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Abstract

This study aims to investigate the relationship between pre-service form, elementary mathematics and elementary science teacher's STEM awareness and questioning skills. In addition to this aim, whether differences existed or not was also investigated in terms of the gender, class level and department variables. A total of 195 pre-service teachers participated in the study from the 3rd and 4thyears in the fall semester of the academic year of 2019-2020. The STEM Awareness and Questioning Skills Scales were used in this correlation study. Non-parametric tests were used in data analysis. For the STEM awareness positive opinion dimension, statistically significant differences were found in favour of the 4thyear participants. For the questioning skills knowledge control dimension, a statistically significant difference was found according to the gender in favour of the male participants. A medium-level positive relationship was found between the STEM awareness positive opinion dimension and the questioning skills dimensions, while a low-level relationship was found between the negative opinions and questioning skills dimensions.

Introduction

With the advancing technology, the need to reach qualified and accurate information for individuals has increased gradually within the education system. In order to meet such needs, individuals need to think creatively, gain a critical perspective and develop problem-solving skills both in business and in their daily lives (Şahin, 2019). These skills are expected to increase the competitiveness of countries during the innovation race between countries (Akgündüz et al., 2015). Additionally, the superiority and continuity of a country in scientific and economic fields depend on training of specialists in STEM (Science, Technology, Engineering, Mathematics) disciplines that are trained with these skills in the workforce (Raines, 2012).

STEM is a holistic approach known in the international literature as Science, Technology, Engineering and Mathematics (STEM) that enables development of 21st-century skills in individuals such as problem-solving, leadership, media literacy and communication skills (Buyruk & Korkmaz, 2016; Bybee, 2010; Dugger, 2010; Hebebci & Usta, 2017; Karakaya & Avgın, 2016; Rogers & Portsmore, 2004). With this approach, it is important to integrate technological developments with education, produce qualified information, put it into practice and increase the interest in the disciplines of science, technology, engineering and mathematics (Lacey

& Wright, 2009). Incorporation of the STEM approach in the education systems of countries is because they want to have a voice in the developing and changing world (Çorlu, Capraro & Capraro, 2014). Many countries, especially the United States, have incorporated the STEM approach into their education systems (Karakaya et al, 2018). The economic growth and the scientific leadership in United States are linking with STEM education (National Research Council, 2011).

Turkey is one of the developing countries in the world in STEM education fields and aims to compete with other countries economically and scientifically by revising its education system with STEM education. A review of studies on STEM in Turkey reveals that the STEM approach that was introduced to the world literature gained momentum after the call for papers regarding STEM education in 2014 (Çorlu, 2014), a research report about STEM Education in Turkey published in 2015 (Akgündüz et al., 2015) and activities of TUBITAK supporting STEM education within the development plan between 2011-2016 (Baran, Canbazoğlu-Bilici, & Mesutoğlu, 2015). This situation is supported by the emergence of papers from abroad mostly in studies conducted before 2015using the keywords of STEM or FeTeMM. The first STEM studies were carried out by universities followed by the objectives added by the Ministry of National Education to attach importance to STEM education in the strategic plan of 2015-2019 (Çevik, Danıştay & Yağcı, 2017). It was clearly indicated in the research report about STEM Education in Turkey published in 2015 that there was a need to raise a generation, consisting of individuals who are interested in STEM fields, innovative and entrepreneurial and who are able to think creatively (Akgündüz et al., 2015).

