gathering additional data based on the feedback provided by the external consultant. The research process of the study was reported in detail to help this process in terms of data collection, data analysis and results.

Finally, the confirmability was conducted by the objectivity of the researcher. In this regard, the results of the study are not based on the prejudices and preferences of the researcher; it is based on participants' ideas, experiences and sharing. Audit trail technique by writing field notes and reconstructing data (Halpern, 1983), was used by the researchers to ensure confirmability in this study.

The researcher's background affects many things in the study, from the subject of the research to the method, from the findings to the results (Malterud, 2001). In order to prevent effects of the researcher, more than one researcher can be involved in the study, thus the process can be developed with different perspectives (Pandey& Patnaik, 2014). Throughout this study, the reflexivity was fostered by exchanging ideas and discussions with the consultant to approach the study objectively even though there was not always another researcher.

CHAPTER 4

RESULTS AND DISCUSSION

In this chapter, the results obtained from the analysis part is presented. Content and thematic analyzes were conducted to see if the results emerge the same thing. In the first part, readiness levels of high schools for STEM education were determined. In determining this, the indicators in the STEM framework were examined separately for each domain according to the responses received from the participants by using conceptual content analysis method. Occurrence of selected words in the text was determined by this method.

In the second part, according to the results of the interview, meaning units were obtained from the significant statements and themes were obtained from the meaning units. This chapter also included the discussion of results.

4.1. STEM Readiness Level

4.1.1. Sample Identifiers of Each Domain

There were 4 domain and 4 readiness levels that are early, emerging, integrated and fully integrated for each domain in the STEM Framework. The framework was edited for this study. The tables arranged according to the STEM framework and the opinions of the participants for each domain are given below. Opinions from teachers were shown with (T) and opinions from administrators were shown with (A).

4.1.1.1. Domain 1: School Vision and Structures for Success

The first sub-domain was STEM mission and vision. Some of the participants' responses were listed below. Then identifiers, in tables below, were determined according to answer of participants.

"I've never heard of STEM education before." (T)

"I've heard of many organizations doing STEM. I heard Ankara Provincial National Education. I heard of the cooperation of TUBITAK and Gazi University." (T)

"I have heard STEM as a system of collaborative work in engineering and science." (T)

"I have heard STEM as a predisposition to mathematics, physics, chemistry, biology and technology." (T)

"The school's mission and vision do not include STEM education." (T)

"Not only here, this system is not being used in schools in Turkey. I don't believe it." (T)

"Because our student quality is low, we cannot give science, technology, engineering and mathematics education to students as much as we want." (T)

"The mission and vision of our school includes STEM education." (A)

"Since this is the project school, the foundations of the STEM are already here." (A)

"The mission and vision of our school includes STEM education, but in practice there are some problems. Theoretically we are trying to implement it." (T)

Table 4.1. *Domain 1.1 STEM Mission and Vision*

Early	**None of the school members** heard the word 'STEM' before. **None of them** has knowledge about STEM. The school **does not have** STEM mission and vision. **None of the school members** interested in the importance of STEM education.
Emerging	**A few school members** heard the word 'STEM' before and they have **insufficient** knowledge about STEM. The school has **developing** STEM mission and vision. **A few school members** interested in the importance of STEM education.
Integrated	**Many school members** heard the word 'STEM' before and they have **sufficient** knowledge about STEM. STEM mission and vision of school has been **almost completed.** **Many school members** interested in the importance of STEM education.
Fully Integrated	**All of the school members** heard the word 'STEM' before. **All of them** has knowledge about STEM. The school has **established** STEM mission and vision. **All of the school members** interested in the importance of STEM education.

The second sub-domain was about STEM-centric culture. In this manner, the answers of participants and identifiers based on these answers are below.

"Courses are not interdisciplinary." (T)

"There are equipped laboratories, but the class includes 34 people. Laboratories for 20 people. 14 people cannot find the opportunity to work individually so taking the student to the laboratory can be a problem." (T)

"We cannot say that there is a STEM study in school, we only use information technology." (T)

"Sometimes we work on a project basis, but it is not enough." (T)

"Physicists are trying to do some new things on solar energy. Here are chemists trying to find new inventions, try to direct students." (T)

"There is no club, organization or project related to STEM as the STEM is not on the agenda right now." (T)

"Robotic club, math club, physics club, they are already working on STEM." (A)

"Some of the main purposes of this school are to give technological support to the country, to go further in the field of science and mathematics and to provide an integration in the world." (A)

"This is already a project school since it was already established, and if you call that STEM, then yes this is a STEM school." (A)

"In the IB program, in the context of Group 4 project, we mostly apply STEM." (T)

"The lessons in the school are not suitable for STEM education because the lessons are very exam oriented." (T)

"Technology is integrated into the courses; we use Vernier Probes to make measurements. Other than that, we use smartphone applications." (T)

Table 4.2. *Domain 1.2 STEM-centric Culture*

Early	There is **no** STEM-oriented study in the school. **None of the school members** efforts to provide a suitable environment for innovation, engineering practices and risk-taking. School **does not have any** classroom or lab for students to do group work, collaboration and project-based learning. **None of the courses** are interdisciplinary.
Emerging	There are **a few** STEM-oriented studies in the school **A few school members** efforts to provide a suitable environment for innovation, engineering practices and risk-taking. School **has insufficient** classroom or lab for students to do group work, collaboration and project-based learning. **A few courses** are interdisciplinary.
Integrated	There are **some** STEM-oriented studies in the school **Some school members** efforts to provide a suitable environment for innovation, engineering practices and risk-taking. School has **some** classroom or lab for students to do group work, collaboration and project-based learning. **Some of the courses** are interdisciplinary.
Fully Integrated	**All** studies in the school are STEM-oriented. **All school members** efforts to provide a suitable environment for innovation, engineering practices and risk-taking. **All classrooms** or labs are designed for students to do group work, collaboration and project-based learning. **All courses** are interdisciplinary.

The third sub-domain was about STEM program evaluation. Some of the participants' answers were listed below and indicators were determined according to these answers.

"There is no unit in the school that controls the applicability of STEM." (T)

"Since our school is more exam oriented, we cannot spend a lot of time on STEM applications and there is no unit that controls STEM." (T)

"We can only reach the science, mathematics part of STEM. We can't get to the engineering part anyway." (A)

Table 4.3. *Domain 1.3 STEM Program Evaluation*

Early	There is **no process** in the school to evaluate the implementation level of STEM
Emerging	There is **a developing process** in the school to evaluate the implementation level of STEM
Integrated	There is **a process** in the school to evaluate the implementation level of STEM
Fully Integrated	There is **an advanced process** in the school to evaluate the implementation level of STEM

Some answers about the fourth domain, about STEM budget, and identifiers according to these answers were listed below.

"We don't have a work called STEM, so we do not have a budget." (A)

"I mean, there is no need for something like STEM Budget, but when it is, it will either be supplied from the students or from the school administration." (T)

"The budget allocated to the school is more than enough to take things related to occupational safety more than our needs related to STEM." (T)

"Our budget is not enough to meet the needs of students." (T)

"The budget is quite insufficient for STEM." (T)

Table 4.4. *Domain 1.4 Budget/Management of Resources*

Early	There is **no STEM** budget in the school.
Emerging	There is **insufficient STEM** budget in the school.
Integrated	There is **sufficient STEM** budget in the school.
Fully Integrated	There is **fully sufficient STEM** budget in the school.

