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EXAMINATION OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) SELF-EFFICACY FOR PRE-SERVICE SCIENCE TEACHERS ON MATERIAL DEVELOPMENT

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Abstract:
In this research aimed at determining the TPACK self-efficacy for pre-service science teachers on material development, the relational screening model was used. The research was carried out with a total of 141 pre-service science teachers from Kahramanmaraş Sütcü Imam University in 2016-2017 fall academic years. The datas were collected by using the "Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development" developed by Balçın and Ergün (2016). Independent-t test, one way variance analysis (Anova) and Tukey analysis were used in the statistical evaluation of the obtained data. Also, data are evaluated on 0.05 level relevance and its percentage, frequency, average and standard deviation levels are calculated. According to the findings obtained in the research, it was determined that the variables of grade level and teaching technologies and material development courses were influenced by TPACK self-efficacy for pre-service science teachers on material development ($p<0.05$). However, it was determined that gender, level of academic achievement and intensity of technology use did not affect the TPACK self-efficacy for pre-service science teachers on material development.

Keywords: Technological pedagogical content knowledge (TPACK), self-efficacy, pre-service science teacher, material development

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1. Introduction

Teacher competences and the formation of these competencies are a matter of national and international work (Canbazoğlu Bilici, 2012; Erdem, 2005; Öğretmen Yetiştirme ve Eğitimi Genel Müdürlüğü [ÖYEGM], 2006; Seferoğlu, 2009). Qualification is a qualification that must be possessed in order to make or develop a profession accurately and successfully (Şişman, 2000: 9). Skills, and attitudes of the profession in order to competently perform the profession of a person (Alkan & Hacıoğlu, 1997; ÖYEGM, 2008). The Council Higher Education (YÖK) has defined teacher competencies within the scope of the "National Education Development Project". According to YÖK (2008), the competences teachers should have;

- Competencies related to subject area and field education
- Competencies related to the teaching-learning process
- Competencies related to monitoring, evaluation and record keeping of learners
- Descriptive vocational Competencies are collected under headings (YÖK, 2008, 1-4).

Technological developments in the international arena have affected many countries' education systems, as well as being in many areas. As a result of the integration in the education of technological developments, it has caused the change of the professions in the field of education and training, especially in the institutions that educate teachers. Technological innovations in education are provided by the coexistence of pedagogy, human and performance fields (Ferdig, 2006). It is not enough that technological improvements alone contribute to education (Koehler and Mishra, 2005). It has been seen that teachers can use this technology in education (Carr, Jonassen, Litzinger & Marra, 1998). Pedagogical knowledge in teacher competences is very important (Shulman, 1987). Koehler and Mishra (2005) provided the framework of technological pedagogical content knowledge by including the expression of technology in the pedagogical content knowledge. Technological pedagogical content knowledge (TPACK); Technological Knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) are the information that makes up a more meaningful whole in the center (Dikmen & Demirer, 2016; Koehler & Mishra, 2005). The theoretical framework established by technological pedagogical content knowledge (TPACK) reveals the characteristics of teachers for the effective integration of instructional technology (Övez & Akyüz, 2013). Technological Knowledge (TK) is information about advanced technologies (computer, digital technology, word processors) besides standard course technologies (chalk, book, board) (Canbazoğlu Bilici, 2012). A teacher who has a technological knowledge can easily perform the operation of technological devices, the loading of programs and the storage of data (Mishra and Koehler, 2006). Content knowledge (CK) is information about the subject matter that teachers need to teach (Mishra & Koehler, 2006; Wetzel, Foulger & Williams, 2008-2009; Baran, Chuang & Thompson, 2011). Pedagogical Knowledge is the knowledge that the teacher should have for teaching the subject area (Wetzel & et al., 2008-2009). Technological content knowledge (TCK) is the appropriate technology decision making information for teaching teachers' subject area knowledge (Koehler & Mishra, 2008). Teachers who have technological content knowledge (TCK) benefit students by using technology (Canbazoğlu Bilici, 2012; Koehler, Mishra & Yahya, 2007). Technological pedagogical knowledge (TPK) is the information about the limitations and benefits of the technological tools used in teaching (Koehler & Mishra, 2009). Teachers who have technological pedagogical knowledge (TPK) can prepare digital presentations in the classroom environment according to the level of students taught in the subject area (Graham, Burgoyne, Cantrell, Smith, Clair & Harris, 2009). Pedagogical content knowledge (PCK) is information about the methods and techniques teachers use to teach the subject area (Shulman, 1986). According to Mishra and Koehler (2006), who are active in the conceptualization and the formation of the theoretical framework of TPACK, Technological pedagogical content knowledge is a combination of the subject knowledge that an expert will possess, the technological content knowledge that a technical individual will possess and the pedagogical knowledge more advanced knowledge. The framework of TPACK, which is formed by Koehler & Mishra (2009) and other types of information that was interacted, is given in Figure 1.

