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Abstract

The aim of this study is to determine the academic achievements of 8th graders in mathematics and science courses and STEM skill levels. The research has been carried out with the survey model. The sample of the study consists of 251 8th grade students in the 2020-2021 academic year. Math and Science academic achievement tests and STEM skill levels scale was used for data gathering. The scores obtained within this framework have been analyzed using arithmetic mean, standard deviation, t and Pearson r correlation and regression analyses. As a result of the research, we have reached that the means of the students in science and mathematics courses are similar and low. STEM skill levels of male and female students have been found to be similar in terms of science, mathematics, engineering, and technology factors, but male students are more successful than female students in both math and science courses. It has also been found that STEM skill levels influence students' math and science academic achievements, and STEM skill level perceptions influenced students' math and science achievements.

Introduction

The Program for International Student Assessment (PISA), organized every 3 years by the Organization for Economic Cooperation and Development (OECD), is a program preferred by countries. A total of 600,000 students from 79 different countries participated in this program in 2018 (OECD, 2018a). The purpose of participating countries in this program is to increase their own reputation, to see the quality of education evaluated by an independent organization, and to contribute to their literacy in the fields of mathematics and science (Yıldırım, 2021). Turkey did not participate in the first program but participated in the second program in 2003. Since Turkey has implemented the projects of the International Association for the Evaluation of Educational Achievement (IEA), it has not been able to participate in the first implementation of the program. However, Turkey was able to participate in its second application in 2003 with 4,855 students (MONE, 2005). The results of the program conducted in 2018 were declared and students of OECD countries revealed a basic level of proficiency in the field of mathematics and science (OECD, 2018a). The OECD mean for mathematics is 76% for level 2 and above, and 11% for level 5 and above. The science course mean is 78% for level 2 and above, and 7% for level 5 and above. The mean literacy score was 77% for level 2 and above, and 9% for level 5 and above (OECD, 2018b). Turkey has remained below the OECD mean in all three areas of mathematics, science, and literacy. The mean level of mathematics in Turkey was about 63% for level 2 and above, and 5% for level 5 and above. The science mean was about 75% for level 2 and above, and 2% for level 5 and above. The mean literacy rate was about 74% for level 2 and above, and 3% for level 5 and above (OECD, 2018b). This result suggests that students in the 15-year-old age group at the secondary and high school levels need a different teaching approach.

Students in the age group of 15 also participate in the "Central Examination on Secondary Education Institutions" conducted by the Ministry of National Education (MONE) in addition to these international exams, and the number of students participating in the exam varies by year. The number of students who took the exam in 2019 and 2020 was 1,029,555 and 1,472,088, respectively, and the participation rates were determined as 85.08% and 88.08% (MONE, 2019b, 2020). Students answer 20 questions in the science, mathematics, and Turkish courses, and 10 in the history of Turkish Republic of Revolution and Ataturkism, Religious Culture and Moral Knowledge, foreign languages courses (MONE, 2019b, 2020). The correct answer means of the courses are published in the evaluation reports of the exams. The means in the 2019 report were 9.97 in science and 5.09 in mathematics, while the means of other courses were 11.75, 6.88, 6.83 and 4.65, respectively. The means in the 2020 report were 10.2 in science and 4.39 in mathematics, while the means of other courses were 10.00; 5.05; 6.39 and 3.53, respectively (MONE, 2019b, 2020). Compared to the means of 2019 and 2020, there is an increase in science, while there is a decrease in mathematics and other courses.

Compared to the PISA and high school transition exam results, they were found to be the high school transition exam (Central Examination on Secondary Education Institutions) conducted in 2018 and 2019 included 2 of the math questions, 1 of the PISA proficiency levels, and 1 of the PISA proficiency levels (Öztürk & Masal, 2020). The two examination systems are evaluated when together, it is seen that the academic achievement of the students of the 15th age group in Turkey is low. Turkey's mean in the PISA exam remains below the OECD mean and there is a mean decrease in the high school transition exam (OECD, 2018b, MONE 2019b, 2020).

Students after 12 years of compulsory education, attend the Higher Education Institutions Examination (YKS) conducted by the Center of Student Election and Settlement (ÖSYM) when they want to study for a bachelor's degree. 2,296,137 candidates participated in the YKS, Basic Proficiency Test (TYT) session held in 2020 (ÖSYM, 2020). As we look at the results that are reflected in the 12 years of training of these candidates, it is seen that Turkey's overall academic success is low. The mean number of correct answers in Turkish (40 questions), Social Sciences (20 questions), Basic Mathematics (40 questions) and Science (20 questions) is calculated as respectively 18.23; 9, 13; 7.0 and 3.76 (ÖSYM, 2020). The fact that the mathematical and science achievements of individuals who will be trained in specialization in their professions are low in this way suggests that a different teaching approach is needed in 12 years of education for the future of the country. The 12-year education process has been modeled on other countries, but it is necessary to take the quality of their education as an example rather than just modeling the duration of the education (Babadağ & Sarıbaş, 2015). Education is vital in creating qualified human resources. In other words, quality education means quality graduates (Suratno, Wahono, Chang, Retnowati & Yushardi, 2020). The reason why the future of countries is associated with mathematics and science is because it is necessary for citizens to understand the scientific and technical problems affecting their lives (Matthews, 2007). Educational programs in Turkey were changed in 2018. It has been determined that there is no interdisciplinary interaction in the curriculum and that the course hours and programs are inflexibly the result-oriented and the implementation parts are inadequate (Akgündüz et al., 2015). However, with the change approved by MONE (Ministry of National Education) in 2018, new curriculums were created in an integrated structure that attaches importance to individual differences, values and skills rather than simply conveying knowledge in order to educate individuals with 21st century skills. (MONE, 2018a, 2018b). The integration of curriculums between disciplines is seen as important in order to give students skills in line with their abilities. Countries such as the USA, Japan and UK use STEM education in their education systems and these countries' PISA and TIMSS results have increased (Sakarya, 2015).

