Examination of the attitudes of grade 7 and 8 students towards STEM education in Turkey and Ghana

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The purpose of this study is to examine the attitudes of middle school 7th and 8th grade students towards STEM education in Turkey and Ghana. The research was conducted to a total of 974 grade 7 & 8 middle school students (480 from Turkey-Mugla Province and 494 from Ghana-Accra Province) during the spring semester of 2018-2019 academic year. A quantitative research method was used in this research. The attitudes of the students towards STEM show statistically significant difference in each dimension depending on which country the schools are located. The study revealed that the students' attitudes towards STEM education were "positive". While there was no significant relationship between students' attitudes towards STEM and their gender and grade levels, there was a significant difference between their attitudes and the place where their schools were located.

Keywords: Ghana, gender, middle school, STEM education, Turkey

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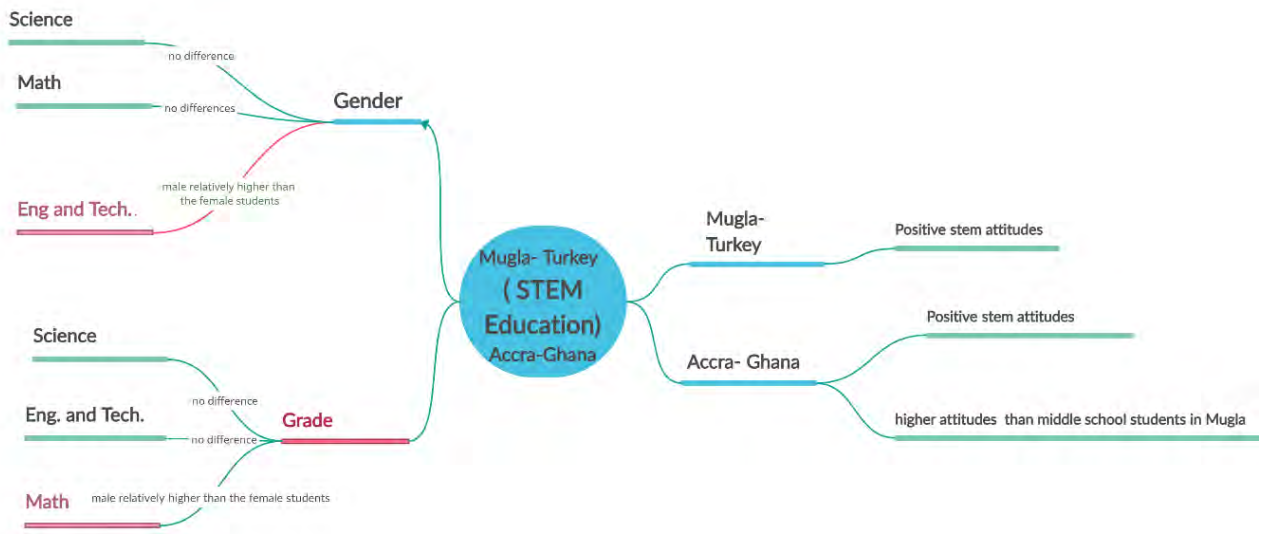

1 Introduction

The terminology "STEM education" refers to the integrated instruction and learning associated with the fields of science, technology, engineering, and mathematics, which usually involves instructional programs at all levels of education in both formal and informal classroom settings. The goal of the convergence of STEM disciplines is to improve the capabilities of students in the "four C's" of the 21st century: critical

thinking, creativity, communication, and Collaboration. STEM education aims at training students for the future and to help develop them into problem solvers who can participate in the architecture and manufacturing sector of any given economy. This educational approach contributes greatly to national economic growth, as students would be best trained to use high-level critical thinking skills. STEM Education was formulated by the National Science Foundation (NSF) and was initially referred to as Science, Math, Engineering and Technology (SMET) (Sanders, 2009). This educational approach was designed to enhance the creative, innovative, and analytical thinking ability of students to improve their levels of productivity. Furthermore, STEM education also has implicit (latent) goals and contributions. Students' career choice and the positive changes in their attitudes towards stem-related disciplines are among these contributions. Exposing students to STEM education enhances their awareness of their own learning abilities and may encourage girls to pursue STEM fields or occupations. (English, Hudson, & Dawes, 2011). Moreover, it was discovered that some of the students who previously believed that engineering was a masculine, or a male-dominated field began to believe that hat women could also be engineers after going through the STEM applications. The contribution of STEM applications to gender equality can be seen in some studies conducted in Ghana. According to Nyavor (2017), factors such as deeply established gender stereotypes, socio-cultural beliefs that girls cannot participate in STEM education and the inadequacy of citizens' awareness of the importance of STEM education are among the major barriers to girls enrolling in STEM education in Ghana.

