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An evaluation of technological pedagogical content knowledge (TPACK) of in-service teachers: A study in Turkish public schools

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KEYWORDS

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A B S T R A C T

In the current study, the technological pedagogical content knowledge (TPACK) perceptions of Turkish in-service teachers working in public schools were investigated. The survey method was employed to investigate the in-servive teachers' perceptions of TPACK in terms of some demographic variables. The participants of the study consisted of volunteering in-service teachers (n = 200) from different public elementary and high schools. The results of the study indicated that the in-service teachers' TPACK perceptions were affected by their gender, occupational experience, educational level, teaching level, and taking educational computer and Internet use seminar variables. The results also revealed that the in-service teachers' perceptions of TPACK were at a moderate level. The results suggested that further efforts are required to develop the in-service teachers' TPACK perceptions in order to integrate ICTs into teaching and learning process effectively in the classroom.

Introduction

The use of Information and Communication Technologies (ICTs) in the twenty-first century has caused crucial developments in many fields as well as the education field itself (Peterson, 2004). Such use of ICTs, at the same time, has led to significant changes in teaching and learning process in the classroom specifically (Harris, 2002). As ICTs begin to gain popularity in schools and the children are increasingly growing up with this technology, the intense use of ICTs by teachers in teaching and learning process is increasing rapidly (Chai, Koh, & Tsai, 2010). The integration of ICTs into teaching and learning in the classroom for teachers brings a more challenging process day by day (Shafer, 2008) as a matter of fact that teachers play an important role in the effective use of ICTs in teaching and learning process (Teo, Ursavaş, & Bahçekapılı, 2012). As ICTs have entered into classrooms, there is an increased interest in the essential roles and qualities of teacher knowledge bases necessary for successful technology integration (Kurt, 2012). In this sense, ICTs-integrating teacher means going beyond the skills of information and communication technologies and developing an understanding in terms of the complex relationships between pedagogy, technology, and content (Alayyar, Fisser, & Voogt, 2012; Niess, 2005).

The research literature shows that teachers are inefficient in regard of their subject-specific use of ICTs (e.g., Kramarski & Michalsky, 2010) and they also do not have the necessary knowledge and experience to incorporate technologies into classroom teaching and learning process (e.g., Buckenmeyer & Feritas, 2005). Although teachers have started to be educated about what technology to use, they are not well trained about how and where to use technology in the classroom (e.g., Koehler, Mishra, & Yahya, 2007; Savaş, 2011). Not only providing teachers with technology–supported efficient training is considered important, but also it is seen very crucial to understand the three components (technology, pedagogy, and content) as well as the relationships between them (Erdoğan & Şahin, 2010). As it is considered a serious problem to see technology, pedagogy, and content differently from each other (Niess, 2005), teachers have to improve themselves in the fields of technology, pedagogy, and content in order to have a successful professional career (Şahin, 2011). In teaching and learning process, it is important not only how teachers teach (pedagogy) and what they teach (content), but it is also important which materials (technology) they use while teaching (Jones & Moreland, 2004). A teacher who can navigate between these interactions acts as an expert who is different than only a subject matter, pedagogy, or teaching expert (Baran, Chuang, & Thompson, 2011; Mishra & Koehler, 2006). Instead of being treated content knowledge and pedagogical knowledge as separated domains of teacher knowledge bases, they should be considered to have mutual relationships with each other (Shulman, 1987). Therefore, the Technological Pedagogical Content Knowledge (TPACK) framework to explain each aspect which is technology knowledge, content knowledge and pedagogical knowledge (Voogt, Fisser, Roblin, Tondeur, & van Braak, 2013), and the relationships amongst them was developed by Koehler and Mishra (2005) in their study.

By following Koehler and Mishra's (2005) conceptualisation of technological pedagogical content knowledge (TPACK) model, several researchers applied interventions or course designs to improve teachers' level of TPACK (e.g., Angeli & Valanides, 2009; Chai, Koh, & Tsai, 2010; Niess, 2005). Besides, some researchers focused on the relationship between TPACK levels of teachers and some variables (e.g., Lee & Tsai, 2008; Niederhauser & Perkmen, 2010). Also, some other researchers investigated the level of TPACK of pre-service or in-service teachers especially in countries in Asia (e.g., Jeong So & Kim, 2009; Koh, Chai, & Tsai, 2010; Liang, Chai, Koh, Yang, & Tsai, 2013) as well as other few countries out of Asia (e.g., Alayyar, Fisser, & Voogt, 2012; Angeli & Valanides, 2009; Niess, 2005). There are also, of course, some researchers focusing on teachers' level of TPACK perceptions in Turkish context (e.g.,Çelik, Şahin, & Aktürk, 2014; Erdoğan & Şahin, 2010; A. Karataş, 2014; Kaya & Dağ, 2013; Kaya, Kaya, & Emre, 2013; Kula, 2015; Kurt, 2012; Savaş, 2011; Semiz, 2011; Şahin, 2011; Şahin, Çelik, Aktürk, & Aydın, 2013). In these researches, for example, Şahin (2011) developed a new survey for determining technological pedagogical content knowledge (TPACK) of pre-service teachers, Kaya and Dağ (2013) adapted TPACK scales into the Turkish language and culture. Furthermore, F. I. Karataş (2014) examined in-service secondary mathematics teachers' TPACK and technology integration self-efficacy, Erdoğan and Şahin (2010) investigated the relationship between mathematics teacher candidates' TPACK and their achievement levels, Savaş (2011) examined pre-service science teachers' perceived TPACK regarding genetics,