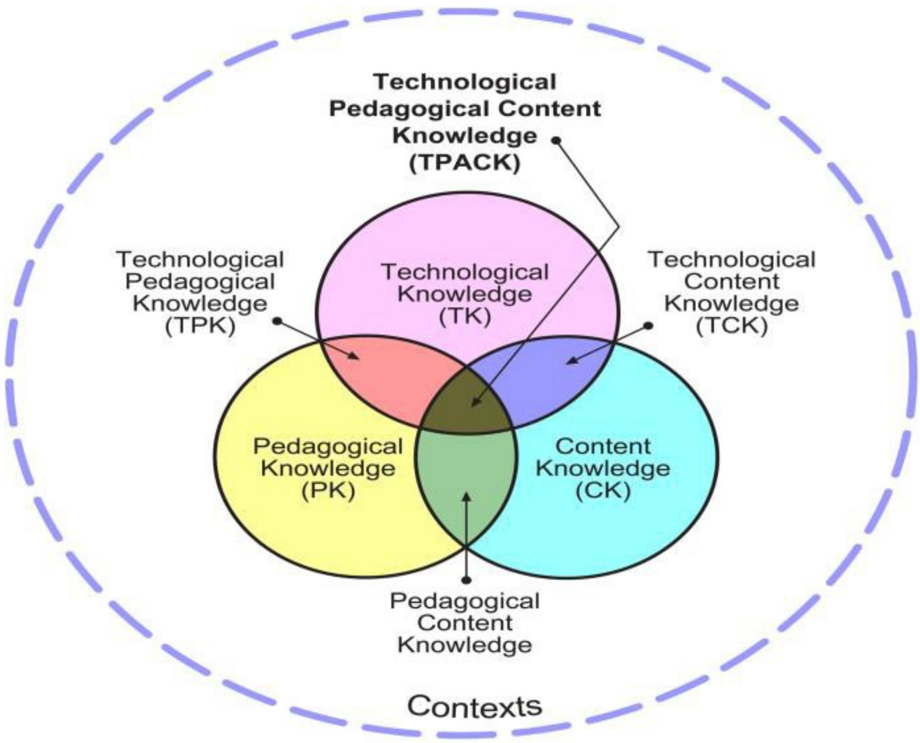

Figure 1: TPACK Model formed by Koehler & Mishra (2009)

This conceptual framework of TPACK and the types of information it interacts with enables teachers to establish relationships between concepts (Dikmen et al., 2016). Due to the contribution of technological pedagogical content knowledge to teacher competencies, it is seen that many national and international studies have been made until now.

