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Teacher candidates attitudes towards the stem and sub-dimensions of stem

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Abstract

The developments in science and technology have led to changes in the expectations of countries from the future and the individuals. In the 21st century, focusing on innovative approaches in the education system has become compulsory to raise individuals who question, find rapid and effective solutions to problems and who could think scientifically. One of these approaches is Science, Technology, Engineering and Mathematics (STEM) training. The aim of this study is to evaluate the relationship between STEM and STEM sub-dimensions. The study group consists of 204 teacher candidates from different departments of the Faculty of Education of Sakarya University during the academic year 2018/2019. To collect data, the attitude scale for STEM and the sub-dimensions of STEM were used in the study. One-way ANOVA was used in this correlation for parametric tests. According to the results of the study, there is a positive and significant relationship between STEM and all STEM sub-dimensions based on the data collected from teacher candidates.

Keywords: STEM, sub-dimensions, teacher candidates.

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1. Introduction

Rapid developments in science and technology have an important place in the process of creating terminal behaviour change in individuals (Prevalla, 2016). It is an undeniable fact that children born and raised in a digital world should be guided to be able to use technological equipment effectively in their lives. The efficient use of technological tools is directly proportional to the knowledge, skills and objectives of the users (Montero Fleta, 2017). Nowadays, the fact that technology offers new alternatives in the field of education helps to solve the problems encountered in education and enables to create new learning environments for individuals (Roshdi, 2017). Developing technology has brought up the necessity of raising individuals who can use technology actively, and on purpose, who can access the information they want, independently from time and space, who can use this information, and who have the basic skills for the use of information and communication technologies and who present the requirements of the modern age (Alkan, 2018).

The necessity of revisions in the education systems has emerged for the education of individuals who have the knowledge and skills required by the 21st century, According to Demirci Guler (2017), the reason for making changes in the education systems of countries is to educate individuals who can work interdisciplinary and who have the 21st century skills. Science, Technology, Engineering and Mathematics (STEM) is a meta-discipline, where disciplinary information comes together to form a new whole (Kubat & Guray, 2018; Lantz, 2009).

STEM consists of the abbreviation of the initials of Science, Technology, Engineering and Mathematics. STEM Education is an approach aiming at converting theoretical knowledge into practice, product and innovative discoveries allowing students to see the knowledge they learned in science, technology, engineering and mathematics course as parts of a whole (MEB, 2017). Kennedy and Odell (2014) define STEM education as an integrated effort to remove the barriers between disciplines and to present a solution process to the problems with current tools and technologies. Venville, Rennie and Wallace (2012) similarly refer to STEM education as a necessary application to teach a subject with an interdisciplinary approach by considering it from a point of view based on different disciplines, rather than a single discipline which limits its explanation. STEM education provides the students with the opportunity to find solutions to their daily life problems by harmonising the contents of the four disciplines and integrating disciplines (Moore et al., 2014).

STEM (FeTeMM) is an abbreviation with the initials of science, technology, engineering and mathematics. Although this teaching approach, called STEM in the USA, has become more widely used as an integration of mathematics and science courses, it also serves to teach engineering and technology in and out of classroom activities (Sahin, Ayar & Adıguzel, 2014). The origins of the STEM-FeTeMM teaching approach date back to 1990 (Corlu, Capraro & Capraro, 2014; Sahin et al., 2014; Yamak, Bulut & Dundar, 2014; Yildirim and Altun, 2015).

The teachers have an important responsibility in the training of the human profile that the countries need. The need for individuals who can think scientifically, question, solve problems, work interdisciplinary, be productive, criticize, work creatively and cooperatively has increased (Akaygun & Aslan Tutak, 2016). With the STEM education, it is important that teachers have the knowledge and skills to use different disciplines in an integrated manner in the training of students who have the 21st century skills. Corlu et al. (2014) also stated that the aim of STEM initiatives is to increase the number and quality of STEM teachers. Teachers need to have subject matter knowledge, pedagogical knowledge and pedagogical content knowledge in order to plan the educational process by bringing the disciplines together (Shulman, 1986).

In the study conducted by Basaran (2018), it was concluded that in-school Stem activities positively affect the social products, social product team work, social product presentation and cognitive process engineering skills of pre-school children. In his study, Alici (2018) stated that the problem-based Stem education has a positive effect on the attitudes and career perceptions of the students. Ciftci (2018) emphasised on the fact that the Stem approach was effective in improving the scientific creativity levels of the students, and that these were effective in developing their opinions about Stem professions. In addition, Bilekyigit (2018) mentioned that Stem approach provides the permanence of the course and increases the interest of career. Teacher candidates should know and be able to apply STEM education in order to educate students who have high academic success and who can bring together different disciplines to think as scientists. Developments in science and technology require the regulation of learning environments and the update of the methods and techniques to be used. In this study, in order to improve the quality of education and to contribute to the literature, teacher candidates who will be Stem implementer were asked to answer the following questions to get their opinions:

1.1. Purpose

In this study, it is aimed to evaluate the attitudes of the teacher candidates' towards STEM and STEM's sub-dimensions.

