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STEM EDUCATION AWARENESS OF PRE-SERVICE SCIENCE TEACHERS

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Abstract

This research aimed to determine pre-service science teachers' STEM awareness in terms of different variables. Data were collected from 148 pre-service science teachers studying at a state university in Turkey who were chosen through the convenience sampling method. "STEM Awareness Scale (SAS)" was employed as data collection tool, and the data were analyzed using IBM SPSS-21 statistical program. For data analysis, Independent t test, variance analysis (ANOVA) and Tukey significance test were used. No statistically significant difference in pre-service science teachers' STEM awareness in terms of gender, academic achievement score, technology usage frequency, and family income level. While they significantly differ in their STEM awareness with regard to grade level.

Keywords: STEM, STEM education, STEM awareness, pre-service science teachers

1. Introduction

Scientific and technological developments in recent years affected the countries' economical, education and social structures and caused to reveal new approaches. STEM education, which is an approach that aims to students to gain interdisciplinary problem solving skills in the center of engineering development of science, technology, mathematics and engineering knowledge and skills (Karakaya & Avgın, 2016; Buyruk & Korkmaz, 2016; Bybee, 2010b; Dugger, 2010; Rogers & Porstmore, 2004), constitutes the best example for the educational context,. It is a teaching system that provides integrated approach in science, technology, mathematics and engineering disciplines (Corlu, 2012; 2013). It launched in the US in 1990's (Bybee, 2010) and it takes part in countries' educational policies. It aims to make compatible integrity of different disciplines and to make students to understand this integrity (Smith & Karr-Kidwell, 2000), and to educate students who will lead novelties (Buyruk & Korkmaz, 2016; Şahin, Ayar & Adıgüzel, 2014; Roberts, 2012). STEM education, Interdisciplinary integration can be by including all the science, technology, mathematics and engineering or synchronise them in the center of one of them (Karakaya, Avgın, 2016; Yamak, Bulut & Dündar, 2014; Moore, Stohlmann, Wang, Tank, & Roehrig, 2013).

STEM education is capital of importance for countries that wish to have a say on the international platform and accord to knowledge-technological developments (Çorlu, Capraro & Capraro, 2014) considering 21th century skills intended to enhance students' interest and tendency through science, technology, mathematics and engineering in STEM education (Baran, Canbazoğlu-Bilici, Mesutoğlu, 2015). Students are expected to generate solutions for problems by using 21th century knowledge and skills. At this point, the related research concluded that students' interest, attitude, and achievements were affected positively when

STEM disciplines were integrated (Karakaya & Avgın, 2016; Yıldırım & Selvi 2016; Gülhan & Şahin, 2016; Yıldırım & Altun, 2015; Baran, &et al., 2015; Gencer, 2015; Şahin & et al., 2014; Yamak & et al., 2014; Wendell, Connolly, Wright, Roger, Barnett & Marulcu, 2010; Fortus, Dershimer, Krajcik, Marrx & Mamlok-Naaman; 2004; Roth, 2001).

Many studies were conducted about STEM education with an international dimension. For example, Chachashvili, Milner & Lissitsa (2016) investigated factors that affect high school students' interest through STEM education. The results of this study point out that STEM learning experience positively associates with students' interest in pursuing STEM fields in tertiary education. Likewise, Christensen, and Knezek (2017) examined middle school students' STEM interest and carrier intention in STEM disciplines. The results of study invaded that middle school students who have stated that they plan to pursue a career in STEM, also show higher dispositions toward STEM and STEM career measures. Rehmat (2015) searched problem based learning approach for STEM integration in elementary level. In his master thesis, Saad (2014) designed burden experiments together with students, and stated that the relation between engineering and space can be forced by the help of STEM education. Unfried, Faber and Wiebe (2014) investigated students' attitudes towards STEM fields. Similarly, Tseng, Chang and Lou (2013) searched students' attitudes towards STEM fields in project based learning environment. Naizer, Hawthorne and Hanley (2014) examined the effect of a STEM summer camp on the rural place on students' mathematics, science, technology and problem solving skills. Moore, Stohlmann, Wang, Tank and Roehrig (2013) investigated engineering practice and integration in K-12 STEM fields. Wendell, Connolly, Wright, Jarvin, Rogers, Barnett and Marulcu (2010) researched the effect of using engineering design on elementary students' science learning. Doppelt, Mehalik, Schunn, Silk and Krysinski (2008) conducted a case study in order to see design based learning model in the context of science. Wells, Sanchez, and Attridge (2007) executed modelling on the students' interest on science, technology, engineering and mathematics. Fortus, Dershimer, Krajcik, Marx and Mamlok-Naaman (2004) also studied design based science and student learning. Roth (2001) also examined the relation between technology and science learning.