STEM education is multidimensional and extends beyond the core areas that make up the STEM term. The basis of STEM education starts in childhood. From the early grades and through their play interaction and family settings, children interrelate with the universe in ways that will encourage science, technology, engineering, and mathematics-related literacy. STEM education can contribute to encouraging girls to learn and develop other skills, such as STEM literacy and math skills in low-income countries. In this respect, it may lead to further strengthening the education systems of these nations (UNICEF, ITU, 2020). Even though research show that professions related to mathematics and science are perceived as male-dominated occupations, mathematics in STEM content mostly shows that it has the strongest masculinity for both genders, followed by physics and chemistry (Makarova et al., 2019). In the study of Boateng & Gaulee (2019), the interviews conducted with female faculty members

specialized in STEM fields in universities in Ghana that revealed that despite the supports accessible to them, the gender differences perpetuated by patriarchy characterized these women's educational and professional experiences notwithstanding their achievement. Their gendered experiences in higher education were worsened by the fact that certain sources of support turned out to be sources of prejudice. This was due to the fact that as women advanced in the academic STEM field, they were seen as a menace to the patriarchal established order.

This study will provide an insight into, among other things, whether students' attitudes toward STEM differ significantly based on gender. Similarly, other studies in the literature suggest that students' attitudes towards STEM do not vary significantly among genders (Yenilmez & Balbağ, 2016; Karakaya & Avgın, 2016; Aydın et al., 2017; Balçın et al., 2018). Male students scored higher on mathematics attitude mean scores than female students (Alkan et all., 2004; Else-Quest et all., 2013; Kasimu & Imoro, 2017). STEM interests are fueled by a variety of factors. Middle school boys are more likely to want to pursue a STEM profession. Teachers and programs, on the other hand, can have an impact on a student's career interest. Applied scientific education activities also have a favorable impact on middle school female students' career interests in STEM fields (Christensen & Knezek, 2016). In OECD countries, twice as many 15-year-old boys than girls expect to work in professions such as engineering, scientist, and architecture. OECD adult skill survey results show that wages are highly correlated with career choice (OECD, 2017: 106). It is worth pointing that this situation may differ according to countries. There may be different motives for STEM education and career choice, and these grounds or rationales may also be flexible. Thus, although there have been some positive developments recently, Turkey has always scored below the OECD average in the fields of science and mathematics as shown in the 2003, 2006 and 2009 PISA report. The observed significant difference has neither increased nor decreased over the years (OECD, 2012). STEM education also helps in closing ethnic and gender gaps in math and science in countries like Ghana. There are initiatives to increase the roles of women and minorities in STEM-related fields. Although male students are more oriented to selecting careers in STEM-related areas, STEM studies and practices in Ghana and Turkey tend to yield positive changes in girls' attitudes towards STEM in terms of equal opportunities and may influence the girls' attitudes towards this educational approach. As a result, it is thought that it will be relevant to examine the STEM related attitudes in these countries. Succoring the youth towards defeating

their anxieties in relation to mathematics and improving their confidence in STEM related capacities will result in the youth choosing more of STEM-related careers and as such, to help in breaking traditional gender roles (OECD, 2017).

The proportion of women studying in fields of education considered as STEM areas in Turkey between 2014 and 2018 was 42% (UNESCO & IBE, 2017: 20). When this is examined more closely, it can be seen that while women are overrepresented in subjects like biology and health sciences, they are underrepresented in sectors like engineering and information technologies. Math and science are traditionally portrayed as more "masculine" subjects, while social sciences and arts are viewed as more "feminine," and the media, television, and film industries continue to use patterns to reinforce this perspective. The lack of female professionals in STEM fields is not due to lack of cognitive skills. On the contrary, the main factor that causes girls who want to study in the field of STEM and women who have graduated from STEAM fields to be excluded from this field may be the male-dominated understanding rooted in science and STEM education (Taş & Bozkurt, 2020). There is a similar negative situation in relation to the attitude of girls towards STEM in Ghana. This is largely influenced by values the girls or women in Ghana place in this area of study and the educational background of their parents. However, there is a clear indication that career development in Ghana depends on the power and values that both parents and society impose on girls from early childhood. In both Turkey and Ghana, there are some slogans for the girl child education. For example, "Send your daughter to school", as if it were only girls who should be sent to school. What about the boy? This question points to the fact that something is seriously wrong (Acheampong, 2014:34).