There are studies carried out by universities on the effectiveness of STEM activities designed using teaching methods such as context-based learning (Yıldırım, 2018), mastery learning (Yıldırım & Selvi, 2017), and argumentation (Yıldırım & Turk, 2018). Additionally, opinions of teachers (Açıkgül Fırat, 2020; Akgündüz & Akpınar, 2018; Bakırcı & Kutlu, 2018; Eroğlu & Bektaş, 2016; Gülgün, Yılmaz, & Çağlar, 2017; Hebebci, 2019; Özbilen, 2018; Özcan & Koştur, 2018; Taştan-Akdağ & Güneş, 2017; Timur & İnançlı, 2018; Uğraş, 2017; Uğraş & Genç, 2018), students (Akgündüz & Akpınar, 2018; Aydın & Karslı Baydere, 2019; Dönmez, 2017; Gülhan & Şahin, 2016; Hebebci, 2019; Karakaya, Yantırı, Yılmaz, & Yılmaz, 2019; Taştan-Akdağ & Güneş, 2017; Yıldırım & Turk, 2018) and pre-service teachers (Bektaş & Aslan, 2019; Hacıoğlu, Yamak, & Kavak, 2016; Şahin, 2019; Timur & İnançlı, 2018; Uğraş & Genç, 2018; Yıldırım, 2020) on the STEM approach were examined. Studies on STEM education were compiled by Yıldırım (2020) using the ADDIE expansion, and the STEM teacher institutes education model was introduced. In this model, it was ensured that a total of 80 hours of training was provided to teachers, and teachers created their own lesson plans.

Studies should ensure that STEM awareness is raised both at universities and among teachers. As a result, the competitiveness of countries in competition with each other with high STEM awareness is likely to increase. Awareness is defined as individuals or societies being conscious and sensitive towards their environment (Keleş, 2007). An increase in awareness levels means that the person is aware of themselves and their environment (Çevik, 2017). Thus, individuals with high STEM awareness are those who are conscious and sensitive about STEM education. It may be considered that these people will shape their own attitudes and behaviours with the STEM approach over time.

The literature on STEM awareness demonstrates that studies related to STEM education are important at all years of study and levels, and it is of great importance to examine the practical relationships between STEM disciplines, theory and practice at schools and universities (Çorlu, et al., 2012). In another study, the STEM awareness levels of university students were analysed based on the gender and year level variables, and it was found that STEM awareness was high, and there was no significant relationship between the class levels of the female students (Hebebci & Usta, 2017). In a master's thesis where the effects of STEM activities on science teachers' STEM awareness were investigated, it was stated that pre-service teachers who conducted such activities increased their awareness and had a positive attitude towards STEM dimensions (Şahin, 2019). In a study conducted with pre-service pre-school teachers, it was concluded that the teachers who received STEM education had higher awareness, and the awareness levels of male students were significantly higher than those of female students (Ünlü & Dere, 2019). In a study focusing on examination of STEM awareness based on different variables among secondary school teachers, it was observed that positive and negative STEM awareness was not significantly different in terms of the gender and year level variables, but there was a significant difference in the type of faculty of graduation and professional seniority variables (Çevik et al., 2017).

A literature review shows that there are mainly case studies that are designed to determine STEM awareness. The study conducted by Deveci (2018) was aimed at determining the relationship between STEM awareness and entrepreneurial characteristics. It was revealed that STEM awareness is the most predictive of emotional intelligence among entrepreneurial features. This study conducted by Deveci ascertained that STEM awareness may be related to other variables. It is expected that teachers or pre-service teachers who practice STEM activities in their classes, that is, who have a high STEM awareness, will have the capacity to create STEM awareness by activating their inquiry-based learning strategies (Reeve, 2015). Additionally, the innovative, critical thinking, creativity and problem-solving aspects of the STEM approach are also features that may be seen in individuals with high questioning skills (Aktaş, 2019).

Questioning skills generally aim to guide students to structure their knowledge, understand scientific content conceptually, develop relevant process skills and understand the nature of science (Chin & Chia, 2006; Ekici, 2017; Zion & Sadeh, 2007). The questioning skill defined as a basic skill by the Ministry of National Education (2004) involves noticing and understanding the problem by asking the correct and meaningful questions, planning research on what to solve and how to solve the problem, estimating and testing the results and developing ideas.