4.1.1.2. Domain 2: STEM Curriculum, Instruction and Assessment

As it is clearly seen below, there were many responses for this domain and they were about the curriculum, instructional strategy, students' attitudes towards STEM and applications of STEM.

"Because there is a problem in the education system, children are mostly students with low level of academic knowledge, so I do not intend to do anything as the project. We are just trying to explain the events they need to know." (T)

"I use the inquiry method. We are trying to make the student find the truth by asking the questions of what, why, why and how." (T)

"There is no study on practicing in the field of engineering in our school. The general system is focused on entering a university and therefore the student has to pass the university exam." (T)

"Sometimes we use the method of inquiry, so we use it when appropriate." (T)

"Using the method of inquiry varies from teacher to teacher. So, some teachers provide, some do not. It also changes according to course." (A)

"Capacities are not enough, times are not available to encourage stem applications. So, there is no such demand." (T)

“12th grade students receive skills training. There they learn the engineering procedures, they learn the process and they familiarize the steps. I think this is useful and effective.” (T)

“We have our 3D printers in our laboratory as an opportunity to design and practice in the field of engineering.” (A)

“Our teaching methods are not appropriate with the school's STEM vision and mission since our students are preparing for the TYT-AYT exams in the 12th grade, they are only studying for the exam after the 10th grade.” (T)

“STEM is left on the initiative of the teacher. If the teacher wants to do, does not want to do, does not do.” (A)

“Instead of giving the information directly, the question-answer method is used both for understanding the current level of knowledge of children and for evaluating at the end of the course.” (T)

“Usually we do projects with IB students, 6 people, not with other students.” (T)

Table 4.5. *Domain 2.1 Academic Rigor and Instructional Quality*

Early	There is **no application** to encourage students in the school to make STEM practices There is **no students-centered instruction** in the school. Inqury method is **not using** in lectures. Teaching methods are **not appropriate** with the school's STEM vision and mission
Emerging	There are **few applications** to encourage students in the school to make STEM practices There is **sometimes** students-centered intruction in the school. Inqury method is **rarely** used in lectures. Teaching methods are **partially appropriate** with the school's STEM vision and mission
Integrated	There is **some application** to encourage students in the school to make STEM practices There is **often s**tudents-centered instruction in the school. Inqury method is **often** used in lectures. Teaching methods are **appropriate** with the school's STEM vision and mission
Fully Integrated	There **are various applications** to encourage students in the school to make STEM practices. There is **always** students-centered instruction in the school. Inqury method is **always** used in lectures Teaching methods are **fully appropriate** with the school's STEM vision and mission

Domain 2.2 was about STEM-centric curriculum and some identifiers such as STEM opportunities and integration of STEM into the lectures have been revealed based on the answers given.

“Now there is no future-oriented work since there is a problem in the system. We have children to pass the class, so there is nothing to think about their future.” (T)

“Unit and lesson plans do not contain STEM.” (A)

“If the curriculum is intended for STEM, the unit and course plans may include STEM.” (T)

“So far we have done nothing under the name STEM but STEM is always a part of the courses; model making, drawings…” (T)

Table 4.6. *Domain 2.2 STEM-centric Curriculum*

Early	Teachers **do not** integrate STEM into their courses. Curriculum maps, unit plans, and lessons **do not include** STEM content Students are **not offered** any opportunities for STEM in real-life applications
Emerging	Teachers **sometimes** integrate STEM into their courses. Curriculum maps, unit plans, and lessons **partially include** STEM content Students are **sometimes offered** any opportunities for STEM in real-life applications
Integrated	Teachers **often** integrate STEM into their courses. Curriculum maps, unit plans, and lessons **often include** STEM content Students are **often offered** any opportunities for STEM in real-life applications
Fully Integrated	Teachers **always** integrate STEM into their courses. Curriculum maps, unit plans, and lessons **always include** STEM content Students are **always offered** any opportunities for STEM in real-life applications

The answers for the part of authentic assessment and staff capacity were nearly the same for all schools.

"This issue must be in the planning of the administration and the ministry, it is difficult for the teacher to do something very active as an individual." (T)

"Our school does not have assessments criteria for STEM" (A)

"We use authentic assessment within IB classes, but I don't know how effectively we use it." (T)

Table 4.7. *Domain 2.3 Authentic Assessments*

Early	Authentic assessments are **not used** by teachers to monitor student progress
Emerging	Authentic assessments are **sometimes used** by teachers to monitor student progress
Integrated	Authentic assessments are **often used** by teachers to monitor student progress
Fully Integrated	Authentic assessments are **always used** by teachers to monitor student progress

"Teachers must attend in-service training in terms of using technology, assessment and academic knowledge in order to implement STEM." (A)

"First of all, the technological environment needs to be provided. For STEM, as far as I understand, there must be a chemistry laboratory, a physics laboratory, mathematical tools, and courses in computer technology. This tusk is beyond us, if this environment is provided to us, we can contribute to our student." (T)

"The number of teachers is sufficient, but since there is no study for STEM, the information is insufficient." (A)

Table 4.8. *Domain 2.4 Staff Capacity*

Early	Teachers **have not any experience** in STEM content and **have not any** pedagogical knowledge about STEM education. The school **does not support** teachers to provide professional learning in STEM content Information sharing is **not provided** within and outside the school on STEM programs and opportunities.
Emerging	Teachers have experience in STEM content, but it is **insufficient** and **insufficient** pedagogical knowledge about STEM education. The school **rarely supports** teachers to provide professional learning in STEM content Information sharing is **rarely provided** within and outside the school on STEM programs and opportunities
Integrated	Teachers **have sufficient experience** in STEM content and **have sufficient** pedagogical knowledge about STEM education. The school **often supports** teachers to provide professional learning in STEM content Information sharing is **often provided** within and outside the school on STEM programs and opportunities
Fully Integrated	Teachers **are proffessional** in STEM content and **have deep** pedagogical knowledge about STEM education. The school **always supports** teachers to provide professional learning in STEM content Information sharing is **always provided** within and outside the school on STEM programs and opportunities

4.1.1.3. Domain 3: Strategic Partnerships

Strategic STEM Partnership was questioned in this part and the responses obtained from the participants were as follows.