1.2. Sub-objectives

The sub-objectives created for the purpose of the research are listed as follows:

1. Are the attitudes of teacher candidates about Sciences were different according to the demographic data (gender, grade, department, STEM related course, relation to STEM and having knowledge about STEM)?
2. Are the attitudes of teacher candidates about Technology were different according to the demographic data (gender, grade, department, STEM related course, relation to STEM and having knowledge about STEM)?
3. Are the attitudes of teacher candidates about Mathematics were different according to the demographic data (gender, grade, department, STEM related course, relation to STEM and having knowledge about STEM)?
4. Are the attitudes of teacher candidates about Engineering were different according to the demographic data (gender, grade, department, STEM related course, relation to STEM and having knowledge about STEM)?
5. Are the attitudes of teacher candidates about STEM were different according to the demographic data (gender, grade, department, STEM related course, relation to STEM and having knowledge about STEM)?
6. Is there a significant relationship between teacher candidates' attitudes about science, technology, mathematics, engineering and STEM?

1.3. Importance

It is thought that the acceptance of STEM method by teacher candidate, which is an innovative educational approach of the research results, will contribute to the literature and the future studies in this field.

2. Method

2.1. Model of research

In this study, the relational research model of quantitative methods was used to evaluate the attitudes of the teacher candidate towards STEM and STEM's sub-dimensions. The quantitative method is a type of research, which can be observed, measured and quantified of phenomenon and events (Buyukozturk, 2014).

2.2. Study group

A total of 204 teacher candidates (117 females and 87 males) studying in various departments of Sakarya University Faculty of Education constitute the study group.

2.3. Data collection tools

In this study, it is aimed to evaluate the attitudes of the teacher candidates' towards STEM and STEM's sub-dimensions. In this context, it was used as a data collection tool from attitude scale for STEM and STEM's sub-dimensions developed by Keles, Kiremit and Aktamis (2017).

Attitude scales prepared previously for science, technology, mathematics, engineering and STEM subjects were analysed for each scale. A five-point Likert-type rating was used for each item in the scales; (5 = Totally Agree, 4 = Agree, 3 = No Idea, 2 = Disagree and 1 = Completely Disagree).

Number of items of scales as follows:

Attitude scale for science—15

Attitude scale for technology—18

Attitude scale for mathematics—16

Attitude scale for engineering—15

Attitude scale for STEM—20.

2.4. Data Analysis

General average and Standard deviation values were taken into consideration in explaining the data differences for the sub-dimensions of the scale.

3. Findings and comments

This section includes the observations and comments obtained for the objectives and sub-objectives.

3.1. Relating the attitudes of teacher candidates about science, technology, mathematics, engineering and STEM with demographic data

In this section, the attitudes of teacher candidates about science, technology, mathematics, engineering and STEM are correlated with demographic data which are gender, grade, department, STEM related course, relation to STEM and general information about STEM.

3.1.1. The relationship between teacher candidates' science attitudes and gender

Table 1. The relationship between science attitudes and gender of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between groups	1,717	1	1,717		
In groups	36,407	202	0.180	9.528	0.02
Total	38,124	203			

According to the one-way ANOVA test performed when Table 1 is examined, it was concluded that the attitudes of teacher candidates towards science have a significant effect on gender variable ($p < 005$).

3.1.2. The relationship between teacher candidates' science attitudes and classes

Table 2. The relationship between science attitudes and classes of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between groups	8,953	3	2.984		
In groups	29,171	200	0.146	20.46	0.00
Total	38,124	203			

According to the results of the one-way ANOVA test performed in Table 2, it was concluded that the attitudes of teacher candidates towards the science had a significant effect on the class variable ($p < 0.005$). Scheffe test; it does not only correct for double comparisons, it is also a test that analyses all possible comparisons (Can, 2016). The comparative results of the Scheffe test among subgroups are presented in Table 3.

Table 3. Scheffe test results by class variables

Class (I)	Class (J)	Row difference	*S*	*p*
1	2	0.47121*	0.09233	0.000
	3	−0.15022	0.07503	0.264
	4	0.20382	0.07368	0.057
2	1	−0.47121*	0.09233	0.000
	3	−0.62143*	0.08674	0.000
	4	−0.26739*	0.08557	0.023
3	1	0.15022	0.07503	0.264
	2	0.62143*	0.08674	0.000
	4	0.35404*	0.06655	0.000
4	1	−0.20382	0.07368	0.057
	2	0.26739*	0.08557	0.023
	3	−0.35404*	0.06655	0.000

According to Scheffe test results (Table 3), 1–2; 2–3; 2–4; 3–4, there was a significant difference between classes ($p < 0.05$).

3.1.3. The relationship between teacher candidates' science attitudes and department

Table 4. The relationship between science attitudes and department of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	5,976	3	1.992		
In groups	32,149	200	0.161	12.3	0.00
Total	38,124	203			

According to the one-way ANOVA test performed when Table 4 is examined, it was concluded that the attitudes of teacher candidates towards science have a significant effect on the department variable ($p < 0.005$). The post-hoc Scheffe test was used to determine which subgroups differ according to the department variable. The comparative results of the Scheffe test among subgroups are presented in Table 5.