In a study designed to determine the factors affecting the questioning skills of students, it was found that perceptions differed significantly according to gender, year level and science achievement levels (Ekici, 2017). In a master's thesis related to the effect of the inquiry-based learning strategy on students' questioning skills and science achievements, it was concluded that there was a significant relationship between the students' achievement scores and their perceptions of questioning skills (Taşkoyan, 2008). A study that investigated the questioning skills of pre-service teachers in the context of pedagogical content knowledge determined that the pre-service mathematics teachers' questioning skills were not sufficient (Tanışlı, 2013).

Although there are many studies on STEM education in the literature, it is noteworthy that there are a limited number of studies investigating STEM awareness and questioning skills together (Ayar & Adıgüzel, 2014; Çorlu et al., 2014; Eroğlu & Bektaş, 2016; Siew, Amir & Chong, 2015; Şahin, 2019). The literature review on STEM awareness and questioning skills presented no study that focused on revealing the relationship between the two concepts and on revealing teachers' STEM awareness and questioning skills. However, there are a plethora of studies regarding STEM carried out on students and teachers. The aim of this study is to reveal the relationship between pre-service teachers' STEM awareness and their questioning skills.

The Aim of the Study

The aim of this study is to investigate the relationship between the STEM awareness and questioning skills of pre-service elementary school mathematics and science teachers. For this purpose, the following questions were addressed:

1. Is there any significant difference among the STEM awareness levels of pre-service form, elementary science and elementary mathematics teachers based on their gender, year levels and departments?
2. Is there any significant difference between the pre-service form, elementary science and elementary mathematics teachers' questioning skills dimensions including knowledge acquisition, knowledge control and self-confidence based on their gender, class levels and departments?
3. Is there any significant relationship between the pre-service form, elementary science and elementary mathematics teachers' STEM awareness and their questioning skills dimensions including knowledge acquisition, knowledge control and self-confidence?

Method

In order to address research questions, this non-experimental study was carried out. This study involved collecting data to determine whether, and to what degree, a relationship exists among two or more quantifiable variables (Kline, 2009).

Participants

The participants of this study consisted of all 3rd and 4th-year students enrolled at the departments of form teaching, elementary mathematics teaching and elementary science teaching within the Faculty of Education, Siirt University during the academic year of 2018-2019. The reason for selection of pre-service teachers studying at these programs was that they took part in programs that could be associated with STEM at Siirt University and took courses with STEM content. Among the other programs related to STEM, there were no classes with STEM content in the Computer and Instructional Technologies Teaching program. Additionally, Physics, Chemistry and Biology teaching programs were not available at the Faculty of Education at Siirt University. Therefore, the purposive sampling method was used in the study. It is known that the STEM approach is introduced along with practices in the classes in the course content of Science and Technology Teaching and Special Teaching Methods until the 3rd year. A total of 242 pre-service teachers studying these classes were mainly expected to be reached with 219 of them filling in questionnaires during the course hours. However, the results of 195 pre-service teachers were evaluated after 24 of the collected questionnaires were excluded from the study for the reasons stated in the data analysis section. The characteristics of the pre-service teachers participating in the study are shown in Table 1.

Table 1 highlights that 96 (49%) of the 195 pre-service teachers participating in the study were pre-service form teachers, 49 (25%) were pre-service elementary mathematics teachers, and 50 (26%) are were pre-service science teachers. Of the pre-service teachers, 104 (53%) were in their 3rd year of study, and 91 (47%) were in their4th year. Additionally, 109 (56%) were women, and 86 (44%) were men.

Table 1. Characteristics of Participants within the Sample

		Class Level				Gender				Total	
		3rd Year		4th Year		Female		Male			
		f	%	f	%	f	%	f	%	f	%
Department	Form	53	55	43	45	46	48	50	52	96	49
	Elementary Mathematics	30	61	19	39	29	59	20	41	49	25
	Elementary Science	21	42	29	58	34	68	16	32	50	26
	Total	104	53	91	47	109	56	86	44	195	100

Data Collection Tools

Within the scope of this study, two separate scales were taken from the literature to measure STEM awareness and questioning skills.

