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INVESTIGATION OF SCIENCE TEACHER CANDIDATES' OPINIONS TOWARDS SCIENCE, TECHNOLOGY, ENGINEERING AND MATH (STEM) TEACHING

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ABSTRACT

In the present research, its aim was to investigate the opinions of prospective science teachers regarding science, technology, mathematics, and engineering teaching orientations. The research group of the study was constituted of 205 teacher candidates who were studying in the 1st, 2nd, 3rd and 4th grade at university' science education department in the academic year of 2017-2018. Integrated STEM teaching orientation scale was used as data collection tool in the study. In the analysis of the data, t-test and one-way analysis of variance were used for independent samples. As a result of the study, it was determined that the science teachers' opinions about the knowledge, value, attitude, subjective criterion, perceived behaviour control, and behavioural orientation on the integrated STEM teaching orientation scale were positive. It was found that there was a meaningful difference according to the grade level and grade average that teacher candidates did not differ according to gender variable.

Keywords: *Teacher Candidates, STEM, STEM Teaching*

INTRODUCTION

Innovations in science and technology, the changing needs of the individual and society, learning and teaching theories and innovation of the approaches, and also developments affect the roles expected of individuals (Ministry of Education [MEB], 2018a). Day by day, considering the fast advances and developments in science and technology, the need for individuals who can follow the developments in this field, catch up with the age and have a critical perspective has increased (Gökbayrak & Karışan, 2017). For this reason, individuals with 21st century skills should be trained to meet needs. The aim of science education today is to enable students to have scientific thinking, to have a wide perspective, to be responsible to their own countries and societies, to be creative individuals who think, criticize and question with 21st century skills (Yıldırım, 2016). Science, Technology, Engineering and Math training, which is a new educational approach, aims to provide students with 21st century skills and to train students in a holistic way (Ceylan, 2014). The concept of Science, Technology, Engineering and Math (STEM) consists of the abbreviation of the initials of STEM which are defined to be integrated with each other (Akgündüz et al., 2015). STEM education aims to enable the students to learn the problems of the world and solve the problems they will face in the future and to enable the students to acquire the knowledge in a more holistic and organized way (Aydin et al., 2017). The abbreviation STEM is defined as an approach based on problem and design, which is on the agenda of educators in

the United States and in many countries, which makes the student active or have been involved in or included in the curriculum (Tarkın-Çelikkıran & Aydın-Günbatar, 2017).

STEM education has become mandatory in all countries; they have tried to make life-oriented learning and interdisciplinary approach focused because of memorizing education system (MEB, 2018b). In the leading countries such as the United States, European Union, Korea, Germany, Japan and China, STEM education has begun to be applied in secondary schools and universities starting from primary schools (MEB, 2016). Turkey has received low scores in mathematics and science on The Programme for International Student Assessment (PISA) 2015 and the score is below the Organisation for Economic Co-operation and Development (OECD) average (Akgündüz et al., 2018). Therefore, in order to get a better result in the exams such as Trends in International Mathematics and Science Study (TIMSS) and PISA, STEM education should be necessary (MEB,2016).

Teachers play a very important role in terms of implementation and spread of STEM education in our country. (Çolakoğlu & Günay-Gökben, 2017). Through STEM training activities, teachers will make the learning more permanent and allow students to progress in science, technology, mathematics and engineering fields in the future (Hacıömeroğlu, 2018). Thus, STEM will enable them to move to the profession in their field. Therefore, it is necessary for the teacher candidates to have knowledge about STEM education before starting the work.

When the literature is examined, there are studies conducted on teacher candidates about STEM education. Yıldırım and Altun (2015) investigated the effect of STEM education and application of engineering education on academic achievement of science teachers. As a result of the research, they concluded that STEM education is effective in increasing academic achievement.

Kızılay (2016) tried to determine the opinions of science teacher candidates with open-ended questions about STEM field and education. As a result of this study, prospective teachers reported that STEM fields were related. Kırılmazkaya (2017), in her study, the teacher candidates to study the teaching orientation level STEM. As a result of the study, it was concluded that the prospective teachers' opinions about teaching education were positive.

Yenilmez and Balbağ (2016) investigated candidate teachers (science education and primary school math) attitudes towards STEM. As a result of the study, it was found that the teacher candidates' attitudes towards STEM were generally positive and science teacher candidates were more positive than primary mathematics teacher candidates.