This study to also tends to examine the relationship between grade level and the attitudes the students portray towards STEM. The study will investigate whether there is a significant difference between these two variables, including whether the 8th grade students' preparation for the competitive and onerous high school entrance exam in Turkey creates a change in attitudes towards STEM. In the literature, there are findings pointing to the fact that there is a negative correlation between the STEM career interests of middle school students and their grade levels. Thus, STEM career interests of the students diminish as the progress in grade levels (Ergün, 2019). Science teaching and learning in Ghana starts at the first grade of primary education and greater emphasis is put on it in middle school. According to Ghana's strategic program for achieving scientific and technological literacy in the shortest possible time, one of the two main goals of the curricula developed over the years is to produce

competent professionals to conduct research at the highest level in various scientific disciplines. Then, it is aimed to train students in such a way that they physically explore and produce information through the interaction with their environment and activities conducted in laboratories (Ministry of National Education [MONE], 2016). In the middle school curriculum, a total of six class hours are allocated to science education (MONE, 2016). In addition, for the effective delivery of integrated science education in the 2013 middle school curriculum, it is recommended that each school should have science equipment and materials so that students can interact during integrated science classes (MONE, 2016). The launch of two main initiatives (projects) in Accra, Ghana, in cooperation with the ministry of education of the government of Ghana, to improve STEM education in Ghana can be seen as an advantage of Ghana in terms of stem education. Below is a brief information of the STEM education in both countries.

1.1 An overview of science and STEM education by the countries

Turkey

When the Turkish Science Curriculum of 2018 is examined, the importance of students experiencing science, technology, engineering, and mathematics as well as applications related to entrepreneurship is clearly stated. In this regard, it is aimed at supporting the students to establish the connection between engineering and science, to understand the interdisciplinary interaction and to develop their views about the world by applying what they have learned. It is said that the advancement in Turkey's scientific research and technological development capacity will intend increase the socio-economic development and competitiveness (MONE, 2016). Relating to the reform initiative in the curriculum, it was aimed to raise innovative individuals with advanced innovation skills, high scientific creativity, analytical thinking, qualification that can help students get themselves employed in the fields of STEM profession, and to achieve high potential power of the national economy in global competition. However, teachers have great responsibilities in integrating this interdisciplinary integrated educational approach into the teaching process. It is very important for teachers to acquire sufficient knowledge, skills, and equipment necessary for the STEM education approach, to have teacher guides, teaching materials, lesson plans that they can use during the teaching process in order to fully realize the STEM integration. Only a meagre percentage of Turkish students studying in private schools

meet international standards in STEM disciplines. School type is an important predictor of the success of STEM subjects of Turkish students (Alacaci & Erbaş, 2010). Private school students from Turkey continuously took place in the first 10 countries in International Mathematics and Physics Olympiad and this is a good performance. When the performances of private and public schools are analyzed separately, the results differ significantly in favor of Private schools, up to two standard deviations in mathematics and science performance (Berberoğlu & Kalender, 2005).

Turkey, as in other OECD countries, PISA (Program for International Student Assessment), TIMSS (International Mathematics and Science Study Trends) and PIAAC (International Assessment Program of the International Adult Competencies) the main objective of the international assessments such as the aforementioned is to evaluate ability of the education system of the countries in adapting to changes of the modern age and also to determine its success in raising the requisite human capital (TEDMEM, 2016). Students who are 15 years of age in OECD countries are evaluated in mathematics, reading and science fields in an International Student Assessment Program for every three years (PISA), Turkey's success in this assessment seems to be below the OECD average when examined. The recently announced results of PISA 2015 (OECD, 2017), according to which Turkey ranks 50th among 72 countries, thus, a down performance compared to previous tests. At the same time, according to the results of TIMSS (2015), among the 50 countries participated, while the grade 4 students in science were ranked 36th, the grade 8 students in science stood at 21st. This is quite engrossing for Turkey. The most interesting result is that the percentage of students who have been successful in science at level 6 since 2006 is 0% (Şirin & Vatanartıran, 2014). Turkey's failure to obtain the desired success in these exams can be explained by failure to fulfil the requirements of STEM education. However, just as any other country particularly among the OECD countries, Turkey is always in efforts to meet the requirements of STEM education and accelerate the success in the STEM disciplines.

