INTEGRATION OF STEM EDUCATION MODEL TO SCIENCE COURSE

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SUMMARY
The aim of this study is to examine the students' academic achievement changes and their affective attitude towards science, technology, engineering and mathematics by applying the subjects and gains included in the secondary school science curriculum to the STEM education model. For this purpose, 5th, 6th, 7th. STEM activity books were prepared and applied to 183 students according to 2015-2016 education 1st semester science curriculum and achievements. After the application in all classes, activity evaluation questions were applied and evaluated for each activity. STEM attitude scale was applied to all students in the form of pre-test and post-test. Based on this approach of STEM education model, the design of instructional design on the basis of STEM education in secondary school science course; the answer to the question of whether there is a change in students' academic achievement and attitudes. It is aimed to develop engineering thinking structures by engineering design and programming in STEM activities at a young age. As a result of the study, it was determined that students' interest towards science developed positively with STEM activities.

Key Words: STEM, Science, Engineering, Technology, Mathematics

INTRODUCTION
STEM; It is an interdisciplinary learning approach consisting of the initials of the words Science, Technology, Engineering and Mathematics. The aim is to enable students to learn science, technology, engineering and mathematics by engaging solid academic disciplines with real-life subjects. STEM is to educate individuals who have entrepreneurial spirited lifelong learning skills and who are sensitive to society by asking questions, defining problems, asking for creative thinking (Akgündüz, Aydeniz, Çakmakçı, Çavaş, Çorlu, Öner, Özdemir, 2015).

STEM is particularly referred to as a new approach to science education in Turkey. (SciTechEnM (science, technology, engineering and mathematics). Since we are expecting individuals from our age to produce, Science and Technology, Engineering and Mathematics are foreseen to be able to bring together their knowledge in the fields of science, technology, engineering and mathematics. In addition, it has been found that STEM education increases students' interest and motivation towards science courses (Yamak, Bulut, Dündar, 2014).

STEM students who play an important role in the development of twenty-first century skills are trained as adaptability, communication, social skills, problem solving, self-control and scientific thinking (Bybee, 2010). Maltese and Tai (2010) 's study with STEM shows that the level of orientation towards the STEM disciplines of middle school senior students in the following term is three times higher than those who are not educated on the basis of STEM education. Therefore, it has been emphasized that students' interest in STEM disciplines will be discovered at an early age and will help them to move towards STEM related fields in the following years (Maltese, Tai, 2011). It is seen that students with STEM skills cannot turn to science and engineering professions or to disciplines that require mathematics, science and technology literacy (Merrill and Daugherty, 2010).

It is ensured that individuals who are experts in the disciplines of science, technology, engineering and mathematics, which will take part in the labor force to ensure and sustain the superiority of STEM education in the scientific and economic fields of a country (Raines, 2012). In this respect, in recent years, there has been a rapid development in many countries on the basis of STEM training. Murphy

and Mancini-Samuelsen (2012) state that STEM education is generally aimed at high school students but recently it has started to focus on secondary school students (Murphy, Mancini-Samuelson, 2012). STEM education is one of the new approaches that aims to educate students in a holistic way and to give them 21st century skills. The most difficult area for teachers is not to explain the subject, but to integrate the activities prepared in accordance with the subject with the science program. Therefore, more applications are needed with STEM education discipline.

The most important indicator of the applicability of teaching models is the level of achievement of the objectives. Therefore, the impact of STEM education on students' academic achievement and 21st century skills needs to be examined. Sentence of the research problem ı Is there an effect on the attitudes and academic achievement of secondary school students in science course by using STEM education model? ".

Thus, in this study, the effect of restructured instructional design on students' affective and cognitive skills towards science, technology, engineering and mathematics will be investigated.

Sub research questions

1. Is there a significant difference in the attitudes of science students towards STEM education model?
2. Is there a significant difference in STEM activities applied to the students taking science course and their interest in science and engineering knowledge?
3. Is there a statistical difference in the STEM attitude scales of the secondary school students taking the science course?
4. Is there a statistical difference in STEM attitude scales of secondary school students taking science course according to gender?

1. Purpose of the Study

Today, the education system of many countries aims to educate students as individuals with 21st century skills. STEM education aims to compare students with questions and problems that will encourage students to learn, eliminate interdisciplinary distinction and provide a fully integrated education.

The aim of STEM education is to provide learning in a holistic way by establishing a relationship between disciplines (Smith, Karr-Kidwell, 2000). In general, in STEM education, Moore, Stohlmann, Wang, Tank, and Roehrig, (2013) attempt to integrate the disciplines of science, mathematics, technology and engineering by establishing a relationship between real life problem and content. In STEM education, inclusion emphasized that these four areas should be adapted as content or one should be considered as the focus and the others should be used as context to teach the content of this focused discipline (Moore, Stohlmann, Wang, Tank, Roehrig, 2013). This can also be done by combining at least two, if not all, of these four areas. In other words, STEM education can be considered as a shift from division of science and mathematics courses into multidisciplinary education (Riechert, Post, 2010).

The aim of this study is to examine the students' academic achievement changes and their sensory attitude towards science, technology, engineering and mathematics by applying the subjects and gains included in the curriculum of the Secondary Science Science course within the curriculum according to STEM education model. Based on the STEM education model, the design of instructional design on the basis of STEM education in secondary school science course; the answer to the question of whether there is a change in the academic achievement and attitudes of students.

2. Importance of Research

We should work on increasing the interest in STEM education by making the STEM education model attractive for students everywhere by applying the development of Science, Technology, Engineering and Mathematics skills at every level of the education system, from pre-school to higher education, out-of-school activities and in-school activities.

Developing a holistic program in our schools and creating an environment conducive to STEM education in order to enable students to connect between disciplines, to be willing to learn, to increase their success in mathematics and science, to improve the teaching and learning of STEM subjects (Gallant, 2011). Hartzler, who conducted thirty individual studies on the effect of integrative teaching on student achievement, (2000), found that science and mathematics, which was taught on the basis of a holistic understanding, increased the students' success, interest, desire and self-efficacy.