Kurt (2012) tried to develop TPACK levels of pre-service English language teachers through a design study, and lastly Semiz (2011) investigated pre-service physical education teachers' TPACK, technology integration self-efficacy, and instructional technology outcome expectations in their studies. Thus, as it is seen from the research literature, there is no study that directly examines the perceptions of TPACK of in-service teachers in Turkey. Also, most of the studies focusing on TPACK are seen to be carried out on pre-service teachers, not on in-service teachers formally working in schools in Turkey. According to A. Karataş (2014), although it is seen important to study with pre-service teachers, the TPACK levels of in-service teachers should be examined because technology integration is experienced in the classroom. Also, as Hofer and Harris (2012) state, the majority of the TPACK-based studies have focused upon development of pre-service teachers' level of TPACK. However, it is understood that the research literature has mostly neglected to examine the level TPACK perceptions of in-service teachers. Hence, it is needed that researchers should begin to explore how the TPACK develops with in-service teachers. For this reason, more research should be carried out focusing on in-service teachers to determine the TPACK level of them. Therefore, this paper investigates the level of TPACK of Turkish teachers in terms of some demographic variables in order to determine the level of TPACK perceptions of these teachers. More research that study how TPACK levels of teachers are affected by some variables are needed to understand the level of TPACK of in-service teachers working in public schools in Turkey.

Literature review

Technological pedagogical content knowledge
The concept of technological pedagogical content knowledge (TPACK) has emerged over the last decade (Chai, Koh, & Tsai, 2013). The theory of
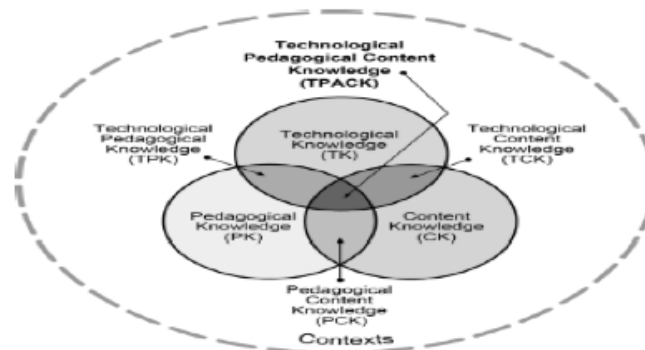

Figure 1. Technological Pedagogical Content Knowledge (Mishra & Koehler, 2008).

TPACK was developed by Koehler and Mishra (2005) over Shulman's (1986) Pedagogical Content Knowledge (PCK) model. Elaborating upon the study of Shulman (1986), who proposed PCK referring to the intersection of subject-specific knowledge, pedagogical knowledge, and knowledge of the teaching context, Mishra and Koehler (2006) have proposed a framework to define the knowledge teachers need to acquire in order to integrate technology into teaching and learning process effectively. The term TPACK began to gain widespread popularity in 2006 after Mishra and Koehler's seminal work outlining the model and describing each of the central constructs (F. I. Karataş, 2014). The original acronym TPCK has been recently changed to TPACK for the ease of pronunciation of the term (see Thompson & Mishra, 2007). The framework of TPACK consists of three main components of knowledge: technology, pedagogy, and content and interactions amongst these components, represented as pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK) (Mishra & Koehler, 2006). The framework proposes combining these three main components of knowledge in four additional types of knowledge; pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). The TPACK framework is commonly shown using a Venn diagram with three overlapping circles, each representing a distinct form of teacher knowledge (see Figure 1).

The TPACK is a theoretical framework for understanding teacher knowledge required for an effective technology integration process (Mishra & Koehler, 2006). It describes "how teachers' understanding of technologies and pedagogical content interact with one another to produce effective teaching with technology" (Koehler & Mishra, 2008, p. 12). The TPACK includes the knowledge of how to make concepts understandable by using technology, knowledge of how to use technology with pedagogical knowledge in order to meet the needs of students, knowledge of the difficulties in learning concepts and how to eliminate these difficulties buy using technology, knowledge of students' epistemological beliefs and background knowledge and how to increase their epistemological beliefs level by using technology (Koehler & Mishra, 2008). The TPACK represents a "thoughtful interweaving of all three key sources of knowledge; technology, pedagogy, and content" (Mishra & Koehler, 2006, p. 14). As Koehler and Mishra (2008) argue that "at the heart of good teaching with technology are three components: content, pedagogy, and technology and relationships between them" (p. 11). According to Baran, Chuang, and Thompson (2011), the TPACK "acts as a useful framework for thinking about what knowledge teachers must have to integrate technology into teaching and how they might develop this knowledge" (p. 371). So as to understand the model proposed by Mishra and Koehler (2006), the three main components of knowledge; content knowledge (CK), technology knowledge (TK), and pedagogy knowledge (PK) as well as four additional types of knowledge; pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK) are explained shortly below.

Content Knowledge (CK): This knowledge is about the actual subject matter that is to be taught to students in school (Mishra & Koehler, 2006; Koehler & Mishra, 2008). This knowledge refers to the knowledge, understanding, skill, and disposition that are to be learnt by school (Shulman, 1987).

Technology Knowledge (TK): This knowledge refers to standard technologies such as books, chalk and blackboard, as well as more advanced technologies such as the Internet and digital video (Mishra & Koehler, 2006).

Pedagogy Knowledge (PK): This knowledge refers to the knowledge about teaching and learning process and practices and it includes educational purposes, goals, values, strategies, and more (Koehler & Mishra, 2008).