Ghana

As the student population in Africa keeps growing, there is an increasing need for improved learning opportunities and access to higher education (Worldbank, 2014). The situation in Ghana: According to the Worldbank (2014), sub-Saharan Africa has underdeveloped research capacity within STEM. The report deals with research, skills and education demands, including STEM as a key socio-economic transformation and

poverty alleviation in Africa. In the fields of STEM, the enhancement of the standard of higher training will help millions of young people in Africa every year. In March 2014 the African Government and the ministers, including Ghana, agreed to adopt the "call for a joint action," which uses a strategy that will accelerate Aica towards an advanced knowledge-based society within a generation with strategic investments in science and technology. The Ghana Government introduced initiatives and services in the framework of curriculum reforms to improve and expand the practice of STEM, beginning from a basic level. The Ministry of Education and the Ministry for Environment, Research, Technology, and Innovation are required to introduce more science students to the country's education system.

Like in almost every country, scientific and technological innovations in Ghana play an increasingly important role in combating both the advantages and challenges of globalization, as well as of a knowledge economy. Students need to build expertise at a degree above what in the past was appropriate, using STEM education systems at excel in a modern knowledge-based and sophisticated technical environment. STEM education is thought to help close ethnic and sex differences in mathematics and science in a developing country such as Ghana. Traditional gender roles can be broken by STEM education through actions to increase women's and minority roles in STEM-related areas. STEM education and careers should be a national priority in order to compete in a global economy. In order to explain the effects, each decision can be used to one direction by STEM.

According to Opoku (2019), It is worth remembering that several decades ago Ghana took the STEM route. In the original aim for the establishment of what is now known as the University of Cape Coast, initially named as the University College of Science Education, which was to train science teachers for the country and also intended to add value to the primary commodities produced by industrialization, speaks to the prime given by the STEM subjects over 50 years ago. There is a university of science and technology in the country known as Kwame Nkrumah University, which is to turn research and technical experience into relevant business applications. There are also several technical, polytechnical, technical and vocational universities. Such institutions provide sense to the expected broad application of mathematics and science to deepen education 's importance to national growth.

Centered on literature findings from the literature review conducted, attitudes of middle school students towards STEM education in Turkey and in a different country has not been revealed. In this context, the research is aimed at determining the

attitudes of middle school students towards STEM education in two countries, by comparing the similarities and the differences in terms of some variables, with the intention of filling the gap in the field. Accordingly, the purpose of this study is to comparatively examine the attitudes of 7th and 8th grade middle school students towards STEM education in Turkey and Ghana. Within the framework of this general purpose, answers to the following questions were sought:

- What is the attitude level of middle school 7th and 8th grade students towards STEM in both countries combined?
- Is there any significant difference between the attitudes of middle school 7 and 8 grade students towards STEM and gender in the two countries?
- Is there any significant difference between middle school 7 and 8 grade students' attitude towards STEM and their grade level?
- Is there any significant difference according to the attitude towards STEM of 7th and 8th grade students and the country variable where the school are located?

2 Method

2.1 Model of the research

In order to examine and compare the attitudes of middle schools' grade 7 and 8 students in Turkey and Ghana, quantitative a research method known as relational screening model was used. Relational screening is a research model designed to describe the existence of two or more variables and their level of variation as well as the degree of co-exchange between multiple variables as the model includes both correlation and comparison forms (Karasar, 2016). This research method was used because the research does not only intend to investigate the attitudes of the students towards STEM education, but it also aims at probing the relation between the students' attitudes and their gender, grade levels, and their location.

2.2 Sample

The universe of this study constituted middle school grade 7 and 8 students acquiring education in Mugla province of Turkey and in Accra metropolis of Ghana during the 2018-2019 academic year. As for the sample, the schools were determined by using random sampling method where a total of 974 students from 17 middle school affiliated to the ministry of education of the countries were reached. This numbers

consist of 480 students from 8 middle schools in Mentese District in Mugla of Turkey and 494 students from 9 middle schools in Ga West in Accra metropolis of Ghana as clearly illustrated in the tables below:

Table 1. Demographic information of the student of the sample.