The related literature in Turkey shows that there are studies about scale development studies through STEM education (Hacıömeroğlu & Bulut, 2016; Buyruk & Korkmaz 2016; Gülhan & Şahin 2016; Yıldırım & Selvi, 2015b), and about integration and activity studies (Yıldırım & Selvi 2016; Corlu & Aydın, 2016; Gencer, 2015; Yıldırım, & Altun 2015; Şahin & et al., 2014; Yamak & et al.., 2014; Ercan & Şahin, 2013). Karakaya and Avgın (2016), and Gülhan and Şahin (2016) investigated the students' attitudes towards STEM education in terms of different variables. As a result of the research, it was determined that the STEM attitudes of students differ according to the independent variables. The aim of the research by Aydın, Saka and Guzey (2017) was to adapt science, technology, engineering, mathematic (STEM) attitude scale and to retain whether there was differences or not on the 4-8 grade student's STEM attitude by applying scale on them. Research by Bakırcı and Karışan (2017) aims to investigate the preservice primary school, mathematics and science teachers STEM awareness. In a different study, Tekerek, Karakaya, and Tekerek (2016) examined ethical reasoning levels of lecturers in STEM fields. Yenilmez and Balbağ (2016) examined the STEM attitudes of prospective science and middle school mathematics teachers. The results of this research demonstrates that there is no significant interaction effect for gender and department variables however there is significant difference among different department students. As a result of the research, it was determined that for all independent variables there were no statistically significant difference in ethical reasoning of lecturers.

When the purposes and importance of STEM education were considered, it can be said that it is necessary to introduce in national wide (Çorlu, Adıgüzel, Ayar, Çorlu & Ozel, 2012)

and to increase the awareness. However, these have not been achieved yet (Çavaş, Bulut, Holbrook & Rannikmae, 2013; Çorlu & et al., 2012; Marulcu & Sungur, 2012). In STEM education, significant responsibilities are assigned to teachers in having students integrated and interdisciplinary perspectives. For these reasons, it is very important to determine pre-service teachers' awareness about STEM (Buyruk & et al., 2016). However, to the best of the researchers' knowledge, no study has been carried out with the aim of determining the pre-service teachers' awareness of STEM. In this regard, the present is hoped to contribute to the literature.

1.1. Purpose of Research

The purpose of the present research is to determine pre-service science teachers' STEM awareness in terms of different variables. Accordingly, responses were sought for the following research questions:

1. Does pre-service science teachers' STEM awareness differ in terms of gender?
2. Does pre-service science teachers' STEM awareness differ in terms of grade level?
3. Does pre-service science teachers' STEM awareness differ in terms of academic achievement score?
4. Does pre-service science teachers' STEM awareness differ in terms of technology usage frequency?
5. Does pre-service science teachers' STEM awareness differ in terms of family income level?

2. METHOD

2.1. Research Model

In this research, the relational screening model was used. The relational screening model is a general screening model used in research to determine the changes in two or more variables and the degree of change (Karasar, 2006, 81).