In the 1990s, the acronym "SMET" was used by The National Science Foundation [NSF)] to refer to "science, mathematics, engineering and technology" (Sanders, 2009). However, Judith Ramaley, (2001) a former employee of the NSF, changed to "STEM" for the first time. (Ref: Breiner, Harkness, Johnson, & Koehler, 2012). But STEM education has a long history of launching Sputnik, the first Russian artificial satellite, into space in 1957, which shocked many states, especially the USA. According to Mervis (2010), the Sputnik crisis was described as the second STEM crisis, and the first was in the war, the invention of nuclear weapons of mass destruction and the establishment of the NSF were at stake with World War II. Technological developments in this period were important for reflecting countries. Atomic bombs, synthetic rubber, various means of transport indicated that the United States was a developing country. However, in the case of Sputnik, many countries, especially the United States and the United Kingdom, realized that they were lagging in STEM fields. The National Aeronautics and Space Administration (NASA) was established in the U.S. in 1958 and was responsible for many STEM education initiatives (White, 2014). STEM education has been an interdisciplinary and practice-oriented teaching approach and science, technology, engineering, and mathematics disciplines must be integrated (Akgündüz et al., 2015). STEM education congregates different disciplines to ensure meaningful learning, connecting real-life knowledge with learned knowledge. Therefore, meaningful learning is provided by a STEM program integrated into the courses (Yıldırım & Altun, 2015). Integrative STEM education increases students' achievements and keeps their interests and motivations high. A meta-analysis study by Becker and Park (2011) on how STEM with an integrative approach an impact on students' learning has, has concluded that the integrative approach improves student achievement. It is observed that students' interest in science and mathematics decreases at an early age in schools using traditional education methods, and therefore they move away from the two important disciplines of STEM education (Sanders, 2009). If the course activities are not organized to meet the needs of the students, if new strategies are not developed, it is seen that the participation in the course decreases with the internal motivation of the students (Akbaba, 2006).

The main purpose of STEM education is to provide students with the necessary knowledge in mathematics and science courses, while also gaining skills such as problem solving, critical thinking, creativity, and collaboration (Acar, Tertemiz & Taşdemir, 2019). "The Partnership for 21st Century Learning (P21)" is an organization that defines the integration of 21st century skills into education in the United States (P21, 2019). While mathematics and science are key subjects, creativity, critical thinking, communication, and collaboration are among the important skills for learning and innovation. Therefore, it is necessary to ensure that 21st century skills aimed at practice and learning are included in the 21st century curriculums (P21, 2019). STEM education aims to enable the integrated branches of mathematics, science, technology, and engineering to be practiced in everyday life situations and to use students' theoretical knowledge in related fields (Yıldırım & Gelmez-Burakgazi, 2020). Research conducted by Acar and others (2019) found an association between students' mathematical achievements, science achievements and problem solving skills. Since STEM education is an integrated approach, success of students in both mathematics and science courses has increased. A study with 6th grade students conducted by Ergün and Balçın (2019) concluded that problem-based STEM activities increase students' achievements. Ceylan (2014) created the teaching design for acid and bases on the basis of STEM in an experimental study with 8th grade students and found that the academic achievements, creativity and problem solving skills of stem-based students increased more. An experimental study by Çakır and Ozan (2018) concluded that STEM activities further increase the success of math classes for 7th graders. In the semi-experimental study carried out by Yildirim and Selvi (2017) in 3 stages, it was concluded that STEM activities increase the academic achievement of 7th grade students in science course.