“There are conferences given to students, but this is just to overcome the anxiety of the exam not about STEM.” (T)

“Parents expect from us to pass the course of their child. There is no concern for the future of the child.” (T)

“We are communicating with universities, parents, engineers, outside people, the mayor, there is a very active cycle here.” (A)

“We have cooperation with universities; METU, Bilkent and TOBB.” (T)

“There is no request from the parents for STEM because the goals are different after four o'clock. So, tell the 11th and 12th grade students and parents about STEM as much as you want, even if they know the benefits, they ignore it.” (A)

“We never talk about STEM with our parents.” (T)

Table 4.9. *Domain 3.1 STEM Partnerships*

Early	The school **does not have any** strategic partnership on STEM There is **no** cooperation with families, universities, etc. to make STEM education more powerful There is **no resource** available to share developments with parents on STEM
Emerging	The school has **limited** strategic partnerships on STEM There is **limited** cooperations with families, universities, etc. to make STEM education more powerful There are **limited** resources available to share developments with parents on STEM
Integrated	The school has **some** strategic partnerships on STEM There is **some** cooperations with families, universities, etc. to make STEM education more powerful There are **some** resources available to share developments with parents on STEM
Fully Integrated	The school has **effective** strategic partnerships on STEM There is **effective** cooperations with families, universities, etc. to make STEM education more powerful There are **effective** resources available to share developments with parents on STEM

4.1.1.4. Domain 4: STEM College and Career Readiness

"*Children do not know what the profession wants, does not know about the career." (T)*

"Nowadays it is easy to reach information, if you do routing, if you do motivational things to children, children can research them and if you attract interest in it you can do scientific discussion on this subject." (T)

"Usually, such things are announced to children through the school. I cannot say that the sensitivity of the families on this subject is very high." (T)

"Students do not have opportunities such as guidance and internship in STEM." (A)

Table 4.10. Domain 4.2 Access to STEM college and career opportunities for middle and high school students

Early	**No** source used to inform high school students and their families about the importance of STEM. **No** student knows about career opportunities, scholarships, financial aid, information about attending colleges related to STEM.
Emerging	**Limited** sources used to inform high school students and their families about the importance of STEM. **Limited** students know about career opportunities, scholarships, financial aid, information about attending colleges related to STEM.
Integrated	**Some** sources used to inform high school students and their families about the importance of STEM. **Some** students know about career opportunities, scholarships, financial aid, information about attending colleges related to STEM.
Fully Integrated	**All** sources used to inform high school students and their families about the importance of STEM. **All** students know about career opportunities, scholarships, financial aid, information about attending colleges related to STEM.

"Students choose the important part of their choices due to environmental impact, family pressure. Does not choose with the concern of the profession." (T)

“We are schools that are following a certain system. There is nothing about the stem environment. We can only give motivation to the children to reach the information and to draw their goals in the direction of knowledge, but the parents can be contacted by telephone, via the internet.” (A)

“More than STEM guidance, we are trying to guide students to pass the university exam.” (T)

“We're just directing, giving information about, but it's limited.” (T)

Table 4.11. *Domain 4.3 Planning Student Outreach and Support for Pre-K-12 STEM Initiatives*

Early	The school **does not** provide students with guidance on STEM related pathways
Emerging	The school **rarely** provides students with guidance on STEM related pathways
Integrated	The school **often** provides students with guidance on STEM related pathways
Fully Integrated	The school **always** provides students with guidance on STEM related pathways

4.1.2. Domain Scores

Domain scores are in tables below and School 1 is used for Normal High School, School 2 is for Industrial Vocational High School, School 3 is for Science High School and School 4 for Private High School. At the end of the analysis, the level of readiness was determined according to the scores obtained by the schools. The score between 1 and 25 determined as Early, 26-50 as Emerging, 51-75 as Integrated and 75-100 as Fully Integrated.

Focal point of Domain 1 consisting of 4 subdomains, was STEM vision of schools and structures for success. Domain 1.1 was about STEM mission and vision and there were

3 sub-categories for Domain 1.1. The minimum score that could be obtained from each category was 1 and the maximum score was 4, so participants get scores between 4 and 12 from this domain. Domain 1.2 was about STEM-centric culture and included 4 categories and the scores of participants ranged from 4 to 16. Domain 1.3 was about STEM program evaluation and Domain 1.4 was about STEM budget. The max score obtained from these domains is 8 and 4 for min. Final maximum score that participants can get from this domain was determined as 36 out of 100.

Domain 2 was mainly about STEM Curriculum, Instruction, and Assessment and it included 4 subdomains and each domain included some categories again. As a result of analyzes performed by applying the same process as above, the max score obtained from this domain was 44 out of 100.

Same procedure was applied for Domain 3 and Domain 4 and the max score for Domain 3 is 8 and for Domain 4 is 12 out of 100.

4.1.2.1. Results of Domain 1

- **Domain 1.1**

According to data obtained from the participants, none of the school members in the Normal High School have heard of STEM before and they were not interested in STEM. Only a few members have heard it before in Industrial Vocational High School, but they didn't know exactly what it meant and again a few of them were interested in STEM education. Some said STEM was a name of an organization made by some institutions. According to some participants, STEM was a common system of working in engineering and science, or 'something' about science, mathematics and technology. On the other hand, all participants of science and private high schools were aware of STEM education and all of the participants were interested in it. Participants from the private high school said that STEM was an ‘interdisciplinary approach.’ As a result, while STEM mission and vision were not established in the normal high school and industrial vocational high school, the science high school had this mission and vision and it was about to be completed in the private high school.

Total score of schools out of 12 for Domain 1.1 is like below:

Normal High School: 3

Industrial Vocational High School: 5

Science High school: 12

Private High School: 11

Table 4.12. *Scores of Domain 1.1*

	DOMAIN 1.1 STEM Mission and Vision											
	Number of school members have heard of STEM before				Number of school members interested in STEM				STEM mission and vision of school			
	None of	Few	Some	All	None of	Few	Many	All	No	Developing	Almost Completed	Established
School 1	*				*				*			
School 2		*				*			*			
School 3				*				*				*
School 4				*				*			*	

According to the results, participants are generally confused about the meaning of STEM and STEM education. Teachers from the private high schools have full knowledge of STEM because they are the part of International Baccalaureate Program. This can be an advantage for them because the IB program encourages teachers and students to think critically, to have self-reflection and to make connection between different disciplines ("Benefits for Teachers," n.d.). Besides, the participants from science high school have strong knowledge of STEM and this may be due to the fact that they collaborate with universities such as METU and Bilkent. When this is the case, the establishment of a STEM mission and vision is inevitable for these schools. On the other hand, participants from other schools are not interested in STEM because of the university entrance exam and students' academic quality. Low academic level is seen as an obstacle for providing science, technology, engineering and mathematics education to students. This should not be an excuse because STEM activities can be designed to be applicable at all levels and at any times of education (U.S. Department of Education, 2015). Hence, STEM is not on their agenda for the time being, but what happens in the future is unknown.

- **Domain 1.2**

When the STEM-centered Culture domain is examined, as shown in Table 2, there were only a few studies related with STEM and a few courses available for interdisciplinary in Normal High School and Industrial Vocational High School. Although there are laboratories, these schools also did not have classes and laboratories allowed for STEM activities or there were insufficient ones. The participants from the Normal High School stated that the classes were crowded, and this was an obstacle for STEM. The number of STEM-oriented studies, STEM classes and laboratories and availability of interdisciplinary courses was relatively higher in other schools. In addition, it can be said that the number of school members to create a suitable STEM education atmosphere in the school is higher than others in the science high school and the private high school, although not enough.