STEM training has strategic importance in order to protect the competitiveness of our country on an international scale. innovation in this area has become especially critical for Turkey's competitiveness in the economic area (in Corlu, Capraro, 2014). Studies on STEM in particular, science, technology, mathematics and engineering education, in general; will contribute to education and the national economy. Thus, the economy of the country will develop and the level of developed countries will be reached (Marulcu and Sungur, 2012). For this reason, this research will be a step for the studies to be carried out towards the development of the national economy.

Practicing in science helps the student to understand how scientific knowledge develops, such direct participation teaches them to understand the broad approaches to understanding the world, modeling, and research. Participating in engineering allows students to understand both the work of engineers and the link between engineering and science.

It is thought that activity books covering science, technology, engineering and mathematics in STEM discipline will be prepared and contribute to better understanding of the necessary gains. STEM students receive practical training by making use of technological products, producing solutions to problems, by doing STEM activities. While finding solutions to the problems that come before them at a young age, it finds multiple solutions by developing different alternatives in its thinking structure. This situation is to get rid of the student's memorization system and become individuals with 21st century skills. It contributes to the future occupations of the students through STEM activities and experiences gained at school.

METHOD

1.Research Model

In this research, relational survey (descriptive) research model was used. Participants' views on a topic or event, or interest, skills, abilities, attitudes, etc. The characteristics of which are generally determined on larger samples than other studies are called screening studies. Descriptive methods are aimed at revealing the current situation of the problem to be investigated and to be investigated. The main feature of these methods is to work the current situation in their own conditions and as it is (Sönmez, Alacapınar, 2011).

STEM education approach used in the research studies carried out respectively. In order to prepare STEM activity books, STEM activity booklets were prepared together with three specialist science teachers according to the achievements by examining the curriculum of Primary Education Institutions Science Education Program of Ministry of Education and Education (TTKB, 2013). Scales were prepared by using literature review. Pre-test questions were prepared and applied. Prepared STEM activity books were applied. After the activities, the students were given activity points. After the final test, the expected changes and the end-of-year report card grades were evaluated. Finally, all data were analyzed and comments were made.

2.Working Group

The research was carried out in the 5th (n = 67) - 6. (n = 34) - 7. (n = 42) in a private education institution in Bahçelievler district of Istanbul in the first semester (17 weeks) of the 2015-2016 academic year. and 8th (n = 40) students. The participants of this study were provided with 183 students from 5th, 6th, 7th and 8th grade levels. Classes and number of students are shown in Table 1:

Table 1. *Number of participants*

	Female Student	Male Student	Total number
5-A	7	10	17
5-B	7	9	16
5-C	8	10	18
5-D	9	7	16
6-A	9	9	18
6-B	7	9	16
7-A	8	6	14
7-B	7	8	15
7-C	9	4	13
8-A	7	7	14
8-B	8	5	13
8-C	7	6	13
Total	93	90	183

3.Data Collection Tools

Firstly, a questionnaire containing 10 questions demographic information about STEM education model and 38 questions STEM attitude scale about STEM education model were applied to the 5th, 6th, 7th and 8th grades. The questions applied in the survey including demographic information; gender, class, number of siblings, status of having own computer, presence of own cell phone, presence of internet connection in cell phone, level of computer usage (according to personal perception), for which purposes internet use, social networks and how many hours per day is at the computer.

3.1. SYSTEM Attitude Scale

In this study, the validity and reliability of the STEM Attitude Scale, which was previously adapted to Turkish at secondary school level, was adapted to Turkish by analyzing its validity and reliability (Yıldırım & Selvi, 2015). In this study, EM STEM Attitude Scale dayalı was named as EM STEM-Middle School Attitude Scale dayalı based on the related literature. This 5-point Likert scale developed by Faber et al. (2013) consists of four sub-dimensions: Mathematics, science, engineering-technology and 21st century skills. During the implementation phase of the scale, students were given one lesson time and the scale was applied in the classroom environment after the necessary explanations were made by the researchers. As a result of validity analysis, 38-item STEM Attitude Scale was prepared in 5-point Likert type. The rating consists of 5 options: “strongly disagree”, orum disagree ”,“, undecided ”,“ agree ”and“ strongly agree ”. The reliability analysis measures the consistency of the responses to the questionnaire prepared according to a predetermined type of scale. By consistency here is meant the consistency of answers to questions containing only ordinal scale answers. The main analysis used for reliability analysis is to find the Cronbach Alpha (α) value. Each item can have a single α value, or all questions can have an average α value. The α value obtained for all questions indicates the total reliability of that attitude scale and is expected to be greater than 0.7, lower α values indicate that the questionnaire has poor reliability, and α> 0.8 indicates that the attitude scale has high reliability. Pre-test reliability analysis ratio shows that it is high reliability as 0.867.

Pre test validity analysis

Summary of statement process

		N	%
Statement	Valid	168	97,7
	Unvalid	4	2,3
	Total	172	100,0

a. List based on all variables in operation

Validity Statistics	
Cronbach's Alpha	N Unit
0,867	38

The final test showed that the reliability analysis ratio was as high as 0.843.

Summary of statement process			
		N	%
Statement	Valid	180	98,4
	Unvalid	3	1,6
	Total	183	100,0

a. List based on all variables in operation

Validity Statistics	
Cronbach's Alpha	N Unit
0,843	38

3.2. STEM Activity Evaluation Schedule

17-week STEM activities were applied to each class and students were scored at the end of each activity in line with the activity evaluation schedule. The total score was changed from a 16-point system to a hundred-point system. Table 2 shows their score table.