Many studies in this field reveals the necessity of STEM education. (Akgündüz et al., 2015; Altunel, 2018; Ayverdi & Öz Aydın, 2020; Çolakoğlu & Günay Gökben, 2017; PwcTürkiye & TÜSİAD, 2017). The disconnect between the skills that employers seek in their employees and the skills that employees acquire in school life reveals the necessity of STEM education and the current system does not reveal the skills needed. The trend towards STEM areas in Turkey is decreasing day by day. When the preferences between 2000 and 2014 were examined, the settlement rate of people who preferred STEM areas decreased from 85.63% in 2000 to 27.88% in 2010 and increased to 38.23% in 2014. (Akgündüz et al. 2015). According to these results, STEM-based education is a necessity for Turkey. In the so-called information age, these rates will be insufficient to meet the manpower the country needs. STEM education should be took part in the education system to help the country thrive and catch up with the age, and the next generation should be allowed to move to STEM fields. Studies on STEM should be carried out in the country so that social awareness should be raised, its applicability must be ensured, and it should be removed from being the subject of research only and a social renewal should be carried out in order to become a state policy (Akgündüz et al., 2015). The education system should be in a structure that teaches students to take responsibility, emphasizes the importance of solidarity, gives technological knowledge such as programming to students in the first years of their education, directs them to think and enables them to become entrepreneurs. If this structure cannot be created, it will not be possible to train individuals who master STEM disciplines and use their skills in these disciplines to develop products. Therefore, it will not be possible for Turkey to compete with other countries economically (Akgündüz et al., 2015).

Artificial intelligence, internet of things (IOT), intelligent life technologies, 3D design and production, space exploration, cyber security, virtual reality, augmented reality concepts are gaining importance and develops rapidly in these fields in this period called Industry 4.0 (Yıldırım, 2021). Due to the current developments, the importance of developing new methods and techniques related to education and to prefer school applications with an innovative approach suitable for the 21st century has increased even more (MONE, 2019a). Especially recently, STEM approach has become even more important. Because countries increase the quality of education by innovating in the fields of science, mathematics, technology, and engineering (Ulutan, 2018). The aim of interdisciplinary and application-based training is to prepare individuals for life. A real STEM education should increase students' understanding of how things work and improve their use of technology (Bybee, 2010).

Science centres and many projects contribute to STEM education in Turkey. Istanbul Aydın University's "STEM For Disadvantaged Students Especially Girls" project, Aziz Sancar's "Girls in STEM" project are examples of projects in the country (Ulutan, 2018). TUBITAK (The Scientfic and Technological Research Council of Turkey) has completed the centre of science projects in Konya, Kayseri, Kocaeli and Bursa provinces. The centre of science in Elazig, Gaziantep, Antalya (Kepez), Sanliurfa, Istanbul (Uskudar), Düzce, Denizli continue their projects Afyonkarahisar, Karaman and Tokat provinces also have science centre projects that are in the application period. The aim of the science centres here is to enable individuals of various age groups with different backgrounds to communicate with science and understand science and technology, to make science accessible to them, to increase the importance of science in society, to carry out experimental and practical activities to raise awareness in this field, to move children to try and explore (TÜBİTAK, 2019). TUBITAK makes important contributions to STEM education with these studies.

The training of teachers who will train individuals with 21st century skills is also important. Trained teachers will not be enough to train the STEM-educated individuals we need only if they have the knowledge to teach in their field (Çorlu, Capraro and Capraro, 2014). If the science teacher just teaches the science field and does not integrate technology, mathematics, and engineering into his courses, he cannot be a STEM educator, even though he's in stem. He is just a science teacher (White, 2014). What is expected of teachers is not to give theoretical knowledge in science, mathematics, technology, engineering courses, but to be a role model, to encourage students to think at a high level, to enable them to develop products, to reach the level of invention and innovation. (MONE, 2016). STEM education is thought to benefit this education needed. Education systems based solely on reading, writing and arithmetic will not lead individuals to success in tomorrow's technological world (Dugger, 2010).

In the literature, STEM education is seen to make significant contributions to the academic achievement of students. McClain (2015) when compared the math achievements of students who did not receive STEM education, it found that students who received STEM education were more successful. In their study He, Li, Turel, Kuang, Zhao and He (2021), gave 2 months of STEM education to kindergarten students aged 5-6 years old. At the end of this process, it was determined that the mathematical skills of the students improved. Dedeturk, Kırmızıgül and Kaya (2020) also concluded that STEM activities increase students' achievements. This study was carried out as a semi-experimental study with 6th grade students on the sound of science course. In the study carried out by Ercan and Şahin (2015) with 7th grade students, it was determined that design-based science course increases students' achievements. With their work, Yaki, Saat, Sathasivam and Zulnaidi (2019) aimed to determine the effects of an integrated STEM education on science success and to identify the change in students with different academic abilities. To this end, they worked with 100 Nigerian science students in the 11th grade. T was noted that the academic abilities of the 51 students in the experimental group were different. While the experimental group took courses within the scope of STEM education, the other group took courses in the traditional method and the experimental group students were found to be more successful in science. However, there was no significant interaction between the teaching approach and the students' different academic abilities, and students with low academic abilities were the group with the most gains. Siregar, Rosli, Maat, and Capraro

(2019) aimed to synthesize research on STEM education and mathematical success through their meta-analysis work. In this study, experimental research published in 1998-2017 was discussed. As a result of the study, STEM was found to have an impact on mathematical success, but they did not obtain data on STEM's impact on mathematical success in terms of education level, publication source and duration of the experiment. Likewise, Suratno and others (2020) found that in their study with middle school students, students' academic achievements improved as well as problem solving skills. When the studies are examined, it can be said that STEM education has a positive effect in increasing the academic achievement of students, as well as contributing to the development of 21st century skills such as problem solving and creativity. With this study, it was desired to determine the STEM skill levels of 8th grade students and the achievements of mathematics and science courses according to the renewed curriculum. In this context, the aim of the research is to examine the achievements of 8th grade students in mathematics and science courses within the framework of STEM skill levels.