It has been determined that the scale works for TPACK in the literature (Koehler and Mishra, 2005, Archambault & Crippen, 2009, Schmidt, Baran, Thompson, Mihra, Koehler & Shin, 2009, Burgoyne, Graham & Sudweeks, 2010; MaKinster, Boone & Trautmann, 2010; Doğan, 2010, Şahin, 2011, Canbazoğlu-Bilici, Yamak, Kavak & Guzey, 2013, Pamuk, Ergun, Çakır, Yılmaz & Ayas, 2013, Balçın & Ergün, 2016). Studies in which the scales for TPACK are adapted to Turkish have been determined (Timur & Taşar, 2011; Altun, 2013; Bal & Kandemir, 2013; Öztürk & Horzum, 2011). North and Noyes (2002) examined the change in attitudes towards computers and components of children in Malaysia and Jordanian children, according to the gender. Chai, Koh, Tsai and Tan (2011) stated that the relevance of pedagogical approaches to the 12 week ICT course in TPACK framework of Singapore primary school teacher candidates and the construct validity of a TPACK scale. Chai, Koh and Tsai (2013) stated that the issues related to BIT integration, which was published in the 74th edition of the TPAB framework. Kaya, Özdemir, Emre and Kaya (2011) studied the self-efficacy of IT and technology teacher candidates on TPACK. Canbazoğlu Bilici (2012) studied the self-efficacy of science teacher candidates' technological pedagogical content knowledge (TPACK) in their doctoral thesis study. Özgen, Narlı and Alkan (2013) studies. Mathematics teacher candidates' perceptions of technological pedagogical content knowledge and technology usage frequency were investigated. Yavuz Konakman & et al. (2013) investigated the perceptions of TPACKs of classroom teachers who are studying at Mersin University according to various variables. Sancar Tokmak, Konakman and Yelken (2013) investigated the TPACK self-perceptions of preschool teacher candidates studying at Mersin University. Övez and Akyüz (2013) have modeled the TPACK structures of primary school mathematics teachers in their work. In the study of Honey and Karademir (2013), the self-evaluation levels of social studies teachers on TPACK were determined. In the study of Meriç (2014), science and technology teacher candidates searched for self-confidence in the level of technological pedagogical content knowledge. Açıkgül and Aslaner (2015) investigated the perceptions of confidence in the TPACK for elementary school mathematics teacher candidates. Önal and Çakir (2015) examined self-confidence perceptions of technological pedagogical content knowledge of teaching faculty members. Karakaya and Avgın (2016) examined the TPACK self-efficacy of teachers in different fields (Physics, Chemistry, Biology, and Science).

Technological infrastructure is established in the projects implemented in Turkey and education integration of technology is ensured. Using technological sub-constructs that are created, teachers have great responsibilities to improve teaching quality through new methods and techniques. The use of materials in education facilitates both learning in a multidisciplinary environment and making it easier for students to remember individual information in an individual way and to learn abstract and complex concepts (Akçay, Feyzioğlu ve Tüysüz, 2003). A human being learns by seeing 83%, hearing 11%, smelling 3.5%, touching 1.5% and tasting 1% (Kaya, 2006, s:28). Therefore, the teacher has to research and develop new materials to increase the learning capacities and learning quality of the students. In order to use technology successfully in education, it is necessary to carry out studies for teachers of the future. The first step is to determine the TPACK self-efficacy of pre-service teachers on material development. However, it has been determined that the studies on this subject are not sufficient (Gülbahar, 2008; Devecioğlu & Akdeniz, 2010; Akdeniz & Akbulut, 2010; Birişçi & Metin, 2009). It is thought that the research can contribute to the field development in the determining the TPACK self-efficacy for pre-service science teachers on material development.

1.1. The aim of the research

In this research aimed at determining the TPACK self-efficacy for pre-service science teachers on material development for these purposes, the following research questions were determined:

1. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of gender?
2. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of grade level?
3. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of academic achievement level?
4. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of technology usage frequency?

5. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of participating in technology course?
6. Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of acquiring instructional technology and material development lesson?

2. Methodology of Research

2.1. Research model

In this research, a relational screening model, which is a descriptive research model for determining the relationship between TPACK self-efficacy and material development skills of pre-service science teachers, is used. The screening model is a method aimed at achieving generalized opinion on a sample selected from the universe or universe consisting of many elements (Karasar, 2006). The relational screening model is a screening model that examines the relationship of two or more variable variables (Karasar, 2006, 81).

2.2. Data collection tool

In the research, "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development*" developed by Balçın and Ergün (2016) was used. The scale was prepared with a 5-point likert type consisting of 40 questions with 8 factors. In the scale, 1 = I do not agree completely, 2 = I disagree, 3 = Unstable, 4 = I agree, 5 = I agree completely. Balçın and Ergün (2016) determined the Cronbach alpha reliability coefficient of the scale to be 0.93. In this study, the Cronbach alpha reliability coefficient was set at 0.95.