STEM Awareness Scale

The “STEM Awareness Scale” developed by Buyruk and Korkmaz (2016) was used to determine the STEM awareness levels of the pre-service teachers. Validity and reliability tests were also carried out within this study. In order to ensure the construct validity of the scores obtained from the scale, explanatory factor analysis was performed. Kaiser-Meyer-Olkin (KMO) and Bartlett’s tests were performed to see the adequacy of the sample for factor analysis, and the Cronbach’s Alpha statistic for each construct was calculated to obtain reliability evidence for the scale scores. These values are shown in Table 2.

Table 2. KMO, Bartlett’s and Cronbach’s Alpha Values of the STEM Awareness Scale

Kaiser-Meyer-Olkin (KMO)		.850
Bartlett’s Test	Chi-Squared	2218.079
	Df	136
	Sig.	0.000
Cronbach Alpha		
Positive Opinion		.87
Negative Opinion		.81

A KMO value of higher than 0.60 and a significant Bartlett's test result are necessary to perform factor analysis in terms of sampling adequacy (Pallant, 2007). It will be appropriate to include items with a factor load distribution above 0.30 in the scale (Kline, 1994). Considering these situations in the literature, it was seen that item 12 of the scale that was applied had no relationship to any factor and was therefore excluded from the scale. Another study that applied the same scale(Çevik et al., 2017) also stated that item 12 in the scale was excluded as it did not co-operate well with the rest of the scale. The scale consists of two factors as positive and negative opinions, and the factor load distributions of the items are shown in Table 3.

Table 3. Factors in the STEM Awareness Scale and Load Distributions

Positive Opinion	Item 1	.56	Negative Opinion	Item 11	.67
	Item 2	.89		Item 13	.41
	Item 3	.69		Item 15	.87
	Item 4	.74		Item 16	.77
	Item 5	.55		Item 17	.40
	Item 6	.82			
	Item 7	.48			
	Item 8	.87			
	Item 9	.75			
	Item 10	.66			
	Item 14	.74			

Table 3 highlights that the STEM Awareness Scale consists of two factors, the load distributions of 11 items that make up the first factor range between 0.48 and 0.89, and the load distributions of the 5 items that make up the second factor range between 0.40 and 0.87. These two factors were found to explain 55.53% of the total variance. Tavşancıl (2005) stated that the variance explained in multiple factor scales should be between 40% and 60%.

For the reliability of the scale, the Cronbach's Alpha value shown in Table 2 was examined. This value was calculated as 0.87 for the positive opinions dimension and 0.81 for the negative opinions dimension. The fact that this value of more than 0.70 is sufficient for reliability is prevailing in the literature (Field, 2005). In the original scale, Buyruk and Korkmaz (2016) reported the Cronbach's Alpha values as 0.93 for positive opinions and 0.81 for negative opinions.

The Questioning Skills Scale

The "Questioning Skills Scale" developed by Karademir and Saracaloğlu (2013) was used to determine the questioning skills of the pre-service teachers. Like the STEM Awareness Scale, validity and reliability tests were conducted for this scale, as well. Exploratory factor analysis was performed for construct validity after receiving opinions from two experts for content validity. Prior to this analysis, the Cronbach's Alpha coefficient was calculated, as well as performing KMO and Bartlett's tests. These values are shown in Table 4.

Table 4. KMO, Bartlett's and Cronbach's Alpha Values of the Questioning Skills Scale

Kaiser-Meyer-Olkin (KMO)		0.813
Bartlett's Test	Chi-Squared	1634.494
	Df	91
	Sig.	0.000
Cronbach Alpha		
Knowledge Acquisition		0.71
Knowledge Control		0.81
Self-confidence		0.88

Table 4 highlights that the KMO value was higher than 0.60, and the Bartlett's test was significant. The factor load distribution of the Questioning Skills Scale was calculated, and the results in Table 5 were reached.