Considering this data, the total score of schools out of 16 for Domain 1.2 is like below:
Normal High School: 6
Industrial Vocational High School: 8
Science High school: 13
Private High School: 12

Table 4.13. *Scores of Domain 1.2*

	DOMAIN 1.2 STEM-centric Culture															
	STEM-oriented studies				Classes/laboratories for STEM				Availability of interdisciplinary courses				Number of school members create suitable environment for STEM			
	No	Few	Some	All	No	Few	Some	All	No	Few	Some	All	None of	Few	Many	All
School 1		*			*					*			*			
School 2		*				*				*				*		
School 3			*				*					*			*	
School 4			*				*				*				*	

While STEM-centered culture in schools has not yet developed, some schools seem eager to do so. Science high school and private high school has some clubs working on STEM, but this is not a concept that is spread throughout the school. Since the projects carried out by the scope of the IB program include the STEM approach, the private school seems to be advantageous. One of the good points obtained from the results is that; the participants from all schools realize that integrating technology into the courses does not mean STEM. At this point, being conscious is necessary to create STEM-centric culture. Not only those who integrate technology into the lectures but also coding employees, makers and those who do science experiments think that they do STEM, but it is not (Eğitimpedia, 2016). The other important point in creating a STEM-centric culture is to create a suitable environment and to have teachers and administrators willing to do so but it seems quite difficult for some schools. The normal high school is one of these schools and members of it are not willing to create STEM environment in the school. It can be because of the exam-centered education system in Turkey or the characteristics of participants but this is the subject of another work. Here, it seems that schools still need time and desire to develop STEM culture.

- **Domain 1.3**

According to the data obtained from STEM program evaluation and STEM Budget Domains, there were not any evidence for the evaluation process of STEM education in schools and no budget was created for STEM. Since there was no STEM education in schools, STEM Budget and evaluation criteria are not needed. All schools got the score 1 out of 4 for these domains.

Table 4.14. *Scores of Domain 1.3*

	DOMAIN 1.3 STEM Program Evaluation			
	Evaluation Process			
	No	Developing	Sufficient	Advanced
School 1	*			
School 2	*			
School 3	*			
School 4	*			

Table 4.15. *Scores of Domain 1.4*

	DOMAIN 1.4 Budget/Management of Res.			
	STEM Budget			
	No	Insufficient	Sufficient	Fully Sufficient
School 1	*			
School 2	*			
School 3	*			
School 4	*			

According to the responses of the participants, there is no STEM budget concept since there is no STEM education in schools. Their budgets are insufficient even for current needs. Likewise, the STEM evaluation process cannot be mentioned because there are no STEM practices in schools' agendas. In order for schools to allocate STEM budget, they must first meet their daily needs such as laboratory equipment and project expenses. All of the schools interviewed said that they do not have a sufficient budget and that they create a budget through funds, school administration and families if needed.

4.1.2.2. Results of Domain 2

- **Domain 2.1**

In this part, 4 sub-domains were created according to the data obtained from the domain of Academic Rigor and Instructional Quality. Clearly seen in the table below, in the Science High School and the Private High Schools, student-centered courses and usage of inquiry methods are always included in lectures, while other schools are rarely included. Besides, teaching methods were not appropriate for STEM education in the Normal High School and there were no STEM applications. At this stage, there was no school where STEM practices were fully implemented. Also, teaching methods were not entirely appropriate for STEM in any school.

According to this data, the total score of schools out of 16 for Domain 2.1 is like below:

Normal High School: 6

Industrial Vocational High School: 8

Science High school: 13

Private High School: 14

Table 4.16. *Scores of Domain 2.1*

	DOMAIN 2.1 Academic Rigor and Instructional Quality															
	STEM applications				Student-centered Instruction				Inquiry method usage				Suitability of teaching methods for STEM			
	No	Few	Some	Various	Never	Sometimes	Often	Always	Never	Rarely	Often	Always	No	Partially appropriate	Appropriate	Fully appropriate
School 1	*					*				*			*			
School 2		*				*				*				*		
School 3			*					*				*		*		
School 4			*					*				*			*	

Using the method of inquiry, integrating of STEM into the lectures and using STEM applications generally depend on the teachers' initiative in our education system. Especially in the private high school, teachers are careful about this issue because using inquiry method and student-centered lectures are necessity for the IB program. Also, teachers in the science high school are willing to apply STEM into the lectures but university entrance exam is a serious obstacle for them because students after 10^{th} grade do not want to take interest in something instead of the exam. On the other hand, teachers are not willing to apply it in the normal high school. In general, teaching methods are not appropriate for STEM because the national curriculum of Turkey is not suitable for doing something directly related to STEM. In addition, other difficulties that teachers complain about are the low academic level of students and a lack of time. During the interviews, it was seen that some teachers had no idea what the inquiry method was. This showed that teacher education is a more urgent necessity than STEM education in our country. According to Vermunt (2014), student-learning and teacher-learning processes cannot be considered independently because the quality of teacher-learning determines the quality of student-learning. Therefore, it should be remembered that teacher learning, which enables teachers to develop new skills, is a continuous process (Solheim, 2017).

- **Domain 2.2**

Whether STEM integration is provided to the courses and whether there is a STEM content curriculum and the opportunities offered for STEM applications are examined under this domain. While STEM integration into the courses was never done in the normal high school, it was rarely seen in others. In addition, there was no STEM content-curriculum in any school. Only in the private high school, STEM was partially included in the curriculum. Although the participating schools in general do not provide students with opportunities to apply STEM, they have been told that these opportunities are sometimes available in Industrial Vocational High Schools and Private High School.

In light of this data, the total score of schools out of 12 for Domain 2.2 is like below:

Normal High School: 3

Industrial Vocational High School: 5

Science High school: 4

Private High School: 6

Table 4.17. *Scores of Domain 2.2*

	DOMAIN 2.2 STEM-centric Curriculum											
	Integration STEM into the courses				STEM content in curriculum				STEM application opportunities for students			
	Never	Sometimes	Often	Always	Never	Partially	Often	Always	Never	Sometimes	Often	Always
School 1	*				*				*			
School 2		*			*					*		
School 3		*			*				*			
School 4		*				*				*		

The results of the interviews showed that there are not many STEM application opportunities for students in schools. The field trips in industrial vocational high school are a good opportunity for students to have knowledge about the working principles of technological tools. Field trips that take students away from the normal classroom environment are very important in the development of STEM education in order to see real-world applications of theoretical knowledge.

- **Domain 2.3**

As it seen in the table below, except for the rare use in the Private High School, there were no usage of authentic assessment in the other schools. Hence, the score of the Private High School is 2 and other schools' score is 1 out of 4 for this part.

Table 4.18. *Scores of Domain 2.3*

	DOMAIN 2.3 Authentic Assessment			
	Authentic assessment usage			
	Never	Sometimes	Often	Always
School 1	*			
School 2	*			
School 3	*			
School 4		*		

With authentic assessment, which is different from traditional assessment, students have the opportunity to apply their basic knowledge and skills to the real world (Mueller, n.d.). Sadly, I must state that the schools still use methods such as multiple-choice tests, fill-in-the-blanks, true-false, matching, which are part of the traditional assessment. Again, only the IB program has sanctions that encourage the use of authentic assessment, but this is not used very effectively.

- **Domain 2.4**

The capacity of the staff was examined in this domain and it showed that the teachers' experience and pedagogical knowledge in STEM content was insufficient in all schools. In addition to this, there was no sharing about STEM in the private high school and the normal high school, while others were rarely shared. In addition, STEM support was most frequently provided by the science high school, while no support was provided by the normal high school.