STEM Teaching Orientation Dimensions

STEM teaching orientation dimensions are knowledge, value, attitude, subjective norms, and perceived behaviour control and behavioural orientations (Hacıömeroğlu, 2018). Lin and Williams (2016) refer to prospective teachers' adaptation of STEM instruction to their courses and their desire to use interdisciplinary behaviour as a behavioural approach towards STEM teaching. In this context, knowledge, value, attitude, subjective norms, alongside perceived behaviour control and behavioural orientations were used to examine the orientation levels of prospective teachers in STEM education. Knowledge size is to have knowledge of prospective teachers about their fields and other fields. Value dimension is the self-evaluation status of teacher candidates. Attitude dimension includes the practice of teaching STEM. The subjective criterion dimension includes the positive or negative behaviours of the school principals, colleagues, university lecturers of the reference groups in the behavioural orientation towards STEM teaching (Hacıömeroğlu, 2018). On the other hand; the perceived behavioural control dimension includes the evaluation and use of important resources and opportunities for pre-service teachers, during the teaching of STEM (Kırılmazkaya, 2017). The behavioural orientation dimension includes the use and adaptation of STEM teaching by teacher candidates in the professional life (Hacıömeroğlu, 2018).

PURPOSE OF THE STUDY

In this research, it is aimed to examine the opinions of prospective science teachers regarding science, technology, mathematics and engineering teaching orientations. The following questions were asked in this study:

1. What are the views of prospective science teacher's candidate about STEM teaching tendency?
2. Do prospective science teachers differ in STEM teaching tendency in terms of gender factor?
3. Do science teacher candidates differ in terms of the classroom level factor in STEM teaching orientation?
4. Do science teachers differ in their teaching orientation in terms of their grade point averages?

METHODOLOGY

In this research, mixed method which applies both quantitative and qualitative research methods is followed. Survey model is based on the quantitative stage and it is convenient to general survey model. The qualitative research is based on the views of the participants or the interests, skills, abilities, attitudes, etc. of a topic or event which are usually based on larger samples than on other studies (Büyüköztürk et al., 2011).

Research Sample

The study group of the research consisted of male and female total 205 science teacher's candidate who were studying on the 1st, 2nd, 3rd and 4th grade at one of the universities in Turkey, department of science education in 2017-2018 academic year.

Data Collection Tool

In the study, "The Preservice Teachers' Integrative STEM Teaching Intention Questionnaire" which was developed by Lin & Williams (2016) and adapted to Turkish by Hacıömeroğlu & Bulut (2016) was used. The Cronbach alpha reliability coefficient of the scale is 0.94. The scale consists of five dimensions; knowledge (α = 0.93), value (α = 0.86), attitude (α = 0.87), subjective norms (α = 0.69), perceived behaviour control and behavioural intention (α = 0.86) (Hacıömeroğlu, 2018). The scale consists of 31 items in total which are knowledge (1, 2, 3, 4), values (5, 6, 7, 8, 9, 10), attitude (11, 12, 13, 14, 15, 16), subjective norms (17, 18, 19, 20, 21), perceived behaviour control and behavioural intention (22, 23, 24, 25, 26 27, 28, 29, 30, 31) (Hacıömeroğlu & Bulut, 2016). The preservice teachers' integrative STEM teaching intention questionnaire' scale is 7-likert type.

Data Analysis

Analysis of data in the study was performed using SPSS 22.0 package program. In order to determine whether the opinions of the prospective teachers in the research about the level of STEM teaching orientation differ, t test was used for independent sample in gender and one-way analysis of variance (ANOVA) test in grade level and grade averages. To examine if there is a significant difference in the results of the analysis and the variances is homogeneous or not, Scheffe test was used. But if not homogeneous, the Dunnett C test was used. Teacher candidates' answers to the scale were based on 1.00-1.85 very strongly disagree, 1.86-2.71 strongly disagree, 2.72-3.57 disagree, 3.58-4.43 nor disagree, 4.44-5.29 agree, 5.30-6.15 strongly agree and 6.16-7.00 very strongly agree intervals (Kan, 2009).