Table 2. STEM activity evaluation chart

Control List Very good: 4 Good: 3 Average: 2 Needs to be developed : 1

		Experimental Design	Scientific Results	Data Sum	Verbal Description	Total Point	Percantage point
49	X Student	3	2	3	3	11	69
50	Y Student	4	4	4	4	16	100

In the STEM activity evaluation chart, experimental design, scientific results, data collection and verbal expression structures of the students were evaluated. In the experimental design, students were designed to make designs like an engineer. By analyzing scientific results and scientific data, mathematical gains of science were evaluated. Data were collected by using technological products and evaluated with mathematical concepts. In the oral expression, he makes the analysis of the data he obtained by comparing the data he obtained on the model he designed with the scientific results.

In the activity, the students create their models by designing like engineers. Science understands the concept of speed on the subject of force and movement. It collects data using technological tools and transfers the collected data to the graph using mathematical expressions. Students are able to comprehend four different sciences in an activity with STEM education approach.

Finally, at the end of the semester, science scorecard grades data of all the students who participated in the study were collected and edited. Students have had three written exams during the semester. They received three in-class performance grades. The performance of their in-class grades was evaluated according to three situations.

1. Participation in the course activity was evaluated.
2. The assignments given in the course activity were evaluated.
3. The STEM activities are evaluated in the classroom activities and the table analyzes are given in Table 3.

Tablo 1. **End-of-term school report chart**

Control List A : (85-100)		B :(70-84)		C:(55-69)	D: (45-54)		E :(24-44)		
		1.Exam	2.Exam	3.Exam	1. classroom activities	2 classroom activities	3 classroom activities		
49	X Student	89	95	94	90	100	100	95	A
50	Y Student	100	86	91	100	100	100	96	A

4.STEM Event Applications

The aim of this study is to apply the activities of science, technology, engineering and mathematics (STEM) compatible science course to the students. The aim of this course is to reveal the students' experiences, achievements and cognitive and affective effects of these activities on students. Within the scope of this aim, STEM was applied to the students and data were collected from the students before and after the application. In order to prepare STEM activities, unit analyzes were made in the curriculum of the Ministry of National Education and activities were prepared according to the gains. 5, 6, 7. 17-week practice-based activity booklets for Grades 8 and 8 were designed.

STEM training model implementation process;

1. The first week students were informed about STEM education approach to all classes. Information was given about STEM training approach and practices. Information about science laboratory usage, iPad usage and applications will be given.
2. The science curriculum was examined and activities appropriate to the curriculum were created. The created events have been uploaded to the students' iPads. Activities were made using the activity books installed on their iPads.
3. The activities were implemented in accordance with the curriculum. The students analyzed the necessary data by using iPad applications and evaluated the results of the activities by the teachers.
4. The students were evaluated by using the activity booklets loaded on Ipad and evaluated according to the table in Table-2.

Achievements and applications created by STEM education approach in the science course were prepared according to class levels.

5.Data Analysis

Before starting the analysis of the collected data, it should be decided whether the analysis is parametric or non-parametric. Therefore, the normality test should be performed to determine which of these tests is appropriate for the available data. Parametric tests are appropriate if the data is normally distributed, and non-parametric tests are appropriate if the data is not normally distributed.
For this purpose, the 38-item STEM attitude scale, pre- and post-tests, which could affect the STEM education approach, were tested for normal distribution according to class factor. For this purpose, all items of the pre and post tests were subjected to the normality test separately by using SPSS 20.0 program. Since the significance values of the preferred Shapiro-Wilk test are less than 0.05, the hypothesis that 95 95% confidence data is normally distributed red is rejected since there are fewer than 50 participants in the sub-values of the class variable in the normality test. In this case, non-parametric tests were used for the analysis of the data set.

5.1. Demographic analysis of STEM questionnaire

In the study, firstly, a questionnaire containing 10 questions about demographic information about STEM education model was applied to 5.6.7 and 8th grades. Gender, class, number of siblings, own computer and mobile phone, internet connection status (according to pre-test and post-test) were analyzed in the demographic values of STEM questionnaire.

5.2. STEM attitude analysis

Wilcoxon Signed Color Test (Paired Samples) was performed after the STEM attitude scale's pre-test and post-test. This test was used to test the significance of the difference between the scores of the two related sets of measures.

5.3. Analysis of STEM activities

Kruskal Wallis H-Test (Independent Samples) was used for the analysis of the activities applied to the classes. The Kruskal Wallis technique tests whether two or more unrelated sample environments differ significantly from each other. The analysis compares the scores of a dependent variable of 172 samples.

5.4. Analysis of difference between classes

The difference between the classes was also analyzed by Kruskal Wallis H-Test.

5.5. Gender-based analysis

The Mann Whitney U-test tests whether the scores obtained from two unrelated samples differ significantly from each other. This test tests whether two unrelated groups have similar distributions in the universe in terms of the variable of interest.

RESULTS AND COMMENTS

1. Demographic analysis of STEM questionnaire

As the first week of the school, 172 students participated in the pre-test and all students participated in the final test (n = 183). As can be seen in Table 4, the participants of the study are equally distributed in terms of gender. It is seen that the majority of students have a computer and mobile phone with Internet connection.

Table 4. Analysis of STEM questionnaire demographic values in pre and post tests

Demographic	Demographic Information Subfields	Pre test	Post Test
Gender	Female	90	92
	Male	82	91
Class	5. Grade	65	67
	6. Grade	34	38
	7. Grade	40	40
	8.Grade	33	38
Number of siblings (himself included)	1	39	42
	2	78	86
	3	35	35
	4	20	20
Having his own personal computer	Yes (With internet)	129	133
	Yes (No internet)	7	6
	No – but I'm using someone elses	30	37
	No – I don't have any access to PC	6	7
Having his own mobile phone	Yes Post paid line	67	81
	Yes- Prepaid line	54	55
	No	51	46
If he has mobile phone, internet access	No	116	121
	No	56	62

In the continuation of demographic questions, questions were asked about computers and students' use of computers, which is an important element for STEM. As can be seen in Table 5, more than half of the students perceive themselves as individuals with good computer skills. Students will be more active in the courses by using computer technology in a good way.