2.2. Data Collection Tool

"STEM Awareness Scale (SAS)" developed by Buyruk and Korkmaz (2016) was used in this study. It was a 5-point Likert type scale and consisted of 17 questions with 2 factors. As the items were pointed from 1 (absolutely agree) to 5 (absolutely disagree) Buyruk and Korkmaz (2016) calculated Cronbach's alpha value of the positive opinion factor as .929, Cronbach's alpha value of negative opinion factor as .806 and Cronbach's alpha of all scale as .927. In this research, Cronbach's alpha value of the positive opinion factor was calculated as .903, Cronbach's alpha value of negative opinion factor was calculated as .912 and Cronbach's alpha of all scale was calculated as .903.

2.3. Data Analysis

Data were analyzed by using IBM SPSS-21 statistical program. Mann-Whitney U-test, variance analysis (ANOVA) and Tukey significance test were used. Significance level was determined as .05. On the other hand, percentage, frequency, average and standard deviation values were given.

2.4. Research Group

In this research, convenience sampling method was used. The study group consisted of 148 pre-service science teachers studying at Kahramanmaras Sutcuimam University, Turkey. It was conducted in the fall semester of 2016-2017 academic year. The demographic information of the participants was given in Table 1.

Table 1. *Demographic information of pre-service science teachers*

		f	%
Gender	Female	133	89.9
	Male	15	10.1
Grade	2nd Grade	51	34.5
	3rd Grade	45	30.4
	4th Grade	52	35.1
Academic achievement score	Others	28	18.9
	2.50-2.99	85	57.4
	3.00-3.49	31	20.9
	3.50-4.00	4	2.7
Technology usage frequency	Sometimes	14	9.5
	Middle	59	39.9
	Very	75	50.7
Family income level	0TL-1500TL	64	43.2
	1501TL-2000TL	44	29.7
	>2000TL	40	27.0
		148	100.0

3. Results

In this section, the findings about pre-service science teachers' STEM awareness in terms of several variables were given. The first research question investigated whether "They differ in their STEM awareness in terms of gender?" t-test was conducted. The results of the test were given in Table 2.

Table 2. *The results of t-test for gender variable*

Scale	Gender	N	$\bar{X}$	sd	t	p
SAS	Female	133	4.00	146	1.486	.05
	Male	15	3.69			

**p<.05*

When the results in Table 2 were examined, there was no significant difference in pre-service science teachers scores in terms of gender ($t_{(146)} = 1.486$; $p \geq .05$).

The second research question searched whether *"They differ in their STEM awareness regarding grade level?"* The results of one-way analysis of variance (ANOVA) were given in Table 3 and Table 4.

Table 3. *Frequency, mean score and standard deviation for grade level*

	N	$\bar{X}$	ss
2nd grade	51	3.83	.58
3rd grade	45	4.13	.46
4th grade	52	3.96	.61
	148	3.97	.56

Table 4. *The results of one-way ANOVA test for grade level*

		Sum of Squares	sd	Mean of Squares	F	*p*	Tukey
SAS	Between Groups	2.253	2	1.127	3.591	.030*	3>2
	Within Groups	45.494	145	.314			
	Total	47.747	147				

When the results in Table 3 and Table 4 were examined, there was a significant difference in pre-service science teachers scores in terms of grade level [$F_{(2,145)}$=3.591; $p< .05$].

The third research question was intended to seek for an answer to the question *"Does pre-service science teachers' STEM awareness differ in terms of academic achievement score?"* The test results were given in Table 5 and Table 6.

Table 5. *Frequency, mean score and standard deviation for academic achievement score*

	N	$\bar{X}$	ss
Others	28	3.87	.50
2.50-2.99	85	3.91	.59
3.00-3.49	31	4.16	.54
3.50-4.00	4	4.25	.36
	148	3.97	.56

Table 6. *The results of one-way ANOVA test for academic achievement score*

		Sum of Squares	Sd	Mean of Squares	F	*p*
SAS	Between Groups	1.967	2	.656	2.063	.108
	Within-Groups	45.780	144	.318		
	Total	47.747	147			

As illustrated in Table 5 and Table 6, there was no significant difference in pre-service science teachers' scores in terms of academic achievement score [$F_{(2,144)}$=2.063; $p>.05$].