Pedagogical Content Knowledge (PCK): This knowledge refers to the idea that pedagogy and content are interwoven that is applicable to the teaching of specific content (Koehler & Mishra, 2008; Shulman, 1987). This knowledge includes students' prior knowledge, different teaching strategies in a particular discipline, pedagogical technologies and effective teaching methods (Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2008; Mishra & Koehler, 2006).

Technological Pedagogical Knowledge (TPK): This knowledge refers to the understanding of the manner in which technology and content influences and constrains one another (Koehler & Mishra, 2008). This knowledge is the knowledge of how to use specific technology in specific ways to change teaching and learning (Harris, Mishra, & Koehler, 2009).

Technological Content Knowledge (TCK): This knowledge is an understanding that technology and content influence and constrain each other (Koehler & Mishra, 2008). It refers to knowledge of how technology can create new representations for specific content (Baran, Chuang, & Thompson, 2011).

Technological Pedagogical Content Knowledge (TPACK): The TPACK is different from knowledge and its individual component concepts and their intersections (Koehler & Mishra, 2008; Mishra & Koehler, 2006). This knowledge refers to the complex interrelationships between technological knowledge, pedagogical knowledge, and subject matter knowledge of teachers (Mishra & Koehler, 2006). The TPACK is not a simple combination of three independent components; rather, content, pedagogy, and technology are independent, each one affecting the others (Harris, Mishra, & Koehler, 2009). It refers to the complex interrelationships between a teacher's technology use, instructional methods, and understanding of the subject matter (Mishra & Koehler, 2006).

Purpose of the study

It is seen that numerous studies on the TPACK model have been conducted in the research literature; however most of them have attempted to investigate the relationships between TPACK and some other demographic variables. Although there are some studies investigating teachers' level of TPACK perceptions in terms of their demographics especially in the foreign literature, very few of these studies focused on the investigation of the level of TPACK perceptions of teachers in Turkish context. In this sense, it can be said that there is a lack of research regarding the level of TPACK perceptions of Turkish teachers in the literature. Hence, more research is needed to be conducted in this scope. Therefore, the aim of this study is to examine in-service teachers' level of TPACK perceptions in terms of some demographic variables. Since the Ministry of National Education (MoNE) of Turkey has taken important steps to integrate technology through the F@tih project (Movement of Increasing Opportunities and Improving Technology) into teaching and learning process at school (see Dündar & Akçayır, 2014; Özdemir, 2013; Pamuk, Çakır, Ergun, Yılmaz, & Ayas, 2013), this study is believed to have the potential to provide information regarding the technology integration efficacy of teachers. Such comparison of in-service teachers' level of TPACK perceptions with demographic variables may contribute to understand the role of these variables in the integration process of technology in teaching and learning in the classroom. With the aim of examining in-service teachers' level of TPACK perceptions in terms of some variables such as gender, occupational experience, educational level, teaching level, and taking educational comouter and Internet use seminar, the current study attempted to investigate the level of TPACK perceptions of in-service teachers from the Turkish context. Within this framework, the answers to the following questions have been sought in the study:

- What is the profile of the in-service teachers in terms of technological pedagogical content knowledge?
- Are there significant differences between in-service teachers in terms of their demographic variables (gender, occupational experience, educational level, teaching level, and taking educational computer and Internet use seminar) regarding technological pedagogical content knowledge?

As discussed earlier in the literature review section of the study, more studies on in-service teachers' level of TPACK in terms of demographic variables are required to better understand the role of demographic variables in the integration of technology into teaching and learning process in the classroom. Hence, the current study represents such research initiative to present a profile of in-service teachers' TPACK levels in terms of some demographic variables.

Methodology

Research design

This study is a descriptive one. In this study, the survey method was employed to investigate in-service teachers' level of technological pedagogical content knowledge (TPACK) levels in terms of gender, occupational experience, educational level, teaching level, and taking educational computer and Internet use seminar variables. The major purpose of surveys is to describe the characteristics of a population (Fraenkel & Wallen, 2009). More broadly, "surveys gather data at a particular point in time with the intention of describing the nature of existing conditions or identifying standards against which existing conditions can be compared" (Cohen, Manion, & Morrison, 2007, p. 205).

Participants

The participants of the study consisted of volunteering in-service teachers (n = 200), selected according to the cluster sampling method from three-layer groups (high, middle, and low socio-economic structure) (McMillan & Schumacher, 2006) from eight different public elementary and high schools in Nigde province (37º57′N, 34º40′E) in the central Anatolia region of Turkey. Of the participants, 53.5% (n = 107) were female and 46.5% (n = 93) were male in the study. With regard to occupational experience, 18.0% (n = 36) of the teachers had 1-5 years of experience, 29.0% (n = 58) of them had 6-10 years of experience, 32.0% (n = 64) of them had 11-15 years of experience, and lastly 21.0% (n = 42) of them had more than 16 years of occupational experience. Also, it was seen that 89.5% (n = 179) of the teachers had undergraduate level of education and 10.5% (n = 21) of them had postgraduate level of education. Lastly, it was seen that 56.0% (n = 112) of the teachers are teaching at elementary school level, whereas 44.0% (n = 88) of them are teaching at high school level. Finally, it was understood that the teachers' mean years of age was 33.7 (SD = 3.16) in the study. Table 1 shows some of the demographic information of the participating in-service teachers.