Table 5. Students' computer usage analysis

Demographic	Demographic Information Subfields	Pre test	Post test
How do you define your own use as a computer user?	Expert	13	15
	Good user	58	59
	Normal	80	87
	Amateur	19	20
	Beginner	2	2

2. SYSTEM attitude scale analysis

The first week of the school (pre-test) and last week (post-test) was applied to measure the change in attitude between. Table 6 shows the questions of the scale, pre-test and post-test participants, minimum and maximum scores, scale means and standard deviations.

Table 6. Analysis of STEM attitude survey in pre and post tests

STEM Attitude Scale Questions	Pre test					Post test				
	n	Min	Max	Ort	S.S	n	Min	Max	Average	S.S.
1. I always be succesful in science.	172	1.00	5.00	3.72	0.89	183	1.00	5.00	3.61	0.92
2. I would like to have more science classes in school.	172	1.00	5.00	3.48	1.17	183	1.00	5.00	3.38	1.26
3. Science is more difficult for me than most of my subjects.	172	1.00	5.00	2.12	1.22	183	1.00	5.00	2.33	1.31
4. Science is not one of my strengths.	172	1.00	5.00	2.15	1.12	183	1.00	5.00	2.49	1.34
5. I learn things about science quickly.	172	1.00	5.00	3.56	0.93	183	1.00	5.00	3.55	1.17
6. Science is boring.	171	1.00	5.00	1.82	1.12	183	1.00	5.00	2.27	1.43
7. I think that learning science will help me in my daily life.	172	1.00	5.00	4.11	1.08	183	1.00	5.00	4.01	1.11
8. I need science to learn the other subjects at school.	172	1.00	5.00	3.52	1.08	183	1.00	5.00	3.50	1.17
9. I need to be successful in science to enter my preferred university.	172	1.00	5.00	4.05	1.14	183	1.00	5.00	3.73	1.24
10. I need to be successful in science to get the job I want.	172	1.00	5.00	3.83	1.12	183	1.00	5.00	3.61	1.31
11. Knowing science is important to get a good job.	172	1.00	5.00	3.86	1.07	183	1.00	5.00	3.80	1.14
12. Knowing engineering is important to get a good job.	171	1.00	5.00	3.40	1.21	181	1.00	5.00	3.52	1.28
13. Knowing digital technologies is important to get a good job .	171	1.00	5.00	3.95	1.06	183	1.00	5.00	4.04	1.13
14. In order to get a good job, it is important to know mathematics.	172	1.00	5.00	4.44	0.84	183	1.00	5.00	4.31	1.05
15. Science, technology, engineering and mathematics make our lives better .	172	1.00	5.00	4.34	0.87	183	1.00	5.00	4.19	1.08
16. Science, technology, engineering and mathematics are very important in our lives.	172	1.00	5.00	4.30	0.90	183	1.00	5.00	4.13	1.09

17. Having a job involving science, mathematics, engineering or technology makes me more successful in my life.	172	1.00	5.00	4.25	0.93	183	1.00	5.00	4.15	1.11
18. Science, technology, engineering and mathematics are important for the future of our country.	172	1.00	5.00	4.34	0.94	183	1.00	5.00	4.34	1.05
19. The benefits of science, technology, engineering and mathematics are far greater than the harmful effects they may cause.	172	1.00	5.00	3.54	1.24	183	1.00	5.00	3.80	1.14
20. I would like to have a job involving science, math, engineering or technology.	171	1.00	5.00	3.88	1.17	183	1.00	5.00	3.97	1.21
21. In order to learn engineering, I must be successful in science and mathematics	171	1.00	5.00	4.18	0.95	183	1.00	5.00	4.27	0.94
22. When something new is discovered, I enjoy learning it quickly.	171	1.00	5.00	4.12	0.96	183	1.00	5.00	4.34	0.85
23. It is fun to learn engineering.	171	1.00	5.00	3.43	1.08	183	1.00	5.00	3.81	1.05
24. I believe I can succeed in engineering.	171	1.00	5.00	3.54	1.17	183	1.00	5.00	3.64	1.15
25. I would like to take more courses involving engineering.	171	1.00	5.00	3.29	1.22	183	1.00	5.00	3.61	1.24
26. I enjoy learning science.	171	1.00	5.00	4.09	1.04	183	1.00	5.00	3.99	1.07
27. Learning Engineering helps me learn science, math or technology.	171	1.00	5.00	3.82	1.04	183	1.00	5.00	3.88	1.18
28. I'd like to take more courses with science.	171	1.00	5.00	3.60	1.16	182	1.00	5.00	3.66	1.23
29. I'm good at science.	171	1.00	5.00	3.85	1.06	183	1.00	5.00	3.91	1.05
30. Learning science helps me learn math, engineering or technology.	171	1.00	5.00	3.93	1.03	183	1.00	5.00	4.11	0.96
31. Learning mathematics helps me learning science, engineering or technology.	171	1.00	5.00	4.04	1.03	183	1.00	5.00	4.11	1.07
32. Using technology helps me to learn science math or engineering.	171	1.00	5.00	4.01	0.97	183	1.00	5.00	4.11	1.11
33. I enjoy learning math.	171	1.00	5.00	3.97	1.18	183	1.00	5.00	4.10	1.16
34. I'm successful in maths.	171	1.00	5.00	3.98	1.09	183	1.00	5.00	3.99	1.23
35. I would like to have subjects which	171	1.00	5.00	3.73	1.24	183	1.00	5.00	4.09	1.13

contains more maths.										
36. I'm good at using technology.	171	1.00	5.00	4.07	0.90	183	1.00	5.00	4.28	0.93
37. I enjoy learning technolgy.	171	1.00	5.00	4.36	0.84	183	1.00	5.00	4.30	0.97
38. I would likte to have more subjects about technology..	171	1.00	5.00	4.20	1.03	183	1.00	5.00	4.24	1.03

Wilcoxon Signed Ranks Test was performed to see if there was a statistically significant change in the elapsed time interval. This test is a non-parametric test which is used in place of the dependent sample t-test in parametric tests and tests whether two different time measurements of the same individuals are different in terms of a variable specified by the measurement.