Demographic features		**Turkey**		**Ghana**		**Turkey + Ghana**	
		N	%	N	%	%	%
Gender	Male	253	52,7	277	56,1	530	54,4
	Female	227	47,3	217	43.9	444	45,6
Total		480	100	494	100	974	100
Grade level	Grade 7.	303	63,1	258	52,2	561	57,6
	Grade 8.	177	36,9	236	47,8	413	42,4
Total		**480**	**100**	**494**	**100**	**974**	**100**

2.3 Data collection

As a data collection tool in this research, the scale developed for grade 4 to 12 students by Faber et all. (2013) in North Carolina State University Friday institute known as "STEM Attitude Scale" was used. The scale is a Likert type which is aimed at measuring the students' attitudes towards STEM and 21st century skills, as well as their interest in STEM fields. It is a 5-points Likert type and consists of mathematics, science, engineering, and the abilities of the 21st Century. Thus, the scale consists of the aforementioned four dimensions and thirty-seven items. Cronbach Alpha reliability coefficient values of the factors ranged between 0.86 and 0.89 and the Cronbach Alpha reliability coefficient of the scale (total) was calculated as 0.94 (Yıldırım & Selvi, 2015). In this study, the Cronbach Alpha reliability coefficients calculated for the sub-factors of the scale ranged between 0.82 and 0.89, and the Cronbach Alpha reliability coefficient of the scale (total) was determined as 0.91. While the measurement tool was administered in Turkish in Turkey, it was administered in English in Accra-Ghana using the original scale.

To determine whether the data obtained from the scale shows normal distribution, a single sample Kolmogorov-Smirnov test was applied, and the kurtosis-skewness values were interpreted by examining the histogram graph. Kolmogorov-Smirnov test indicates that the data do not follow a normal distribution since the `p` value is less than 0.050 (Df (974) = 0.52, p = 0.000).

2.4 Data analysis

Within the scope of the research, the data obtained from the scale were checked and the incomplete or erroneous collected data were extracted. The SPSS 25 statistical software was used in the analysis of the data. Whether the obtained data was suitable for analysis was checked. The data was then analyzed by using the non-parametric tests since the data did not exhibit a normal distribution trend. Since the scale used in the collection of quantitative data is 5 Likert, the scale options and scoring intervals used during the analysis of the data is illustrated in the Table 2 below:

Table 2. Scale options and score ranges in the evaluation of the data.

Options	Points awarded	Score range
I strongly disagree	1	1.00-1.80
I do not agree	2	1.81-2.60
undecided	3	2.61-3.40
I agree	4	3.41-4.20
Absolutely I agree	5	4.21-5.00

3 Results

Attitudes of middle school 7th and 8th grade students towards STEM

In line with the first research question, the finding as illustrated in the Table 3 below shows the general level of the attitudes of the students towards STEM in Turkey and Ghana.

Table 3. Attitude levels of middle school 7th and 8th grade students towards STEM.

Sub dimensions	**N**	**Average**	**Std. deviation**	**Minimum**	**Maximum**
Math	974	3.4258	1.02840	1.00	5.00
Science	974	3.6869	.79266	1.00	5.00
Engineering and Technology	974	3.6820	.82401	1.00	5.00
21st Century Skills	974	4.0763	.71266	1.00	5.00
Total Score of The Scale	974	3.7452	.59985	1.27	5.00

The above Table 3 illustrates the minimum and maximum scores, averages and standard deviations representing the levels of the attitudes towards STEM exhibited

by the students in the two countries including the whole scale and its sub-dimensions. This result demonstrated that students in both countries have very high attitudes towards STEM.

Students' gender and STEM attitudes

In line with the second research question, Mann-Whitney U-Test was used in order to determine the status of STEM attitude levels of the middle school students in relation to their genders. The findings obtained from the analysis are presented in the Table 4 below.

Table 4. Mann-Whitney U-test comparison results regarding STEM attitude levels according to gender variable.