Table 5. Scheffe test results by department variable

Class (I)	Class (J)	Row difference	*S*	*p*
Science	Maths	−0.02098	0.07258	,994
	Computer	0.03581	0.08961	,984
	Other	0.41390*	0.07417	0.000
Maths	Science	0.02098	0.07258	,994
	Computer	0.05679	0.09799	,953
	Other	0.43488*	0.08410	0.000
Computer	Fen	−0.03581	0.08961	,984
	Maths	−0.05679	0.09799	,953
	Other	0.37809*	0.09917	0.003
Other	Science	−,20382	0.07417	0.000
	Maths	0.26739*	0.08410	0.000
	Computer	−0.35404*	0.09917	0.003

According to Scheffe test results (Table 5), department variables compared to sub-groups fen-other; A significant difference was found between mathematics-other and computer-related parts (p < 0.005).

3.1.4. The relationship between teacher candidates' attitudes to science and STEM education

Table 6. The relationship between teacher candidates' attitudes to science and STEM education one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	8,999	1	8.999		
In groups	29,125	202	0.144	62.41	00.00
Total	38,124	203			

According to the results of the one-way ANOVA test performed when Table 6 is examined, it was concluded that the attitudes of teacher candidates towards science had a significant effect on STEM education variable (p <005).

3.1.5. The relation between teacher candidates' attitudes to science and being related to STEM

Table 7. The relation between teacher candidates' attitudes to science and being related to STEM one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	4,922	2	2.461		
In groups	33,202	201	0.165	14.90	00.00
Total	38,124	203			

According to the one-way ANOVA test performed when Table 7 is examined; It was concluded that the attitudes of teacher candidates towards science had a significant effect on STEM-related variable ($p < 0.005$).

3.1.6. The relationship between teacher candidates' knowledge about STEM and science attitudes

Table 8. The relationship between teacher candidates' knowledge about STEM and science attitudes one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	3,925	3	1.308		
In groups	34,199	200	0.171	7.652	00.00
Total	38,124	203			

According to the results of the one-way ANOVA test performed in Table 8, it has been concluded that the attitudes of teacher candidates towards science have a significant effect on the variable of knowledge about STEM ($p < 0.005$).

3.1.7. The relationship between teacher candidates' technology attitudes and gender

Table 9. The relationship between technology attitudes and gender of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	,251	1	0.251		
In groups	19,255	202	0.095	2.635	0.106
Total	19,506	203			

According to the one-way ANOVA test performed when Table 9 is examined, it was concluded that teacher candidates' attitudes towards technology did not have a significant effect on gender variable ($p > 0.005$).

3.1.8. The relationship between teacher candidates' technology attitudes and classes

Table 10. The relationship between technology attitudes and classes of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	7,823	3	2.608		
In groups	11,683	200	0.058	44.64	0.000
Total	19,506	203			

According to the one-way ANOVA test performed when Table 10 is examined, it was concluded that teacher candidates' attitudes towards technology had a significant effect on the class variable ($p < 0.005$). The comparative results of the Scheffe test among subgroups are presented in Table 11.

Table 11. Scheffe test results by class variables

Class (I)	Class (J)	Row difference	*S*	*p*
1	2	0.30566*	0.05843	0.000
	3	−0.16373*	0.04748	0.009
	4	−0.29150*	0.04663	0.000
2	1	−0.30566*	0.05843	0.000
	3	−0.46939*	0.05489	0.000
	4	−0.59716*	0.05415	0.000
3	1	0.16373*	0.04748	0.009
	2	0.46939*	0.05489	0.000
	4	−0.12777*	0.04212	0.029
4	1	0.29150*	0.04663	0.000
	2	0.59716*	0.05415	0.000
	3	0.12777*	0.04212	0.029

According to Scheffe test results (Table 11), when the sub-groups of the class variables were compared, a significant difference was found between all classes (1., 2., 3., and 4.) ($p < 0.005$).

3.1.9. The relationship between teacher candidates' technology attitudes and department

Table 12. The relationship between technology attitudes and department of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	4,977	3	1.659		
In groups	14,529	200	0.073	22.83	00.00
Total	19,506	203			

According to the one-way ANOVA test performed when Table 12 is examined, it was concluded that the attitudes of teacher candidates towards technology had a significant effect on the department variable ($p < 0.005$).

Post-hoc Scheffe Test was used after ANOVA to determine which subgroups differ according to the department variable. The comparative results of the Scheffe test among subgroups are presented in Table 13.

Table 13. Scheffe test results by department variable

Class (I)	Class (J)	Row difference	*S*	*p*
science	Maths	0.17296*	0.04879	0.007
	computer	−0.05226	0.06024	0.861
	Other	0.37356*	0.04986	0.000

maths	Science	−0.17296*	0.04879	0.007
	computer	−0.22522*	0.06588	0.010
	Other	0.20061*	0.05654	0.007
computer	Fen	0.05226	0.06024	,861
	Maths	0.22522*	0.06588	0.010
	other	0.42582*	0.06667	0.000
other	Science	−0.37356*	0.04986	0.000
	Maths	−0.20061*	0.05654	0.007
	computer	−0.42582*	0.06667	0.000

According to Scheffe test results (Table 13), science-mathematics, fen-other, mathematics-computer, there was a significant difference between mathematics-other and computer-other parts ($p < 0.05$).

3.1.10. The relationship between teacher candidates' attitudes to technology and STEM education

Table 14. The relationship between teacher candidates' attitudes to technology and STEM education one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,51	1	1.51		
In groups	19,355	202	0.096	1.577	0.211
Total	19,506	203			

According to the one-way ANOVA test performed when Table 14 is examined, it was concluded that teacher candidates' attitudes towards technology had no significant effect on STEM education variable ($p > 0.005$).