Research Questions

Is there a correlation between the math and science course achievements of 8th graders and STEM skill levels?

- What are the perceptions of STEM skill levels and academic achievements?
- Is the perceptions of STEM skill levels and academic achievements differing according to the gender of the students?
- Is Stem skill levels have any impact on mathematics course success?
- Is Stem skill levels have any impact on science success?
- Is there a correlation between STEM skill levels and mathematics and science success levels?
- Does STEM skill levels predict their success levels of mathematics and science?

Method

Research Model

In this study, a survey model from quantitative research was preferred to determine the math and science achievements and STEM skill levels of 8th grade students. The characteristics of the situation experienced are determined and evaluated within the framework of the standards and possible relationships are determined in the descriptive studies. The purpose of this type of research is to define its relevant status, to explain it thoroughly (Çepni, 2012).

Participants

The participants of this research consists of 251 students, including 111 females and 140 males, who were in the 8th grade in the 2020-2021 academic year during pandemic. Convenience sampling method was used in the selection of students. First, 8th graders were reached through their teachers and asked to complete success tests with scale. For this purpose, teachers were contacted on social platforms and asked to provide a link to the data collection tool to 8th grade students. Then, a link was sent directly to the 8th graders from social platforms, and they were asked to provide this link to the 8th grade students they knew. Teachers and students who are communicated in daily life were also asked to forward the link to 8th grade students. This contributed to the distribution of the link to 8th grade students who were educated at the same school. Thus, 251 8th graders were reached.

Instruments

Mathematics Achievement Test

The mathematics achievement test was created from the subjects in the 1st semester of the 8th grade. These topics are: "multipliers and multiples", "exponential expressions", "squared expressions", "data analysis", "probability of simple events", "algebraic expressions and identifications". There are 27 objectives related to these subjects in the current curriculum of MONE mathematics course. In this study, 2 objectives related to probability were not included and a 25-gain test was created. There are 5 objectives related to probability. When asked each question about all 5 objectives it was thought that the question distribution would be more than the amount of question of the probability subject. Therefore, it was preferred that the two objectives at the basic level should not be included in the test. The item pool was selected among the questions that were previously used in the national exams held by MONE. 30 questions were determined considering the objectives from this question pool. This 30-question success test was finalized with the opinion of five primary math's teachers. Thus, a 30-question success test was developed to determine the 1st semester math achievement scores of the 8th graders who participated in the study. According to the results obtained from the study group of the achievement test prepared, Kr-20 value was determined as 0.95, mean of difficulty index was determined as 0.61 and the distinctiveness values of the questions were summarized in Table 1.

Table 1. Distinctiveness Index of the Items of the Mathematics Course Achievement Test

Item No	Distinctiveness	Item No	Distinctiveness
I1	0.5	I16	0.868
I2	0.809	I17	0.897
I3	0.706	I18	0.809
I4	0.721	I19	0.632
I5	**0.294**	I20	0.794
I6	0.632	I21	0.779
I7	0.853	I22	0.794
I8	0.765	I23	0.779
I9	0.735	I24	0.794
I10	0.706	I25	0.721
I11	0.721	I26	0.824
I12	0.632	I27	0.779
I13	0.809	I28	0.853
I14	0.794	I29	0.706
I15	0.721	I30	0.632

When Table 1 is examined, all questions except the 5. question, have a fairly good level of item discrimination, it is observed that the item 5 is very close to 0.3. Accordingly, it was not necessary to take questions from the academic achievement test. Accordingly, it is possible to say that the scale of students is valid and reliably measure the academic achievements for the objectives related to the first semester period of 8th grade.

Science Course Achievement Test

The test was formed by the subjects of the 8th grade. These topics are: "World and Universe", "Living Things and Life", "Physical Events", "Substance and Nature". MONE Sciences course is 36 objectives related to these issues in the current teaching curriculum. However, most of these 30 objectives are generally included in the 1st period. Therefore, the objectives following the 30th objectives were not used in this study. 5 of the 30 objectives in the 1st period were not included and a 25-objective science success test was created. It was preferred not to include these objectives in the test. Since the two objectives on acids are related to observation and taking precautions, the two objectives related to biotechnology are discussion and prediction and the objective related to adaptation is connected to observation and explanation and considering the distribution of questions of the subjects. The item pool was selected among the questions that were previously used in the national exams held by MONE. 30 questions were determined considering the objectives from this question pool. This 30-question achievement test was finalized with the opinion of two science teachers. Thus, a 30-question achievement test was developed to determine the 1st semester science achievement scores of the 8th grade students who participated in the study. According to the results obtained from the study group of the achievement test prepared, Kr-20 value was determined as 0.94, mean of difficulty index was determined as 0.60 and the Distinctiveness values of the questions were summarized in Table 2.