	Gender	N	Average rank	Rank sum	U	Sig. (p)
Math	Male	444	488.91	217074.00		
	Female	530	486.32	257751.00	117036.000	.886
	Total	974				
Science	Male	444	480.29	213248.50		
	Female	530	493.54	261576.50	114458.500	.464
	Total	974				
Engineering and Technology	Male	444	558.98	248188.50		
	Female	530	427.62	226636.50	85921.500	.000
	Total	974				
21st Century Skills	Male	444	470.28	208806.50		
	Female	530	501.92	266018.50	110016.500	.080
	Total	974				
Total Score of The Scale	Male	444	504.06	223803.50		
	Female	530	473.63	251021.50	110306.500	.093
	Total	974				

As it is seen in Table 4, when the findings obtained from the scale are examined, it can be seen that there is no significant difference between students' STEM attitudes and their genders [t (974) = .093, p> .05]. When the sub-dimensions are analyzed, the attitudes of the students towards STEM show a statistically significant difference only in the engineering dimension as far as their genders are concern. When the mean scores as seen in the table are observed, the male students have relatively higher attitudes in engineering dimension than the female students (558.98> 427.62). In

summary, there was no significant difference between students' attitudes towards STEM and their gender except for the "engineering" component in the two countries combined.

Attitudes towards STEM of 7th and 8th grade secondary school students in Turkey and Ghana

In line with the third research question, Mann-Whitney U-Tests were used for non-parametric independent measurements to examine whether students' scores from four different dimensions of STEM attitude scale make a significant difference in relation to the grade level of the students. The findings are presented in the Table 5 below.

Table 5. Mann-Whitney U-test comparison results regarding STEM attitude levels according to the class variable students read.

	Class	N	Average Rank	Rank Sum	U	Sig.(p)
Math	Grade 7	561	505.82	283764.50		
	Grade 8	413	462.62	191060.50	105569.5	.018
	Total	974				
Science	Grade 7	561	490.67	275266.00		
	Grade 8	413	483.19	199559.00	114068.0	.682
	Total	974				
Engineering and Technology	Grade 7	561	493.18	276676.50		
	Grade 8	413	479.78	198148.50	112657.5	.462
	Total	974				
21st Century Skills	Grade 7	561	504.85	283220.50		
	Grade 8	413	463.93	191604.50	106113.5	.025
	Total	974				
Total Score of The Scale	Grade 7	561	502.62	281970.00		
	Grade 8	413	466.96	192855.00	107364.0	.051
	Total	974				

As it is observed in Table 5, when the findings obtained from the analysis results of the scale are examined, it can be noticed that there is no significant relationship between students' STEM attitudes and their grade levels [N (974) = 0.051, p> .05]. When all sub-dimensions are examined with the help of Mann-Whitney U analysis, it

can be understood that students' attitudes towards `mathematics` and `21st Century Skills` dimensions show a statistically significant difference in relation to their class levels with sig. values of .018 and .025 respectively. When the rank average scores are examined as in Table 5, 7 grade students in mathematics have higher (505.82> 462.62) attitudes than 8 graders. It was determined that there was no significant difference between students' attitudes towards STEM and their grade levels as far as the other sub-dimensions and the scale are concerned. However, despite no significant difference between the grade levels in terms of their attitudes, students in the higher grade relatively demonstrated less positive attitude towards STEM.

Attitudes towards STEM of 7th and 8th grade students in Turkey and Ghana

In line with the fourth research question, Mann-Whitney U-Test was applied in order to determine the status of the students` attitudes STEM according to the geographic location of the schools (country) variable and the findings obtained as a result of the analysis are presented in the Table 6 below.

Table 6. Mann-Whitney U-test comparison results regarding STEM attitude levels according to country variable.

	Country	N	Average rank	Rank sum	U	Sig. (p)
Math	Turkey	480	240.72	115545.00	105.000	.000
	Ghana	494	727.29	359280.00		
	Total	974				
Science	Turkey	480	407.89	195787.50	80347.500	.000
	Ghana	494	564.85	279037.50		
	Total	974				
Engineering and Technology	Turkey	480	423.41	203238.00	87798.000	.000
	Ghana	494	549.77	271587.00		
	Total	974				
21st Century Skills	Turkey	480	420.15	201670.50	86230.500	.000
	Ghana	494	552.94	273154.50		
	Total	974				
Total Score of The Scale	Turkey	480	318.95	153095.50	37655.500	.000
	Ghana	494	651.27	321729.50		
	Total	974				

When the findings obtained from the scale are examined, as can be seen in Table 6, it is obvious that there is a significant difference between students' STEM attitudes and from which country their schools are situated [t (974) = .000, p <.05]. When the sub-dimensions are analyzed, it can be seen that the attitudes of the students towards STEM show a statistically significant difference in each dimension depending on which country the schools are located. From Table 6, when the average scores of the students in the two counties are compared, it can be understood that the middle school students in Ghana seem to have exhibited higher attitudes than the middle school students in Turkey in each and every sub-dimension.