3.1.11. The relation between teacher candidates' attitudes to technology and being related to STEM

Table 15. The relation between teacher candidates' attitudes to being related to STEM one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,512	2	0.756		
In groups	17,944	201	0.090	8.442	0.000
Total	19,506	203			

According to the one-way ANOVA test performed when Table 15 is examined, it was concluded that teacher candidates' attitudes towards technology had a significant effect on STEM-related variable ($p < 0.005$).

3.1.12. The relationship between teacher candidates' knowledge about STEM and technology attitudes

Table 16. The relationship between teacher candidates' knowledge about STEM and technology attitudes one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	7,396	3	2.465		
In groups	12,110	200	0.061	40.71	0.000
Total	19,506	203			

According to the one-way ANOVA test performed when Table 16 is examined, it was concluded that the attitudes of teacher candidates' towards technology had a significant effect on STEM-related variables (p <0.005).

3.1.13. The relationship between teacher candidates' mathematics attitudes and gender

Table 17. The relationship between mathematics attitudes and gender of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,342	1	1.342		
In groups	30,356	202	0.150	8.928	0.003
Total	31,697	203			

According to the one-way ANOVA test performed when Table 17 is examined, it was concluded that the attitudes of teacher candidates' towards mathematics had a significant effect on gender variable (p < 0.005).

3.1.14. The relationship between teacher candidates' mathematics attitudes and classes

Table 18. The relationship between mathematics attitudes and classes of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	9,468	3	3.156		
In groups	22,229	200	0.111	28.39	0.000
Total	31,697	203			

According to the one-way ANOVA test performed when Table 18 is examined, it was concluded that the attitudes of teacher candidates' towards mathematics had a significant effect on the class variable (p < 0.005). Post-hoc Scheffe Test was used after ANOVA to determine which subgroups were different according to the class variable. The comparative results of the Scheffe test among subgroups are presented in Table 19.

Table 19. Scheffe test results by class variables

Class (I)	Class (J)	Row difference	S	P
1	2	0.40460*	0.08060	0.000
	3	−0.08838	0.06550	0.611
	4	−0.27605*	0.06432	0.001
2	1	−0.40460*	0.08060	0.000
	3	−0.49298*	0.07572	0.000
	4	−0.68064*	0.07470	0.000
3	1	0.08838	0.06550	,611
	2	0.49298*	0.07572	0.000
	4	−0.18766*	0.05810	0.017
4	1	0.27605*	0.06432	0.001
	2	0.68064*	0.07470	0.000
	3	0.18766*	0.05810	0.017

According to Scheffe test results (Table 19), class variable when compared subgroups 1-2.; 1-4; 2-3; 2-4 and 3-4, there was a significant difference between classes ($p < 0.005$).

3.1.15. The relationship between teacher candidates' mathematics attitudes and department

Table 20. the relationship between mathematics attitudes and department of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	8,977	3	2.992		
In groups	22,720	200	0.114	26.34	0.000
Total	31,697	203			

According to the results of the one-way ANOVA test when Table 20 is examined, it was concluded that the attitudes of teacher candidates' towards mathematics had a significant effect on the department variable (p <0.005). The comparative results of the Scheffe test among subgroups are presented in Table 21.

Table 21. Scheffe test results by section variable

Class (I)	Class (J)	Row difference	*S*	*p*
Science	Maths	0.20780*	0.06101	0.010
	computer	0.01234	0.07533	,999
	Other	0.53171*	0.06235	0.000
Maths	Science	−0.20780*	0.06101	0.010
	computer	−0.19546	0.08238	0.135
	Other	0.32391*	0.07070	0.000
Computer	Fen	−0.01234	0.07533	0.999
	Maths	0.19546	0.08238	0.135
	other	0.51937*	0.08337	0.000
Other	Science	−0.53171*	0.06235	0.000
	Maths	−0.32391*	0.07070	0.000
	computer	−0.51937*	0.08337	0.000
		0.20780*	0.06101	0.010

According to Scheffe test results (Table 21), science-mathematics; fen-other, there was a significant difference between mathematics-other and computer-related parts ($p < 0.05$).

3.1.16. The relationship between teacher candidates' attitudes to mathematics and STEM education

Table 22. The relationship between teacher candidates' attitudes to mathematics and stem education one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,719	2	0.896		
In groups	29,906	201	0.149	60.020	0.003
Total	31,697	203			

According to the one-way ANOVA test performed when Table 22 is examined, it was concluded that the attitudes of teacher candidates' towards mathematics had a significant effect on STEM-related variable (p <005).

3.1.17. The relationship between teacher candidates' knowledge about STEM and mathematics attitudes

Table 23. The relationship between teacher candidates' knowledge about STEM and mathematics attitudes one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	F	p
Between Groups	7,656	3	2.552		
In groups	24,041	200	0.120	21.23	0.000
Total	31,697	203			

According to the one-way ANOVA test performed when Table 23 is examined; it was concluded that the attitudes of teacher candidates' towards mathematics had a significant effect on STEM-related variables ($p < 0.005$).

3.1.18. The relationship between teacher candidates' engineering attitudes and gender

Table 24. The relationship between engineering attitudes and gender of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,306	1	1.306		
In groups	56,014	202	0.277	4.708	00.03
Total	57,139	203			

According to the results of the one-way ANOVA test (Table 24), it was concluded that the attitudes of teacher candidates' towards engineering had a significant effect on gender variable ($p < 0.005$).