2.3. Working group

The study group of the research constitutes 2nd, 3rd and 4th grade pre-service science teachers who are studying at Kahramanmaras Sütcü Imam University. The research was conducted during the fall semester of the 2016-2017 academic years. The distribution of the demographic information of pre-service science teachers participating in the research is given in Table 1.

Table 1: Demographic information distribution of pre-service science teachers

		f	%
Gender	Female	129	91.5
	Male	12	8.5
Grade level	2nd grade	46	32.6
	3rd grade	49	34.8
	4th grade	46	32.6
Academic achievement level	Other	15	10.6
	2.50-2.99	86	61.0
	3.00-3.44	37	26.2
	3.50-4.00	3	2.1
Technology usage frequency	Sometimes	12	8.5
	Moderate	64	45.4
	Very often	65	46.1
Participating in technology course	Yes	22	15.6
	No	119	84.4
Acquiring instructional technology and material development lesson	Yes	89	63.1
	No	52	36.9
All		141	100.0

2.4. Analysis of data

The data obtained in the research were analyzed using the IBM SPSS 21 statistical program. Independent-t test and one way analysis of variance (ANOVA) were used to evaluate the data obtained from the research. In addition, percentages, frequencies, mean and standard deviation values were also determined in the study by evaluating the 0.05 significance level. Technological pedagogical content knowledge (TPCK) self-efficacy scale for pre-service science teachers on material development

3. Findings

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of gender?"* was searched. The independent t-test results obtained are given in Table 2.

Table 2: The results of t-test for gender variable

	Gender	N	$\overline{X}$	sd	t	p
Scale	**Female**	129	3.87	139	0.98	.92
	Male	12	3.86			

p<0.05

According to Table 2, there was no significant difference in pre-service science teachers' scores in terms of gender (t(139) =0.98; p>0.05). It can be said that gender is not an effective factor in Technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of grade level?"* was searched. The obtained one-way analysis of variance (ANOVA) results are given in Table 3 and Table 4.

Table 3: Frequency, mean score and standard deviation according to grade level

Grade level	N	$\bar{X}$	ss
2nd grade	46	3.70	.47
3rd grade	49	4.00	.39
4th grade	46	3.91	.56
All	141	3.87	.49

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

		Sum of squares	sd	Mean of squares	F	P	Tukey
Scale	Between Groups	2.184	2	1.092	4.690	.011*	3>2
	Within Groups	32.128	138	.233			
	Total	34.312	140				

****p<0.05***

According to Table 3 and Table 4, there was significant difference in pre-service science teachers' scores in terms of grade level [F(2,138)=4.690; p<0.05]. According to the Tukey analysis, it was determined that the pre-service science teachers who are studying in the third grade are higher than the pre-service science teachers who are studying in the second grade. It can be said that grade level is an effective factor in Technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of academic achievement level?*" was searched. The obtained one-way analysis of variance (ANOVA) results are given in Table 5 and Table 6.

Table 5: Frequency, mean score and standard deviation according to academic achievement

Academic achievement level	N	$\bar{X}$	ss
Other	15	3.85	.63
2.50-2.99	86	3.83	.52
3.00-3.49	37	4.00	.35
3.50-4.00	3	3.70	.12
	141	3.87	.49

Table 6: The results of one-way ANOVA test for academic achievement level

		Sum of squares	sd	Mean of squares	F	P
Scale	Between Groups	.840	3	.280	1.146	.333
	Within Groups	33.472	137	.244		
	Total	34.312	140			

p<0.05

According to Table 5 and Table 6, there was no significant difference in pre-service science teachers' scores in terms of academic achievement level [F(3,137)=1.146; p>0.05]. It can be said that academic achievement level is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. However, according to the average results, it was seen that the academic achievement (3.00-3.49) pre-service teachers was higher than in the other academic achievement level pre-service teachers.

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of technology usage frequency?*" was searched. The obtained one-way analysis of variance (ANOVA) results are given in Table 7 and Table 8.

