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SCIENCE TEACHERS' LEVEL OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE AND RESEARCH OF THEIR ATTITUDES TOWARD TO THE TECHNOLOGY[1]

FEN BİLİMLERİ ÖĞRETMENLERİNİN TEKNOLOJİK PEDAGOJİK ALAN BİLGİSİ (TPAB) DÜZEYLERİ VE TEKNOLOJİYE YÖNELİK TUTUMLARININ İNCELENMESİ

Asuman ALTUNOĞLU

Ministry of National Education, Teacher, İstanbul / Turkey

Assoc. Prof. Dr. Ahmet Hakan HANÇER

Cumhuriyet University, Education Faculty, Sivas/ Turkey

ÖZ

Bu çalışanın amacı, fen bilimleri öğretmenlerinin; teknolojik pedagojik alan bilgisi (TPAB) düzeylerini, teknolojiye yönelik tutumlarını, TPAB düzeylerinin ve teknolojiye yönelik tutumlarının çeşitli değişkenler açısından farklılaşıp farklılaşmadığını belirlemek ve TPAB düzeyleri ile teknolojiye yönelik tutumları arasındaki ilişkiyi araştırmaktır. Bu çalışma 2016 - 2017 eğitim öğretim yılında İstanbul'un çeşitli ilçelerinde görevli 188 fen bilimleri öğretmeni ile nicel araştırma yöntemlerinden ilişkisel tarama modeli kullanılarak gerçekleştirilmiştir. Araştırmada verileri toplamak amacı ile "TPAB ölçeği" ve "Teknoloji Tutum Ölçeği" kullanılmıştır. Çalışma sonucunda; fen bilimleri öğretmenlerinin TPAB ölçeğinin tüm alt boyutlarında ve ölçek genelinde "iyi" düzeyde olduğu, teknolojiye yönelik tutumlarının ise "olumlu" olduğu görülmüştür. Fen bilimleri öğretmenlerinin TPAB düzeylerine cinsiyet açısından bakıldığında; TPAB ölçeğinin genelinde ve TP, PB, TPB, TAB, PAB, TPAB alt boyutlarında erkek öğretmenler lehine anlamlı bir farlılık olduğu görülmektedir. Fen bilimleri öğretmenlerinin teknolojiye yönelik tutum düzeylerinin değişimine cinsiyet açısından bakıldığında; kadın öğretmenler lehine anlamlı bir farklılık olduğu görülmüştür. Fen bilimleri öğretmenlerinin TPAB düzeyleri ve teknoloji tutumları arasında pozitif yönde, düşük düzeyde ve anlamlı bir ilişki olduğu tespit edilmiştir.

Anahtar Sözcükler: Teknolojik pedagojik alan bilgisi, teknoloji tutumu, fen bilimleri öğretmenleri, cinsiyet, korelasyon

ABSTRACT

Aim of that study is to determine the level of science teachers' technological pedagogical content knowledge (TPCK), their attitudes toward to the technology, level of their TPCK and whether their attitudes toward to technology become different or not in terms of various variables and to search the relation between the TPCK level and their attitudes toward to technology. This study was realized by using relational screening model which is one of the methods of quantitative research, with 188 science teachers working in different districts of Istanbul between the academic years of 2016 – 2017. In this study on purpose of collecting data 'TPCK scale' and Technological Attitude Scale were used. At the end of the study; all science teachers have been seen as 'good' at the all sub-dimensions and throughout of TPCK scale and they have been seen as positive at their attitude toward to technology. When examining TPCK level of science teachers in terms of sex, throughout the TPCK scale and at the sub-dimension of TK, PK, TPK, TCK, PCK, TPCK a significant variation is seen in favor of male teachers. When examining the science teachers' level of attitude toward to technology in terms of sex; there is a significant variation in favor of female teacher. Between the science teachers' TPCK level and their technological attitudes positively and a significant relation has been determined.