Table 1. Demographic Information of the Participants (n = 200)

Variables	Number	Percentage
Gender		
Male	93	46.5
Female	107	53.5
Occupational Experience		
1-5 Years	36	18.0
6-10 Years	58	29.0

11-15 Years	64	32.0
16 and above years	42	21.0
Educational Level		
Undergraduate	179	89.5
Postgraduate	21	10.5
Teaching Level		
Elementary School	112	56.0
High School	88	44.0
Age	33.7 (SD = 3.16)	

Data collection

The data of this study were collected from in-service teachers in public elementary schools in Nigde province of Turkey. Firstly, numerical data for teachers and schools in the elementary and high school levels of the education system were obtained from the database of the Ministry of National Education (MoNE). Then, the data collection instrument was prepared for the application. The data collection instrument was delivered by the researcher visiting the public elementary and high schools in the sample of the study. Before the data collection instrument was administrated, the participants were informed about the purpose of the study. A volunteer participation of the teachers in the study was taken seriously into account so that no volunteer was offered any present or payment as money. While the data of the study were collected by the researcher by visiting the schools, the collection of the data lasted for about one-month time. The application of the survey instrument of the study lasted for approximately two days for each school. The data collection instrument with teachers was conducted in their schools during weekday time. Finally, after the data collection instruments were collected from the participants, each data collection instrument was numbered and then coded in MS Excel 2007 package and then transferred to SPSS 17.0 software for the statistical analyses.

Data collection instruments

In direction of determining teachers' level of TPACK perceptions, the "Technological Pedagogical Content Knowledge (TPACK) Survey", developed by Şahin (2011) has been used in the study. The survey comprised seven sub-dimensions: (1) technology knowledge (TK), (2) pedagogy knowledge (PK), (3) content knowledge (CK), (4) technological pedagogical knowledge (TPK), (5) technological content knowledge (TCK), (6) pedagogical content knowledge (PCK), and (7) technological pedagogical content knowledge (TPACK). The survey was administrated on a group of pre-service teachers from six different departments at a Turkish medium university. All the items in the survey employed a 5-point Likert scale (i.e., complete = 5, not at all = 1). There are 47 items totally in the survey and the factor loads ranged from .60 to .90. Cronbach's Alpha internal consistency of the survey has been calculated as .93 for TK, as .90 for PK, as .86 for CK, as .88 for TPK, as .88 for TCK, as .92 for PCK, and as .92 for TPACK sub-dimensions. There were also positive correlations amongst the sub-dimensions of the survey. A high score in the survey indicated a favourable response towards the measured sub-dimension (Şahin, 2011). Finally, the participants were also asked to supply some demographic information in terms of their gender, occupational experience, educational level, etc. without indicating their names as a part of the survey delivered.

Data analysis

After the data collection instruments were collected from the participants, SPSS 17.0 software was used in relation with the statistical analyses. In the analysis of the data collected in the study, the independent samples t test was used in order to compare teachers' level of TPACK perceptions in terms of their gender, educational level, teaching level, taking educational computer and Internet use seminar and variables. Also, variance (ANOVA) analysis was used in order to compare teachers' level of TPACK perceptions in regard of their occupational experience variable.

Results

Results in relation to descriptive statistics

In this part of the study, it is demonstrated some descriptive statistics in relation to in-service teachers' level of TPACK perceptions (see Table 2). According to the analysis, it is seen that the overall means of the sub-dimensions of the TPACK reported by the in-service teachers are mostly moderate; TK (M = 3.26, SD = 11.65), PK (M = 3.09, SD = 5.97), CK (M = 3.76, SD = 2.29), TPK (M = 3.03, SD = 3.10), PCK (M = 3.27, SD = 3.01), and TPACK (M = 3.35, SD = 3.02). When the sub-dimensions of the survey are examined, it is understood that the highest mean score belongs to CK (M = 3.76, SD = 2.29), while the lowest mean score belongs to TCK (M = 2.90, SD = 6.23) in the study. Considering these values obtained, it may inferred that the in-service teachers' level of TPACK perceptions is mostly moderate.

Table 2. Descriptive Statistics for In-Service Teachers' Level of TPACK Perceptions (n = 200)

Sub-Dimensions	M	SD	SE
TK	3.26	11.65	.82
PK	3.09	5.97	.42
CK	3.76	2.29	.16
TPK	3.03	3.10	.21
TCK	2.90	6.23	.44
PCK	3.27	3.01	.21
TPACK	3.35	3.02	.21

Table 2 shows the means of the level of TPACK of in-service teachers. According to the table given, it is seen that the TK, PK, CK, TPK, PCK and TPACK levels of in-service teachers are seen to be moderate, whereas TCK level of them is understood to be rather low.

Results in relation to demographic variables

The results of the level of TPACK perceptions of in-service teachers in relation to some demographic variables are presented in this part of the study. In this context, the results of TPACK levels of in-service teachers in terms of gender are presented in Table 3.