The total score of schools out of 12 for Domain 2.3 is like below:

Normal High School: 4

Industrial Vocational High School: 6

Science High school: 7

Private High School: 5

Table 4.19. *Scores of Domain 2.4*

	DOMAIN 2.4 Staff Capacity											
	Teachers' experience and pedagogical knowledge in STEM content				Information sharing about STEM				School support			
	No	Insufficient	Sufficient	Professional	Never	Rarely	Often	Always	Never	Rarely	Often	Always
School 1		*			*				*			
School 2		*				*				*		
School 3		*				*					*	
School 4		*			*					*		

According to the data from participants, teachers do not feel academically sufficient about the STEM education but especially the teachers in the industrial vocational high school are willing to do STEM. They also say that administrators can support them in this regard, but this support on its own is not sufficient, and the physical structures of the schools need to be made suitable to the STEM. On the other hand, teachers and administrators have no demands on self-improvement. However, there is no systematic flow of information about STEM in the schools. Participants create this flow through their own efforts and aspirations.

4.1.2.3. Results of Domain 3

According to the data obtained from the participants, schools had not any strategic STEM partnership with universities or with any other companies except for the Industrial Vocational High School and Science High School. There was also no cooperation for STEM with the families and there were limited collaborations with other schools.

The total score of schools out of 8 for Domain 3.1 is like below:

Normal High School: 2

Industrial Vocational High School: 3

Science High school: 4

Private High School: 2

Table 4.20. *Scores of Domain 3.1*

	DOMAIN 3.1 STEM Partnerships							
	Strategic Partnership				Cooperation with families, universities			
	No	Limited	Some	Effective	No	Limited	Some	Effective
School 1	*				*			
School 2	*					*		
School 3	*						*	
School 4	*				*			

According to the answers of participants from normal high school, parents are not worried about their children's future and their only concern is that their children get high marks in exams. Since there is no demand from the families, the school does not show any educational movement for STEM. However, educational collaborations with families or universities are crucial for development in education. According to Marti (2013), STEM collaborations can provide teachers and students with counseling, support and classroom resources, as well as facilitating the flow of information and learning opportunities about STEM.

4.1.2.4. Results for Domain 4

According to the results of the Access to STEM College and Career Opportunities and Planning Student Outreach Domains, sources were limited to inform students about STEM career in three schools and there was no source in normal high school. In addition to sources, number of students that have information about STEM opportunities were again limited and no student in the normal high school had information about STEM opportunities. Finally, in the normal high school, students were unable to receive guidance for future planning in STEM related areas, but rarely in other schools.

The total score of schools out of 8 for Domain 4.2 and the total score out of 4 for Domain 4.3 is like below:

Normal High School: 2 and 1

Industrial Vocational High School: 4 and 2

Science High school: 4 and 2

Private High School: 4 and 2

Table 4.21. *Scores of Domain 4.2*

	DOMAIN 4.2 Access to STEM college and career opportunities							
	Sources to inform students				Number of students have information about STEM opportunities			
	No	Limited	Some	All	No	Limited	Some	All
School 1	*				*			
School 2		*				*		
School 3		*				*		
School 4		*				*		

Table 4.22. *Scores of Domain 4.3*

	DOMAIN 4.3 Planning Student Outreach			
	Provision of STEM guidance			
	Never	Rarely	Often	Always
School 1	*			
School 2		*		
School 3		*		
School 4		*		

As the education system in our country is mainly for the university exam, the only focus of the students and families is to study for the exam. As such, it is not surprising that there is none or a limited career planning for STEM in schools where there are already very limited studies under the name of STEM education.

- **Summary of the Scores**

The overall scores of the schools are shown in the table below.

The readiness level of the normal high school is ‘emerging’ with total 30 points, but it is actually closer to the boundary of ‘early’. The readiness level of the industrial vocational high school is again ‘emerging’ with a total 44 points, but unlike the normal high school, it is closer to the boundary of ‘integrated’. The science high school and the private high school are already in the ‘integrated’ level with scores very close to each other.

Table 4.23. *Summary of Results*

	Domain 1 (…/36)	Domain 2 (…/44)	Domain 3 (…/8)	Domain 4 (…/12)	Total (…/100)
Normal High School	11	14	2	3	30
Industrial Vocational High School	15	20	3	6	44
Science High School	27	25	4	6	62
Private High School	25	27	2	6	60
Average Score	19.5	21.5	2.8	5	49

When the atmosphere of the normal high school was examined, it was seen that it could be made physically suitable for STEM education with its classrooms and laboratories. But according to the participants, the negativities that decrease the readiness level of the school are as follows:

- Material inadequacies,

- A lack of demand for STEM from students and parents,

- Exam-oriented education system,

- A lack of enthusiasm by teachers.

In the industrial vocational high school, there is still an appropriate physical environment for the STEM education, but it needs to be improved. Some negativities that appear to be a problem for STEM education according to the interviews are as follows:

- Students with low academic level,

- Prejudices about industrial vocational high schools,

- Problem of communication between teachers.

The private high school seems to be on the integrated level of readiness. Thanks to the IB program, this school is familiar with STEM education without even realizing it. Some issues that are needed to be overcame in order to be ready for STEM education are as follows:

- Limited number of IB students

- Limited number of IB teachers

- Anxiety for the national university entrance exam

The science high school has an integrated level for STEM education with 62 points. Although it is not an IB school, it is pleasing for this school to be at the integrated level. The only thing seen as an obstacle to STEM education in this school is again the university entrance exam anxiety, and indirectly, the education system.

According to the average score derived from analyzes, the readiness level of high schools in Ankara is 'emerging' with 49 points, out of 100. Although there are common problems in all schools, some of the problems that appear to be specific to school types, such as students having a low academic level, have been a factor that brought down the level of readiness.

In the final part of the analysis, the significant statements were determined from the answers of participants. Then meaning units were created based on the significant statements (Appendix D). Finally, these meaning units were grouped to reveal themes. The themes that created as a result of this study are seen in Appendix E.

These themes are:

- Needs of knowledge and awareness of STEM
- Needs of STEM-integrated curriculum
- University exam anxiety is an obstacle for STEM.

- Needs of budget and materials for STEM

Theme 1: The need for knowledge and awareness of STEM

According to the results of the interviews, many participants do not know much about the STEM or have incomplete and incorrect information. As such, the STEM awareness of the participants is quite low. While many participants know STEM as a name only, others describe it as a method, tool or something new. In this case, STEM needs to be correctly defined in order for schools to be ready for STEM education.

Some quotes about the definition of STEM are below:

"I heard of STEM, but I didn't hear of STEM education." (T)

"STEM is something that many organizations do." (T)

"STEM is a learning method in the fields of science, technology, engineering and mathematics." (A)

"STEM means being prone to mathematics, physics, chemistry, biology and technology." (T)

"STEM is a system where all sciences are together." (T)

Theme 2: The need for STEM-integrated curriculum

One of the themes that emerged during the interviews was the need for a curriculum involving STEM. If the curriculum includes STEM applications, teachers will have time to apply them. In addition, as it will be in the curriculum, STEM applications will need to be assessed and perhaps an evaluation unit will be established in schools. In addition, students and parents will take this issue seriously and thus, interest in STEM will increase.