Key Words: Technological pedagogical content knowledge, technological attitude, science teachers, gender, correlation.

1. INTRODUCTION

Teachers are the manpower of the education system and they have crucial role and responsibility in raising individuals pursuant to ever-changing social requirements (Odabaşı and Kabakçı 2007). Researches indicate

[1] At the Institute of Educational Sciences of Cumhuriyet University, It was produced from the master's thesis conducted by Asuman Altunoglu under the consultancy of Assoc. Prof. Dr.Ahmet Hakan Hançer

that teachers are more important than all other facts having impact on students' school success when compared to factors such as management, organization and economic status of the school (Rivkin, Hanushek and Kain, 2005) and impact and importance of a teacher's qualifications and competencies on student success is clearly stated (Rockoff, 2003; Akyüz, 2006; Goe and Stickler, 2008; Atar, 2014). Hence, teachers must have knowledge, skills and behaviors required under innovations and developments in the education segment.

Improving quality of teaching profession can only be possible by first determining the competencies teachers must have in the professional life and making sure that teacher candidates have necessary competencies (Erdem, 2005). In this context, studies showing impact and importance of teacher qualifications in then student development process focus of teacher competencies.

Our country dwells on the teacher competencies, as is the case with all around the world. The Ministry of National Education (MEB) established general field and specialization competencies about the teaching profession for improving quality of teacher training and guiding teachers. The general competencies of teaching profession, which entered into force based on the Ministry of National Education's approved dated 17.04.2006 and published on the Journal of Communiqués numbered 2590, includes six essential competencies as well as 31 sub competencies and 233 performance indicators set forth based on these fields of competencies.

The Ministry of National Education expects the teachers to have the following six essential competencies:

1. Personal, professional values and professional development

2. Student recognition

3. Teaching and learning process

4. Monitoring and evaluation of learning, development

5. School, family and social relationships

6. Program and content knowledge

The specialization competencies are unique to each branch for every course and they complement the general field competencies. Specialization competencies of a science teacher are designed to be used for determining development goals of science teachers in their respective fields as well as reviewing performance of the teachers and building career steps, designing programs offered for teacher candidates and organizing on-the-job trainings for teachers. The specialization competencies set forth for science teachers have five essential fields of competency; planning and organizing learning-teaching process, monitoring and evaluating scientific, technological and social developments, cooperating the school, family and society and assuring professional development, and there are performance indicators identified with A1, A2 and A3 levels for each competency (ÖYEGM, 2008). These competencies are determined based on Pedagogical Content Knowledge.

Pedagogical Content Knowledge (PCK), brought into literature by Shulman (1986), emerged as a mixture of content knowledge and pedagogical knowledge, and it refers to a teacher's knowledge in selecting the best techniques and methods to be used for assuring comprehension of a subject and taking into consideration subject area and student characteristics.

Shulman (1986, 1987) offers analytical distinctions between different types of knowledge required for efficient teaching as well as a conceptual framework. Shulman (1987) defined seven different categories of teacher knowledge: three of these are content knowledge, curriculum knowledge and pedagogical content knowledge that cover content aspects of teaching knowledge. Researches on teacher knowledge have been focusing on PCK and content knowledge (CK) in the last twenty years (Hill, Rowan & Ball, 2005; Kleickmann, et al., 2013; Krauss, et al., 2008). As a result of the meta-analysis study made by Coe, Aloisi, Higgins and Major (2014) on professional developments of teachers, PCK is confirmed to be the factor that contributes the most to the student success.

Mishra and Koehler (2006) added a technological aspect to the definition of PCK and introduced the concept of Technological Pedagogical Content Knowledge (TPCK). Koehler and Mishra defines TPCK as a type of knowledge developed for enabling teachers to offer efficient teaching through the use of technology and emerged from integrating technological knowledge into the types of knowledge teachers must have.