Table 5. Factors in the Questioning Skills Scale and Load Distributions

Knowledge Acquisition	Item 1	0.49	Knowledge Control	Item 7	0.38	Self-confidence	Item 12	0.89
	Item 2	0.66		Item 8	0.49		Item 13	0.90
	Item 3	0.59		Item 9	0.85		Item 14	0.85
	Item 4	0.67		Item 10	0.79			
	Item 5	0.75		Item 11	0.55			
	Item 6	0.55						

Table 5 highlights that the questioning skills scale consists of three factors; there are 6 items under the first factor (knowledge acquisition), and the factor load values range between 0.55 and 0.75; the second factor consists of 5 items (knowledge control), and the factor values range between 0.38 and 0.85; the third factor consists of 3 items (self-confidence), and the factor load values range between 0.85 and 0.90,and these three factors explain 58.39% of the total variance. Finally, the Cronbach's Alpha reliability coefficient of the questioning skills scale was calculated as 0.71 for knowledge acquisition, 0.81 for knowledge control and 0.88 for self-confidence. In the original scale, Karademir and Saracaloğlu (2013) reported the Cronbach's Alpha values as 0.76 for knowledge acquisition, 0.66 for knowledge control and 0.82 for self-confidence.

Data Analysis

During the data analysis process, the scales responses obtained from 219 pre-service teachers enrolled at the Form Teaching, Elementary Mathematics Teaching and Science Teaching programs were recorded in the SPSS 21.00 program. Then, the participants who repeatedly marked the same answer (i.e. I absolutely agree) in these scales and left some, many or all items blank were excluded from the study. The remaining 195 participants were firstly analysed in the data collection tools section for construct validity, and an item was removed from the STEM Awareness Scale. Then, reliability coefficients and factor load distributions were calculated for the dimensions of both scales.

For both scales, after they were recorded on the SPSS 21.0 software as "I absolutely disagree: 1", "I disagree: 2", "I am indecisive: 3", "I agree: 4" and "I absolutely agree: 5", the mean scores of the dimensions of the STEM Awareness, “positive opinions” and “negative “opinions” and the mean scores of the dimensions of questioning skills “knowledge acquisition”, “knowledge control” and “self-confidence” were calculated separately based on each independent variable including gender, class level and department and are presented in the findings section in tables.

To decide on one of the parametric or non-parametric tests, the normal distribution tests presented in Table 6 were calculated via Kolmogorov-Smirnov, while skewness/kurtosis values were calculated via Shapiro-Wilk statistics. As seen in Table 6, as the p-value of both scales used in the study was smaller than .05, and the skewness/kurtosis values were outside the values between -1.0 and +1.0 (Tabachnick & Fidell, 2012), the study was continued with non-parametric tests.

Table 6. Normality Test Results of the STEM Awareness and Questioning Skills Scales

		Kolmogorov-Smirnov			Shapiro-Wilk			Skewness/Kurtosis
		St.	N	p	St.	N	p	S/K
STEM Awareness	Positive Opinion	.07	195	.03	.97	195	.00	-.52/.32
	Negative Opinion	.14	195	.00	.93	195	.00	.85/.25
Questioning Skills	Knowledge Acquisition	.13	195	.00	.89	195	.00	-1.52/4.60
	Knowledge Control	.08	195	.00	.98	195	.01	-.23/.06
	Self-confidence	.11	195	.00	.94	195	.00	-.51/.00

Mann-Whitney U tests were conducted between the variables of gender and year levels, and Kruskal Wallis tests were conducted between the departments. Spearman’s rho values were calculated as non-parametric correlation test for the same reasons in order to reveal the relationship between STEM Awareness and Questioning Skills. The results of these tests are also presented in the findings.

Findings

In this section, firstly, whether there was a significant difference between the pre-service teachers' STEM awareness and questioning skills according to their department, year level and gender variables, and then, the relationships between the dependent variables were examined. The findings are presented in tables.

1. *Is there any significant difference among the STEM awareness levels of pre-service form, elementary science and elementary mathematics teachers based on their gender, year levels and departments?*

Table 7 shows whether there was a significant difference between the positive and negative opinions of the pre-service teachers' STEM awareness according to the gender and year level variables using Mann-Whitney U test.