Table 2. Distinguishing Index of the Items of the Science Course Achievement Test

Item No	Distinctiveness	Item No	Distinctiveness
I1	0.632	I16	0.721
I2	0.750	I17	0.353
I3	0.735	I18	0.794
I4	0.721	I19	0.779
I5	**0.294**	I20	0.618
I6	0.779	I21	0.676
I7	0.794	I22	0.559
I8	0.824	I23	0.779
I9	0.809	I24	0.294
I10	**0.294**	I25	0.588
I11	0.779	I26	0.838
I12	0.809	I27	0.853
I13	0.779	I28	0.779
I14	0.765	I29	0.824
I15	0.794	I30	0.809

When Table 2 is examined, all questions except the 5.and 10th question, have a fairly good level of item discrimination, it is observed that the item 5 and 10th are very close to 0.3. Accordingly, it was not necessary to take questions from the academic achievement test and it can be said that the scale can measure the academic achievements of the students for the objectives of the 8th grade 1st semester of the science course in a valid and reliable way.

STEM Skill Levels Perception Scale

STEM Skill Levels Perception Scale", was designed by Korkmaz, Çakır and Uğur Erdoğmuş (2021). By this scale, it is aimed to determine the basic STEM skill levels of middle school students. The scale consisting of 23 items and 3 sub-factors is arranged in the type of 7 Likert. There is a rating of "1:I do not agree at all and 7: I strongly agree." 11 items in the science sub-factor have an internal coefficient of consistency of 0.899. There are 6 items in the sub-factor of engineering and technology and have an internal coefficient of consistency of 0.858. Finally, there is th6e 6-items mathematical sub-factor and has an internal coefficient of consistency of 0.800. The internal consistency coefficient value for the whole scale is also determined as 0.940. The KMO value calculated for 23 items and three factors is 0.960, and the values of the Bartlett test are $\varepsilon 2 = 5100.\ 5;\ df = 253;\ p < 0.001$. Factor loading of items have values between 412 and 0.638. The variance values explained by science, engineering and technology and mathematical factors are 22.67, 16.30, 13.2, respectively, and the total variance described is 52.23%. Correlation coefficients of the first factor range from 0.651 to 0.730, the second in the range of 0.681 to 0.759, and the third in the range of 0.632 to 0.747. Item differentiation values range from 13,123 to 22,753 and total item differentiation is 44,798. The distinguishing values of science, engineering and technology, mathematics sub-factors are 37,953, respectively; 31.593; 26,332.

Data Collection

The data was collected through the Google Form. In the first part of the form, some information about the content of the study is presented. It has been made clear that sincere answers are expected from students and that the data will not be used anywhere other than the study. In the following part of the form, there is a "demographic information" section, a "STEM Skill Levels Perception Scale" section, a "Math Success Test" section, and a "Science Success Test" section. The students completed the form by filling out these departments respectively.

Data Analysis

To determine whether parametric analyses can be performed on the collected data, it is analyzed whether the data is distributed normally, and the results are presented in Table 3. When Table 3 is examined, it is seen that the level of significant of the data collected for all three scales is less than 0.05, in other words, the data is not distributed normally according to the results of the Kolmogorov-Smirnov test. However, since the Skewness and kurtosis coefficients are examined, it is seen that these coefficients are between +1.5 and -1.5 and the data can be considered normal accordingly (Büyüköztürk, 2016). On the other hand, Levene's test was used to examine whether the variances were homogeneous, and it was seen that the variances were homogeneous as a result. The scores obtained within this framework have been analyzed using arithmetic mean, standard deviation, t and Pearson r correlation and regression analyses. Academic achievement test scores have been converted to a system of 100. In addition, according to the STEM total score, students are divided into three skill levels. When determining these levels, the highest score (23 items x 7 Likert) from the STEM skill levels scale has been calculated as 161, divided by 3 and a success interval of 54 points is determined. Thus, students with a score between 0-54 have been grouped as students with lower, 55-109 points, middle and 110-161 students with high-level STEM skills. However, this level is not participated in the analysis because the number of students at the lower level have been only 4.

Table 3. Normality Test Results

Factors		Kolmogorov-Smirnov (Sig.)	Skewness	Kurtosis
STEM Skill Levels	F1: Science	0.000	-0.621	-0.101
	F2: Mathematics	0.000	-0.943	0.752
	F3: Engineering and Technology	0.000	-0.710	0.257
	Total Points	0.003		
Mathematics Academic Achievement		0.000	-0.320	-1.447
Science Academic Achievement		0.000	-0.548	-1.219

Findings

Descriptive Findings

Students' perceptions of STEM skill levels are summarized in Table 4.