Çepni (2005) argues that individuals must become familiar with technologies through formal and informal education so that they can be adapted to technological innovations. Hence, teachers are the persons who are expected to perform this task. This is why teachers must actively use information and communication technologies. This will enable them to keep up with advancements in their fields as well as self-improvement, integration of technology into learning, teaching and evaluation processes and cultural improvement (Avcı, 2014). Technological attitude is one of the crucial factors that determine teachers' efficient and productive use of technology in any educational environment (Bilgin, Tatar and Ay, 2012). Accordingly, teachers' attitude towards use of technology in teaching comes into prominence.

If we review the literature in this field, we can see that there are studies discussing TPCK level and TPCK competencies of teachers and candidate teachers (Avcı, 2014; Canbaz Bilici, 2012) and their attitude towards use of technology in education as well as their attitude towards information and communication technologies (Yavuz and Coşkun, 2008İ Cüre and Özdener, 2008) as independent aspects but there are recent studies reviewing TPCK levels of secondary school teachers based on use of teaching technologies (Bilici and Güler, 2016) and reviewing classroom teacher candidates' technological attitude and their TPCK competencies (Bilgin et. al, 2012) in connection with TPCK levels of other branch teachers and information, communication technologies (Albayrak Sarı, Canbazoğlu Bilici, Baran ve Özbay, 2016), and also experimental studies with teachers (Chai, Koh and Tsai, 2010).

As seen on the literature, teachers must master technological knowledge, skills and pedagogical content knowledge; this will enable teachers to provide proper learning environments and contribute to student success, in other words, teachers must be technological pedagogical content knowledge. However, it is observed that number of studies focusing on TPCK levels of science teachers, who teach a course closely associated with technology, and their technological attitude is not sufficient; majority of available studies were conducted with teacher candidates and number of studies focusing on teachers, who are actively involved in education-training profession, is not sufficient.

Therefore, it is considered that conducting a study on TPCK levels of science teachers and their technological attitude and identifying incompetence, if any, would be useful for teachers and teacher candidates attending to faculties of education so that science teachers can offer efficient teaching and education. Purpose of this study, which is based on this idea, is to identify TPCK levels of science teachers and their technological attitude, whether their TPCK levels and technological attitude change based on various variables and to investigate the relationship between TPCK levels and technological attitude. In accordance with this purpose, the study tries to answer the following sub problems:

1. What is the TPCK level of science teachers? Is there any significant difference based on gender?

2. What is the technological attitude of science teachers? Is there any significant difference based on gender?

3. Is there a significant relationship between TPCK levels of science teachers and their technological attitude?

2. METHOD

One of the quantitative research methods, namely "relational screening model" was used on this study. "Screening model is a research approach that tries to define a past or current situation as is; relational screening model is an approach that tries to determine the existence and / or extent of covariance between two or more variables" (Karasar, 2012).

2.1. Population and Sampling

Population selected for this study includes science teachers working for secondary schools in Istanbul. The sampling group includes 188 science teachers worked in Istanbul in the academic year of 2016 and 2017. The study used "convenience sampling method", one of the non-random sampling methods. The demographic characteristics of science teachers included in the research's sampling group are given on Table 1.

Table 1. Demographic Characteristics of Science Teachers

Variables	Sub dimensions	Frequency	Percent
Gender	Female	127	67,6
	Male	61	32,4

2.2. Data Collection Techniques

"TPCK Scale" and "Technological Attitude Scale" were used to collect data on this study.

Technological pedagogical content knowledge (TPCK) scale: "TPCK Scale" designed by Şahin (2011) was used for determining TPCK levels of science teachers. The "TPCK Scale" is a 5-point Likert type of scale covering 47 items and 7 sub dimensions (1st Technological Knowledge, 2nd Pedagogical knowledge, 3rd

Content Knowledge, 4th Technological Pedagogical Knowledge, 5th Technological Content Knowledge, 6th Pedagogical Content Knowledge and 7th Technological Pedagogical Content Knowledge). The scale was designed by Şahin (2011). Each item on the scale is scored with the following: "1: I don't know", "2: I know a little", "3: I know", "4: I know well" and "5: I know very well". This 47-item scale was given to 348 teacher candidates under the scope of validity and reliability study conducted by Şahin (2011) and Cronbach alpha values were calculated respectively as follows: 0.80, 0.82, 0.79, 0.77, 0.79, 0.84 and 0.86.