Table 3. Perception of Teachers' Level of TPACK in Terms of Gender

Variables	Gender	M	SD	df	t	p
TK	Male [a]	3.39	11.97	198	2.371	.019
	Female [b]	3.13	11.05			
PK	Male [a]	3.03	5.45	198	-.934	.351
	Female [b]	3.16	6.46			
CK	Male [a]	3.82	2.73	198	1.866	.064
	Female [b]	3.71	1.70			
TPK	Male [a]	3.13	3.19	198	1.912	.057
	Female [b]	2.92	2.97			
PCK	Male [a]	3.42	3.17	198	2.810	.004
	Female [b]	3.12	2.73			
TCK	Male [a]	2.87	6.29	198	-.614	.540
	Female [b]	2.94	6.18			
TPACK	Male [a]	3.46	2.95	198	2.910	.006
	Female [b]	3.23	3.00			

Note. *p < .05, a n = 93, b n = 107

According to Table 3 given, it is seen that there is a statistical significant difference between in-service teachers' level of TPACK perceptions in terms of gender in TK t (198) = 2.371, p < .05, PCK t (198) = 2.810, p < .05, and TPACK t (198) = 2.910, p < .05 sub-dimensions. According to the analysis, it is understood that male in-service teachers have higher mean scores in these sub-dimensions than their female colleagues. However, it is not seen any significant statistical difference between in-service teachers' level of TPACK in relation to gender in PK t (198) = -.934, p > .05, CK t (198) = 1.866, p > .05, TPK t (198) = 1.912, p > .05, and TCK t (198) = -.614, p > .05 sub-dimensions, respectively. These results suggest that gender has an effect on TK, PCK, and TPACK levels of in-service teachers; male in-service teachers have higher scores in these knowledge sub-dimensions.

In order to examine in-service teachers' level of TPACK in terms of occupational experience, one-way variance (ANOVA) analysis was employed and the results of the effects of occupational experience on the level of TPACK perceptions of in-service teachers are presented in Table 4.

Table 4. Perception of Teachers' Level of TPACK in Terms of Occupational Experience

Variables	M	SD	df	F	p
TK					
1-5 year [a]	3.97	5.03			
6-10 year [b]	3.52	2.17		677.24	.000
11-15 year [c]	2.76	1.51	3-196		
16 + year [d]	2.07	1.58			
PK					
1-5 year [a]	4.01	3.34		364.55	.000
6-10 year [b]	3.45	2.04	3-196		

	M	SD	df	F	p
11-15 year [c]	2.12	.85			
16 + year [d]	1.97	.39			
CK					
1-5 year [a]	4.16	1.42			
6-10 year [b]	3.67	.66	3-196	281.260	.000
11-15 year [c]	3.37	.47			
16 + year [d]	3.43	.64			
TPK					
1-5 year [a]	3.81	2.62			
6-10 year [b]	2.67	.41	3-196	160.10	.000
11-15 year [c]	2.57	.28			
16 + year [d]	2.27	.24			
PCK					
1-5 year [a]	3.69	6.45			
6-10 year [b]	2.67	1.21	3-196	466.60	.000
11-15 year [c]	2.05	.39			
16 + year [d]	2.12	.51			
TCK					
1-5 year [a]	4.09	1.48			
6-10 year [b]	3.08	.83	3-196	84.890	.000
11-15 year [c]	2.70	.59			
16 + year [d]	2.39	.44			
TPACK					
1-5 year [a]	3.94	1.92			
6-10 year [b]	3.20	1.12	3-196	245.53	.000
11-15 year [c]	3.13	.93			
16 + year [d]	2.53	.44			

Note. *p < .05, a n = 36, b n = 58, c n = 64, d n = 42

According to Table 4 given, it is seen that there are statistical significant differences between in-service teachers' level of TPACK perceptions in terms of their occupational experiences in TK F (3,196) = 677.24, p < .05, PK F (3,196) = 364.55, p < .05, CK F (3,196) = 281.26, p < .05, TPK F (3,196) = 160.10, p < .05, PCK F (3,196) = 466.60, p < .05, TCK F (3,196) = 84.890, p < .05, and TPACK F (3,196) = 245.53, p < .05, respectively. According to the analysis, it is understood that in-service teachers' level of TPACK in terms of their occupational experiences differs in all sub-dimensions in favour of younger in-service teachers. These results suggest that occupational experience variable has an effect on all sub-dimensions of TPACK; younger or inexperienced in-service teachers have higher level of TPACK perceptions in general (also cf. Table 5).

In order to examine in-service teachers' level of TPACK perceptions in terms of their educational level, one-way variance (ANOVA) analysis was employed and the results of the effects of educational level variable on the level of TPACK perceptions of in-service teachers are presented in Table 5.

Table 5. Perception of Teachers' Level of TPACK in Terms of Educational Level

Variables		M	SD	df	t	p
TK						
Undergraduate [a]		3.02	10.20	198	-10.743	.000
Postgraduate [b]		4.20	3.67			
PK						
Undergraduate [a]		2.75	4.70	198	-13.891	.000
Postgraduate [b]		4.49	1.41			
CK						
Undergraduate [a]		3.62	1.61	198	-15.746	.000
Postgraduate [b]		4.33	1.15			
TPK						
Undergraduate [a]		2.69	1.59	198	-26.449	.000
Postgraduate [b]		4.40	.73			

	M	SD	df	t	p
PCK					
Undergraduate [a]	3.00	2.27	198	-14.899	.000
Postgraduate [b]	4.37	.92			
TCK					
Undergraduate [a]	2.49	2.40	198	-36.878	.000
Postgraduate [b]	4.56	1.26			
TPACK					
Undergraduate [a]	3.12	2.13	198	-16.513	.000
Postgraduate [b]	4.27	1.05			

Note. *p < .05, a n = 179, b n = 88

According to Table 5 given, it is seen that there is a statistical significant difference between in-service teachers' level of TPACK perceptions in terms of educational level in TK t (198) = -10.743, $p < .05$, PK t (198) = -13.891, $p < .05$, CK t (198) = -15.746, $p < .05$, TPK t (198) = -26.449, $p < .05$, PCK t (198) = -14.899, $p < .05$, TCK t (198) = -36.878, $p < .05$, and TPACK t (198) = -16.513, $p < .05$ sub-dimensions, respectively. According to the analysis, it is understood that the in-service teachers who have postgraduate level of education have higher mean scores in all sub-dimensions of the TPACK than their colleagues who have undergraduate level of education. These results suggest that educational level variable has an effect on all sub-dimensions of TPACK of in-service teachers; in-service teachers who have postgraduate level of education have higher scores in these knowledge sub-dimensions.

