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Adaptation of a TPACK survey to Turkish for secondary school teachers

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Abstract
The purpose of this study is to adapt technological pedagogical and content knowledge (TPACK) survey which was developed by Koh, Chai & Tsait (2010). The survey was administered to 285 teachers who teach a variety of subject areas at the secondary school level in Edirne. The translation equivalence, back translation and content validity done by the specialists. All data was analysed by using Lisrel 8.7 and IBM SPSS 19. The results of the confirmatory factor (CFA) analysis were as follows: $\chi 2/sd$ 2.89, RMSEA .08, GFI .85, AGFI .81, RMR .03, SRMR .03, NFI 98, NNFI .99 and CFI .99. The CFA results showed that original 5 factor scale fitted with Turkish data. Cronbach alpha coefficients were .74, .87, .89, .92 and .84 for the factors respectively and .94 for overall TPACK survey. Item total correlations ranged from .56 to .91. All t-test results of upper 27% and lower 27% group were meaningful. The findings revealed that TPACK survey was a valid and reliable instrument for measuring secondary school teachers' TPACK.

Keywords: TPACK; survey adaptation; secondary school teachers; CFA

1. Introduction

In his landmark paper, *Those Who Understand: Knowledge Growth in Teaching,* Lee Shulman (1986) introduced the concept of pedagogical content knowledge (PCK) and defined it as going beyond content or subject matter knowledge to include knowledge about how to teach particular content. In his work, to develop a theoretical framework, he raised important questions like "What are the domains and categories of content knowledge in the minds of teachers?" and "How are content knowledge and general pedagogical knowledge related?" (p. 9). This important work has contributed a lot to teacher education programs. The pedagogical content knowledge concept was extended by adding the technology component to it and thus TPCK was used to describe teachers' body of knowledge in terms of how they made 'intelligent pedagogical uses of

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technology' (Koehler, Mishra & Yahya, 2007, p. 741). The TPCK acronym was renamed TPACK to make it easier to remember and to form a more integrated whole for the three kinds of knowledge addressed: technology, pedagogy, *and* content (Thompson & Mishra, 2007-2008, as cited in Schmidt *et al.,* 2009, p. 123).

The TPACK framework highlights three core knowledge components: Content, Pedagogy, and Technology. It refers to the knowledge that emerges from an understanding of an interaction of these three components (Kereluik *et al.,* 2011). According to Mishra and Koehler (2006), quality teaching requires an understanding of the complex interplays between these three key sources of knowledge in a specific teaching context. Teachers must understand that "technology has affordances and constraints for representing content ideas and for affording and constraining the kinds of teaching approaches used to teach those ideas" (Kerehluik *et al.,* 2011, p. 15). Obviously, this whole process requires a new type of literacy and ability.

According to Mishra and Koehler (2006), there are seven constructs in the TPACK framework. The first three are the knowledge of subject matter (Content Knowledge-CK), knowledge of various technologies (Technology Knowledge-TK), and knowledge of the process or methods of teaching (Pedagogical Knowledge-PK). As emphasized by Harris, Mishra and Koehler (2007), the expertise of teachers to integrate technology lies within the interactions they can build between TK, PK and CK. Therefore, the other four constructs are knowledge of subject matter representation with technology (Technological Content Knowledge-TCK), knowledge of using technology to implement different teaching methods (Technological Pedagogical Knowledge-TPK), knowledge of teaching methods for different types of subject matter (Pedagogical Content Knowledge-PCK), and finally knowledge of using technology to implement teaching methods for different types of subject matter (TPACK). These constructs are shown in Figure 1 below:

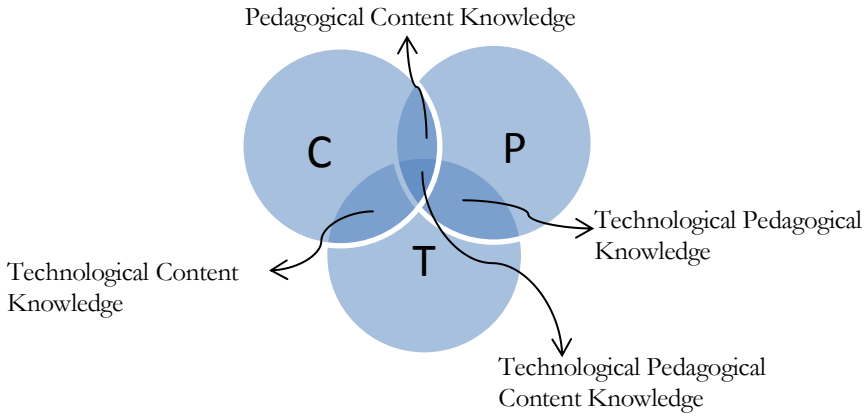

Figure 1. TPACK (Technological Pedagogical Content Knowledge) Framework (Mishra & Koehler, 2006)

Researchers have worked on creating survey instruments that assess both pre-service and in-service teachers' levels of TPACK. Koehler and Mishra (2005) developed a survey instrument that consisted of 35 items—33 Likert scale items and 2 short-answer questions—attempting to determine the level of TPCK knowledge both at the individual and group levels. Archambault and Crippen (2009) developed a 24-item survey to measure TPACK for online teaching based on a sample of 596 K-12 teachers. Schmidt *et al.* (2009) developed a survey extending these two studies to develop a robust survey that measures elementary school teachers' understanding of each component of the TPACK framework with a sample of 124 pre-service teachers. Graham *et al.* (2009) developed a 30-item TPACK survey for science teaching.

These and similar surveys have been widely used either in their original forms or have been adapted to several cultures to identify the TPACK competencies of teachers (Chai, Koh, & Tsai, 2010; Kaya *et al.,* 2011; Yurdakul, 2011; Öztürk & Horzum, 2011). Both quantitative and qualitative studies have been conducted to identify both prospective and on-job teachers' self-efficacy perceptions on TPACK and on using technology-related instructional planning (Bozkurt & Cilavdaroglu, 2011; Gömleksiz & Fidan, 2011; Harris & Hofer, 2011; Beşoluk & Horzum, 2011; Jang & Tsai, 2012; Koh *et al.,* 2010; Wetzel & Marshall, 2011-12). With the results of these and similar studies focusing on identifying teachers' TPACK competencies and perceptions of teachers on TPACK, researchers have worked on to design and improve both pre-service and in-service training programs (Agyei & Voogt, 2012; Alsofyani *et al.*, 2012; Larkin *et al.*, 2012; Martinovic & Zhang, 2012; Meng & Sam, 2013), offered suggestions for challenges that might emerge during such programs (Martinovic & Zhang, 2012); and designed programs for specific subject area teachers like mathematics or science (Akkoc *et al.*, 2011; Agyei & Voogt, 2012; Larkin *et al.*, 2012; Meng & Sam, 2013; Niess *et al.*, 2009).

For the Turkish context, several adaptations of TPACK instruments have been made. Öztürk and Horzum (2011) adapted Technological Pedagogical Content Knowledge Scale developed by Schmidt *et al.* (2009). The scale was implemented on 291 elementary school teachers for validity and reliability studies. In the Turkish version of the scale, the alpha value was calculated as .96. Timur and Taşar (2011) adapted the technological pedagogical content knowledge confidence scale developed by Graham *et al.* (2009) into Turkish. The instrument consists of 31 items and four dimensions. The scale was given to 393 science and technology teachers to determine its validity and reliability. Reliability analysis of the instrument revealed that the Cronbach-Alpha coefficient was (.92) for the instrument and the reliability coefficients of the four sub-dimensions were .89, .87, .89, and .86 respectively for the TCPK, TPK, TCK and TK. Horzum (2011) adapted the web pedagogical content knowledge survey which was developed by Lee, Tsai & Chang (2008). The

scale was implemented on 232 prospective teachers of computer education and instructional technologies department for validity and reliability studies and the Alpha value was calculated as .94. Yurdakul *et al.* (2012) developed a TPACK instrument for pre-service teachers with 33 items and four factors. It was used with 995 pre-service teachers and the Cronbach's Alpha coefficient for the whole scale was .95, whereas the values of Cronbach's alpha coefficient for individual factors of the scale ranged between .85 and .92.