This scale was used on 247 teacher candidates, who are senior students of Cumhuriyet University, for determining reliability coefficient of the scale. The Cronback alpha values calculated for the overall scale and sub dimensions are given on Table 2.

Table 2. Reliability Analysis Results of TPCK Scale

Content	A
1st Sub Dimension	0.81
2nd Sub Dimension	0.86
3rd Sub Dimension	0.86
4th Sub Dimension	0.84
5th Sub Dimension	0.82
6th Sub Dimension	0.83
7th Sub Dimension	0.82
Entire Scale	0.88

A review of Table 2 reveals that reliability values related to sub dimensions of the scale and reliability values related to the general scale are high. These values confirm that the study might use the scale on science teacher

Technological attitude scale: "Technological attitude scale" was used for determining attitude levels of science teachers related to use of technology in education. The scale developed by Yavuz (2005) has 19 items and 5 factors. These factors are as follows, respectively: "non-use of technological tools in education", "use of technological tools in education", "effect of technology on education life", "teaching use of technological tools" and "evaluation of technological tools". The scale has thirteen positive and six negative items. Cronbach alpha value was calculated as 0.86 as a result of reliability coefficient analysis made about the scale (Yavuz, 2005). Each item on the technological attitude scale should be scaled as follows: "5: Strongly Agree", "4: Agree", "3: Neutral", "2: Disagree" and "1: Strongly Disagree". Accordingly, for coding data, points from five to one are given when scoring options for items stating a positive sentence and points from one to five are given when scoring options for items stating a negative sentence.

This scale was used on 247 teacher candidates, who are senior students of Cumhuriyet University, for determining reliability coefficient of the "Technological Attitude Scale" applied on this research. The Cronback alpha value was calculated as 0.83. This alpha value confirms that the scale is reliable and can be used.

2.3. Data Analysis

The study used SPSS (Statistical Package for the Social Sciences) package program for data analysis. Percentage and frequency, which are both descriptive analysis methods, were used to indicate demographic information of science teachers in the population based on gender variable. Descriptive analysis was conducted to determine TPCK, TPCK sub dimensions and technological attitude levels of teachers and averages were taken into consideration. Kolmogorov-Smirnov test was used to find out whether TPCK and technological attitude levels of teachers vary based on gender and single-factor ANOVA test, which is one of the parametric tests, was used after confirming normal data distribution. Pearson correlation coefficient analysis was used for determining the relationship between TPCK levels and technological attitude of science teachers. p=,05 significance level was used for interpreting data of this study.

3. FINDINGS

Findings of the study are explained below on the basis of sub dimensions.

Findings related to the 1st Sub Problem

The first sub problem of the research is "What is the TPCK level of science teachers? Is there any significant difference based on gender?" and TPCK scale was used on science teachers to find out more about this sub problem. The descriptive analyses about the TPCK levels obtained from the scale are given on Table 3.

Table 3. Descriptive Analysis on TPCK Scale scores of Science Teachers

Measurement	N	Minimum	Maximum	$\overline{X}$	S
TK	188	1,64	5,00	3,63	,7658
PK	188	1,83	5,00	3,81	,7065
TPK	188	1,75	5,00	4,10	,7229
PCK	188	1,57	5,00	3,85	,7336
TCK	188	1,50	5,00	4,00	,7464
CK	188	1,83	5,00	3,92	,6663
TPCK	188	2,00	5,00	3,88	,7493
General	188	2,42	5,00	3,83	,4272

Since TPCK scale uses 5-point scoring, the evaluation can define values between 1.0 – 1.80 as "none", 1.80 – 2.60 as "few", 2.60-3.40 as "average", 3.40 – 4.20 as "good" and 4.20 – 5.0 as "very good". The review of Table 3 confirms that average scores of science teachers for sub dimensions of TPCK scale are within the range of 3.63 and 4.10 and the average score calculated for the general scale ($\overline{X}$ =3,83) corresponds to "good" section of item average.