3.1.19. The relationship between teacher candidates' engineering attitudes and classes

Table 25. The relationship between engineering attitudes and classes of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	15,566	3	5.189		
In groups	41,754	200	0.209	24.85	00.00
Total	57,139	203			

According to the results of the one-way ANOVA test performed on Table 25, it was concluded that the attitudes of teacher candidates' towards engineering had a significant effect on class variable ($p < 0.005$). Post-hoc Scheffe Test was used after ANOVA to determine which subgroups were different according to the class variable. The comparative results of the Scheffe test among subgroups are presented in Table 26.

Table 26. Scheffe test results by class variables

Class (I)	Class (J)	Row difference	*S*	*p*
1	2	−0.20157	0.11046	0.346
	3	−0.42578*	0.08977	0.000
	4	−0.72719*	0.08815	0.000
2	1	0.20157	0.11046	0.346
	3	−0.22421	0.10378	0.201

	4	−0.52562*	0.10238	0.000
3	1	0.42578*	0.08977	0.000
	2	0.22421	0.10378	0.201
	4	−0.30141*	0.07962	0.003
4	1	0.72719*	0.08815	0.000
	2	0.52562*	0.10238	0.000
	3	0.30141*	0.07962	0.003

According to Scheffe test results (Table 26), class variable when compared to subgroups 1–3; 1–4; 2–4 and 3–4, there was a significant difference between classes ($p < 0.005$).

3.1.20. The relationship between teacher candidates' engineering attitudes and department

Table 27. The relationship between engineering attitudes and department of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	15,209	3	5.070		
In groups	42,110	200	0.211	24.07	0.00
Total	57,139	203			

According to the results of the one-way ANOVA test performed on Table 27, it was concluded that the attitudes of teacher candidates' towards engineering had a significant effect on the department variable ($p < 0.005$). Post-hoc Scheffe test was used after ANOVA to determine which subgroups were different according to the section variable. The comparative results of the Scheffe test among subgroups are presented in Table 28.

Table 28. Scheffe test results by department variable

Class (I)	Class (J)	Row difference	*S*	*p*
Science	maths	0.70598*	0.08307	0.000
	computer	0.24403	0.10256	0.133
	other	0.24680*	0.08488	0.040
Maths	science	−0.70598*	0.08307	0.000
	computer	−0.46195*	0.11215	0.001
	other	−0.45918*	0.09626	0.000
Computer	fen	−0.24403	0.10256	0.133
	maths	0.46195*	0.11215	0.001
	other	0.00277	0.11350	10.000
Other	science	−0.24680*	0.08488	0.040
	maths	0.45918*	0.09626	0.000
	computer	−0.00277	0.11350	10.000
		0.70598*	0.08307	0.000

According to Scheffe test results (Table 28), science-mathematics, fen-other, a significant difference was found between mathematics-computer and mathematics-other departments ($p < 0.005$).

3.1.21. The relationship between teacher candidates' attitudes to engineering and STEM education

Table 29. The relationship between teacher candidates' attitudes to engineering and STEM education one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,182	1	1.182		
In groups	56,138	202	0.278	4.252	0.040
Total	57,319	203			

According to the results of the one-way ANOVA test performed on Table 29, it was concluded that the attitudes of teacher candidates' towards engineering have a significant effect on STEM education variable ($p < 0.005$).

3.1.22. The relation between teacher candidates' attitudes to engineering and being related to STEM

Table 30. The relation between teacher candidates' attitudes to engineering and being related to STEM one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	8,599	2	4.300		
In groups	48,720	201	0.242	17.73	0.000
Total	57,319	203			

According to the results of the one-way ANOVA test performed on Table 30, it was concluded that the attitudes of teacher candidates' towards engineering had a significant effect on STEM-related variable ($p < 0.005$).

3.1.23. The relationship between teacher candidates' knowledge about STEM and engineering attitudes

Table 31. The relationship between teacher candidates' knowledge about STEM and engineering attitudes one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	15,057	3	5.019		
In groups	42,262	200	0.211	23.75	0.000
Total	57,319	203			

According to the results of the one-way ANOVA test performed on Table 31, it was concluded that the attitudes of teacher candidates' towards engineering had a significant effect on STEM-related variables ($p < 0.005$).

3.1.24. The relationship between teacher candidates' STEM attitudes and gender

Table 32. The relationship between STEM attitudes and gender of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,197	1	1.197		
In groups	27,990	202	0.139	8.635	0.004
Total	29,187	203			

According to the results of the one-way ANOVA test performed on Table 32, it was concluded that pre-service teacher candidates' attitudes towards STEM have a significant effect on gender variable ($p < 0.005$).

3.1.25. The relationship between teacher candidates' STEM attitudes and class

Table 33. The relationship between STEM attitudes and class of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	4,197	3	1.399		
In groups	24,990	200	0.125	11.19	0.00
Total	29,187	203			

According to the results of the one-way ANOVA test performed on Table 33, it was concluded that teacher candidates' attitudes towards STEM have a significant effect on class variable ($p < 0.005$). Post-hoc Scheffe Test was used after ANOVA to determine which subgroups were different according to the class variable. The comparative results of the Scheffe test among subgroups are presented in Table 34.