4 Discussion

When the findings related to the first research question of the study were examined, the middle school 7 and 8 grade students towards attitudes towards STEM were determined. Considering the literature available peculiar to the topic in question in Turkey as well as on international basis, the number of studies designed to assess students' attitudes towards STEM is increasing day-in-day-out. However, the same cannot be said for Ghana. In this study, firstly, the attitudes of middle school students towards STEM and whether they are related to various variables were examined. According to the descriptive results obtained, the attitudes of middle school grade 7 and 8 students in both counties combined towards STEM and science, mathematics, engineering, and technology, and 21st century skills were generally at the level of "I agree" which means they generally showed a positive attitude. There are researches that depict some level of similarities in terms of result such as Aydın et all. (2017) and Balçin et all., (2018). When the attitudes of students towards STEM on the basis of factors, the 21st century. It was determined that their attitudes towards skills component were more positive than other components. However, on the basis of the sub-dimensions, the highest attitude level demonstrated by the students was towards 21st century skills. The positive attitudes showed by the students in the two countries implies that STEM education could be implemented in these countries with relative ease.

When the findings related to the second research question of the study were analyzed, it was understood that there was no significant difference between the students' attitudes towards STEM based on their gender except for the "engineering" component. The results of the studies such as Yenilmez & Balbağ (2016), Karakaya & Avgın (2016), Aydın et all. (2017), Toma & Greca (2018), Balçın et all. (2018), and

Özyurt., Kuşdemir & Başaran (2018) are similar to this result, in which the students' attitude towards STEM scores did not change significantly depending on gender. Based on the averages taken in this study, it was found that male students' attitudes towards STEM were higher than female students, although no significant difference was found in terms of gender. In the study carried out in both countries in the same time period, positive perceptions towards FETEM education help to close the ethnic and gender gaps in mathematics and science in underdeveloped countries such as Ghana. Studies on STEM can serve to increase the roles of women and minorities in Ghana. In this context, STEM education can break traditional gender roles.

From analyzing and examining the sub-dimensions of the scale, it was understood the attitudes of the students towards STEM showed a statistically significant difference in the engineering dimension depending on their gender and this difference was in favor of male students. A similar was attain by Yenilmez and Balbağ (2016), in their study conducted to prospective science and math teachers in which they found that there was a significant relationship between teacher candidates' attitudes towards engineering and their genders. In relation to this significant relationship, it can be said that male teachers' attitudes towards engineering and technology dimension are relatively more positive than female candidates. Similarly, Ergün (2019) and Balçın et all. (2018), conducted to middle school students, although there was no significant difference between students' attitudes towards engineering component and their gender, male students were determined to be relatively more positive than female students. There are some other studies similar to this result obtained from this study in the literature. For instance, the fact that male students have a higher attitude in the engineering part of STEM applications (Mahoney, 2009 and Unfried, Faber, & Wiebe, 2014) are found in the literature. There is no clear or easy answer to complex questions regarding gender disparities in science and mathematics research literature on whether and when (in the life span) there are disparities between females and males in cognitive abilities required for good STEM careers. The Research literature specifically addresses questions about the extent to which gender differences can be attributed to "innate" explanations, socialization, or how these two types of influences interact with each other. Inquiries about the ways in which males and females vary are contentious, as findings can have consequences for public policy and the way people think about schooling, job decisions, and "normal" positions for males and females in society (Halpern et all., 2007).

The reason for this may be due to the fact that girls tend have less advantage in designing new products, creating and repairing things, dealing with machines and electronic gadgets and seeing themselves insufficiently acquainted with engineering and technology related areas. There is ample evidence of major gender disparities in academic achievement in countries around the world. In particular, girls appear to have an advantage in reading achievement compared to boys, whereas boys have traditionally had an advantage in mathematics and science. Girls have been narrowing the gaps in these fields of study in many countries, but current evidence from the Southern and Eastern Africa Consortium for Educational Quality Monitoring (SACMEQ) appears to suggest that these gender disparities continue unabated (UNESCO & IBE, 2017).