2. Purpose

The literature survey showed that TPACK surveys have been designed or adapted mostly for elementary school teachers and pre-service teachers but have been limited for use for secondary school teachers. The purpose of this study is to offer a TPACK survey that could be used for secondary school teachers. With the help of the literature, the TPACK survey developed by Koh *et al.* (2010) was selected to be adapted to Turkish as it was developed for subject area teachers of secondary school teachers.

3. Method

3.1. Sample

285 teachers who teach a variety of subject areas at the secondary school level in the city of Edirne constitute the sample group. Among the participants, 62.1% were female (n=177) and 37.9% were male (n=108). Of the teachers who teach various subject areas, 58 were English language teachers (20.4%), 48 were mathematics teachers (16.8%), 41 were Turkish language teachers (14.4%), 39 were science and technology (13.7%), 29 were social sciences (10.2%), 19 were technology and design (6.7%), 14 were physical education and sport teachers (6.7%) and 37 were from various fields (13%). 85 teachers (29.8%) have 1-5 years, 87 teachers (30.5%) had 6-10 years and 56 teachers had 11-15 years of teaching experience (19.6%). 57 teachers (20%) had taught for more than 16 years. The majority of the teachers (n=266, 93.3%) held an undergraduate degree. Frequency and percentages for gender, teaching experience, graduation degree and subject areas of participants are presented in Table 1.

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Table 1. *Characteristics of Participants*

Characteristics	n	%	*Characteristics*	n	%
Gender			Subject Area		
Female	177	62.1	English language	58	20.4
Male	108	37.9	Mathematics	48	16.8
Years of teaching experience			Turkish language	41	14.4
1 to 5 years	85	29.8	Science and technology	39	13.7
6 to 10 years	87	30.5	Social sciences	29	10.2
11 to 15 years	56	19.6	Technology and design	19	6.7
16 years or more	57	20.0	Physical education	14	4.9
Graduation			Other	37	13.0
Undergraduate	266	93.3			
Graduate	19	6.7			

3.2. Data collection

Technological pedagogical content knowledge (TPACK) survey which was developed by Koh, Chai & Tsait (2010) was adapted to Turkish in this study. Exploratory factor analysis that was performed by the authors revealed five factors: Technological knowledge, content knowledge, knowledge of pedagogy, knowledge of teaching with technology and knowledge from creative reflection. The overall reliability of the survey was high (α=.96).

Items were first translated to Turkish by the researchers. Then some changes were done regarding upon the suggestions of two academicians from English language education field. Back translation was made to check the accuracy of the translation by another academician. For the clarity of the items, feedback from five teachers was received. Content validity was verified by two specialists. Three items which were not applicable in Turkish context were removed because these items in the original survey were designed for the teachers who teach a second subject area together with their first major. The last version of the survey and the demographic information part which included questions such as gender, seniority, subject area and level of graduation, were uploaded to an online survey tool and administered to secondary school teachers in April 2013. The survey consists of 27 questions of 5-point Likert-type scale: 1 (strongly disagree); 2 (disagree); 3 (neutral); 4 (agree) and 5 (strongly agree).

3.3. Evaluation of data

The confirmatory factor analysis (CFA) was used to test if the original scale's structure fits with the Turkish data. Lisrel 8.7 was used to run CFA. CFA results were evaluated by using these indices: Chi-Square Goodness of Fit (χ2), Root Mean Square Error of Approximation (RMSEA), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square

Residuals (RMR), Standardized Root Mean Square Residuals (SRMR), Normed Fit Index (NFI), Non- Normed Fit Index (NNFI) and Comparative Fit Index (CFI). Modification indices were examined to improve the model structure for two times.