Table 34. Scheffe test results by class variables

Class (I)	Class (J)	Row difference	*S*	*p*
1	2	−0.00513	0.08545	10.000
	3	−0.18767	0.06945	0.066
	4	−0.34658*	0.06820	0.000
2	1	0.00513	0.08545	10.000
	3	−0.18254	0.08029	0.163
	4	−0.34145*	0.07920	0.000
3	1	0.18767	0.06945	0.066
	2	0.18254	0.08029	0.163
	4	−0.15891	0.06160	0.087
4	1	0.34658*	0.06820	0.000
	2	0.34145*	0.07920	0.000
	3	0.15891	0.06160	0.087

According to Scheffe test results (Table 34), class variables when compared to subgroups 1–4 with 2–4 there was a significant difference between classes ($p < 0.005$).

3.1.26. The relationship between teacher candidates' STEM attitudes and department

Table 35. The relationship between STEM attitudes and department of teacher candidates' one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	2,742	3	0.914		
In groups	26,445	200	0.132	6.912	0.00
Total	29,187	203			

According to the one-way ANOVA test performed when Table 35 is examined; It was concluded that the attitudes of teacher candidates' towards STEM have a significant effect on the department variable ($p < 0.005$). Post-hoc Scheffe Test was used to determine which subgroups were different according to the section variable. The comparative results of the Scheffe test among subgroups are presented in Table 36.

Table 36. Scheffe test results by department variable

Class (I)	Class (J)	Row difference	*S*	*p*
Science	Maths	0.21799*	0.06583	0.013
	Computer	0.15520	0.08127	0.305
	Other	0.27233*	0.06727	0.001
Maths	Science	−0.21799*	0.06583	0.013
	Computer	−0.06280	0.08888	0.919
	Other	0.05434	0.07628	0.917
			0.06583	
Computer	Fen	−0.15520	0.08127	0.305
	Maths	0.06280	0.08888	0.919
	Other	0.11713	0.08995	0.639
		−0.27233*	0.06727	0.001
Other	Science			
	maths	−0.05434	0.07628	0.917
	computer	−0.11713	0.08995	0.639
		0.21799*	0.06583	0.013

According to Scheffe test results (Table 36), a significant difference was found between science-mathematics and science and other departments when compared with the sub-groups of the department variable ($p < 0.05$).

3.1.27. The relationship between teacher candidates' attitudes to the relationship between teacher candidates' attitudes to engineering and STEM education

Tablo 37. The relationship between teacher candidates' attitudes to the relationship between teacher candidates' attitudes to engineering and STEM education" one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	0,84	1	0.084		
In groups	29,103	202	0.144	0.580	0.447
Total	29,187	203			

According to the results of the one-way ANOVA test performed on Table 37, it was concluded that the attitudes of teacher candidates' towards STEM did not have a significant effect on STEM education variable ($p > 0.005$).

3.1.28. The relation between teacher candidates' attitudes to STEM and being related to STEM

Table 38. The relation between teacher candidates' attitudes to STEM and being related to STEM one-way anova test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	1,128	2	0.564		
In groups	28,059	201	0.140	4.040	0.019
Total	29,187	203			

According to the results of the one-way ANOVA test performed when Table 38 is examined, it was concluded that the attitudes of teacher candidates' towards STEM have a significant effect on STEM-related variable ($p < 0.005$).

3.1.29. The relationship between teacher candidates' knowledge about STEM and STEM attitudes

Table 39. The relationship between teacher candidates' knowledge about STEM and STEM attitudes one-way ANOVA test result

Source of variance	Total of squares	SD	Squares mean	*F*	*p*
Between Groups	3,846	3	1.282		
In groups	25,340	200	0.127	10.11	0.000
Total	29,187	203			

According to the one-way ANOVA test performed when Table 39 is examined, teacher candidates' attitudes towards STEM was concluded that there is a significant effect on the variable of knowledge about STEM ($p < 0.005$).

3.2. Determination of the Relationship between the Attitudes of the Teacher Candidates about Science, Technology, Mathematics, Engineering and STEM

The correlation technique was considered appropriate in order to evaluate this relationship included in the study. Correlation; it is defined as a statistical technique in which the amount of relationship between two variables and the effects of other variables related to these variables are controlled (Buyukozturk, 2013). In this context, when considering the distribution characteristics, 'Pearson Correlation Coefficient' was used in the analysis stage since the data were distributed normally. Pearson Correlation Coefficient; It is used to determine the amount of relationship between two variables which are obtained as a direct order (ordinal) or sorted according to a certain (Satıcı, 2014). According to the results of the Pearson Correlation Coefficient, the findings of the study on the relationship between the relevant variables are given in Table 31–40.

Table 40. Result of Pearson correlation analysis between teacher candidates' attitudes towards science and mathematics

	N	*R*	*p*
Attitude towards Science			
Attitude towards Technology	204	0.104	0.030

As seen in Table 40, there was a positive and significant relationship between teacher candidates' attitudes towards science and their attitudes towards technology (r = 030 and $p < 0.005$).

Table 41. Result of Pearson correlation analysis between teacher candidates' attitudes towards Science and Mathematics

	N	*R*	*p*
Attitude towards Science Attitude towards Mathematics	204	0.341	0.000

As seen in Table 41, there was a positive and significant relationship between teacher candidates' attitudes towards science and their attitudes towards mathematics (r =0.341 and $p < 0.001$).