First, Kolmogorov-Smirnov test was used on TPCK scale data to determine whether they have normal distribution so that finding out whether there is significant difference between TPCK levels of science teachers based on gender can be possible, and the available data is given on Table 4.

Table 4. Normality Distribution of TPCK Scale Data

Scale	Skewness	Kurtosis	Kolmogorov-Smirnov
			P
TPCK	-,451	-,062	,015

According to findings given on Table 4, p=,015 (p<,05) which means that data does not have normal distribution. However, Tabachnick and Fidell (2013) argues that if skewness and kurtosis values remain within the range of -1.5 and + 1.5, this might be interpreted as normal distribution. The data distribution was accepted as normal because the skewness and kurtosis values calculated are within the range given by Tabachnick and Fidell, and parametric analysis methods were used for statistical procedures.

After confirming that the data obtained from TPCK scale have normal distribution, Levene test was used on data obtained from TPCK scale and sub factors in order to examine homogeneity of variances. Levene test results were calculated as follows; p = 0,079 for TK, p= 0,965 for PK, p= 0,314 for CK, p= 0,849 for TPK, p= 0,433 for TCK, p= 0,062 for PCK, p= 0,092 for TPCK and p=0,546 for the general TPCK scale. The fact that calculated significance values (p) is p>,05 for all of them confirms homogeneity of variances. After these analyzes, data was tested with a parametric test, namely single-factor ANONA. The relationship between TPAB levels and gender of science teachers is given on Table 5 and Table 6.

Table 5. Descriptive Statistics of TPCK Scale and Sub Factors based on gender

Sub Factor	Gender	N	$\overline{X}$	S
TK	Female	127	3,56	.7165
	Male	61	3,79	.8440
PK	Female	127	3,73	,6890
	Male	61	3,97	,7206
CK	Female	127	3,86	,6784
	Male	61	4,04	,6285
TPK	Female	127	4,01	,7319
	Male	61	4,30	,6674
TCK	Female	127	3,88	,7519
	Male	61	4,25	,6778
PCK	Female	127	3,77	,7633
	Male	61	4,02	,6432
TPCK	Female	127	3,80	,7846
	Male	61	4,05	,6433
General	Female	127	3.67	,6255
	Male	61	3.91	,5938

The review of Table 5 confirms that the average highest score ($\overline{X}_{Female}$ =4,01, $\overline{X}_{Male}$ = 4,30) obtained on the scale by the female and male science teachers is for TPK sub dimension and the lowest ($\overline{X}_{Female}$ =3,56,

$\overline{X}_{Male}$ = 3,79) is for TK sub dimension. Furthermore, it is observed that averages calculated for male science teachers on all sub dimensions of the TPCK scale are higher than the averages calculated for female teachers. Single-factor ANOVA test was used to determine whether these differences are statistically significant.

Table 6. Single-Factor ANOVA Results for Effect of Gender on TPCK and Sub Factors