As can be seen in Table 6, it was made to test whether there was a significant difference between the pre-test and post-test scores of the STEM attitude scale. As a result of Non-Parametric Wilcoxon Signed Ranks Test; The difference between the means of the rankings was statistically significant on 8 questions out of 38 questions at p <.000 level. The difference was in favor of the pre-test. In other words, it is stated in Table 7 that the attitudes of the students who make up the study group at the end of STEM applications have changed significantly. Students realize that they do not need only science in order to be successful in the university (question 9), and they have realized both the benefits and harms of science practices (question 19).

Table 7. Significance of the difference between STEM attitude scale pre-test and post-test scores test results

STEM Attitude Scale Questions		N	Rank Average	Row total	z	p
Final Test Question 4 – Pre Test Question 4	Negative Rank	59	60.95	3596.00	-2.215	0.027
	Positive Rank	76	73.47	5584.00		
	Equal	37				
	Total	172				
Final Test Question 6 – Pre Test Question 6	Negative Rank	48	47.42	2276.00	-3.373	0.001
	Positive Rank	70	67.79	4745.00		
	Equal	53				
	Total	171				
Final Test Question 9 – Pre Test Question 9	Negative Rank	69	64.68	4463.00	-2.034	0.042
	Positive Rank	52	56.12	2918.00		
	Equal	51				
	Total	172				
Final Test Question 19 – Pre Test Question 19	Negative Rank	45	58.23	2620.50	-2.174	0.030
	Positive Rank	71	58.67	4165.50		
	Equal	56				
	Total	172				
Final Test Question 22 – Pre Test Question 22	Negative Rank	49	56.56	2771.50	-2.204	0.028
	Positive Rank	70	62.41	4368.50		
	Equal	52				
	Total	171				
Final Test Question 23 – Pre Test Question 23	Negative Rank	45	59.83	2692.50	-3.149	0.002
	Positive Rank	80	64.78	5182.50		
	Equal	46				

Table 7. Significance of the difference between STEM attitude scale pre-test and post-test scores test results

STEM Attitude Scale Questions		N	Rank Average	Row total	z	p
	Total	171				
	Negative Rank	53	62.30	3302.00		
Final Test Question 25 – Pre Test Question 25	Positive Rank	78	68.51	5344.00	-2.384	0.017
	Equal	40				
	Total	171				
	Negative Rank	41	59.43	2436.50		
Final Test Question 35 – Pre Test Question 35	Positive Rank	76	58.77	4466.50	-2.817	0.005
	Equal	54				
	Total	171				

3.STEM Analysis of Activities

During the study, 17 weeks of STEM activities were applied to each class and at the end of each activity, students were given an activity evaluation chart. Experimental design, scientific results, data collection and verbal expression categories were scored in the range of 1-4. The total score was converted to 16 for ease of analysis and 100 for the maximum total score. Table 8 shows their score table.

Table 8. Effectiveness evaluation schedule

Control List	Very good: 4	Good: 3	Average: 2	Needs to be developed: 1				
		Experimenta l Design	Scientific Results	Data Collection	Verbal Lecture	Total Point	Percentage Point
49	X Student	3	2	3	3	11	69
50	Y Student	4	4	4	4	16	100

When the standard deviations are examined, it is seen in Table 9 that the lowest average is in the experimental design step and the highest average is in the verbal presenting dimension.

Tablo 9. *Etkinlik değerlendirme çizelgesinin ortalaması ve standart sapması*

	n	Min.	Max.	Average	Standard Deviation
Experimental Design	192	2.93	3.93	3.43	0.24
Scientific Results	192	2.77	3.95	3.44	0.25
Data Collection	192	2.87	4.00	3.47	0.24
Verbal Lecture	192	2.85	4.00	3.60	0.20
Total Point (Out of 16)	192	12.20	15.65	13.94	0.80
Total Point (Out of 100)	192	76.00	98.00	87.15	5.04

STEM activities were carried out for 17 weeks as Grade 5, 4, 6, 2, 7, 3 and 8. Table 10 shows the ranking of the average of all activities of the 5th grade from high to low by considering the averages one by one. 8th activity which is integrated to 5th grade National Education curriculum was “Let's get to know our excretory system”. The students completed their activities within the group working discipline. The activities were completed with design, mathematical data analysis and technological tools. In experimental designs, the students created the design by revealing their engineering ideas. By gathering data in the models they created, they obtained mathematical analyzes and reached scientific results.

Table 10. All activity results in 5th Grades

Activity	Average out of 16	Average out of 100
8.Activity	14.85	91.23
11. Activity	14.84	91.39
12. Activity	14.74	91.23
16. Activity	14.68	91.66
4. Activity	14.67	91.31
6. Activity	14.65	91.56
2. Activity	14.62	90.30
5. Activity	14.61	92.81
1. Activity	14.60	90.97
3. Activity	14.60	90.16
9. Activity	14.56	92.72
7. Activity	14.45	92.11
10. Activity	14.43	89.83
14. Activity	14.37	89.84
13 Activity	14.37	88.86
15. Activity	14.22	91.72

Table 11 presents the ranking of all the activities of the 6th grades from high to low by considering the averages one by one. One of the activities integrated into the 6th grade National Education curriculum was the 6th activity "Who is this blood cell activity".