Table 42. Pearson correlation analysis between teacher candidates' attitudes towards Science and Engineering

	N	*R*	*p*
Attitude towards Science Attitude towards Engineering	204	0.066	0.004

According to Table 42, a positive and significant relationship was found between pre-service teachers' attitudes towards technology and their attitudes towards mathematics (r =0.748 and $p < 0.005$).

Table 43. Result of Pearson correlation analysis between teacher candidates' attitudes towards Science and STEM

	N	*R*	*p*
Attitude towards Science Attitude towards STEM	204	0.548	0.000

Table 43 is examined; There was a high positive and significant correlation between the attitudes of teacher candidates' towards science and their attitudes towards STEM (r =0.548 and $p < 0.001$).

Table 44. Result of Pearson correlation analysis between teacher candidates' attitudes towards Technology and Mathematics

	N	*R*	*p*
Attitude towards Technology Attitude towards Mathematics	204	0.748	0.000

According to Table 44, a positive and significant relationship was found between teacher candidates' attitudes towards technology and their attitudes towards mathematics (r = 0.748 and $p < 0.001$).

Table 45. Result of Pearson correlation analysis between teacher candidates' attitudes towards Technology and Engineering

	N	*R*	*p*
Attitude towards Technology Attitude towards Engineering	204	0.596	0.000

According to Table 45, there was a high positive and significant relationship between teacher candidates' attitudes towards technology and their attitudes towards engineering (r =0.596 and p < 0.001).

Table 46. Result of Pearson correlation analysis between teacher candidates' attitudes towards Technology and STEM

	N	*R*	*p*
Attitude towards Technology Attitude towards STEM	204	0.588	0.000

Table 46 examined: A positive and significant relationship was found between teacher candidates' attitudes towards technology and their attitudes towards STEM ($r = 0.588$ and $p < 0.001$).

Table 47. Results of Pearson correlation analysis between teacher candidates' attitudes towards Mathematics and Engineering

	N	*R*	*p*
Attitude towards Mathematics Attitude towards Engineering	204	0.382	0.000

Table 47 is examined: There was a high positive and significant relationship between teacher candidates' attitudes towards mathematics and their attitudes towards engineering ($r = 0.382$ and $p < 0.001$).

Table 48. Result of Pearson correlation analysis between teacher candidates' attitudes towards Mathematics and STEM

	N	*R*	*p*
Attitude towards Mathematics Attitude towards STEM	204	0.356	0.000

Table 48 examined: A positive and significant relationship was found between teacher candidates' attitudes towards mathematics and their attitudes towards STEM ($r =0.356$ and $p < 0.001$).

Table 49. Results of Pearson correlation analysis between teacher candidates' and *stem and attitudes towards Engineering*

	N	*R*	*p*
Attitude towards Engineering Attitude towards STEM	204	0.372	0.000

Table 49 is examined: A positive and significant relationship was found between pre-service teachers' attitudes towards engineering and their attitudes towards STEM ($r =0.372$ and $p < 0.001$).

one-way ANOVA which is a parametric test was used in this correlation. One-way ANOVA tests whether there is a statistically significant difference between at least two of the averages for more than two independent groups, with the absence hypothesis as 'there is no significant difference between averages' and when the p-value calculated for the significance of the *F*-value exceeds 0.005, the hypothesis is considered accepted (Can, 2016).

As there is homogeneity (Levene test $f = 0.192$, $p > 0.05$) among the examined sections, ANOVA was used to analyse the data because the distribution fulfilled the normality assumption (Kolmogorov–Smirnov $p > 0.05$).

4. Results and conclusion

In this study in which the relationship between STEM and STEM's sub-dimensions was tried to be determined, the results of the study were determined as follows:

When comparing the attitudes of teacher candidates about science according to demographic data (gender, grade, department, STEM related course, relation to STEM and knowledge about STEM); a significant difference was found between all variables. As a result of the analysis, the gender variable for the attitudes about science is in favour of female students. When the department variable is compared in terms of attitudes about science; it was found to be significant in favour of the mathematics department. In addition, when other variables are correlated with the attitudes about science; they have been found significant for STEM-related courses, relation to STEM and knowledge about STEM. Similarly, in the study of Karakaya et al. (2018), it was found that there was a significant difference in the awareness of science teachers about STEM approach according to gender, professional experience, in-service/course/seminar and education level. In the study of Marulcu and Sungur (2013) conducted with science teacher candidates, almost half of the teacher candidates stated that learning engineering is very important for science education.

When comparing the attitudes of teacher candidates about technology according to demographic data (gender, grade, department, STEM related course, relation to STEM and knowledge about STEM); a significant difference was found between the variables of grade, department, relation to STEM and knowledge about STEM; no significant difference was found between gender and STEM-related courses. When comparing the department variable according to the attitudes about technology, it was found significant for computer department. In addition, when correlating the other variables according to the attitudes for technology, it has been found significant for relation to STEM and knowledge about STEM. In the study of Sen and Timur (2018) about the orientation of teacher candidates to STEM education and technology, the orientation of teacher candidates to technology have been found at an acceptable level.