Cronbach Alpha correlation coefficients and corrected item total correlations were calculated to examine the reliability of the scale. Item analysis and correlation matrix were also investigated. In order to examine the differences between upper 27% and lower 27% groups, t-test was used. Pearson correlation coefficient was used to calculate the correlations between the factors. Mean and standard deviations were used to perform descriptive statistics.

4. Results

4.1. Results of confirmatory factor analysis

The results of first CFA found as follows: $\chi 2=660.36$ (sd=179, p=.00), $\chi 2/sd = 3.69$, RMSEA .09, RMR .03, SRMR .03, GFI .82, AGFI .77, NFI .98, NNFI .98 and CFI .98. Modification indices were examined in order to decrease the chi square value. There was a notable relation between error covariances between TPK1 and TPK2 which were in the same latent variable. So, second analysis was run by adding an error covariance between these items.

According to second CFA analysis results; $\chi 2=570.43$ (sd=178, p=.00), $\chi 2/sd = 2.92$, RMSEA .08, RMR .03, SRMR .03, GFI .84, AGFI .79, NFI .98, NNFI .99 and CFI .99. The second analysis gave a better result compared to the previous analysis; the modification indices suggest a better model. The third analysis was run by adding an error covariance between PK1 and PK2 which were in the same latent variable to improve the model.

According to the third confirmatory factor analysis results, $\chi 2=508.48$ (sd=176, p=.00) and the value of $\chi 2/sd$ is 2.89. As Schumacker & Lomax (2004) stated, the acceptable range for normed chi-square was 1 to 5, therefore, the model indicates an acceptable fit to the Turkish data.

The fit indexes are recommended to be investigated to decide if the model fits the data reasonably well (Hooper, Coughlan & Mullen, 2008). The results of the fit indexes were respectively, RMSEA .08, GFI .85, AGFI .81, RMR .03 and SRMR .03. As Hooper *et al.* (2008) indicated that RMSEA value between 0 and .08 shows a good fit. The value of RMSEA is at the upper limit of the acceptable fit. A value of one for GFI or AGFI shows a perfect fit whereas a value of zero shows no fit (Schumacker & Lomax, 2004). The values of GFI and AGFI indicate an acceptable fit. Hooper *et al.* (2008) stated that the value of RMR and SRMR below .05 indicates a good fit. The

values of RMR and SRMR also show a good fit. These indices pointed an acceptable fit of the data with the model.

Furthermore, other fit indices were examined. The results of CFA analysis were found as .98 for NFI, .99 for NNFI and .99 for CFI. The values of NFI, NNFI and CFI ≥ 0.95 were presently recognised as indicative of good fit. The all fit indexes pointed out an acceptable fit for the model. Figure 2 shows five factors, items, relations between item and factors of the model structure of TPACK survey. Table 2 shows average and standard deviations of factors and correlations among factors.

As seen from the figure, error covariances ranged from .14 to .55 which was at acceptable level. Factor loadings ranged from .67 to .92 at an acceptable level. Correlations between factors ranged from .72 to .97. As seen from the Table 2, there are high correlations between Content Knowledge and Pedagogic Knowledge (r=.96, p=.01), Teaching with Technology (r=.91, p=.02), and Creative Reflection (r=.89, p=.02). There is strong correlation between Creative Reflection and Teaching with Technology (r=.97, p=.02). As for the correlations above, it can be said that there are moderate correlations between Technological Knowledge and Content Knowledge (r=.85, p=.03), Pedagogic Knowledge (r=.72, p=.04), Teaching with Technology (r=.80, p=.03) and Creative Reflection (r=.76, p=.04). Kline (2005) suggested that correlations among factors should not be so high to verify the model. The high correlations of the model could be questioned considering discrimination validity. The participants of the study couldn't made conceptual distinctions between TPACK constructs. Furthermore, mean scores and standard deviations showed that teachers felt confident about all TPACK factors. These findings suggest that all knowledge areas of TPACK should be taken into account to design and develop pre and in service teacher training. Because the interrelations of factors recommend that the development of one knowledge area will affect the other knowledge areas.