Sub Factor	Source of Variance	Sum of Squares	Sd	Average of Squares	F	P
TK	Inter-groups	2,239	1	2,239	3,876	,045*
	In-groups	107,426	186	,578		
	Total	109,664	187			
PK	Inter-groups	2,377	1	2,377	4,860	,029*
	In-groups	90,972	186	,489		
	Total	93,349	187			
CK	Inter-groups	1,336	1	1,336	3,043	,083
	In-groups	81,690	186	,439		
	Total	83,026	187			
TPK	Inter-groups	3,497	1	3,497	6,903	,009*
	In-groups	94,220	186	,507		
	Total	97,716	187			
TCK	Inter-groups	5,401	1	5,401	10,170	,002*
	In-groups	98,786	186	,531		
	Total	104,187	187			
PCK	Inter-groups	2,423	1	2,423	4,588	,033*
	In-groups	98,226	186	,528		
	Total	100,649	187			
TPCK	Inter-groups	2,588	1	2,588	4,702	,031*
	In-groups	102,389	186	,550		
	Total	104,977	187			
General	Inter-groups	1070,366	1	112,919	6,342	,013*
	In-groups	3311,804	186	17,805		
	Total	3424,723	187			

*p<.05

The review of Table 6 confirms that there is a significant difference (p<,05) within the 95 % reliability range in favor of male teachers when it comes to points scored by the science teachers on the general scale and sub factors of TK, PK, TPK, TCK, PCK and TPCK. As for the sub dimension of CK, it is confirmed that there is no significant difference (p>,05) between science teachers based on gender.

Findings related to the 2nd Sub Problem

The second sub problem of the study is: “What is the technological attitude of science teachers? Is there any significant difference based on gender?” Kolmogorov-Smirnov was used to determine whether data obtained from Technological Attitude Scale about this sub problem has normal distribution, and the findings are available on Table 7.

Table 7. Normality Distribution of TAS Data

Scale	Skewness	Kurtosis	Kolmogorov-Smirnov
			P
TTS	-,307	,552	,200

As seen on the findings available on Table 7, the skewness and kurtosis values are within the range of -1.50 and 1.50 and the significance level is p=,200 (p>,05). In other words, the findings confirm the normal distribution of data. Hence, parametrical analysis methods were used on statistical procedures made with data obtained from TAS.

After confirming that the data obtained from TAS has normal distribution, Levene test was used to review homogeneity of variances. The Levene test results about TAS were calculated as p=,210, in other words p>,05. The calculated significance (p) value, namely p>,05, confirms homogeneity of variances. As a result of these analyzes, data was tested with a parametric test, namely single-direction variance analysis ANOVA, for answering the questions asked on the second sub problem. The relationship between TAS levels and genders of science teachers is given on Table 8 and Table 9.

Table 8. Descriptive Statistics of TAS Scores based on gender of science teachers

Gender	**N**	$\bar{X}$	**S**
Female	127	4,18	,40339
Male	61	4,00	,45116
Total	188	4,12	,42715

TAS score average of science teachers is 4.12 and the highest score of the scale is 5. Accordingly, as seen on Table 8, the technological attitude of science teachers is at a high level.

Table 9. Single-Factor Anova Results about Gender's Effect on TAS Scores

Source of Variance	Total of Squares	sd	Average of Squares	F	P
Inter-groups	1,403	1	1,403	7,977	,005*
In-groups	32,716	186	,176		
Total	34,119	187			

*P<,05

Review of Table 9 confirms that there is a significant difference in favor of female teachers when it comes to gender-related differences between technological attitude levels of science teachers (F(1, 186) =7,977; p=,005).

Findings related to the third sub problem

The third sub problem of the research is: "Is there a significant relationship between TPCK levels of science teachers and their technological attitude?" Pearson correlation coefficient analysis was used for this sub problem and the results are given on Table 10.

Table 10. Correlation between TPCK level and TAS

Variables	N	$\bar{X}$	S	r	P
TPCK	188	3.83	,6378	,245	,001
TAS	188	4.12	,4272		

If the correlation coefficient is between 0.00 and 0.29, there is a low level and positive relation between the variables (Büyüköztürk et al., 2008). Review of Table 10 confirms that there is a low level and positive significant (p<,05) relation (r=,245) between the points scored by science teachers on TPCK scale and points scored on TAS. Hence, we can argue that TPCK level increases in parallel to the increase of technological attitude. If we take into consideration the determination coefficient (r^2=,06), we can say that 6 % of the total variance on TPCK level comes from technological attitude.