As seen in Table 7, the female pre-service teachers' STEM awareness levels were higher than those of the male participants, but the difference in the scores was not significant. The positive opinion of the 4th-year pre-service teachers was significantly higher than that of the 3rd-year pre-service teachers. As regards to the negative opinion in STEM awareness, no significant difference was observed based on either gender or year level.

Table 7. Mann-Whitney U Results of STEM Awareness Dimensions Based on Variables of Gender and Class Level

		N		ss	Mean Rank	Rank Sum	Z	U	p
Positive STEM Awareness	Female	109	4.18	.58	104.93	11437.50	-1.933	3931.50	.05
	Male	86	4.03	.53	89.22	7672.50			
Negative STEM Awareness	Female	109	2.01	.82	91.84	10011.00	-1. 722	4016.00	.08
	Male	86	2.26	.96	105.80	9099.00			
Positive STEM Awareness	3rdYear	104	4.02	.60	89.64	9323.00	-2.213	3863.00	**.03**
	4thYear	91	4.21	.51	107.55	9787.00			
Negative STEM Awareness	3rdYear	104	2.07	.89	94.37	9814.50	-.964	4354.50	.34
	4thYear	91	2.18	.90	102.15	9295.50			

Whether STEM awareness was significantly different with respect to the department variable is shown in Table 8 via Kruskal Wallis test results.

Table 8. Kruskal Wallis Test Results for STEM Awareness Dimensions Based on Departments

		N		ss	Mean Rank	Chi- Square	Df	p
Positive Opinion	Form	96	4.18	.58	104.44	3.462	2	.18
	Elementary Mathematics	49	4.02	.49	86.05			
	Elementary Science	50	4.08	.60	97.35			
Negative Opinion	Form	96	2.12	.96	95.69	1.611	2	.45
	Elementary Mathematics	49	2.22	.83	106.72			
	Elementary Science	50	2.03	.82	93.89			

Table 8 highlights that the departments' positive opinion STEM awareness was close to each other. According to the Kruskal Wallis test results, there was no significant difference between the positive and negative opinions of the departments.

2. *Is there any significant difference between the pre-service form, elementary science and elementary mathematics teachers' questioning skills dimensions including knowledge acquisition, knowledge control and self-confidence based on their gender, class levels and departments?*

The Mann Whitney U test results regarding the pre-service teachers' questioning skills dimensions of knowledge acquisition, knowledge control and self-confidence are shown in Table 9.

Table 9. Mann-Whitney U Results Regarding the Questioning Skills Dimensions Based on Variables of Gender and Class Level

		N		ss	Mean Rank	Rank Sum	Z	U	p
Knowledge Acquisition	Female	109	4.08	.54	96.76	10547,00	-.347	4552.00	.73
	Male	86	4.10	.62	99.57	8563.00			
Knowledge Control	Female	109	3.56	.63	90.87	9905.00	-1.99	3910.00	**.04**
	Male	86	3.73	.77	107.03	9205.00			
Self-confidence	Female	109	3.52	1.03	97.74	10653.50	-.073	4658.50	.94
	Male	86	3.58	.95	98.33	8456.50			
Knowledge Acquisition	3rdYear	104	4.04	.65	94.27	9804.00	-.993	4344.00	.32
	4thYear	91	4.15	.48	102.26	9306.00			
Knowledge Control	3rdYear	104	3.64	.68	95.93	9977.00	-.549	4517.00	.58
	4thYear	91	3.64	.72	100.36	9133.00			
Self-confidence	3rdYear	104	3.50	1.03	95.12	9892.00	-.770	4432.00	.44
	4thYear	91	3.60	.96	101.30	9218.00			

As seen in Table 9, the mean scores of the male pre-service teachers in the questioning skills dimension of "knowledge control" were significantly higher than those of the female participants. No significant difference in terms of the gender variable was found in the dimensions of "knowledge acquisition" and "self-confidence". According to the class level independent variable, no significant difference was found between the levels in any dimension.