Table 4. Students' STEM Skill Levels

Factors		N	Low	High	M	SD	Low D	Mid DG.	High D
STEM Skill Levels	F1: Science	251	11	77	58.2	12.7	-	-	-
	F2: Mathematics		6	42	34.1	6.7	-	-	-
	F3: Engineering and Technology		4	42	30.5	8.2	-	-	-
	Total Points		23	161	122.7	25.9	4	72	175
Mathematics Academic Achievement			0	100	61.1				
Science Academic Achievement			0	93	60.1				

When Table 4 is examined, it is seen that the perception scores of the students regarding STEM skill levels ranged from 23 to 161 and the mean was 122.7. If examined in terms of their level, it is that only 4 of the students perceived their STEM skills as lower, 72 as medium and 175 as high level. When examined in terms of factors, it is seen that the mean in the science factor is 58.2, the mathematics factor is 34.1 and the Engineering and Technology factor is 30.5. Accordingly, it can be said that stem skill levels are high according to the perceptions of the students, 72 students perceive themselves at a moderate level and 175 students perceive themselves at a high level. When analyzed the academic achievements of the students, it is seen that the mean for the mathematics course is 61.1 and the mean for the science course is 60.1. It can be said that the means of the students in science and mathematics class are similar and low according to the results.

Changes in Term of Demographics

Students' STEM skill levels and academic achievements by gender are summarized in Table 5.

Table 5. Students' STEM Skill Levels and Academic Achievements by Gender

			N	M	SD	t	df	p
STEM	F1: Science	Female	111	58.1	13.0	0.027		0.978
Skill	F2: Mathematics	Male	140	58.1	12.7			
Levels	F3: Engineering and Technology	Female	111	33.8	6.6	-0.745		0.457
	Total Points	Male	140	34.4	6.7			
	F1: Science	Female	111	30.0	8.5	-0.766	249	0.445
	F2: Mathematics	Male	140	30.8	8.0			
	F3: Engineering and Technology	Female	111	121.9	26.0	-0.423		0.673
		Male	140	123.3	25.8			
Mathematics Academic Achievement		Female	111	54.1	29.3	-3.259		0.001
		Male	140	66.5	30.6			
Mathematics Academic Achievement		Female	111	56.2	28.6	-2.115		0.036
		Male	40	63.7	7.9			

When table 5 is examined, the mean of students' STEM skill levels in terms of total scores is 121.9 for females and 123.3 for males. In this case, it can be said that the mean of males is higher than the mean of females. However, there is no statistically significant difference between males and females *(t (251) = -0.423; p>0.05)*. It can be accordingly concluded that the STEM skill levels of the male and female students in terms of total score are similar. In the factor of science courses, the means of students' STEM skill levels were 58.1 for both females and males. It can be said in this case, that the mean of females is equal to the mean of males. There is no statistically significant difference between males and females *(t (251) = 0.027; p>0. 05)*. Accordingly, STEM skill levels of male and female students are similar in terms of science course factor. In the mathematical course factor, the mean of students' STEM skill levels was 33.8 for females and 34.4 for males. It can be revealed then that the mean of males is higher than the mean of females. However, there is no statistically significant difference between males and females *(t (251) = -0.745; p>0.05)*. Accordingly, STEM skill levels of male and female students are similar in terms of math course factor.

In the factor of engineering and technology, the mean of students' STEM skill levels was 30.0 for females and 30.8 for males. In this case, it can be said that the mean of males is higher than the mean of females. However, there is no statistically significant difference between males and females *($t_{(251)}$ = -0.766; p>0.05)*. Accordingly, STEM skill levels of male and female students are similar in terms of engineering and technological factors. As the academic achievements of the students are examined, it is reveals that the mean for mathematics course is 54.1 for females and 66.5 for males. It can be in this case, said that the mean of males is higher than the mean of females. It may be stated that there is a statistically significant difference between males and females in terms of mathematical academic success *($t_{(251)} = -3.259, p<0.05$)*. It can be thereby verbalized that male students are more successful in mathematics than female students.

The mean for science classes is 56.2 for females and 63.7 for males. In this case, it can be said that the mean of males is higher than the mean of females. There is a statistically significant difference between males and females in terms of science academic achievement *($t_{(251)} = -2.115, p<0.05$)*. Accordingly, it can be verbalized that male students are more successful in science class than female students. Since there are only 4 students with lower STEM skill level perceptions, this group was not included in the analysis when examining the effect of STEM skill level perceptions on math. The impact of STEM skill levels on math success of a total of 247 students at medium and high achievement levels is summarized in Table 6.

Table 6. Differentiation in Mathematics Academic Achievement of Students according to STEM Levels

		N	M	SD	t	df	p
Mathematical Academic Achievement	Medium	72	44.6	27.5	-5.946	245	0.000
	High	175	68.5	29.1			

When table 6 is examined, it is seen that the mean of 72 students with moderate STEM skill level perceptions is 44.6 and the mean of 175 students at the upper level is 68.5. In this case, it can be said that the mean of the group with high perceptions of STEM skill level is higher than the mean of the group with mid-levels. In terms of mathematical academic achievement, there is a significant difference between the group with a mid-perception of STEM skill level and the group with a high perception of STEM skill level *($t_{(247)} = -5.946, p<0. 05$)*. It can be worded thus that students with high perception of STEM skill level in mathematics class are more successful than students with mid perception of STEM skill level, in other words, STEM skill levels affect students' mathematical academic achievements. Since there are only 4 students with low STEM skill level perceptions, this group was not included in the analysis when examining the impact of STEM skill level perceptions on science. The impact of STEM skill levels of 247 mid and high level of students on science success is summarized in Table 7.