RESULTS

The descriptive statistics of the prospective science teachers on the subscales of the integrated STEM teaching orientation scale (knowledge, values, attitude, subjective norms, perceived behaviour control, and behavioural intention) and the total scores of the scale are shown in Table 1.

In Table 1, there was no significant difference between the average scores of science teacher candidates' knowledge [t:(203)=1.11, p>0.05], value [t:(203)=1.86, p>0.05], attitude [t:(203)=1.90, p>0.05], subjective norms [t:(203)=1.26, p>0.05], perceived behavioural controls and behavioural intention [t:(203)=1.92, p>0.05] sub-dimensions. These findings suggest that science teachers' STEM orientation tendencies do not differ according to gender.

Table 1
T-Test Results for Sub-Dimensions of the Scale According to the Gender of Science Teacher Candidates

Sub-Dimensions	Gender	N	$\bar{X}$	SS	t	p
Knowledge	Female	186	5.70	0.89	1.11	0.27
	Male	19	5.28	1.58		
	Total	205	5.66	0.97		
Values	Female	186	6.08	0.76	1.86	0.07
	Male	19	5.44	1.47		
	Total	205	6.02	0.86		
Attitude	Female	186	5.91	0.80	1.90	0.07
	Male	19	5.27	1.44		
	Total	205	5.85	0.90		
Subjective norms	Female	186	5.29	0.99	1.26	0.22
	Male	19	4.87	1.40		
	Total	205	5.25	1.04		
Perceived behavioural controls and behavioural intention	Female	186	5.95	0.79	1.92	0.06
	Male	19	5.27	1.51		
	Total	205	5.88	0.90		

Table 2
Descriptive Statistics of the Scores of the Prospective Science Teachers on the Sub-Dimensions of the Scale by Class Level

Sub-Dimensions	Grade Level	N	$\bar{X}$	SS
Knowledge	1st	30	5.69	1.08
	2nd	69	5.31	0.99
	3rd	70	5.75	0.95
	4th	36	6.12	0.62
Values	1st	30	5.75	1.06
	2nd	69	5.80	1.00
	3rd	70	6.21	0.67
	4th	36	6.31	0.52
Attitude	1st	30	5.58	1.10
	2nd	69	5.63	0.99
	3rd	70	6.03	0.73
	4th	36	6.15	0.63
Subjective norms	1st	30	5.13	1.21
	2nd	69	4.91	0.99
	3rd	70	5.32	1.03
	4th	36	5.88	0.64
Perceived behavioural controls and behavioural intention	1st	30	5.59	1.06
	2nd	69	5.63	0.96
	3rd	70	6.03	0.81
	4th	36	6.33	0.48

According to the gender variable of science teacher candidates; an independent t test was used to determine whether there was a significant difference between the mean scores of the subscales of the integrated STEM teaching orientation scale and the test results are given in Table 1. According to the grade level of teacher candidates, the difference between the average scores of the subscales of the integrated STEM teaching orientation scale was tested with one-way variance analysis. Table 2 shows descriptive statistics and Table 3 presents ANOVA results.

Table 3
T-Test Results for Sub-Dimensions of the Scale According to the Gender of Science Teacher Candidates

Sub-Dimensions	Variance source	Total Squares	sd	Squares Mean	f	p	Difference (Scheffe)
Knowledge	Between group In group Total	16.45 178.94 195.40	3 201 204	5.48 0.89	6.16	0.00	2-4
Values	Between group In group Total	10.93 143.11 154.04	3 201 204	3.64 0.71	5.11	0.00	2-3 2-4
Attitude	Between group In group Total	10.93 154.34 165.28	3 201 204	3.64 0.76	4.74	0.00	2-4
Subjective norms	Between group In group Total	23.02 198.36 221.38	3 201 204	7.67 0.98	7.77	0.00	1-4 2-4
Perceived behavioural controls and behavioural intention	Between group In group Total	15.71 149.71 165.42	3 201 204	5.23 0.74	7.03	0.00	1-4 2-4

In Table 3, there was significant difference among the average scores of science teacher candidates' knowledge [f(3-201)= 6.16, p<.05], value [f(3-201)= 5.11, p<.05], attitude [f(3-201)= 4.74, p<.05], subjective norms [f(3-201)= 7.77, p<.05], perceived behavioural controls and behavioural intention [f(3-201)= 7.03, p<.05]. Scheffe test was used to determine the difference between grade levels. According to the Scheffe test results, it was determined that the prospective teachers who were studying in the 4th grade (knowledge $\bar{X}$ = 6.12, value $\bar{X}$ = 6.31, attitude $\bar{X}$ = 6.15, subjective criterion $\bar{X}$ = 5.88, perceived behavioural controls and behavioural intention $\bar{X}$ = 6.33) were more positive than the 3rd, 2nd and 1st grades of STEM teaching orientations. These findings suggest that STEM teaching orientations differ according to the class level.