Table 7: Frequency, mean score and standard deviation according to technology usage frequency

Technology usage frequency	N	$\bar{X}$	ss
Sometimes	12	3.72	.33
Moderate	64	3.84	.50
Very often	65	3.93	.50
All	141	3.87	.49

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

		Sum of squares	sd	Mean of squares	F	P
Scale	**Between Groups**	.589	2	.295	1.206	.303
	Within Groups	33.723	138	.244		
	Total	34.312	140			

p<0.05

According to Table 7 and Table 8, there was no significant difference in pre-service science teachers' scores in terms of technology usage frequency [F(2,138)=1.206; p>.05]. It can be said that technology usage frequency is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. However, according to the average scores, it has been determined that the increase of the frequency of technological use leads to increase in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of participating in technology course?*" was searched. The independent t-test results obtained are given in Table 9.

Table 9: The results of t-test for participating in technology course variable

Participating in technology course		**N**	$\bar{X}$	**sd**	**t**	**p**
Scale	Yes	22	3.97	139	1.011	.314
	No	119	3.85			

p<0.05

According to Table 2, there was no significant difference in pre-service science teachers' scores in terms of participating in technology course (t(139) =1.011; p>0.05). It can be said that participating in technology course is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. However, according to the average results, it was seen that the participating in technology course pre-service teachers was higher than not involved in technology course pre-service teachers.

In the research, the question "*Technological pedagogical content knowledge (TPACK) self-efficacy scale for pre-service science teachers on material development differs is in terms of acquiring instructional technology and material development lesson?*" was searched. The independent t-test results obtained are given in Table 10.

Table 10: The results of t-test for acquiring instructional technology and material development lesson variable

	Lesson taking status	N	$\bar{X}$	sd	t	p
Scale	Yes	89	3.96	139	2.759	.007*
	No	52	3.72			

p<0.05

According to Table 2, there was significant difference in pre-service science teachers' scores in terms of acquiring instructional technology and material development lesson ($t(139) = 2.759$; $p<0.05$). According to the average results, it was seen that the acquiring instructional technology and material development lesson pre-service teachers was higher than not involved in acquiring instructional technology and material development lesson pre-service teachers. It can be said that acquiring instructional technology and material development lesson is an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

4. Conclusıon and Discussıon

In this research aimed at determining the TPACK self-efficacy for pre-service science teachers on material development. When the findings were examined, gender is not an effective factor in Technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. Studies on self-efficacy of teacher candidates on TPACK are included in the literature according to gender. Açıkgül and et al. (2015), Kula (2015), Meriç (2014), Sancar Tokmak and et al. (2013), Kaya and et al. (2011), Öztürk (2013), Koh and Chai (2011), North and et al. (2002) also found similar results and these also support the finding of this research. In addition, Karakaya and Avgın (2016), a similar result was found. However, Chai and et al. (2010) found that gender gore was significant in the study. This result differs with the findings of the research.

When the findings were examined, It has been determined that grade level is an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. According to the Tukey analysis, it was determined that the pre-service science teachers who are studying in the third grade are higher than the pre-service science teachers who are studying in the second grade. The results of the research support the idea of proficiency in the technological integration issues expected from teacher training institutions (Ertmer, 1999; Mishra and Koehler, 2006).

When the findings were examined, It has been determined that academic achievement level is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. However, the increase in the level of academic achievement has been shown to lead to the increase of technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. According to Soong and Tan (2010), it is thought that the activity of TPACK and material development in the curriculums should have a positive effect on the self-efficacy of pre-service science teachers. The findings of the study were published by Karakaya and Avgın (2016) are similar to the results of their study.

When the findings were examined, It has been determined that technology usage frequency is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

When the findings were examined, It has been determined that participating in technology course is not an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development. This result is similar to the results of Öztürk (2013), Devecioglu, (2004), Devecioglu and Akdeniz (2007) studies.

When the findings were examined, It has been determined the acquiring instructional technology and material development lesson pre-service teachers was higher than not involved in acquiring instructional technology and material development lesson pre-service teachers. It can be said that acquiring instructional technology and material development lesson is an effective factor in technological pedagogical content knowledge (TPACK) self-efficacy for pre-service science teachers on material development.

As a result, training and adaptation of technology should be implemented in projects and applications. It is necessary for teachers of your future to be more competent in developing TPACK and materials. It is important that the applications that combine science and pedagogical knowledge of science teacher candidates are deceived.

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