Another question of the research searched whether "They differ in *STEM awareness with respect to technology usage frequency?"* The results of one-way analysis of variance (ANOVA) test were presented in Table 7 and Table 8.

Table 7. *Frequency, mean score and standard deviation for technology usage frequency*

	N	$\bar{X}$	ss
Sometimes	14	4.09	.71
Middle	59	3.95	.45
Very	75	3.96	.62
	148	3.97	.56

Table 8. *The results of one-way ANOVA test for technology usage frequency*

		Sum of Squares	Sd	Mean of Squares	F	*p*
SAS	Between Groups	.249	2	.124	.380	.685
	Within-Groups	45.498	145	.328		
	Total	47.747	147			

*$p<.05$

The test results have revealed that there is no significant difference in pre-service science teachers scores in terms of technology usage frequency [$F_{(2,145)}$ =.380*; p>.05*].

The research question investigated whether *"They differ in their STEM awareness in terms of income level?"* The results of one-way analysis of variance (ANOVA) were given in Table 9 and Table 10.

Table 9. *Frequency, mean score and standard deviation for family income level*

Family income level	SAS		
	N	$\bar{X}$	ss
0TL-1500TL	64	3.90	.60
1501TL-2000TL	44	4.00	.61
>2000TL	40	4.02	.43
	148	3.97	.56

Table 10. *The results of one-way ANOVA test for family income level*

		Sum of Squares	Sd	Mean of Squares	F	*p*
SAS	Between groups	.443	2	.221	.679	.509
	Within-Groups	47.305	145	.326		
	Total	47.747	147			

**p<.05*

When the results in Table 9 and Table 10 were examined, there was no significant difference in pre-service science teachers scores in terms of family income level [$F_{(2,145)}$ =.679; *p>.05*].

4. Discussion

STEM teacher has knowledge and practitioner skills in different STEM fields besides the field of expertise (Çorlu, 2014). When the related literature examined, it is seen that both science teachers' and the pre-service science teachers' STEM awareness was not determined. This research aimed to determine pre-service science teachers' STEM awareness in terms of different variables. STEM Awareness Scale (SAS) was used in the research for the aim of the study.

There was no statistically significant difference in pre-service science teachers' STEM awareness in terms of gender. It could be claimed that gender is not an effective factor in STEM awareness of pre-service science teachers. That is, female pre-service science teachers' STEM awareness was found higher than the male pre-service science teachers' STEM awareness. Bakıcı and Karışan (2017) found that gender is not influential on STEM awareness of science teachers. Yenilmez and Balbağ (2016) found that gender is not influential on STEM attitude of pre-service teachers. It may be that men consider themselves more interested in dealing with machines, repairing work, designing new products, and dealing with electronic goods (Yenilmez & Balbağ, 2017). Bolotin and et al. (2016) found that female students who attending secondary education had higher STEM education attention than male students'. Christensen, and Knezek (2017) also found the similar result that the attitudes and knowledge of female students were higher than the attitudes and knowledge of male students after a STEM education camp. Karakaya and Avgın (2016) also reported that female students who attending secondary school had a higher attitude towards STEM than male students. These results supported the findings of this research.

There was a statistically significant difference on STEM awareness of pre-service science teachers in terms of grade level. It can be said that grade level is an effective factor in STEM awareness of pre-service science teachers. Additionally, it was determined that the third grade pre-service science teachers' mean score was higher than the second and fourth grade pre-service science teachers' mean score (Table 3). In order to make differences according to the grade level, the course intensity in the department is influential (Bakırcı &Karışan, 2017). Karakaya and Avgın (2016), Unfried et al. (2014) stated that students' grade level caused to increase in their attitudes and behaviors through STEM education. These results support the findings of the study. However, when the literature is examined, different results are determined (Bakıcı & Karışan, 2017; Yenilmez & Balbağ, 2016; Unfried, Faber, Stanhope Wiebe, 2015; Lamb, Akmal & Petrie, 2015; Mahoney, 2009). This can be explained by the fact that the STEM preparations of the younger students are higher than those of the older students.