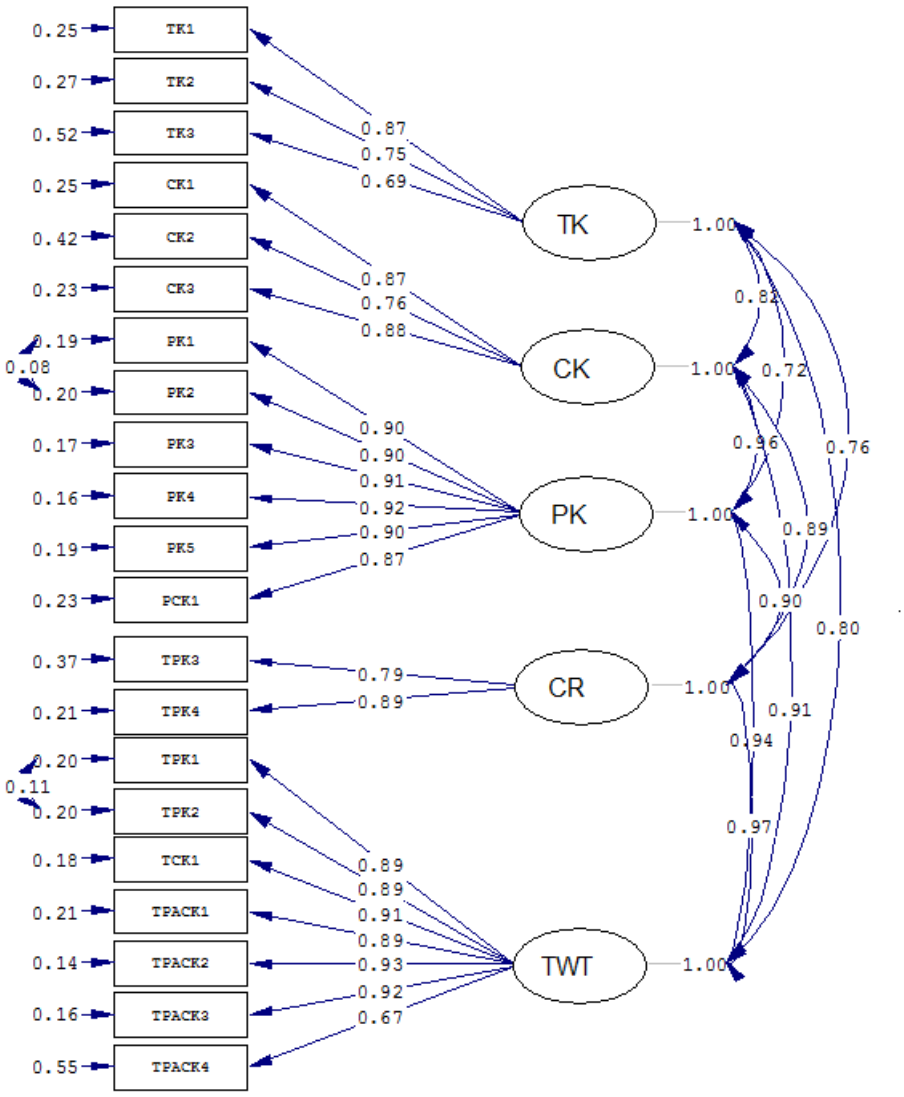

Figure 2. CFA result of TPACK survey

Table 2. *Pearson correlation coefficients between TPACK factors*

Factors	$\bar{x}$	**sd**	**Correlations between factors**				
			TK	**CK**	**PK**	**TWT**	**CR**
Technological knowledge (TK)	3.99	.84	-				
Content knowledge (CK)	4.20	.82	.82*	-			
Pedagogic knowledge (PK)	4.25	.82	.72*	.96*	-		
Teaching with Technology (TWT)	4.07	.81	.80*	.91*	.94*	-	
Creative Reflection (CR)	4.02	.85	.76*	.89*	.90*	.97*	-