In order to examine in-service teachers' level of TPACK perceptions in terms of teaching level, one-way variance (ANOVA) analysis was employed and the results of the effects of teaching level variable on the level of TPACK perceptions of in-service teachers are presented in Table 6.

Table 6. Perception of Teachers' Level of TPACK in Terms of Teaching Level

Variables	M	SD	df	t	p
TK					
Elementary [a]	3.34	12.53	198	1.511	.133
High School [b]	3.18	10.62			
PK					
Elementary [a]	3.22	6.34	198	1.777	.077
High School [b]	2.97	5.51			
CK					
Elementary [a]	3.82	2.27	198	2.259	.025
High School [b]	3.70	2.26			
TPK					
Elementary [a]	3.10	3.32	198	1.311	.192
High School [b]	2.96	2.86			
PCK					
Elementary [a]	3.36	3.05	198	1.766	.079
High School [b]	3.18	2.95			
TCK					
Elementary [a]	3.03	6.47	198	2.022	.045
High School [b]	2.78	5.87			
TPACK					
Elementary [a]	3.47	3.18	198	2.848	.005
High School [b]	3.23	2.75			

Note. *p < .05, a n = 112, b n = 21

According to Table 6, it is seen that there is a statistical significant difference between in-service teachers' level of TPACK perceptions in terms of teaching level in CK t (198) = 2.259, $p < .05$, TCK t (198) = 2.022, $p < .05$, and TPACK t (198) = 2.848, $p < .05$ sub-dimensions. According to the analysis, it is understood that in-service teachers who are working in elementary schools have higher mean scores in these sub-dimensions than their colleagues working in high schools. However, it is not seen any statistical significant difference between in-service teachers' level of TPACK perceptions in relation to teaching level in TK t (198) = 1.511, $p > .05$, PK t (198) = 1.777, $p > .05$, TPK t (198) = 1.311, $p > .05$, and PCK t (198) = 1.766, $p > .05$ sub-dimensions, respectively. These results suggest that teaching level has an effect on CK, TCK, and TPACK levels of in-service teachers; in-service teachers who are working in elementary schools have higher scores in these knowledge sub-dimensions.

In order to examine in-service teachers' level of TPACK perceptions in terms of taking educational computer and Internet use seminar, one-way variance (ANOVA) analysis was employed and the results of the effects of taking educational computer and Internet use seminar variable on the level of TPACK perceptions of in-service teachers are presented in Table 7.

Table 7. Perception of Teachers' Level of TPACK in Terms of Taking Educational Computer and Internet Use Seminar

Variables		M	SD	df	t	p
TK						
Yes [a]		3.75	3.67	198	13.605	.000
No [b]		2.66	8.04			
PK						
Yes [a]		3.69	4.58	198	12.512	.000
No [b]		2.36	4.34			
CK						
Yes [a]		4.00	1.94	198	13.586	.000
No [b]		3.47	1.20			
TPK						
Yes [a]		3.43	3.21	198	9.900	.000
No [b]		2.53	1.34			
PCK						
Yes [a]		3.74	2.58	198	13.608	.000
No [b]		2.69	1.53			
TCK						
Yes [a]		3.32	6.73	198	8.568	.000
No [b]		2.39	2.78			
TPACK						
Yes [a]		3.69	2.74	198	11.116	.000
No [b]		2.93	1.83			

Note. *p < .05, a n = 76, b n = 124

According to Table 7, it is seen that there is a statistical significant difference between in-service teachers' level of TPACK perceptions in terms of taking educational computer and Internet use seminar in TK t (198) = 13.605, p < .05, PK t (198) = 12.512, p < .05, CK t (198) = 13.586, p < .05, TPK t (198) = 9.900, p < .05, PCK t (198) = 13.608, p < .05, TCK t (198) = 8.568, p < .05, and TPACK t (198) = 11.116, p < .05 sub-dimensions, respectively. According to the analysis, it is understood that the in-service teachers who have taken educational computer and Internet use seminar have higher mean scores in all sub-dimensions of the TPACK than their colleagues who have not taken educational computer and Internet use seminar, yet. These results suggest that taking educational computer and Internet use seminar has an effect on all sub-dimensions of TPACK of in-service teachers; in-service teachers who have taken educational computer and Internet use seminar have higher scores in these knowledge sub-dimensions.