There was no statistically significant difference on STEM awareness of pre-service science teachers in terms of academic achievement score. That is, academic achievement score is not an effective factor in STEM awareness of pre-service science teachers. However, it was determined that the more pre-service science teachers' academic achievement, the higher their STEM awareness. High performance of individuals in STEM disciplines depends on their high school education (Table 5). The high academic performance of the student in high school science and mathematics lesson affect the awareness and interest through STEM disciplines (Elliot, Strenta, Adair, Matier & Scott, 1996). Thus, it can be said that in order to increase interest and awareness of individuals in STEM disciplines, increasing the students' academic performance in science and mathematics courses will be effective.

There was no statistically significant difference in STEM awareness of pre-service science teachers in terms of technology usage frequency. That is, technology usage frequency is not an effective factor STEM awareness of pre-service science teachers. However, it was seen that when the technology usage frequency increases, STEM awareness of preservice science teachers decreases (Table 7). Today, rapidly developing technology has become an important point for education and training. The use of technology in education (Yılmaz, 2005) and the use of smart boards in classrooms (Sevindik, 2006) have a positive effect on students' academic achievement and attitudes towards lectures. Therefore, it is necessary to give the required technological advice in STEM education.

There was no statistically significant difference on STEM awareness of pre-service science teachers in terms of family income level. That is, family income level is not an effective factor for STEM awareness of pre-service science teachers. However, the increase in the family income level showed the increase in STEM awareness of preservice science teachers (Table 9). Blotin and et al. (2016) determined that the low level of economic status of the students decreased the interest, attitude, awareness and confidence in the STEM disciplines. These results support the findings of research. However; George-Jackson and Lichtenberger (2012); Lichtenberger and George-Jackson (2013) stated that economically disadvantaged students had more confidence in their STEM core branches than their high-income colleagues.

5. Conclusion

The vision of Turkey in 2023 and the strategic aims determined by the Ministry of National Education, show the importance of STEM education (Çorlu & al., 2012). If a country wants to have a say in scientific, economic or technological fields, it has to be included STEM education into their education system (Lacey & Wright, 2009). The institutions that train teachers have a great responsibility so that STEM education can take

place in line with the goals and objectives of our education system. For this reason, it is necessary to accelerate the efforts to increase the STEM awareness of the pre-service teachers who are studying at the higher education institutions. The increase in awareness of teachers increases their awareness to both themselves and their environment (Buyruk & Korkmaz, 2016). Therefore, educational programs should be organized to include 21st century talents (Corlu & Aydin, 2016).

References

Aydin, G., Saka, M., & Guzey, S. (2017). 4-8. sınıf öğrencilerinin fen, teknoloji, mühendislik, matematik (STEM= FeTeMM) tutumlarının incelenmesi. *Mersin University Journal of the Faculty of Education, 13*(2), 787-802.

Baran, E., Canbazoğlu Bilici, S., & Mesutoğlu, C. (2015). Fen, teknoloji, mühendislik ve matematik (FeTeMM) spotu geliştirme etkinliği. *Araştırma Temelli Etkinlik Dergisi (ATED), 5*(2), 60-69.

Bakırcı, H., & Karışan, D. (2018). Investigating the Preservice Primary School, Mathematics and Science Teachers' STEM Awareness. *Journal of Education and Training Studies, 6*(1), 32-42.

Bybee, R. W. (2010). What is STEM education?. *Science, 329*(5995), 996-996.

Bybee, R. W. (2010b). What is STEM education? *Science, 329*, 996. Doi: 10.1126/science.1194998.