Whether the questioning skills differed significantly based on the department variable is shown in Table 10 via Kruskal Wallis test results.

Table 10. Kruskal Wallis Test Results Regarding the questioning Skills Dimensions Based on Departments

		N		ss	Mean Rank	Chi- Square	Df	p
Knowledge Acquisition	Form	96	4.09	.61	99.45	1.124	2	.57
	Elementary Mathematics	49	4.12	.56	102.29			
	Elementary Science	50	4.03	.55	91.02			
Knowledge Control	Form	96	3.70	.75	103.20	2.588	2	.27
	Elementary Mathematics	49	3.51	.68	87.35			
	Elementary Science	50	3.65	.61	98.45			
Self-confidence	Form	96	3.50	1.07	95.91	.279	2	.87
	Elementary Mathematics	49	3.59	.93	99.33			
	Elementary Science	50	3.60	.99	100.71			

As seen in Table 10, the mean scores of "knowledge acquisition" of the pre-service teachers of form, elementary mathematics and science teaching were higher than their "knowledge control" and "self-confidence" dimensions. There was no significant difference between the departments in the dimensions of questioning skills.

3. *Is there any significant relationship between the pre-service form, elementary science and elementary mathematics teachers' STEM awareness and their questioning skills dimensions including knowledge acquisition, knowledge control and self-confidence?*

The non-parametric "Spearman's rho test results" calculated for the relationship between the positive and negative opinions dimensions of STEM awareness of pre-service teachers and the knowledge acquisition, knowledge control and self-confidence dimensions of questioning skills are shown in Table 11.

Table 11. Spearman's Rho Correlation Results Between the STEM Awareness and Questioning Skills Dimensions

STEM Awareness		Questioning Skills		
		Knowledge Acquisition	Knowledge control	Self-confidence
Positive Opinion	Correlation Coefficient	.338**	.308**	.214**
	P	.000	.000	.003
	N	195	195	195
Negative Opinion	Correlation Coefficient	-.201**	-.124	-.184**
	P	.005	.085	.010
	N	195	195	195

**Correlation is significant on the level of .01.

As shown in Table 11, the positive opinion dimension of STEM awareness was positively correlated with questioning skills, and the negative opinion dimension of STEM awareness was negatively correlated with questioning skills. It may be stated that the correlation coefficient is low if it is between .00 and .30, medium if it is between .30 and .70, and high if it is above .70 (Büyüköztürk et al., 2018). Accordingly, the positive opinion dimension of STEM awareness hada medium-level correlation with the knowledge acquisition and knowledge control dimensions of questioning skills, and there was a low-level positive correlation between the positive opinions and self-confidence dimensions. A low-level negative correlation was found between the negative opinions of STEM awareness and questioning skills dimensions.

Discussion and Conclusions

In this study, in which the relationship between pre-service teachers' STEM awareness and questioning skills was examined, firstly, the issue of whether there were significant differences between them according to the independent variables including gender, year level and department was examined, and then, a correlation analysis was conducted between the variables. It was concluded that the STEM awareness of the female pre-service teachers was higher than that of the males, but the difference was not significant. The literature review reveals that male students are found to be more successful than female students in Turkey based on OECD examinations related to science literacy. Additionally, it was concluded that the STEM attitudes and achievements of female students were higher than those of male students (Karakaya & Avgın, 2016; Knezek, Christensen & Tylor-Wood, 2011). There are also results showing that there is no significant difference between teachers or pre-service teachers' STEM awareness and STEM attitudes based on the gender variable (Aydın, Saka, & Guzey, 2017; Bakırcı & Karışan, 2018; Çevik, 2017; Hacıömeroğlu, 2017; Simon, Wagner, & Killion, 2017). These results supported the results of this study.