Discussion

The results of this study indicate that the Turkish in-service teachers have moderate level of TPACK perceptions in general. It is seen that they have moderate level of perceptions in TK, PK, CK, TPK, PCK, and TPACK sub-dimensions. However, it is understood that they have low level of perceptions in TCK sub-dimension. When the sub-dimensions of the survey are examined, it is understood that the highest mean score belongs to CK, while the lowest mean score belongs to TCK in the study. It was seen in the study that the overall means of the sub-dimensions of the TPACK reported by the in-service teachers were all moderate, except TCK sub-dimension which was found as low. Also, research literature reports that TCK is the weakest area of all knowledge sub-dimensions of the TPACK (e.g., Archambault & Crippen, 2009; Gündoğmuş, 2013). However, there are some findings in the research literature that TCK is not the weakest area of all knowledge sub-dimensions of the TPACK (e.g., Graham et al., 2009; A. Karataş, 2014; Semiz, 2011). Hence, it can be said that there are different results in relation to pre-service or in-service teachers' highest or lowest level of TPACK sub-dimension in the literature. The research literature presents contradictory findings in terms of the level of TPACK both for in-service and/or pre-service teachers. Thus, more research is needed in order to better explain the finding obtained in this study. On the other hand, based on the reported mean scores, it seems that the Turkish in-service teachers neither have higher nor lower level of TPACK perceptions. Therefore, it seems that the Turkish in-service teachers have not satisfactory level of TPACK perceptions. Previous research indicates that pre-service teachers rate themselves as slightly above the average in each sub-dimension of the TPACK (e.g., Kabakçı, 2011; F. I. Karataş, 2014; Kaya, Emre, & Kaya, 2011; Koh, Chai, & Tsai, 2010; Neiderhauser & Perkmen, 2006; Öztürk, 2013). However, the level of TPACK perceptions of the in-service teachers is found as moderate in the current study, which is lower than the previously reported results. The findings of the current study is consistent with the findings of some studies in the literature (e.g., A. Karataş, 2014; Burmabıyık, 2014; Gündoğmuş, 2013; Semiz, 2011) which is reported that in-service teachers have moderate level of TPACK perceptions. Also, few

other studies indicate that pre-service teachers' level of TPACK perceptions is lower than the findings of the current study and other previously reported studies in the literature.

In terms of gender variable, it is found out that there is a statistical significant difference between male and female in-service teachers regarding the level of TK, PCK, and TPACK sub-dimensions. According to the analysis, it is seen that male in-service teachers have higher mean scores in these sub-dimensions than their female colleagues. Although some studies indicate that there is not a statistical significant difference between male and female pre-service or in-service teachers in terms of the level of TPACK perceptions (e.g., Burmabıyık, 2014; F. I. Karataş, 2014; Gündoğmuş, 2013; Karakaya, 2012; Mutluoğlu, 2012; Tokmak, Konokman, & Yelken, 2013; Ünal, 2013), some other studies indicate that male pre-service or in-service teachers have higher mean scores in TPACK than their female colleagues (e.g., A. Karataş, 2014; Bulut, 2012; Canbolat, 2011; Forssell, 2011; Lin, Tsai, Chai, & Lee, 2013; Savaş, 2011). Thus, the research literature shows contradictory results in terms of gender variable on the level of TPACK perceptions of pre-service or in-service teachers. Therefore, it is understood that there are some results which are consistent as well as not consistent with the related finding of the current study. However, most of these studies were conducted by considering pre-service teacher samples. Also, the differences between male and female in-service teachers in regard of the level of TPACK perceptions are found mostly in technology-based sub-dimensions (i.e., TK, TPACK). According to the research literature, female pre-service or in-service teachers use computers as well as access to the Internet less than their male colleagues (Akkoyunlu & Yılmaz, 2005; Albion, 2001; Çelik & Bindak, 2005). Hence, this result may explain why female in-service teachers have lower level of TPACK perceptions than their male colleagues in the defined sub-dimensions. Although there are some findings that female in-service teachers have lower level of TPACK perceptions than their male colleagues, this result is needed to be examined deeply in order to better understand the reason underlying this finding in the study.

Statistical differences are detected between in-service teachers in regard of their occupational experience in all sub-dimensions of the TPACK. According to the analysis, it is understood that in-service teachers' level of TPACK perceptions in terms of their occupational experience differs in all sub-dimensions in favour of younger or inexperienced teachers. These results suggest that occupational experience has an effect on all sub-dimensions of TPACK. The obtained result may be due to the training of pre-service teachers in education faculties at universities in Turkey. Pre-service teachers are getting educated based on TPACK day by day at universities (e.g., Kabakçı-Yurdakul, 2013; Yanpar-Yelken, Özgelen, İncikapı, & Sancar-Tokmak, 2015) so that the newly graduated or inexperienced in-service teachers are expected to have higher level of TPACK perceptions than their older or experienced colleagues. More experienced or older in-service teachers feel themselves less sufficient and knowledgeable in technology than their younger or inexperienced colleagues (Liang, Chai, Koh, Young, & Tsai, 2013) as well as they need occupational development trainings in terms of TPACK more than their younger or inexperienced colleagues at school (Demir& Bozkurt, 2010). However, there are contradictory results about pre-service or in-service teachers' level of TPACK perceptions in terms of their occupational experiences in the research literature. While some studies demonstrate that inexperienced or younger teachers have higher mean scores in sub-dimensions of TPACK (e.g., A. Karataş, 2014; Lee & Tsai, 2008; Mutluoğlu, 2012), some other studies show that there are not any significant correlations between teachers' level of TPACK perceptions and their ages (e.g., Burmabıyık, 2014; F. I. Karataş, 2014; Hosseini & Kamal, 2012) indicating that age variable is not a determining factor in the TPACK perceptions of in-service teachers. Although there are contradictory results in terms of the level of TPACK perceptions of in-service teachers regarding their occupational experience, previous studies indicate that intervention programmes are effective or improving the level of TPACK perceptions of pre-service or in-service teachers (e.g., Angeli & Valanides, 2005; Koehler & Mishra, 2005; Kurt, 2012; Mishra & Koehler, 2006; Niess, 2005). Therefore, it is believed that intervention programmes towards in-service teachers are considered to be effective in developing their level of TPACK perceptions.