Buyruk, B., & Korkmaz, Ö. (2016). FeTeMM farkındalık ölçeği (FFÖ): geçerlik ve güvenirlik çalışması. *Türk Fen Eğitimi Dergisi, 13*(2), 61-76.

Chachashvili-Bolotin, S., Milner-Bolotin, M., & Lissitsa, S. (2016). Examination of factors predicting secondary students' interest in tertiary STEM education. *International Journal of Science Education, 38*(3), 366-390.

Cohen, L., Manion, L., & Morrison, K. (2000). Research methods in education. (5th) ed. London New York: Routledge Falmer.

Corlu, M.A., & Aydin, E. (2016). Evaluation of learning gains through integrated STEM projects. *International Journal of Education in Mathematics, Science and Technology, 4*(1), 20-29. DOI:10.18404/ijemst.35021

Corlu, M. S. (2014). FeTeMM eğitimi makale çağrı mektubu. *Turkish Journal of Education, 3*(1), 4-10.

Corlu, M. S. (2013).Insights into STEM education praxis: An assessment scheme for course syllabi. *Educational Sciences: Theory & Practice, 13*(4), 2477-2485. Doi: 10.12738/estp.2013.4.1903

Corlu, M. S. (2012). *A pathway to STEM education: Investigating pre-service mathematics and science teachers at Turkish universities in terms of their understanding of mathematics used in science*, (Unpublished doctoral dissertation), Texas A&M University, College Station, Texas.

Christensen, R., & Knezek, G. (2017). Relationship of middle school student STEM interest to career intent. *Journal of Education in Science, Environment and Health (JESEH), 3*(1),1-13.doi:10.21891/jeseh.45721

Çavaş, B., Bulut, Ç., Holbrook, J., & Rannikmae, M. (2013). Fen eğitimine mühendislik odaklı bir yaklaşım: ENGINEER projesi ve uygulamaları. *Fen Bilimleri Öğretimi Dergisi, 1*(1), 12-22.

Çorlu, M. S., Capraro, R. M., & Capraro, M. M. (2014).Introducing STEM education: implications for educating our teachers for the age of innovation. *Eğitim ve Bilim, 39*(171), 74-85.

Çorlu, M. A., Adıgüzel, T., Ayar, M. C., Çorlu, M. S., & Özel, S. (2012, Haziran). *Bilim, teknoloji, mühendislik ve matematik (BTMM) eğitimi: disiplinler arası çalışmalar ve*

etkileşimler. X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi'nde sunulmuş bildiri, Niğde.

Doppelt, Y., Mehalik, M. M., Schunn, C. D., Silk, E., & Krysinski, D. (2008). Engagement and achievements: a case study of design-based learning in a science context. *Journal of Technology Education, 19*(2), 22-39.

Dugger, W. E. (2010, December). *Evolution of STEM in the United States.* Presented at the (6th) Biennial International Conference on Technology Education Research, Gold Coast, Queensland, Australia. http://www.iteaconnect.org/Resources/PressRoom/AustraliaPaper.pdf.

Ekici, G., & Hevedanlı, M., 2010.Lise öğrencilerinin biyoloji dersine yönelik tutumlarının farklı değişkenler açısından incelenmesi, *Türk Fen Eğitimi Dergisi. 7*(4), 97-109.

Elliot, E., Strenta, A. C., Adair, R., Matier, M., & Scott, J. (1996).The role of ethnicity in choosing and leaving science in highly selective institutions. *Research in Higher Education, 37*(6), 681-709

Ercan, S., & Şahin, F.(2013). *Mühendisliğin fen eğitimine entegrasyonu: mü(fen) dislik integration of engineering into scıence education: mü(fen) dislik/scıen(ce)gineering*. International Symposium on Changes and New Trends in Education, Konya.