4. DISCUSSION AND CONCLUSIONS

Data obtained with TPCK scale were analyzed for determining TPCK levels of science teachers. Based on the analysis results, the average points scored by science teachers on sub dimensions of TPCK scale (TK=3.63, PK=ile 3.80, TPK=4.10, PCK=3.85, TCK=4.00, CK=3.92, TPCK=3.88) and average points scored on the general scale ($\bar{X}$=3,83) were determined. These averages confirm that science teachers have at a "good" level on the sub dimensions of TPCK scale and general scale. These results support the literature in this field. In a similar manner, a study with science teachers in Manisa confirmed that the teachers' level in all sub dimensions of TPCK scale and general scale is "good" (Avcı, 2014). Similar results obtained on studies did with teachers from different branches (Archhambault and Crippen, 2009; Bal and Karademir, 2013; Albayrak Sarı et al., 2015; Göl, 2016; Bilici and Güler, 2016). Another study with science teacher candidates also confirmed that teacher candidates' scores from the sub dimensions of technological knowledge (TK), pedagogical knowledge (PK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technological content knowledge (TCK) as well as the general scale are at a "good" level and the levels of content knowledge (CK) and technological pedagogical content knowledge (TPCK) are "average" (Akarsu and Güven, 2014). Canbazoğlu and Bilici (2012) did a research on teacher candidates and argued that preparation for teaching process contributes to improvement of content knowledge. As also seen on the literature in this field, "good" level of CK dimension might be associated with preparations made by teachers before the class.

Generally, science teachers have "good" TPCK levels and this might be explained with the teaching courses that are included in teacher training programs and that improve pedagogical content knowledge such as special teaching techniques, teaching technology and material development and with the teachers' acknowledgement about the necessity of using educational technologies (Akarsu and Güven, 2014; Bilici and Güler, 2016).

A review of TPCK levels of science teachers based on gender confirms that there is a significant difference in favor of male teachers in the overall TPCK scale and sub factors TK, PK, TPK, TCK, PCK and TPCK. This conclusion is similar to other studies in the literature. A study focusing on primary school mathematics teacher candidates examined TPCK levels of 288 junior and senior teacher candidates. The study concluded a statistically meaningful difference in favor of male teacher candidates in the sub dimensions of Technological Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge and Technological Pedagogical Content Knowledge (Canpolat, 2011). However, some studies concluded that there is significant difference between TPCK levels and gender of teachers. Karakaya (2013) did a study on chemistry teachers and concluded that TPCK levels of male teachers are higher than female teachers but the difference is not at a significant level. Another study with a population of 148 teachers from different branches concluded that average TPCK scores of male teachers are higher than female teachers but this is not a significant difference in terms of gender (Göl, 2016).

Such diverse results in the literature suggest that results might vary based on time, place and conditions of the study. Furthermore, it is interesting that the difference observed in gender also exists in technology dimension and dimensions related to technology. This might be explained with the fact that women have minor difficulties in keeping up with technology when compared to men as well as their decreased interest and aspiration (Avcı, 2014).

Data collected with Technology Attitude scale was analyzed for determining technological attitude levels of science teachers. As seen from TAS score average of science teachers ($\overline{X}$ =4,12), the technological attitude of teachers is at a high level and positive. This result is supported with literature in this field. A study with a population of 483 teachers from different branches also concluded that teachers have a positive technological attitude (Sarı et. al, 2015). In another study focusing on form teacher candidates, teacher candidates stated that classes are more enjoyable with technological tools and instruments; understanding the subject becomes easier and visual aids are helpful (Yavuz and Coşkun, 2008). A study by Karasakaloğlu et, al. (2011) supports these results; it concluded that there is a positive relationship between technological attitude of teachers and use of technology in the teaching process.