Table 7. Differentiation Science Academic Achievement of Students according to STEM Levels

		N	M	SD	t	df	p
Academic Achievement	Medium	72	43.2	27.8	-6.818	245	0.000
of Science Course	High	175	68.1	25.3			

When table 7 is examined, it is seen that the mean of 72 students with moderate STEM skill level perceptions is 43.2 and the mean of 175 students at the upper level is 68.1. In this case, it can be said that the mean of the group with high perceptions of STEM skill level is higher than the mean of the group with mid-levels. In terms of academic success of the science course, it is understood that there is a significant difference between the group with a mid-perception of STEM skill level and the group with a high perception of STEM skill level. As an academic success of the science course, it is revealed that there is a significant difference between the group with a mid-perception of STEM skill level and the group with a high perception of STEM skill level ($t(247) = -6.818$, $p<0.05$). Accordingly, it can be observed that students with high perception of STEM skill level in science class are more successful than students with mid perception of STEM skill level, in other words, STEM skill levels affect students' academic achievements in science.

Correlational Findings

The relationship between students' perceptions of STEM skill levels and their academic achievement levels in mathematics and science is summarized in Table 8.

Table 8. Relationship between Perceptions of STEM Skill Levels and Math and Science Achievement Levels

	Mathematical Academic Achievement	Science Academic Achievement
F1: Science	0.335(**)	0.346(**)
F2: Mathematics	0.459(**)	0.484(**)
F3: Engineering and Technology	0.391(**)	0.399(**)
STEM Perception Total Score	0.408(**)	0.423(**)

**p<0.01, N=251

When table 8 is examined, it is seen that the STEM skill level perception scale has a positively significant relationship with the science factor's mathematical academic achievement *(r = 0.335)* and science course academic achievement *(r = 0.346) (p<0, 05)*. It is also figured out this relationship is significant and positive between factors related to STEM skill levels and academic achievements in mathematics and science. Accordingly, it can be said that students' self-perception of STEM skills is associated with their academic achievements in mathematics and science courses in terms of both total and factor scores, and their academic achievements in mathematics and science courses increase as their perception of STEM skill levels increases. The procedure of mathematical academic achievement of students' STEM skill levels is stated in Table 9.

Table 9. Prediction of STEM Skill Levels to Mathematical Academic Achievement Levels

Variable	B	SE_B	β	$β^2$	t	p
Stable	1.749	8.582	-	-	0.204	.839
STEM Skill Levels Perception	0.483	0.068	0.408	0.166	7.058	0.000

R=0.408, R^2=0.166; F(1, 249)= 49.820, p=0.000; Y=1.749+0,483 STEM

When the results of regression analysis are examined in Table 9, it is seen that students' perception of STEM skill level explains 16% of the variance in math academic achievement scores $(F_{(1, 249)} = 49.820, p = 0.000)$. It may be expressed that the calculated value of $F = 49.820$ and its $p = 0.000$ significant level for the significant of the regression model are the same as the F value for the significant of the model in ANCOVA application, and the variance described by the regression model is equal to the variance described by the ANCONA model.

Accordingly, it can be said that the perceptions of the variable STEM skill level independent of the analysis are the drivers of the students' math academic achievement scores, in other words, they have an impact on the mathematical achievements of my students. The findings of students' perceptions of STEM skill level fatigue their academic achievements are figured out in Table 10.

Table 10. Prediction of STEM Skill Levels to Science Academic Achievement Levels

Variable	B	SE_B	β	$β^2$	t	P
Stable	3.387	7.906	-	-	0.428	.669
STEM Skill Levels Perception	0.464	0.063	0.423	0.178	7.368	0.000

R=0,423 R^2=0,178; F(1, 249)= 54,281, p=0,000; Y=3,387+0,464 STEM

When the results of regression analysis are examined in Table 10, it is seen that students' perceptions of STEM skill level explain 18% of the variance in science academic achievement scores *($F_{(1, 249)} = 54{,}281$, $p = 0{,}000$)*. It may be expressed that the calculated value of $F = 54{,}281$ and its $p = 0.000$ significant level for the significant of the regression model are the same as the F value for the meaningfulness of the model in ANCOVA application, and the variance described by the regression model is equal to the variance described by the ANCONA model. Accordingly, it can be mentioned that the perceptions of the variable STEM skill level independent of the analysis are the drivers of the students' science academic achievement scores, in other words, they have an impact on the students' science achievements.