Some quotes about the need for STEM-integrated curriculum are below:

"As teachers, we have to follow a specific curriculum. So, the Ministry of National Education must prepare and plan a STEM curriculum to be integrated into STEM." (T)

"I don't think our education system is suitable for doing something directly related to STEM." (T)

"*Here, the time is not enough to encourage students to practice STEM applications." (T)*

"In order for unit and lesson plans to include STEM, curriculum should be prepared for STEM." (A)

"The current curriculum is not suitable for STEM because it has an approach that encourages students to memorize." (T)

Theme 3: University exam anxiety is an obstacle for STEM

One of the important issues seen as an obstacle for STEM education is the university entrance exam. Especially the 11^{th} and 12^{th} grade students' only focus is on this exam, as the participants said, there is no time to do something else for the students. Also, there are no demands from parents and students regarding STEM. Although it is not true, STEM is perceived by the participants as something new to do and this understanding is present in almost all participants.

Some quotes about this theme are below:

"*After the 10th grade, our students prepare for the university entrance exam only. They are not interested in STEM because they do not ask anything about STEM in the exam." (T)*

"In order to be successful in STEM education, the examination system must be changed. Teachers and students should be motivated, and STEM-related goals should be demonstrated." (A)

"All students' lives are based on exams. They just want to go to college." (T)

" *Since the aim of the student is to be successful in the university entrance exam, the courses are given as information load." (T)*

"The only thing the parents want is that their children have high grades and pass the university entrance exam." (A)

Theme 4: The need for budget and materials for STEM

Another theme that emerged as a result of interviews is the need for STEM budget. Stating that schools are actually physically suitable for STEM applications; the participants think that STEM is more feasible if the STEM budget is created and the necessary materials are purchased.

Some quotes from participants about this theme are below:

"The school does not have the appropriate resources for STEM. There are no resources available for the student's academic level." (T)

"There are no materials we can use for mathematics at school." (T)

"We have a lack of equipment. We can find budget not from the school but from some foundations when it is necessary for projects. Teachers sometimes pay to buy resources." (A)

"There is no budget for direct STEM education. There is a budget for projects and experiments, but not enough for students' needs." (A)

CHAPTER 5

CONCLUSION

The purpose of this study was investigating the readiness level of high schools in Ankara. STEM Framework prepared by NYCDOE (2015) was used to prepare interview questions. STEM education, which has been very popular in recent years, has its origins in the oldest and it first emerged in America. Today, STEM education, which is important in many countries from Europe to Austria, from New Zealand to India and in Europe, is also very important for our country. STEM education, which is an interdisciplinary approach, encourages students to think multi-faceted and analytical, while developing problem solving skills and providing lifelong learning.

The digital transformation that has continued in the world without slowing down, has also increased economic competition. In Turkey, in order for it to take part in this race, there is a need for sufficient numbers of qualified manpower. This need can only be achieved by acquiring and developing STEM skills in schools. In this context, as it is aware that STEM areas should be given importance in education, reports on STEM education are prepared and studies are carried out to encourage teachers and students to STEM. In this way, the need for qualified workforce can be met and innovation and productivity can be increased. STEM education can give us the chance to become one of the countries that determine the future if it is implemented effectively and appropriately.

In order for STEM education to be implemented in schools, schools should be physically; and administrators, teachers, students and families should be mentally prepared for this. Many factors, such as teacher training for STEM, appropriate classes and laboratories for STEM activities, curricula containing STEM, evaluation of practices and support of families on this issue, affect the readiness of schools. The most important thing is the creation of STEM awareness and the acceptance of the importance of STEM education by everyone.

In this context, this study was conducted to examine the level of readiness of high schools for STEM education. Four different high schools in Ankara were selected and the research started with interviews. Interview questions were prepared according to the NYCDOE STEM framework. After gathering the data and the thematic and content based analyzes, the following results were obtained:

- The readiness level of the normal high school is ‘emerging’ with 30 points, out of 100. Material inadequacies, a lack of demand for STEM from students and parents, exam-oriented education system and a lack of enthusiasm by teachers are the main issues that reduce the level of readiness.
- The readiness level of the industrial vocational high school is again ‘emerging’ with 44 points, out of 100. Students with low academic level, prejudices about industrial vocational high schools and communication problems between teachers are the main obstacles reducing the school’s readiness level.
- The readiness level of the private high school is ‘integrated’ with 60 points, out of 100. The IB program is the big chance for these kinds of schools because their missions and visions are similar to STEM.
- The readiness level of the science high school is again ’integrated’ with 62 points, out of 100. University entrance exam is again an important factor reducing the level of readiness.
- The overall average point of all schools is 49 and it means that; the readiness level of schools in Ankara is ‘emerging’. The point of level is actually closer to the boundary of integrated level but in order to get to the higher level, many arrangements need to be made.

The themes that emerged as a result of the research also support the low readiness level of schools. These themes are as follows:

- ✓ The need for knowledge and awareness of STEM
- ✓ The need for a STEM-integrated curriculum
- ✓ University exam anxiety being an obstacle for STEM
- ✓ The need for budget and materials for STEM

According to the results of this research, it is clear that; Ankara is not fully prepared for STEM education. In order to be ready, STEM awareness must be developed in teachers, students and also families. STEM should not be seen as a 'new practice or course' and should be integrated into the curriculum. Necessary materials, classes and laboratories should be provided for this education. Instead of an exam-oriented system that encourages children to solve multiple choice questions and memorize, an education system that supports experimenting, inquiry, making research and lifelong learning should be planned.

5.1. Implications for Further Studies

- The aim of the research was to investigate the readiness level of high schools for STEM education. In the future studies, readiness of pre-school groups, primary schools, secondary schools and universities can be examined besides high schools.
- This study was evaluated according to the results of interviews with teachers and administrators. In the future, the field of study can be expanded by interviewing with students and parents.
- The themes derived from this study may be useful for future STEM reports.
- The revised STEM framework for this study can be used for future studies.
- This research has given the literature an overview of the level of readiness of high schools. In future studies, factors such as teachers’ age, gender, financial status of the families that affect the level of readiness can be examined in more detail.

5.2. Implications for Practice

- According to the results of this study, high schools in Ankara are not ready for STEM education. It can be said that based on the opinions of teachers, the curriculum developers need to develop a new curriculum which is integrated with STEM for high schools.
- The new developing curriculum can include lessons-related specific objectives such as building a machine, creation of algorithms or designing models.
- In schools where STEM applications are performed, the effectiveness levels of the application of STEM can be evaluated by higher authorities.
- Budget-efficient and convenient lesson materials can be produced for schools to purchase easily.
- Seminars can be organized to give information to families about STEM education and to provide demand on STEM education.
- Trainings can be provided to educate and motivate teachers for STEM education.

5.3. Limitations

In this study, only teachers and administrators from 4 selected schools in Ankara were interviewed. So, the results may not be generalized for all high schools in Turkey. Also, only science and mathematics teachers participated in the study.

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APPENDICES

A. Human Subjects Ethics Committee Approval Form

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 / 145

27 ŞUBAT 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Dr. Gökhan ÖZTÜRK ;

Danışmanlığını yaptığınız yüksek lisans öğrencisi Ümran YİĞİT'in ***"Ankara'daki Okulların STEM Eğitimi için Hazır olup Olmama Durumlarının İncelenmesi"*** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-EGT-028** protokol numarası ile **01.03.2018 - 30.09.2019** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK
Üye

B. Research Permission

ÖİDB

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

Sayı : 14588481-605.99-E.9011683 07.05.2018

Konu : Araştırma İzni

ORTA DOĞU TEKNİK ÜNİVERSİTESİNE
(Öğrenci İşleri Daire Başkanlığı)

İlgi: a) MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2017/25 nolu Genelgesi.
b) 06/04/2018 Tarihli ve 1942 sayılı yazınız.