Table11. All activity results in 6th grades

	Average out of 16	Average out of 100
6. Activity	14.06	87.88
16. Activity	13.93	87.03
10. Activity	13.85	86.56
11. Activity	13.84	86.50
9. Activity	13.77	86.06
1. Activity	13.74	85.84
8. Activity	13.69	85.56
13. Activity	13.53	84.53
2. Activity	13.43	83.91
5. Activity	13.43	83.91
4. Activity	13.40	83.75
7. Activity	13.40	83.72
12. Activity	13.37	83.56
3. Activity	13.24	82.75
15. Activity	13.15	82.19
14. Activity	13.02	81.34

Table 12 shows the ranking of the average of all the activities of the 7th grade students from high to low by considering the averages one by one. The 8th activity, which is integrated to the 7th grade National Education curriculum, was "Let's get to know the internal glands"

Table 12. All activity results in 7th grades

Activity	Average Out of 16	Average Out of 100
5. Activity	13.68	85.52
13. Activity	13.68	85.48
16. Activity	13.65	85.29
3. Activity	13.56	84.75
1. Activity	13.53	84.58
4. Activity	13.49	84.31
11. Activity	13.40	83.75
2. Activity	13.35	83.44
15. Activity	13.27	82.92
9. Activity	13.13	82.08
12. Activity	13.11	81.92
8. Activity	13.10	81.88
10. Activity	13.04	81.52
14. Activity	12.96	80.98
7. Activity	12.91	80.69
6. Activity	12.56	78.52

Table 13 presents the ranking of all activities of the 8th grades from high to low by looking at the averages one by one. One of the activities integrated into the 8th grade National Education curriculum was the 8th activity "The effect of the displaced liquid on buoyancy ".

Table13. Activity results of 8th grades

Activity	Average out 16	Average out of 100
12. Activity	14.69	91.83
16. Activity	14.49	90.56
15. Activity	14.49	90.54
11. Activity	14.44	90.27
13. Activity	14.37	89.81
9. Activity	14.35	89.69
14. Activity	14.19	88.71
1. Activity	13.92	86.98
10. Activity	13.80	86.23
7. Activity	13.77	86.06
8. Activity	13.75	85.96
6. Activity	13.72	85.73
3. Activity	13.71	85.67
5. Activity	13.65	85.29
4. Activity	13.57	84.81
2. Activity	13.36	83.48

In the activities, students will be able to; in other words, they carried out integrated interdisciplinary STEM education supported by mathematics, engineering and technological sciences by centering science. The 5th and 8th grades of the classes have a higher average than the 6th and 7th grades of the activities. The scores obtained by the classes from the activities made a difference according to the unit gains. Students were more active in designing activities with engineering knowledge and scored higher.

Analysis of 4th Grade Difference

According to the results of the Kruskal Wallis H test, whether the STEM attitude scale showed statistically significant differences by grade showed 7 statistically significant differences in the pre-test and 12 questions in the post-test (Table 14 and Table 15).

Table 14. Kruskal-Wallis H pre test results

STEM Attitude Scale Questions	Grade	n	Row Average	Chi Square	Degree of Freedom	p
Pre test Question 1	5.00	65	99.12	9.886	3	0.020
	6.00	34	84.87			
	7.00	40	82.06			
	8.00	33	68.70			
	Total	172				
Pre test Question 6	5.00	65	70.88	12.791	3	0.005
	6.00	34	91.47			
	7.00	40	93.08			
	8.00	32	102.06			
	Total	171				
Pre test Question 13	5.00	65	85.71	8.613		
	6.00	34	72.24			
	7.00	40	102.91			0.035
	8.00	32	80.08		3	
	Total	17				
Pre test Question 14	5.00	65	89.69	7.896	3	0.048
	6.00	34	80.60			
	7.00	40	98.48			
	8.00	33	71.77			
	Total	172				
Pre test Question 29	5.00	64	100.66	10.141	3	0.017
	6.00	34	80.94			
	7.00	40	76.21			
	8.00	33	74.64			

	Total	171				
Pre test Question	5.00	64	94.02	10.454	3	0.015
Soru 33	6.00	34	66.18			
	7.00	40	80.70			
	8.00	33	97.30			
	Total	171				
Pre test Question 34	5.00	64	98.78	12.543	3	0.006
	6.00	34	65.47			
	7.00	40	89.78			
	8.00	33	77.79			
	Total	171				

Table 15. Kruskal-Wallis post test results

STEM Attitude Scale Questions	Grade	n	Row Total	Chi Square	Degree of Freedom	p
Post test Question 1	5.00	67	106.83	9.288	3	0.026
	6.00	38	82.24			
	7.00	40	85.03			
	8.00	38	82.96			
	Total	183				
Post test Question 6	5.00	67	79.27	13.920	3	0.003
	6.00	38	83.97			
	7.00	40	114.48			
	8.00	38	98.82			
	Total	183				
Post test Question 12	5.00	67	98.43	8.384	3	0.039
	6.00	37	69.65			
	7.00	40	94.30			
	8.00	37	95.34			
	Total	181				
Post test Question 13	5.00	67	108.44	15.514	3	0.001
	6.00	38	69.54			
	7.00	40	87.58			
	8.00	38	90.13			
	Total	183				
Post test Question 18	5.00	67	84.91	12.844	3	0.005
	6.00	38	76.61			
	7.00	40	105.73			
	8.00	38	105.45			
	Total	183				
Post test Question 32	5.00	67	101.72	14.998	3	0.002
	6.00	38	65.13			
	7.00	40	99.45			
	8.00	38	93.89			
	Total	183				
Post test Question 33	5.00	67	108.84	23.009	3	0.000
	6.00	38	61.45			
	7.00	40	94.85			
	8.00	38	89.87			
	Total	183				
Post test Question 34	5.00	67	102.30	10.262	3	
	6.00	38	70.71			
	7.00	40	96.35			0,016
	8.00	38	90.55			
	Total	183				
Post test Question 35	5.00	67	102.78	18.895	3	0.000
	6.00	38	62.89			
	7.00	40	89.96			
	8.00	38	104.25			
	Total	183				
	5.00	67	91.27			
	6.00	38	64.78			
Post test Question 36	7.00	40	108.51	18.856	3	0.000
	8.00	38	103.13			
	Total	183				

		67	96.22			
	5.00					
Post test Question 37	6.00	38	64.05	17.085	3	0.001
	7.00	40	102.15			
	8.00	38	101.82			
	Total	183				
Post test Question 38	5.00	67	100.16	12.031	3	0.007
	6.00	38	68.59			
	7.00	40	92.99			
	8.00	38	99.97			
	Total	183				

To see where the difference comes from, all options (Class 5-6-7-8) on SPSS must be determined individually by performing a Mann Whitney U test. The difference from these series of analyzes is summarized in Table 16. According to the STEM attitude scale, the results of the last test revealed a significant difference in the first question, I would always be successful in science according to 5th and 6th grades. In addition, 35, 36, 37 and 38 in the final test of the 7th and 8th grades according to the 6th grade;

I would like to take more courses involving mathematics,
I am successful in using technology,
I enjoy learning using technology in education,

The expressions that I would like to take more courses involving technology made a significant difference.