Discussion, Conclusions and Recommendations

The aim of the research is to examine the achievements of 8th grade students in mathematics and science courses within the framework of STEM skill levels. Within the framework of this aim, the following results have been achieved: In terms of factors, the mean STEM skill levels of the students were 58.2, 34.1, 30.5, respectively, for science, mathematics, engineering, and technology. According to the perceptions of the students, STEM skill levels are high. Of the 251 students, 175 are at the top level, 72 are at the intermediate level and 4 are at the lower level. Korkmaz, Çakır and Uğur Erdoğmuş (2021) determined their STEM skill levels as relatively low in science and mathematics and engineering and technology in their scale adaptation study with 501 secondary school students. Adsay, Korkmaz, Çakır and Uğur Erdoğmuş (2020) found the STEM skill levels of middle school students as moderate in their study with 202 secondary school students. The results of the studies are supportive of each other. It can be said that the academic achievements of the 8th grade students in this study are similar and low in science and mathematics. STEM skill levels can be compared based on their differences in academic achievement by studying with another sample group. Korkmaz, Acar, Çakır, Uğur Erdoğmuş and Çakır (2019) carried out semi-experimental research in quantitative dimension of the study they carried out with mixed research method. The effect of Lego Mindstorms Ev3 based on educational robot sets activities on students' STEM skill levels and attitudes towards science course was determined. As a result of this study, it was found that the perception of STEM skills of the students in the experimental group increased more than the other group. On a factor basis, there was a significant differentiation in science, engineering, and technology factors except mathematics. Suprapto (2016) investigated Indonesian students' attitudes towards STEM. Mathematics is first, science is second, and then attitudes towards STEM has followed them. It was also found that there was a significant corral between attitude sizes towards STEM.

STEM skill levels of male and female students are similar in terms of science, mathematics, engineering, and technology factors. Their mean STEM skill level was 121.9 for females and 123.3 for males, but there was no statistically significant difference between males and females. In their study, Author. (2021) found that there was no gender difference in science, engineering, and technology factors, but that females in mathematics had a higher skill level than males. It can be said that this differences in mathematics may have been due to the student distributions in the sample. In their study conducted by Korkmaz, Çakır and Uğur Erdoğmuş (2021), females are 245 and males are 256. In this study, 111 of the 251 students are females and 140 were males. A study where the numbers of females and males are closer, this sub-problem can be re-evaluated.

When the academic achievements of the students were examined according to their gender, it was determined that male students were more successful than female students in both mathematics and science courses. It is seen that the means of mathematics and science were 54.1, 56.2 of females and 66.5 and 63.7 of males respectively, and this difference was found to be statistically significant. Ergün and Balçın (2019) found that problem-based STEM education improved students' achievements in an experimental study with 6th grade students, but although it affected females' achievements more positively than males' achievements, statistically no significant differences were found in students' achievements according to their gender. The study conducted by Ayaz, Gulen and Gök (2020) found that the use of e-portfolios in STEM education increased academic achievement, but no difference in students' achievements according to their gender. The research, conducted by Kulturel-Konak, D'Allegro, and Dickinson (2011), reviewed gender differences in learning styles and presented recommendations for STEM education. In this study, it was stated that STEM courses can be an obstacle for females because they prefer hands-on learning, while males prefer analytical thinking. Meadows (2018) examined the sense of STEM belonging of successful middle school students and found that there was no difference between males and females. Cahalan et al. (2000) examined gender differences in advanced mathematics and females are achieved more successful results than males. They found that the difference between females was greater in items that required spatial skills, shortcuts, or multiple solutions.

STEM skill level perceptions have an impact on students' math and science achievements. Students' self-perception of STEM skills is associated with their academic achievements in math and science courses in terms of both total and factor scores. In other words, as students' perceptions of STEM skill levels increase, so does their academic achievements in math and science. According to the results of their study with the 8th grade students of Kahraman and Dogan (2020), highly motivated students during STEM activities prove successful studies. Dogan (2019) exhibited the effect of STEM activities on students' scientific process skills, science attitude and STEM attitude and achievements in a mixed-method study with 7th grade students. According to the results of this study, the academic achievements of the experimental group students were found to be higher. Students have expressed that STEM activities increase their interest and knowledge of the course. As a result of the study carried out by Knezek et al. (2013), it was determined that in addition to understanding stem content knowledge, students also developed an improvement in their creativity, perception of STEM subjects and careers. Owston et al. (2020) aimed to determine whether there was a difference in performance and perception among students who received STEM education and did not receive STEM education. STEM students performed better, but they were also found to perceive lessons more negatively. When analyzed the results of the studies, the thoughts and feelings of the students affect the success of the course. Therefore, students' achievements vary depending on how they perceive stem skill levels. The success of the 8th graders in the study in mathematics and science is also rising as their perception of STEM skill level is found to be high. In this context, the following recommendations can be made:

- In order for STEM activities to be used more effectively in classes, teachers can be supported more in relation to STEM applications.
- Since there is a corral between students' academic achievements and STEM education, STEM activities can be included more in the courses to increase students' academic achievements.
- STEM skill levels affect students' math and science academic achievements. In both math and science courses, male students were found to be more successful than female students. Therefore, STEM activities can be carried out that will change females' perceptions to increase their success.

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