When comparing the attitudes of teacher candidates about mathematics according to demographic data (gender, grade, department, STEM related course, relation to STEM and knowledge about STEM); a significant difference was found between all the variables. As a result of the analysis, the gender variable for the attitudes about mathematics is in favour of female students. When the department variable is compared in terms of attitudes about mathematics; it was found to be significant in favour of the science department. In addition, when other variables are correlated with the attitudes about mathematics; they have been found significant for STEM-related courses, relation to STEM and knowledge about STEM. In the study of Yenilmez and Balbag (2016), about the attitudes of Science and Elementary School Mathematics teacher candidates about STEM, science teacher trainees' attitudes towards STEM in terms of science component, it has been concluded that science teacher candidates are more positive in their attitude to STEM for science component, while elementary school mathematics teacher candidates are more positive in their attitude to STEM for mathematics component.

When comparing the attitudes of teacher candidates about engineering according to demographic data (gender, grade, department, STEM related course, relation to STEM and knowledge about STEM); a significant difference was found between all the variables. As a result of the analysis, the gender variable for the attitudes about engineering is in favour of male students. When the department variable is compared in terms of attitudes about engineering; it was found to be significant in favour of the science department. In addition, when other variables are correlated with the attitudes about engineering; they have been found significant for STEM-related courses, relation to STEM and knowledge about STEM.

When comparing the attitudes of teacher candidates about STEM according to demographic data (gender, grade, department, STEM related course, relation to STEM and knowledge about STEM); a significant difference was found between all the variables. As a result of the analysis, the gender variable for the attitudes about STEM is in favour of male students. When the department variable is compared in terms of attitudes about STEM; it was found to be significant in favour of the science department. In addition, when other variables are correlated with the attitudes about STEM; they have been found significant for STEM-related courses, relation to STEM and knowledge about STEM.

In this study, the correlation technique was used to determine the relationship between the attitudes of teacher candidates about science, technology, mathematics, engineering, and STEM and as a result of the analyses, a positive and significant relationship was found between all sub-dimensions of STEM. In the study of Popa and Ciascai (2017), it was determined that the students who participated in the research had been interested in STEM field since their secondary and high school education and developed positive attitudes towards gaining knowledge and skills about engineering and in relation with engineering. In the study of Ozcakir, Sumen and Caliser (2016) conducted on teacher candidates, it was established during the interviews performed that they evaluate STEM education as effective, fun and enhancing the permanence of the information. In their studies, Gokbayrak and Karisan (2017) stated that the application for STEM education improve the scientific process skills of the teacher candidates. In their research studies of Yildirim and Altun, 2015; Can, 2016; Yildirim and Turk, 2018; Lin and Williams, 2015; Akaygun & Aslan-tutak, 2016), the opinions of middle school science and mathematics teachers towards STEM (science, technology, engineering and mathematics) education were examined.

The research was carried out for 30 hours with 28 science and mathematics teachers who were working in Istanbul during the spring semester of 2016–2017 academic year. As a result of the analysis, the teachers emphasised that they did not feel sufficient about STEM education and that a good STEM teacher should have STEM knowledge, pedagogy knowledge and the 21st century skill knowledge. Koçak (2019) aimed in his study to evaluate science, school teaching and mathematics teacher candidates' orientation levels for STEM education, according to different variables such as gender, department and university. The seven-point Likert-type 'Integrated STEM Education Orientation Scale', which was developed by Lin and Williams (2015) and adapted to Turkish by Hacıömeroğlu and Bulut (2016), has been applied to teacher candidates. As a result of the study when considering all the teacher candidates, it was determined that the levels of STEM education orientations were positive in the sub-dimensions of knowledge, value, attitude, subjective criteria and perceived behaviour control and behaviour orientation.

There is no significant difference in the variables of knowledge and subjective criteria when considering the gender variable while there is a significant difference between the mean scores of value, attitude and perceived behaviour control and behaviour orientation sub-dimensions in favour of women. When considering the teacher candidates according to the department variable, the difference between the average scores of knowledge, attitude, value, subjective criteria and perceived behaviour control and behaviour orientation sub-dimensions were found statistically significant.

SUGGESTION

Nowadays, with the acceleration of research studies on STEM education, teacher candidates, who are the most important element of the implementing stakeholders, must be raised as individuals equipped with STEM education to be able to carry out an effective and efficient STEM education (Akaygun & Aslan-tutak, 2016). In this context, in the study about the future studies to be conducted, the following suggestions are presented for the teacher candidates of the Faculty of Education to be educated as individuals equipped with STEM education;

- Implementation, within the scope of the curriculum of Faculties of Education of project design courses in accordance with educational design models in which they can associate their daily lives with STEM education,
- Utilisation of the opportunity of teacher candidates and teachers with positive attitudes about STEM practices to transform it into advantage and organisation of in-service trainings and seminars for teachers on this issue,
- Making the necessary strategic plans for teacher candidates to develop positive attitudes about STEM and to better adopt the relevant training,

- Establishing STEM centres in cooperation with universities and MoNE in order to create well-educated individuals and societies in the disciplines of science, technology, mathematics and engineering,
- Opening courses related to STEM education in undergraduate program, and opening master and doctorate programs,
- Conducting further post-graduate thesis studies on STEM education by universities,
- Courses with STEM content in the Faculties of Education,
- Conducting EU and TUBITAK projects on STEM,
- By promoting STEM centres, it can be suggested that students at all levels receive fair access to quality STEM education.

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