Table 16. Mann-Whitney U test results

STEM Attitude Scale Questions	Grade 5 Grade 6	Grade 5 Grade 7	Grade 5 Grade 8	Grade 6 Grade 7	Grade 6 Grade 8	Grade 7 Grade 8
Pre-Test Question 1	No difference	No difference	5> 8	No difference	No difference	No difference
Pre-Test Question 6	6> 5	7> 5	8> 5	No difference	No difference	No difference
Pre-test Question 13	No difference	No difference	No difference	7> 6	No difference	7> 8
Pre-Test Question 14	No difference	No difference	No difference	No difference	No difference	7> 8
Pre-Test Question 29	5> 6	5> 7	5> 8	No difference	No difference	No difference
Pre-Test Question 33	5> 6	No difference	No difference	No difference	8> 6	No difference
Pre-Test Question 34	5> 6	No difference	No difference	7> 6	No difference	No difference
Post-Test Question 1	5> 6	5> 7	5> 8	No difference	No difference	No difference
Post-Test Question 6	No difference	7> 5	8> 5	7> 6	No difference	No difference
Post-Test Question 12	5> 6	No difference	No difference	7> 6	8> 6	No difference
Post-Test Question 13	5> 6	5> 7	No difference	No difference	No difference	No difference
Post-Test Question 18	No difference	7> 5	8> 5	7> 6	8> 6	No difference
Post-Test Question 32	5> 6	No difference	No difference	7> 6	8> 6	No difference
Post-Test Question 33	5> 6	No difference	5> 8	7> 6	8> 6	No difference
Post-Test Question 34	5> 6	No difference	No difference	7> 6	No difference	No difference
Post-Test Question 35	5> 6	No difference	No difference	7> 6	8> 6	No difference
Post-Test Question 36	5> 6	No difference	No difference	7> 6	8> 6	No difference
Post-Test Question 37	5 > 6	No diffrence	No difference	7 > 6	8 > 6	No difference
Post-Test Question 38	5 > 6	No difference	No difference	7 > 6	8 > 6	No difference

5. Gender-based analysis

The non-parametric version of the independent sample t-test, Mann Whitney U test, was used to see whether there was a statistically significant difference in the pre-test and post-test data of the group in the study. As can be seen in Table 17, gender differences were observed in 4 questions for the pre-test. For questions 9, 13 and 24, the difference is in the direction of boys whereas in question 22 the difference is in the direction of female students.

Table 17. STEM attitude scale questions pre-test Mann-Whitney U test

STEM Attitude Scale Questions	Gender	n	Rank Average	Row Total	Mann-Whitney U	p
Pre-Test Question 9	Girl	90	78.96	7106.50		
	Male	82	94.77	7771.50	3011.500	0026
	Total	172				
Pre-Test Question 13	Girl	90	76.54	6889.00		
	Male	81	96.51	7817.00	2794.000	0006
	Total	171				
Pre-Test Question 22	Girl	89	93.00	8277.00		
	Male	82	78.40	6429.00	3026.000	0040
	Total	171				
Pre-Test Question 24	Girl	89	77.84	6928.00		
	Male	82	94.85	7778.00	2923.000	0020
	Total	171				

When gender difference analysis was performed on the post-test data, it was found in Table 18 that there were significant differences on 9 questions. In all questions in which statistical significant difference was observed, the difference appears to occur in the direction of men.

Table 18. Gender differences analysis on posttest data

STEM Attitude Scale Questions	Gender	n	Row Average	Row total	Mann-Whitney U	p
Post test question 5	Female	92	80.65	7419.50		
	Male	91	103.48	9416.50	3141.500	0.002
	Total	183				
Post test question 12	Female	90	80.76	7268.00		
	Male	91	101.13	9203.00	3173.000	0.007
	Total	181				
Post test question 20	Female	92	84.12	7739.00		
	Male	91	99.97	9097.00	3461.000	0.032
	Total	183				
Post test question 23	Female	92	81.54	7501.50		
	Male	91	102.58	9334.50	3223.500	0.005
	Total	183				
Post test question 24	Female	92	82.98	7634.50		
	Male	91	101.12	9201.50	3356.500	0.016
	Total	183				
Post test question 25	Female	92	84.15	7742.00		
	Male	91	99.93	9094.00	3464.000	0.037
	Total	183				
Post test question 32	Female	92	83.34	7667.00		
	Male	91	100.76	9169.00	3389.000	0.016
	Total	183				
Post test question 37	Female	92	82.67	7605.50		
	Male	91	101.43	9230.50	3327.500	0.008
	Total	183				
Post test question 38	Female	92	79.02	7269.50		
	Male	91	105.13	9566.50	2991.500	0.000
	Total	183				

DISCUSSION AND CONCLUSION

STEM It was found appropriate to present the results obtained in accordance with the research sub-problems in this study where the effects of the activities prepared according to the educational model on the students' attitudes towards STEM, their scientific process levels, their views and abilities towards engineering discipline were investigated. In this section, the results obtained for all sub-problems of the research are discussed and discussed within the framework of the related literature.