It was concluded that there was a significant difference between the STEM awareness positive opinions in favour of the 4th-year participants based on the class level variable. This may be interpreted by examining the curriculum in terms of year levels. During the analysis in the form teaching curriculum, the pre-service teachers had just started to take science and technology teaching courses on the 3rd-year level and had not yet taken the mathematics teaching course. The elementary mathematics and science pre-service teachers, on the other hand, had just started to take the first of the special teaching methods course, but not the second one yet. The 4th-year students had taken all of these courses. The science, engineering, mathematics and technology applications in these courses may have created a significant difference between them. In support of this result and interpretation, Ünlü and Dere (2019) concluded that there is a statistically significant difference between the class year levels of pre-service teachers in favour of pre-service 4th -year teachers and stated that this result may have been related to whether pre-service teachers had completed the courses they had taken or not. This result supported the result of this study. In the study carried out by Hebebci and Usta (2017), it was stated that there was no statistically significant difference between 1st and 2nd-yearpre-service teachers. The reason why 1st and 2nd-year students were not included in this study was that their STEM awareness was thought to be low because they had not yet taken the relevant courses in their curricula.

It was understood that the mean scores in the STEM awareness dimensions were close to each other, and there was no significant difference between them. Similarly, Çevik et al. (2017) found that there was no significant difference between teachers' branch variables in terms of STEM awareness. STEM is not in the content area of a course, but it is a process that involves skills, abilities, factual information and concepts and requires higher-level thinking to move to learn further (Zollman, 2012). This situation shows that the STEM approach can be applied in an interdisciplinary manner rather than in a single field on behalf of the department variable. These results and interpretations supported the results of the study.

The questioning skills of the pre-teachers did not differ significantly in the dimensions of "knowledge acquisition" and "self-confidence" based on the gender variable, but they differed in the dimension of "knowledge control" in favour of the male pre-service teachers. In the study conducted by Karademir (2013), the questioning skills of pre-service teachers were examined with the scale used in this study, and no significant difference was found among the questioning skills dimensions based on the gender variable. Regarding knowledge control, male pre-service teachers' higher mean scores than female pre-service teachers shows that male pre-service teachers have a tendency to bring materials, events and objects together during a problem solution, try different or other solutions and test the accuracy of what they read or test it from more than one source (Karademir & Saracaloğlu, 2013). The questioning skills dimensions did not differ significantly between the class level and department variables. The questioning skills of pre-service teachers were examined by Yılmaz and Karamustafaoğlu (2015) by using the scale that was also used in this study on different variables, and no significant difference was found between the year level and the departments, which did not support the results of this study.

Finally, it was concluded that there was a moderate relationship between the positive opinions dimension of STEM awareness and the knowledge acquisition and knowledge control dimensions of questioning skills. There was also a significant low-level relationship between positive opinions and self-confidence, as well as between negative opinions and the knowledge acquisition and self-confidence dimensions. On the other hand, there was no significant relationship between negative opinions and the knowledge control dimension. This result showed that, with the improvement in STEM awareness, pre-service teachers' questioning skills may increase, or an increase in questioning skills may increase STEM awareness.

Recommendations

The results of this study showed that STEM awareness and questioning skills are interrelated. The situation that teachers have knowledge of teaching only in their field of expertise will not be sufficient in terms of raising trained individuals (Çorlu et al., 2014). Therefore, the following recommendations may be provided:

- Based on the conclusion that there is a significant difference in favour of the pre-service teachers in the 4^{th}year compared to the 3rd year, new courses can be added as it may be considered as an application to the field education courses included during the final years of education faculties.
- The mean scores of the pre-service teachers in knowledge acquisition, knowledge control and self-confidence range between the “indecisive” and “disagree” levels. In order to develop these questioning skills dimensions, course contents may be adjusted based on the inquiry-based learning approach.
- There may be an investigation into whether educational practices designed for STEM education have an impact on pre-service teachers' questioning skills.
- The relationship between pre-service teachers' STEM awareness and critical thinking, analytical thinking and creative thinking with the STEM approach may be investigated.

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