Fortus, D., Dershimer, R. C., Krajcik, J. S., Marx, R. W., & Mamlok-Naaman, R. (2004). Design-based science and student learning. *Journal of Research in Science Teaching, 41*(10), 1081-1110

George-Jackson, C. E., & Lichtenberger, E. J. (2012). College confidence: How sure high school students are of their future majors. Illinois Education Research Council. Policy Research: IERC 2012–2. Retrieved from: http://ierc.education/wp-content/uploads/2014/10/EJL_2012_ACT_College-Confidence_final.pdf.

Gencer, A. (2015). Fen eğitiminde bilim ve mühendislik uygulaması: Fırıldak Etkinliği, *Araştırma Temelli Etkinlik Dergisi (ATED), 5*(1), 1-19.

Gülhan, F., & Şahin, F. (2016).Fen-teknoloji-mühendislik-matematik entegrasyonunun (STEM) 5.Sınıf öğrencilerinin bu alanlarla ilgili algı ve tutumlarına etkisi. *International Journal of Human Sciences, 13*(1), 602-620.

Hacıömeroğlu, G., & Bulut, A. S. (2016). Entegre FETEMM* öğretimi yönelim ölçeği türkçe formunun geçerlik ve güvenirlik çalışması/Integrative Stem teaching intention questionnaire: a validity and relaibility study of the Turkish Form. *Eğitimde Kuram ve Uygulama, 12*(3), 654-669.

Karakaya, F., & Avgın, S. S. (2016). Effect of demographic features to middle school students' attitude towards FeTeMM (STEM). *Journal of Human Sciences, 13*(3), 4188-4198. doi:10.14687/jhs.v13i3.4104

Karasar, N. (2006). *Bilimsel Araştırma Yöntemi.* Ankara: Nobel yayın Dağıtım.

Lacey, T. A., & Wright, B. (2009). Occupational employment projections to 2018. *Monthly Labor Review*, 82-109.

Lamb, R., Akmal, T., & Petrie, K. (2015). Development of a cognition-priming model describing learning in a STEM classroom. *Journal of Research in Science Teaching, 52* (3), 410-437. doi: 10.1002/tea.21200.

Lichtenberger, E., & George-Jackson, C. E. (2013).Predicting high school students' interest in majoring in a STEM field: Insight into high school students' postsecondary plans. *Journal of Career and Technical Education, 28*(1), 19–38.

Mahoney, M. P. (2009). *Student attitude toward STEM: Development of an instrument for high school STEM-based programs*. (Unpublished PhD thesis). The Ohio State University.

Marulcu, İ., & Sungur, K. (2012). Fen bilgisi öğretmen adaylarının mühendis ve mühendislik algılarının ve yöntem olarak mühendislik-dizayna bakış açılarının incelenmesi. *Afyon Kocatepe Üniversitesi Fen Bilimleri Dergisi, 12*(2012), 13-23.

Moore, T.J., Stohlmann, M.S., Wang, H.-H., Tank, K.M., & Roehrig, G.H. (2013). Implementation and integration of engineering in K-12 STEM education. In J. Strobel, S. Purzer, & M. Cardella (Edt.), *Engineering in precollege settings: Research into practice*. Rotterdam, the Netherlands: Sense Publishers.

Naizer G., Hawthorne M. J., & Henley T. B. (2014). Narrowing the gender gap: enduring changes in middle school students' attitude toward math, science and technology. *Journal of STEM Education: İnnovations and Research, 15*(3), 29-34.

Rehmat, A. P. (2015). Engineering the Path to Higher-Order Thinking in Elementary Education: A Problem-Based Learning Approach for STEM Integration. Retrieved from https://digitalscholarship.unlv.edu/thesesdissertations/2497/ on 24.10.2016.

Roberts, A. (2012). A justification for STEM education. *Technology and engineering teacher, 71*(8), 1-5. Retrieved from https://www.iteea.org/File.aspx?id=86478&v=5409fe8e on 24.10.2016.

Rogers, C., & Portsmore, M. (2004). Bringing engineering to elementary school. *Journal of STEM Education, 5*(3), 17-28.