Furthermore, while there was no significant difference between the students` attitudes toward science and their genders, it was found that the attitudes of male students toward maths were relatively more positive than that of the female students with a slight difference in averages. Similar to this result were obtained from the researches of (Alkan, Güzel & Elçi, 2004; Else-Quest et all., 2013; Kasimu & Imoro, 2017), in which the average scores of the attitudes toward maths differ slightly in favour of the male students. In addition, although there was no significant difference between attitudes of the students toward science and their genders in this research, it was obtained that the attitudes of the female students toward science were comparably more positive. Parallel to this result was (Else-Quest et all., 2013; Anwar & Bhutta, 2014; Balçın et all., 2018), in which it was revealed that female students have a more positive attitude towards science. Additionally, further analyses determined that there is no significant relationship between gender and attitudes towards mathematics. Although there was no significant difference in terms of gender in this study, it was revealed that male students' attitudes towards STEM were slightly higher than that of female students. This situation is likely to change due to the trajectory taken by both countries in organizing STEM activities and engineering design programs for the female students.

When the findings related to the third research question of the study were examined, it was determined that there was no significant difference between the students' attitudes towards STEM and their grade levels. When the sub-dimensions of the scale were examined, it could be seen that students' attitudes toward STEM showed a statistically significant difference in the components of “math” and “21st century skills” in relation to their grade levels and this difference was in favor of 7

grade students. However, there was no significant difference between the other sub-dimensions (`Science` and `Engineering and Technology`) attitudes and the grade levels of the students, but the 7th grade students' attitudes were comparatively more positive than the 8th grade students`. This situation can be interpreted as that the students are more interested in the STEM fields at a young age or at lower grade level, and their level of readiness for these areas is higher than that of advanced or high-grade students. When related literature is examined, it was found that there are results parallel to this study. Such as Mahoney (2009), Unfried, Faber and Wiebe (2014), Aydın et all. (2017) in which this result coincides with the result of their work. In addition, similar result was obtained from the examination of the TIMSS 2015 exam results where students tend to love and do better in math and science area during their lower ages or lower grade levels.

When the findings related to the fourth research question of the study are analyzed, a statistically significant difference was seen in both the overall scale and sub-dimensions relating to the students' attitudes towards STEM and the country variable. Students in countries where the STEM attitude scores (province) compared, according to Turkey (in Mugla) from learning students STEM attitudes within view, Ghana (in Accra provinces) have also been found to be lower than the attitude STEM students who were studying. When the sub-dimensions of the scale were examined, it was seen that STEM attitudes of students showed a statistically significant difference in all sub-dimensions depending on the provinces where the school is located, and this difference was in favor of the students in Ghana (Accra).

After analyzing the relevant literature related to this topic, although a parallel study that matches this result (a study comparing the attitude of students in two different provinces in two countries) was not found, the reason for this result could be the fruition of the initiation of two projects in implementation by the government of Ghana in collaboration with the ministry of education to improve and spread STEM education in Ghana, especially in Accra. The aforementioned projects include: 1. the construction of 16 school based interactive STEAM centers worth approximately 88 million cedis, which will provide practical approaches to high school learning and enrich the academic content offered by formal education in STEM. 2. the 76-million-pound Basic Science Mathematics Technology Engineering and Mathematics (BSTEM) program for the delivery and installation of BSTEM equipment to improve the quality of science and mathematics education within the middle education system in Ghana. As a result of these projects, many workshops have been held with both

science teachers and students and as a result, it is thought that students develop a more positive attitude towards both STEM and its activities. However, due to the fact that grade 8 is the final grade of middle school in Turkey, in order for students to be qualified to make a transition from middle school to high school, they are obliged to undertake a major examination, and this could be a contributory factor for the difference between the two countries.

Beside its strengths, the study has some limitations too: In order to better implement STEM education in the two countries particularly Ghana, government and other interested stakeholders should ensure the equipment of schools and students with the necessary technologies and laboratories to support the fully implementation of the STEM approach in schools which could intend affect student attitudes towards STEM education more positively. Another limitation is: Quantitative research method had been used to investigate students' attitudes toward STEM education, however, future similar researches that will intend to study students' attitudes toward STEM could include different research methods such as qualitative research method and comparative analysis in order to improve the reliability and reality. Also, instead of selecting Mugla province to be compared with Accra a capital city of Ghana, ultra-urbanized provinces like Istanbul or Ankara could be chosen by future researchers on the same topic to determine whether that will make a difference or not. Lastly, this study involved middle school grade 7 and 8 students. However, future similar researches in both Turkey and Ghana could be conducted to students at all grade levels from pre-school up to tertiary education.

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