* p<.05

Factor loadings, t and R^2 values are represented in Table 3. As seen from the table, standardized factor loadings of items ranged .67 to .93. t values were between 9.51 and 20.57, which were meaningful for .10. In addition, R^2 values were between .45 and .86. All these values are at

acceptable limit (Çokluk *et al*., 2010; Yılmaz & Çelik, 2009). The results of CFA analysis show that TPACK survey has a valid structure in Turkish context.

Table 3. *Factor loadings and t and R^2 values*

Items	Standardized factor loadings	t-value	R^2	Items	Standardized factor loadings	t-value	R^2
TK1	.87	17.19*	.75	PCK1	.87	18.64*	.77
TK2	.75	9.51**	.73	TPK1	.89	19.33*	.80
TK3	.69	12.73***	.48	TPK2	.89	19.26*	.80
CK1	.87	18.25*	.75	TPK3	.79	15.72*	.63
CK2	.76	15.00*	.58	TPK4	.89	18.49*	.79
CK3	.88	18.51*	.77	TCK1	.91	19.77*	.82
PK1	.90	19.57*	.81	TPACK1	.89	19.10*	.79
PK2	.90	19.41*	.80	TPACK2	.93	20.57*	.86
PK3	.91	19.99*	.83	TPACK3	.92	20.15*	.84
PK4	.92	20.21*	.84	TPACK4	.67	12.72***	.45
PK5	.90	19.57*	.81				

*p<.05, **p=.073, **p=.057

4.1. Results of reliability analysis

4.1.1. Cronbach Alpha and t-test of upper27% and lower 27% group

Cronbach alpha coefficients of the factors and t-test results for the differences between upper 27% and lower 27% group are demonstrated in Table 4. As seen in table, Cronbach Alpha values of the factors were as follows: .74, .89, .88 and .89. In addition, the overall reliability was found as high (α= .94). All the differences between upper and lower 27% groups were significant according to the t-test results. These findings show that the survey has a high reliability.

Table 4. *Cronbach Alpha values, t-test results of lower 27% and upper 27%*

Factors	Cronbach Alpha	Lower 27% Group		Upper 27% Group		t-test
		$\bar{x}$	sd	$\bar{x}$	sd	
Technological knowledge (TK)	.74	3.13	.95	4.68	.43	12.98*
Content Knowledge (CK)	.87	3.25	.95	4.97	.10	15.81*
Pedagogic Knowledge (PK)	.89	3.37	.99	4.99	.02	14.41*
Teaching with Technology (TWT)	.92	3.13	.86	4.91	.11	17.95*
Creative Reflection (CR)	.84	3.00	.86	4.92	.19	19.05*

*p=.00

4.1.1. Correlations matrix

Internal consistency was examined through correlations between factors. Table 5 demonstrates descriptive statistics and the correlations. Correlations between factors changed .65 to .89, which indicated that there were meaningful relationships between factors. Based on these findings, the internal consistency of the survey was at acceptable level. The mean scores of each factors showed that teachers rated themselves as confident about the factors. However, they were slightly less confident about technological knowledge ($\bar{x}$=3.99, sd=.84).