Roth, W. (2001).Learning Science through technological design. *Journal of Research in Science Teaching, 38*(7), 768-790.

Saad, M. E. (2014). *Progressing science, technology, engineering, and math (STEM) education in North Dakota with near-space ballooning.* Master Thesis. Master of Science Grand Forks, North Dakota.

Sevindik, T. (2006). *Akıllı sınıfların yüksek öğretim öğrencilerinin akademik başarı ve tutumlarına etkisi.* Fırat Üniversitesi, Sosyal Bilimler Enstitüsü, Unpublished doctoral dissertation, Elazığ.

Smith, J., & Karr-Kidwell, P. (2000). The interdisciplinary curriculum: a literary review and a manual for administrators and teachers. Retrieved from ERIC database https://eric.ed.gov/?id=ED443172 on 24.10.2016.

Şahin, A., Ayar, M. C., & Adıgüzel, T. (2014). Fen, teknoloji, mühendislik ve matematik içerikli okul sonrası etkinlikler ve öğrenciler üzerindeki etkileri. *Kuram ve Uygulamada Eğitim Bilimleri, 14*(1), 297-322.

Tekerek, M., Karakaya, F., & Tekerek, B. (2016). Ethical reasoning in STEM disciplines. *Journal of Education and Practice, 7*(32), 182-188.

Tseng, K. H., Chang, C. C, Lou, Ş. J. & Chen W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal Technology Design Education, 23*(1), 87–102.

Unfried, A., Faber, M., Stanhope, D. S., & Wiebe, E. (2015). The development and validation of a measure of student attitudes toward science, technology, engineering, and math (STEM). *Journal of Psychoeducational Assessment, 33*(7), 622- 639. doi: 0734282915571160.

Unfried, A., Faber, M., & Wiebe, E. (2014). *Gender and Student Attitudes toward Science, Technology, Engineering, and Mathematics*. Retrieved from http://miso.ncsu.edu/wp-content/uploads/2014/08/AERA-2014-paper-Student-Attitudes-Toward-STEM.pdf .

Wells, B., Sanchez, A., & Attridge, J., (2007). Modeling student interest in science, technology, engineering and mathematics. IEEE Summit. "Meeting the Growing Demand for Engineers and their Educators," Munich, Germany. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4760362

Wendell, K., Connolly, K., Wright, C., Jarvin, L., Rogers, C., Barnett, M., & Marulcu, I. (2010, October). *Incorporating engineering design into elementary school science curricula.* Paper presented at the Annual Meeting of American Society for Engineering Education. Singapore.

Yamak, H., Bulut, N., & Dündar, S. (2014). 5. Sınıf öğrencilerinin bilimsel süreç becerileri ile fene karşı tutumlarına FeTeMM etkinliklerinin etkisi. *Gazi Eğitim Fakültesi Dergisi, 34*(2), 249- 265.

Yenilmez, K., & Balbağ, M. Z. (2016). Fen bilgisi ve ilköğretim matematik öğretmeni adaylarının STEM'e yönelik tutumları. *Journal of Research in Education and Teaching, 5*(4), 301-307.

Yıldırım, B., & Selvi,M. (2016). Examination of the effects of STEM education integrated as a part of science, technology, society and environment courses. *Journal of Human Science, 13*(2), 3684-3695.

Yıldırım, B., & Altun, Y. (2015). STEM eğitim ve mühendislik uygulamalarının fen bilgisi laboratuar dersindeki etkilerinin incelenmesi. *El-Cezeri Journal of Science and Engineering, 2*(2), 28-40.

Yıldırım, B,. & Selvi, M. (2015b).Adaptation of STEM attitude scale to Turkish. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic, 10*(3), 1107-1120.

Yılmaz, M. (2005). *İlköğretim 7.sınıflarda simetri konusunun öğretimde eğitim teknolojilerinin başarı ve tutuma etkisi*, Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü, (Unpublished master thesis), İstanbul.