In regard of the differences between in-service teachers' level of TPACK perceptions and their educational level variable, it is seen that the in-service teachers' level of TPACK differs in all sub-dimensions of the TPACK. According to the analysis, it is understood that the in-service teachers who have postgraduate level of education have higher mean scores in all sub-dimensions of the TPACK than their colleagues who have undergraduate level of education. Similarly, the limited research literature (e.g., Karakaya, 2013) indicates that in-service teachers who have postgraduate level of education have higher mean scores than their colleagues who have undergraduate level of education. Therefore, the research literature supports the related finding of this study. This result may be due to the type of education held in postgraduate level in teacher training. This result can also be explained in regard of the time of exposure to formal education at university level. In this level of education, in-service teacher teachers are not only educated for more two years at master's level and four years at doctorate level in Turkey, they are also trained both in theoretical and practical aspects so that they can combine these two aspects in teaching and learning process in the classroom.

On the other hand, it is seen that there is a statistically significant difference between in-service teachers' level of TPACK perceptions in terms of teaching level in CK, TCK, and TPACK sub-dimensions. According to the analysis, it is understood that in-service teachers who are working at elementary school level have higher mean scores in these sub-dimensions than their colleagues working at high school level. This result may be due to the contextual factors, curriculum, and teaching-learning process held in elementary school level of education. Although the MoNE of Turkey has started the F@tih Project, as mentioned in the introduction part, in 2011 and has been applying this project mostly in high schools, the acquired result interestingly indicates that in-service teachers working in high schools have lower level of TPACK perceptions compared to their colleagues working in elementary schools. Even though Koh, Chai, and Tsai (2010) reported the non-significant effect of teaching level on TPACK perceptions, how in-service teachers' level of TPACK perceptions are related to teaching level variable is not well-researched; therefore, this result needs to be verified within further studies. In future studies, the reasons of the high as well as the low level of TPACK perceptions of in-service teachers working in high schools and elementary schools should be researched in a deeper context.

Lastly, it is seen that there is a statistically significant difference between in-service teachers' level of TPACK perceptions in terms of taking educational computer and Internet use seminar in all sub-dimensions of the TPACK. According to the analysis, it is understood that the in-service teachers participated in the study who have taken educational computer and Internet use seminar have higher mean scores than their colleagues who have not taken educational computer and Internet use seminar, yet. The result acquired in the study is seen significantly important since exposure to an education or training programme in regard of the development of TPACK skills and perceptions of in-service teachers can make these teachers more knowledgeable and skillful as well as have higher perceptions in TPACK. Previous studies indicate the positive influence of intervention programmes on improving the TPACK perceptions of both in-service and pre-service teachers (e.g., Angeli & Valanides, 2005; Canbazoğlu-Bilici, 2012; Graham et al., 2009; Koehler & Mishra, 2005; Mishra & Koehler, 2006). In order to develop the level of TPACK perceptions of in-service teachers, researchers used professional development programmes (e.g., Cantrell & Knudson, 2006; Doering, Veletsianos, Scharber, & Miller, 2009). These development programmes were conducted like field experiences (Cantrell & Knudson, 2006) as well as online learning environments (Doering, Veletsianos, Scharber, & Miller, 2009). Although there are many professional development programmes in terms of the level of TPACK perceptions both for pre-service or in-service teachers abroad, the number of these programmes is seen to be very limited in the Turkish literature. Most of the development programmes in Turkey are seen to be the adaptation (via translations) versions of the TPACK intervention programmes. Therefore, it is seen very urgent as well as crucial to develop such programmes for in-service teachers in order to make them have higher level of TPACK perceptions and conduct the teaching-learning process effectively. Thus, the educational authorities in Turkey such as the MoNE should contribute to the development of such programmes so as to train in-service teachers to integrate ICTs into instruction efficiently.

Limitations of the study

While this study has yielded valuable insights for the improvement of the TPACK framework, it is imperative to note that the study has some limitations. For example, the sample of this study is limited to elementary and high school teachers in a rather small province of Turkey. Besides, the sample rate is also rather small (namely, 200 teachers) so that the results of the study may not be generalized to all teachers in Nigde province as well as in Turkey. In order to be able to generalize the results to the target population, the study can be conducted in a larger scope. Another limitation of the study is that the findings were based on self-reported data of teachers' perceptions of their TPACK knowledge domains. This study has been carried out by using quantitative research methodology. Even though such quantitative data is considered valuable to draw some inferences, it is also seen crucial to collect some qualitative data in order to better understand the reasons underlying those results. This is also a limitation in the study that has not been considered during the research. Supporting studies based on quantitative data with qualitative data is considered to be very useful to understand the reality of the results acquired in a study. Therefore, it is suggested to conduct studies by using mixed-methods approaches to better understand the social reality underlying the results in a study.

Conclusions

The results of the study indicate that TPACK perceptions of in-service teachers are influenced by their some demographic variables (i.e.,gender, occupational experience, educational level, teaching level, etc.) as seen in the research. Also, it appeared that the in-service teachers participated in the study had not enough TPACK perceptions to integrate ICTs into instruction efficiently. Therefore, the study seems to indicate that the in-service teachers needed training so as to combine technology, pedagogy, and content knowledge to conduct teaching and learning process in the classroom effectively. As a whole, the study leads to the conclusion that the MoNE should take the necessary steps to train their in-service teachers so as to integrate ICTs into teaching and learning process effectively and to be successful in implementing the F@tih Project in the education system itself.

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