Üniversiteniz Matematik ve Fen Bilimleri Eğitimi Anabilim Dalı Yüksek Lisans öğrencisi Ümran YİĞİT'in **"Ankara'daki Okulların STEM Eğitimi İçin Hazır Olup Olmama Durumlarının İncelenmesi"** konulu tez çalışması kapsamında uygulama talebi Müdürlüğümüzce uygun görülmüş ve uygulamanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Görüşme formunun (5 sayfa) araştırmacı tarafından uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde bir örneğinin (cd ortamında) Müdürlüğümüz Strateji Geliştirme (1) Şubesine gönderilmesini rica ederim.

Vefa BARDAKCI
Vali a.
Milli Eğitim Müdürü

10. 05. 2018 – 8918

Güvenli Elektronik İmzalı
Aslı İle Aynıdır.
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Bilgi için: A.ARDA
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C. Domain Analyzes Tables

	DOMAIN 1.1 STEM Mission and Vision											
	Number of school members have heard of STEM before				Number of school members interested in STEM				STEM mission and vision of school			
	None of	Few	Some	All	None of	Few	Many	All	No	Developing	Almost Completed	Established
School 1												
School 2												
School 3												
School 4												

	DOMAIN 1.2 STEM-centric Culture															
	STEM-oriented studies				Classes/laboratories for STEM				Availability of interdisciplinary courses				Number of school members create suitable environment for STEM			
	No	Few	Some	All	No	Few	Some	All	No	Few	Some	All	None of	Few	Many	All
School 1																
School 2																
School 3																
School 4																

	DOMAIN 1.3 STEM Program Evaluation			
	Evaluation Process			
	No	Developing	Sufficient	Advanced
School 1				
School 2				
School 3				
School 4				

	DOMAIN 1.4 Budget/Management of Res.			
	STEM Budget			
	No	Insufficient	Sufficient	Fully Sufficient
School 1				
School 2				
School 3				
School 4				

	DOMAIN 2.1 Academic Rigor and Instructional Quality															
	STEM applications				Student-centered Instruction				Inquiry method usage				Suitability of teaching methods for STEM			
	No	Few	Some	Various	Never	Sometimes	Often	Always	Never	Rarely	Often	Always	No	Partially appropriate	Appropriate	Fully appropriate
School 1																
School 2																
School 3																
School 4																

	DOMAIN 2.2 STEM-centric Curriculum											
	Integration STEM into the courses				STEM content in curriculum				STEM application opportunities for students			
	Never	Sometimes	Often	Always	Never	Partially	Often	Always	Never	Sometimes	Often	Always
School 1												
School 2												
School 3												
School 4												

	DOMAIN 2.3 Authentic Assessment			
	Authentic assessment usage			
	Never	Sometimes	Often	Always
School 1				
School 2				
School 3				
School 4				

	DOMAIN 2.4 Staff Capacity											
	Teachers' experience and pedagogical knowledge in STEM content				Information sharing about STEM				School support			
	No	Insufficient	Sufficient	Professional	Never	Rarely	Often	Always	Never	Rarely	Often	Always
School 1												
School 2												
School 3												
School 4												

	DOMAIN 3.1 STEM Partnerships							
	Strategic Partnership				Cooperation with families, universities			
	No	Limited	Some	Effective	No	Limited	Some	Effective
School 1								
School 2								
School 3								
School 4								

	DOMAIN 4.2 Access to STEM college and career opportunities							
	Sources to inform students				Number of students have information about STEM opportunities			
	No	Limited	Some	All	No	Limited	Some	All
School 1								
School 2								
School 3								
School 4								

	DOMAIN 4.3 Planning Student Outreach			
	Provision of STEM guidance			
	Never	Rarely	Often	Always
School 1				
School 2				
School 3				
School 4				

D. Significant Statements and Meaning Units

Significant Statements	Meaning Units
* We have an astronomy club, but it is not a STEM study. * We have robotic club, astronomy club, 3D printer and studies related to electronics. Students are working together with their teachers on these issues after school. * The robotic club can do something in engineering. * While making the model for the course, they are unaware of the engineering perspective. * There are studies on project basis but not enough. * There are math and science clubs but not STEM purpose. * We are attending competitions in the field of mathematics, physics, chemistry and biology, not under the name STEM, we do projects. We have partnerships with universities and families. * Officially we don't have the STEM, but we do a lot of work as STEM	STEM connected studies are not mentioned as STEM
* The students' academic level is very low, so it is very difficult to use inquiry method in lectures. * We have illiterate students. * Students are missing some things from basic education. We have to complete it first. * Since the children are misguided until the 8th grade, the choices are wrong. * Because the academic level of students is very low, they cannot comment about concepts in the lessons. * Students are very indifferent. * Students are academically low-level because there is problem in the education system. * We cannot make projects because academic level is low.	Academically low-level and indifferent students

Significant Statements	Meaning Units
* I have heard STEM as a predisposition to mathematics, physics, chemistry, biology and technology * I don't know exactly what STEM stands for, but I know it's weighted in science. * STEM is a system in which collaborative studies on engineering and science are carried out. * STEM is a system where all sciences meet. * STEM does not sound like a foreign term. * STEM, method of education in science, technology, engineering and mathematics. * Active learning, learning by experience ... When STEM is mentioned, these are coming to my mind. * I heard that many institutions do STEM * I heard STEM as name, I didn't hear its education.	STEM cannot be identified by teachers and managers.
* Cooperation between teachers is entirely at their own initiative * STEM-related practices are entirely on the initiative of teachers * STEM is applied only for IB students. Because their teachers are more conscious * The services that the school provides to the teacher about STEM are very important * There is not much cooperation between teachers because of the curriculum. * If there are studies for STEM, there will be voluntary teachers. * Although we want to do a project, we have to go within the framework of a specific curriculum.	Teacher initiative is very important for STEM application.

Significant Statements	Meaning Units
* The curriculum is applied among the disciplines determined by the government. * As there is a public school, the curriculum is certain, we have the astronomy and space lesson only. * The curriculum needs to include STEM * Courses are not interdisciplinary except for group 4 project in IB program. * We had our engineering practice lesson, but it was removed. We do what the Ministry of Education says. * We cannot go beyond the framework of the national curriculum. * There is no practical and project-oriented study in the national curriculum. * We're schools that run within a certain system. There is no environment in which the STEM environment is established. * We have to implement the annual plan and it does not include STEM.	The national curriculum does not include STEM
* Our high school curriculum test and exam centered * In the 11th and 12th grade, the students' whole lives were centered on the exam. * After the 10th grade, a study is done for the university exam in schools. * In the 11th and 12th grades, the university concept is very important. * The curriculum contains too much things and we have a time problem. * All the students want is to prepare for university exam. * We are trying to guide students in order to win the university entrance exam. * The general organization of the education system is focused on winning the university entrance exam. * Students only want to pass the course, they do not think about their future.	Curriculum only prepared for university entrance examination.