Table 5. *Correlations between TPACK factors*

Factors	$\bar{x}$	sd	Correlations between factors				
			TK	CK	PK	TWT	CR
Technological Knowledge (TK)	3.99	.84	-				
Content Knowledge (CK)	4.20	.82	.72	-			
Pedagogic Knowledge (PK)	4.25	.82	.66	.87	-		
Teaching with Technology (TWT)	4.07	.81	.75	.83	.89	-	
Creative Reflection (CR)	4.02	.85	.65	.76	.81	.86	-

4.1.3. Item analysis

Corrected item total correlations, mean and standard deviations of the items, t-test among upper and lower 27% groups were given in Table 6. Corrected item-total correlations ranged from .56 to .91. These values demonstrated that the discrimination level of the items were high. The value of t-test of upper and lower 27% groups ranged as 9.51 and 13.78 and found to be statistically significant at the level of .01. Mean scores of the items ranged from 3.58 to 4.47 which showed a high confidence of the teachers on TPACK items.

Table 6. *Corrected item total correlations, mean scores and standard deviations of items and t-test among lower and upper 27% group*

Item	r	$\bar{x}$	sd	t-test	Item	r	$\bar{x}$	sd	t-test
TK1	.73	4.07	.93	10.77*	PCK1	.85	4.20	.91	11.65*
TK2	.74	4.32	.93	9.51*	TPK1	.88	4.11	.92	13.09*
TK3	.56	3.58	1.04	11.22*	TPK2	.87	4.16	.89	12.74*
CK1	.82	4.47	.89	8.40*	TPK3	.76	3.93	.97	12.80*
CK2	.74	3.96	.99	12.16*	TPK4	.83	4.11	.88	12.92*
CK3	.84	4.17	.87	12.36*	TCK1	.87	4.15	.86	13.54*
PK1	.87	4.31	.87	10.72*	TPACK1	.86	4.08	.91	13.78*
PK2	.85	4.34	.87	10.43*	TPACK2	.91	4.23	.87	12.30*
PK3	.85	4.22	.87	10.66*	TPACK3	.88	4.12	.87	12.61*
PK4	.87	4.21	.87	12.90*	TPACK4	.65	3.65	1.09	10.71*
PK5	.86	4.20	.93	11.51*					

*p=.00

6. Conclusions and recommendations

Teacher educators acknowledge the need to develop valid and reliable instruments to assess teachers' TPACK. As mentioned in the introduction part, several instruments have been designed for this purpose. With the new concepts like 21st century skills (The Partnership for 21st Century Skills-P21, 2013), Information, Media and Technology Skills have gained a lot of importance when educating the children. Therefore, teachers should also be enriched with the similar skills together with the skills that combine technology, pedagogy, and their content areas. It is now inevitable to include TPACK framework into both pre-service and in-service teacher training and preparation programs. The need to design, evaluate, and refine ICT integration courses for pre-service teachers grounded on sound theoretical framework is still widely recognized among teacher educators (Chai *et al.,* 2011, Mishra *et al.,* 2009). Pierson (2011) found that teachers with both extensive teaching and technological expertise were the most effective technology integrators. This suggests that teachers need to develop a certain level of PCK and TK prior to forming their TPACK. Therefore, it is necessary to be able to measure on-job teachers' TPACK competencies and perceptions to be able to design professional development programs that would support the needs of the teachers. The survey instrument which was developed by Koh, Chai & Tsait (2010) and was adapted in this study serves this purpose.

The instrument was translated and examined by the specialists for the content validity. Then, the survey was administered to 285 teachers who teach a variety of subject areas at the secondary school level. Confirmatory factor analysis was performed to assess the validity of the scale. The results of third confirmatory factor analysis results showed that the original 5 factor scale fitted well with the Turkish data. Cronbach Alpha coefficients, item total correlations and t-tests among upper and lower 27% group indicated high reliability. These findings revealed that the survey is a valid and reliable instrument for measuring secondary school teachers' TPACK. The findings of the descriptive statistics showed that teachers had high level of TPACK perceptions. The instrument which was adapted to Turkish can be used for both pre and in-service teachers of various subject areas to measure their perceptions of TPACK. It could also be used by teacher trainers as a needs analysis instrument. In addition, the survey can also be used as a self-evaluation tool for pre and in service teachers. The descriptive results of the study can be taken into account on developing pre and in-service training programs.

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