If change in technological attitude levels of science teachers is reviewed based on gender, it is observed that there is a significant difference in favor of the female teachers but the average score are close (4.18 and 4.00). As seen on the literature in this field, there are diverse results in this matter. The literature includes studies that concluded there is no significant difference between technological attitude levels and gender of teachers (Karasakaloğlu, et. al., 2011; Çetin et al., 2012; Barut, 2015) and studies that concluded men have more positive attitude (Karamustafaoğlu et al., 2012) or studies that concluded female teachers are more sensitive than male teachers when it comes to use of teaching technologies (Galpin and Sander, 2007). These different results might be related to differences in times, sampling groups and conditions of these studies. Furthermore, this might be also explained by the fact that women living in this modern age of technology improve themselves in use of technology, as required in this age (Barut, 2015).

The fact that female science teachers have technological attitude averages higher than male teachers but have a lower average on TK sub dimension of TPCK scale suggests that women see use of technology in teaching process but they see themselves less qualified in terms of technological knowledge when compared to male teachers. Furthermore, the score averages on technological attitude scale revealed that the male teachers have good technological attitude and the difference from female teachers is only 0.18 point.

Correlation coefficient analysis was done to determine the relationship between TPCK levels and technological attitude of science teachers. The analysis results revealed that there is low-level, positive and significant relationship between TPCK levels and technological attitudes of science teachers and the TPCK level increases in parallel to the increase of technological attitude. Furthermore, it is confirmed that 6 % of total variance in TPCK level comes from technological attitude. This result supports the literature in this field. A study with a population of 342 form teacher candidates from different university was done for reviewing contribution of technological attitude of form teacher candidates to TPCK levels, and this study revealed that teacher candidates' technological attitude account for 28.1 % of the change in their TPCK (Bilgin et al., 2012). Accordingly, it is seen that teachers' positive technological is crucial in adapting technology to the teaching process and improving professional qualifications. Hence, we should bear in mind that improved technological attitudes of teacher candidates and teachers do not only improve use of technology but directly or indirectly have impact on their professional qualifications.

Therefore, vitality of positive technological attitude adopted by teachers and teacher candidates is evident. A study concluded that teacher candidates generally interacting with technology and frequently using technology develop positive attitude and self-sufficiency in the matter (Christensen and Knezek, 2000). This is why teachers' and candidate teachers' interaction with technology must be increased by providing the necessary conditions. Furthermore, continued technological education should be provided to teachers, and the faculties of educational sciences and school environments should offer sufficient level of opportunities for developing positive attitude (Akpınar, 2004).

4.1. Suggestions

The study revealed that female teachers have a TPCK level lower than male teachers. Hence, the faculties of educational sciences should encourage all teacher candidates to use technology even if the candidates are not very interested at the beginning. The classes at the faculties of educational sciences should be technology aided and all teacher candidates should have chance to actively use technology in order to reach a sufficient capacity.

The study confirmed that there is a positive relationship between TPCK level and technological attitude of teachers. Thus, training plans prepared for teacher candidates and teachers should take into consideration not only cognitive aspect but also affective aspect. Furthermore, the training might be rearranged in a manner supporting TPCK and technological attitude interaction.

Teachers will have functional TPCK levels and technological attitudes and improve them if there are platforms that can enable teachers to integrate them into teaching process. When supplying necessary technological tools and equipment at schools for this purpose, teachers who are going to use these tools should be consulted to make necessary arrangements and teachers should receive applied training in this field.

This study focused on only science teachers. Other studies might be done to examine variables having an impact on TPCK and technological attitude of teachers in other branches.

This study is based on screening model. There might be observational studies reviewing TPCK levels of teachers in terms of different variables and based on performance indicators.

It is revealed that female science teachers see themselves less sufficient in the technology-related sub dimension of TPCK scale. Qualitative studies that will offer wider knowledge about the root causes of this fact might be done.

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