1. Conclusions and Discussion Concerning Meaningful Change in Attitudes of Students Participating in the Study against STEM Education Model

At the end of STEM applications, the attitudes of the students in the study group changed significantly. In this case, while students think that science has a strong side at the end of the term, they no longer find it boring and realize that they do not need only science to be successful in university. Based on these findings, it was concluded that STEM education practices had a positive effect on students' academic achievement. The students who complete the activities in the STEM activity booklets analyze the applications in their research and designs and show a positive approach in their attitudes towards STEM. Models created with STEM activity booklets, which are integrated to the science course, provide solutions to problems in daily life. With the solutions it produces, the subject gains of science are reinforced. The students develop different design and engineering concepts while producing different models. By developing different solutions, they participate in project competitions and develop their scientific thinking.

This result obtained in the research supports the theoretical information in the literature. As a result, STEM education, which requires the combination of all knowledge and skills in the fields of science-technology-engineering and mathematics, should be expanded both in and out of school activities as it positively improves students' scientific process skills and attitudes towards science and science. In this way, decreasing interest in students towards science and mathematics can be increased again.

When Güzey, Harwell and Moore (2014) compared the attitudes of STEM-oriented schools to non-STEM-oriented schools towards STEM areas, they observed a significant difference in favor of students studying in STEM-oriented schools. These researches also support the related research in terms of developing their attitudes towards STEM fields in general.

2. Conclusions and Discussion on Determining Students' Interest in Science and Engineering Knowledge of STEM Activities

In the activities, the students have developed their learning structures with the STEM education model approach. It increases cognitive development by thinking and making different interpretations. By taking the science course to the center, they integrate with engineering, mathematics and technological disciplines and create permanent knowledge in their lives. While starting STEM education in our country, it is aimed to provide children with a perspective between science, technology, engineering, and mathematics disciplines, questioning, problem solving, researching, aesthetic point of view and product development skills. These opportunities should be multiplied for students, encouraged in the field of STEM education based on research and inquiry, and their abilities and achievements should be recognized.

The results obtained in this study showed that students' interest towards science was positively developed by STEM activities prepared by STEM education approach in the study conducted by Koç, (2017) with secondary school students. As a result, through STEM-based course activities, students' cognitive, affective and dynamic skills and achievements can be developed to provide meaningful learning in science (Çavaş et al., 2013).

3. Conclusion and Discussion on Statistical Differences in STEM Attitude Scales of Secondary School Students

According to the results of the Kruskal Wallis H test, whether the STEM attitude scale showed statistically significant differences by grade showed 7 statistically significant differences in the pre-test and 12 questions in the post-test (Table 14 and Table 15).

To see where the difference comes from, all options (Class 5-6-7-8) on SPSS must be determined individually by performing a Mann Whitney U test. The difference from these series of analyzes is summarized in Table 16. According to the STEM attitude scale, the results of the last test revealed a significant difference in the first question, I would always be successful in science according to 5th and 6th grades. In addition, 35, 36, 37 and 38 in the final test of the 7th and 8th grades according to the 6th grade;

I would like to take more courses involving mathematics,
I am successful in using technology,
I enjoy learning using technology in education,

The expressions that I would like to take more courses involving technology made a significant difference.

NRC, (2009) stated that STEM activity studies, which are in line with the general principles of engineering education, positively affected students' attitudes towards STEM.

4. Conclusions and Discussion on Statistical Differences in STEM Attitude Scales of Secondary School Students in Working Group by Gender

The non-parametric version of the independent sample t-test, Mann Whitney U test, was used to see whether there was a statistically significant difference in the pre-test and post-test data of the group in the study. In the analysis, gender difference was observed in the fourth question asked in the pre-test. For questions 9, 13 and 24, the difference was in the direction of boys whereas in question 22 it was in the direction of female students. Male students believe that they need to be successful in science to enter the university of their choice, that it is important to use technology well in order to get a good job and that it will be successful in engineering. It has been observed that female students enjoy learning quickly when something new is discovered.

When gender difference analysis was performed on the post-test data, it was found that there were significant differences on 9 questions. In all the questions in which statistical difference is observed in the statistical data, the difference appears to occur in the direction of men. This may be due to the fact that men consider themselves more capable of dealing with machinery, repairing, designing new products, and dealing with electronics. The fact that there was no significant difference between the sex groups over the whole scale was in line with the results of Karakaya and Avgın (2016) study.

5. Suggestions

The steps to be taken as a suggestion for the transition to STEM education in our country and the studies to be done can be summarized as follows:

5.1. Recommendations for STEM Applications

The STEM education approach is an approach aimed at integrating the disciplines of science, technology, engineering and mathematics in the implementation of STEM activities in secondary science. Teachers should be aware of this and support the development of other disciplines during their activities.

STEM education approach and secondary school science STEM activities with one of the objectives targeted by the application of students' knowledge and skills to develop the discipline of engineering. In this respect, it is important that teachers use a language appropriate to engineering terminology and support students' initiatives in this direction. It was determined that computer and I-pad simulations

(interactive education software) used within the scope of STEM education approach and applications of secondary school science STEM activities increased students' motivation towards the lesson. Accordingly, it is thought that it would be beneficial for teachers to include these programs in their own practices. STEM training centers can be established. In these centers, education and activity support can be provided to teachers and students. STEM training center of STEM trainers and academics can support the research and projects of teachers and students. STEM training experts can be assisted in the creation and implementation of STEM activity books. The Ministry of National Education, TUBITAK, industrial organizations and universities should come together at STEM centers to support and plan how to integrate the STEM education model into the education program. Turkey STEM producing the next generation of science and technology centers established in all cities can be grown.

5.2. Suggestions for STEM studies

By integrating STEM studies into the courses, scientific articles and thesis studies can be done. Research on STEM education can be applied to different class levels with different units and comparisons can be made. In order to use secondary education science education more widely and effectively with STEM education approach, it is important to focus on applications that will increase the competencies of science teacher candidates in the future studies. With the help of computer-aided STEM education approach, researches can be carried out to develop science education applications and to disseminate educational software prepared accordingly. STEM training courses can be applied to teachers trained in faculties of education.

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