One-way analysis of variance was used to determine whether there was a difference between the average scores of the sub-dimensions of teacher candidates according to their grade point averages. Table 4 shows descriptive statistics and Table 5 shows the ANOVA results.

Table 4
Descriptive Statistics of Sub-dimensions

Sub-Dimensions		Grade Average	N	$\bar{X}$	SS
Knowledge	(1)	1.5-2.0	6	5.62	0.89
	(2)	2.01-2.49	39	5.01	1.45
	(3)	2.5-3.0	61	5.82	0.79
	(4)	3.01-3.49	50	5.76	0.67
	(5)	3.5-4.0	19	5.94	0.74
Values	(1)	1.5-2.0	6	5.61	1.32
	(2)	2.01-2.49	39	5.56	1.22
	(3)	2.5-3.0	61	6.16	0.73
	(4)	3.01-3.49	50	6.03	0.65
	(5)	3.5-4.0	19	6.43	0.50
Attitude	(1)	1.5-2.0	6	5.11	1.19
	(2)	2.01-2.49	39	5.47	1.29
	(3)	2.5-3.0	61	5.98	0.79
	(4)	3.01-3.49	50	5.95	0.62
	(5)	3.5-4.0	19	6.00	0.65
Subjective norms	(1)	1.5-2.0	6	4.76	1.08
	(2)	2.01-2.49	39	4.85	1.32
	(3)	2.5-3.0	61	5.35	0.97
	(4)	3.01-3.49	50	5.31	0.87
	(5)	3.5-4.0	19	5.57	0.94
Perceived behavioural controls and behavioural intention	(1)	1.5-2.0	6	5.30	1.18
	(2)	2.01-2.49	39	5.41	1.33
	(3)	2.5-3.0	61	6.01	0.75
	(4)	3.01-3.49	50	6.01	0.60
	(5)	3.5-4.0	19	6.10	0.65

In Table 5, there was significant difference among the average scores of science teacher candidates' knowledge [f(4-200)= 5.92, p<.05], value [f(4-200)= 5.03, p<.05], attitude [f(4-200)= 3.70, p<.05], subjective norms [f(4-200)= 2.59, p<.05], perceived behavioural controls and behavioural intention [f(4-200)= 4.54, p<.05], sub-dimensions. Dunnett C test was used to find out among which grade point averages there was a difference. According to the Dunnett C test results, it was found that the students who had a grade point average of 1.5-2.0 ($\bar{X}$ = 5.62), 2.5-3.0 ($\bar{X}$ = 5.82), 3.01-3.49 ($\bar{X}$ = 5.76) and 3.5-4.0 ($\bar{X}$ = 5.94) were more positive than those with 2.01-2.49 (X = 5.01) in the information sub-dimension. According to value sub-dimension, it was found that the students who had a grade point average of 1.5-2.0 ($\bar{X}$=5.61), 2.5-3.0 ($\bar{X}$=6.16), 3.01-3.49 ($\bar{X}$=6.03) and 3.5-4.0 ($\bar{X}$=6.43) were more positive than those with 2.01-2.49 ($\bar{X}$=5.56). According to these findings, there was no difference on STEM teaching orientations in terms of grade point averages in attitude, subjective norms, perceived behavioural controls and behavioural intention sub-dimensions.