Significant Statements	Meaning Units
* Our former alums come here and teach students about technology. * The tendency to engineering branches is too much. So, academics come especially from engineers for guidance. * The alumni association works very actively for out-of-school studies and job opportunities. * We communicate with universities, parents and engineers. Although not directly related to STEM, there are studies. * This school is a project school since it was founded. Joint projects are carried out with ODTU, Bilkent and TOBB.	Strategic partnerships in STEM related studies
* We have problems with STEM-related applications. * There is no widespread STEM consciousness throughout the school. * STEM applications are completely dependent on the teacher. * We implement STEM pseudo * Laboratories are for 20 people, but classes are for 34 people according to regulation, so it's hard to do experiments in the lab. * STEM is not on the agenda. * Although there are STEM applications at school, the number of participants is insufficient.	No STEM application in formality but there is in practice.
* There is no demand for STEM from parents. * We never talked to parents about STEM. * It is very difficult to share information with parents about STEM. There is very little participation in the meetings. * Parents and students have no concerns about STEM.	Indifference of parents

Significant Statements	Meaning Units
* Laboratories are not sufficient in engineering and advanced disciplines. * There is no exactly suitable environment. * We have a lack of material and information. * The budget is inadequate for the STEM. * Technological tools for STEM are missing. * We have no budget except for school council budget. * There is no STEM budget because there is no STEM. * Technological facilities are limited so STEM integration is difficult.	The materials and budget are not enough for STEM.

E. Themes

Meaning Units	Theme
The national curriculum does not include STEM No STEM application in formality but there is in practice Teacher initiative is very important for STEM application.	The need to STEM-integrated curriculum
Curriculum only prepared for university entrance examination. Academically low-level and indifferent students for STEM Parents are indifferent for STEM	University exam anxiety is an obstacle for STEM.
The materials and budget are not enough for STEM. STEM cannot be identified by teachers and managers. Schools have strategic partnerships in STEM related studies. STEM connected studies are not mentioned as STEM.	The need to budget and materials for STEM The need to knowledge and awareness of STEM

F. Interview Questions of Students

<u>1.1 STEM Misyon ve Vizyonu</u>

S: Daha önce STEM eğitimini duymuş muydunuz?

Okulunuzun misyon ve vizyonu arasında STEM eğitimi yer alıyor mu?

Bu misyon ve vizyonu okulun tamamı ya da her birimi paylaşıyor mu?

Okulunuz STEM okulu olarak mı kuruldu? Yoksa sonradan mı STEM okulu oldu? Eğer öyleyse bu vizyona nasıl sahip oldunuz?

<u>1.2</u> <u>STEM Merkezli Kültür</u>

S: Okulunuzda STEM e yönelik çalışmalar yapmak için ne tür kulüpler, organizasyonlar ve projeler yer almakta?

Okulun eğitim atmosferi STEM eğitimine uygun mu?

Dersler disiplinler arası mı işleniyor? Farklı disiplinlerdeki hocalar arasında işbirliği mevcut mu? Bunu nasıl sağlıyorsunuz?

Okuldaki derslerin işlenişi STEM eğitimine uygun mu? Proje tabanlı öğrenme, mühendislik uygulamaları gibi derler yer alıyor mu?

Derslere teknoloji entegrasyonu yapılıyor mu? Yapılıyorsa nasıl?

STEM eğitimine uygun şekilde dizayn edilmiş sınıflar, laboratuvarlar bulunuyor mu?

<u>1.3</u> <u>STEM Program Değerlendirme</u>

S: Okulunuzda STEM'in ne derece uygulanabiliyor ve bunun değerlendirilmesi nasıl yapılıyor? Bunun için bir birim var mı?

<u>1.4</u> <u>Bütçelerin/Kaynakların Yönetimi</u>

S: Okulunuzdaki STEM bütçesini oluştururken ne tür kaynaklara başvuruyorsunuz? Bütçeniz, öğrencilerin ihtiyaçlarını karşılamaya yetiyor mu?

Bütçeniz için destek aldığınız vakıf, bağış, fon ya da başla kaynaklar var mı?

2.1. Akademik Titizlik ve Öğretim Kalitesi

S: Okulunuzdaki öğrencileri STEM uygulamalarına teşvik etmek için ne tür uygulamalarınız mevcuttur? Bu uygulamalar kaç öğrenciyle sınırlıdır?

Derslerde sorgulama methodu kullanılıyor mu? Öğrencilerin derse aktif katılımı sağlanıyor mu?

STEM eğitim programınızın içerikleri neler? Öğrencilerin mühendislik alanında dizayn ve pratik yapma imkanları var mı?

Öğretim yöntemleriniz okulun STEM vizyonu ve misyonu ile uygun mu? Değil ise bununla ilgili ne tür çalışmalar yapıyorsunuz?

2.2.STEM Merkezli Müfredat

S: Öğrencilerin STEM i gerçek hayatta uygulamaları için onlara sunduğunuz imkanlar var mı? Varsa bu imkanlardan bahsedebilir misiniz? Yoksa bu konuyla ilgili ileriye yönelik planlarınız var mı?

Öğretmenler STEM programını derslerine nasıl entegre ediyorlar? Ünite ve ders planları STEM i içeriyor mu?

2.3. Özgün Değerlendirme

S: STEM programının okulunuzda uygulanışını değerlendirmek için STEM'e özgü bir değerlendirme kriteri var mı? Değerlendirme yönteminiz ne?

2.4. Personel Kapasitesi

S: Okulunuzda STEM uygulaması için yeterli sayıda öğretmen, çalışan var mı? STEM ile ilgili özel bir biriminiz var mı?

Öğretmenler STEM i uygulayabilecek şekilde mi seçildi ya da yeterliliklerinin sağlanması için tarafınızdan verilen destekler neler?

STEM programları ve fırsatları hakkında okul içinde ve dışında bilgi akışını nasıl sağlamaktasınız? Bununla ilgili özel bir biriminiz var mı?

3.1. STEM Ortaklıkları

S: STEM eğitimin daha güçlü hale getirmek için ne tür iş birlikleri sağlanmaktadır? (Aileler, üniversiteler vs.) Stratejik ortaklığa sahip olduğunuz kuruluşlar var mı?

Veliler ile STEM hakkındaki gelişmeleri paylaşmak için hangi yolları kullanıyorsunuz? (e-mail, toplantılar vb.)

4.2. Ortaokul ve Lise Öğrencileri için STEM Kolej ve Kariyer Fırsatlarına Erişim

S: Öğrencilerin STEM ile ilgili kariyer imkanlarından vs. nasıl haberi oluyor? Eğitimcileriniz ve STEM partnerleri arasında iş birliği var mı?

STEM'in önemini lise öğrencilerine ve ailelerine aktarmak için kullandığınız kaynaklar nelerdir?

S: Öğrencilerin STEM alanında rehberlik ve staj gibi imkanları nelerdir?

4.3. Öğrencinin Geleceğini Planlama ve K12 Öncesi İçin Destek

S: Öğrencilerin kapasitelerine ve ilgi alanlarına yönelik seçimleri yapılırken nelere dikkat etmektesiniz?

S: Öğrencilerin STEM ile alakalı yol çizmesine nasıl destek oluyorsunuz?