Table 5
Anova Results of Sub-Dimensions

Sub Dimensions	Variance Source	Total Squares	sd	Squares Mean	f	p	Difference (Dunnett C)
Knowledge	Between group In group Total	20.70 174.69 195.40	4 200 204	5.17 0.87	5.92	0.00	2-3 2-4 2-5
Values	Between group In group Total	14.10 139.94 154.04	4 200 204	3.52 0.70	5.03	0.00	2-5
Attitude	Between group In group Total	11.39 153.88 165.28	4 200 204	2.84 0.76	3.70	0.00	
Subjective norms	Between group In group Total	10.93 210.45 221.38	4 200 204	2.73 1.05	2.59	0.03	
Perceived behavioural controls and behavioural intention	Between group In group Total	13.78 151.64 165.42	4 200 204	3.44 0.75	4.54	0.00	

DISCUSSION

In this study, the results obtained from prospective science teachers STEM teaching tendency are explained by using the institutional framework created by Lin and Williams (2016). When we examined the subscales of STEM teaching orientation scale, it was determined that opinions about knowledge, value, attitude, perceived behaviour control, and behaviour orientation subscales correspond to the range of agreement. In the information subscale, it is seen that teacher candidates' views on establishing their relations with other fields are positive. In the value subscale, it is concluded that the candidates reflect their opinions by making self-assessment about STEM education. In the subscale of attitude, the fact that teacher candidates' have willingness to apply the teaching of STEM in their courses shows that their opinions are positive. In the sub-dimension of perceived behavioural control and behavioural orientation, it is seen that candidates are aware of the challenges of STEM teaching and that these difficulties can be overcome. These findings can indicate that the subjective criterion sub-dimension corresponds in part to the range of agreeing. In addition, teacher candidates' opinions are partially positive about support for reference groups for STEM teaching.

According to the results of the research, it is seen that prospective science teachers have the tendency to use and apply STEM teaching in their lessons. In this case, it is concluded that teacher candidates' views on STEM teaching are positive. As a result of the research, when the literature was examining the opinions of the teacher candidates about STEM teaching, studies by Hacıömeroğlu (2018) and Kırılmazkaya (2017) are similar to the results of the present research. Ensari (2017) examined the opinions of prospective physics teachers on STEM activities and STEM education during the Research Project in Field Education (AEAP) course and concluded that the opinions of prospective teachers were positive. In a study by Gülgün et al. (2017), the views of science teachers about STEM education activities were examined. At the end of the study, it was concluded that teachers' opinions were positive, but STEM applications were not passed sufficiently in our country.

It was found that there was no difference in the gender of science teacher candidates in terms of knowledge, value, attitude, subjective norms, perceived behavioural controls and behavioural intention subscales. The female teacher candidates are more positive than male teacher candidates regarding STEM teaching. In a research by Kırılmazkaya (2017) it was found that there was no

meaningful difference in gender. However, male teacher candidates for STEM teaching were more positive than female teacher candidates in his research. The research conducted by Hacıömeroğlu (2018) showed that there was no meaningful difference in gender comparing to the research by Kırılmazkaya (2017). Unlike the research by Kırılmazkaya (2017), there was a meaningful difference between the subjective norms and the average scores in favour of the male candidates. Çevik et al. (2017) found that STEM awareness of secondary school teachers (mathematics, information technologies and science teachers) did not differ according to the gender variable.

A significant difference was found between STEM teaching orientations according to class variable of teacher candidates. Regarding this difference, it was determined that the candidates who are studying in the 4th grade have a positive opinion of STEM teaching orientation than those who are studying at other class levels.

A significant difference was found between STEM teaching orientations according to grade level in the study. According to the Dunnett C test, this difference showed that other grade average is more favourable for STEM teaching orientation views than averages of second grades in the knowledge and values sub-dimension.

Teacher candidates should be informed of STEM education before the start of their profession and the deficiencies and lack in that area should be completed. Courses related to STEM education can be put into the teacher training program at the faculty of education.

CONCLUSION

In the future, it can be said that the tendencies of the science teacher's candidate who are responsible for teaching different disciplines in general are related to the teaching of integrated STEM. Based on the results obtained from this study, it can be said that it is important to conduct long-term mixed method approaches in order to examine the orientation level of the integrated teacher candidates' teaching orientation.

In this way, together with the integrated STEM teaching practices, knowledge, values, attitude, subjective norms, perceived behaviour control, and behavioural intention can be examined in depth. In addition, conducting studies involving integrated STEM teaching applications will help candidates to teach lessons such as science and mathematics as an effective science teacher.

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