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The Technological Pedagogical Content Knowledge-practical (TPACK-Practical) model: Examination of its validity in the Turkish culture via structural equation modeling

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ABSTRACT

The purpose of this study was to examine the construct of the Technological Pedagogical Content Knowledge [TPACK] Practical Model in the Turkish culture using structural equation modeling. The research was conducted on 296 teachers working in 13 different schools. To test the validity and reliability of the 22-item TPACK-Practical scale, item-total and item-rest (sometimes referred to as remainder) correlations, item discrimination, confirmatory factor analysis and Cronbach's alpha reliability analyses were performed. The item-total and item-rest correlation coefficients were high, and all values were significant. The powers of all of the items to differentiate between the top 27% and the subgroup averages were significant ($p < .01$). The original construct was validated according the confirmatory factor analysis that was performed to determine the construct validity. Additionally, Cronbach's alpha reliability coefficient of the scale was determined to be 0.89.

1. Introduction

Today, the expectations of teachers are continuously increasing with changes in teacher roles. The qualifications that a teacher should have and their reflections on the teaching-learning process are constantly being questioned by educational researchers; specifically, the number of studies featuring the integration of technological developments with the education system appears to be increasing. The factors affecting teacher roles and competencies in technological development constitute the basis of these studies.

Studies featuring the integration of technology with education are based on different models. The following models stand out among the studies featuring the *teacher* dimension of technology: (*i*) the Technology Integration Planning Model (Robyler, 2006), (*ii*) the Systematic ICT Integration Model (Wang & ve Woo, 2007), (*iii*) the Apple Future Classes Model (Dwyer, Ringstaff, Sandholtz & Apple Computer Inc., 1990), (*iv*) the Social Model (Wang, 2008), (*v*) the Enhanced Pearson Model (Woodbridge, 2004), and (*vi*) the Technological Pedagogical Content Knowledge [TPACK] model (Koehler & Mishra, 2005). Koehler and Mishra (2005) suggested that in recent years, these models have shifted from technology-oriented to pedagogy-oriented models. Technology-oriented models target teachers' acquisition of the knowledge and skills required to use technology, whereas pedagogy-oriented models target the integration of the teachers' use of the technology with their pedagogical knowledge in the teaching process. The foremost model among the pedagogy-oriented models that focus on the integration of technology with education is the TPACK model.

2. Related literature

2.1. Technological Pedagogical Content Knowledge (TPACK)

The TPACK model has taken its final shape by integrating the '*Technology*' dimension with Pedagogical Content Knowledge [PCK], which is a model that features the necessary characteristics that teachers should have (Koehler & Mishra, 2005). The following are components of TPACK (*see* Fig. 1); (*i*) *technology,* which comprises technical knowledge about equipment about technological tools, including tools such as

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computers, the internet, video, measuring devices, and e-books; (*ii*) *pedagogy,* which considers teaching methods, strategies, and models and consists of subdomains that include how students learn, how to use classroom management skills, course planning and effective student assessment; and (*iii*) *content knowledge*, including subject area knowledge, which varies according to grade level and discipline, and all of the theories and ideas of the concepts belonging to this discipline.

Pedagogical Content Knowledge [PCK] is the combination of knowledge and pedagogy and involves the presentation of the content area via interactions with pedagogical issues; i.e., the selection of appropriate teaching approaches, methods and techniques. *Technological Content Knowledge* [TCK] is the combination of technology and content and refers to the use of technology that is more appropriate for representing the subject and content of a particular discipline. *Technological Pedagogical Knowledge* [TPK] is the combination of technology and pedagogy and considers the effects of technology usage on learning in the teaching process. TPACK addresses the three different skills of technology, pedagogy and content together rather than considering them independently. TPACK involves the presentation of the subject area for effective teaching within the framework of pedagogical approaches in environments that involve the use of technology (Angeli & Valanides, 2009; Graham et al., 2009; Koehler & Mishra, 2005; Koh, Chai, & Tsai, 2013).

In the literature, in addition to the original structure of the TPACK model, the TPACK-converter, TPACK-deep, TPACK-ICT and TPACK-Practical models have also been created by bringing different interpretations to the model (Angeli & Valanides, 2009; Graham, 2011; Kabakci Yurdakul et al., 2012; Yeh, Hsu, Wu, Hwang, & Lin, 2013).

2.2. TPACK-Practical Model

According to Van Driel, Verloop, and De Vos (1998), teacher application knowledge and PCK play an important role in the regulation of the teaching process and in the fulfillment of learning objectives via appropriate teaching strategies. In this context, application knowledge (teaching experience) with the combined use of content and pedagogy skills is involved in the process as much as PCK. The TPACK models have evolved from different perspectives in the literature and tackle knowledge and skill dimensions independent of teaching experience and performance. From this perspective, the TPACK- Practical model is a model that considers the teaching process as the basis upon which application knowledge (teaching experience) and TPACK skills work together. The consideration of TPACK and the teaching process together is important in terms of the skills used through the process and the consideration of the interaction between these two processes in addition to providing immediate feedback. Specifically, it should not be ignored that the processes requiring different technologies, such as the recognition of students, planning, design, and evaluation, require different TPACK skills. According to Yeh et al. (2013), the TPACK skills of teacher candidates are not the same as those of experienced teachers. Thus, teaching processes and outcomes are affected by the interaction of possessed knowledge and skills with teaching experience. Jang and Tsai (2012) stated that the lack of experience and naivety of teachers may act as the limiting factor in the use of TPACK skills. Thus, variables, such as the experience and performance of the teacher, must be involved in the process. The implementations of TPACK skills in different disciplines are also different.

The TPACK-Practical model (see Fig. 2) consists of eight knowledge dimensions from five pedagogical areas. These pedagogical areas include the following: (*i*) learners, (*ii*) subject content, (*iii*) curriculum design, (*iv*) practical teaching, and (*v*) assessments. The knowledge dimensions belonging to these areas are the following: (*i*) using ICT to understand students, (*ii*) using ICT to understand subject content, (*iii*) planning ICT-infused curricula, (*iv*) using ICT representations, (*v*) using ICT-integrated teaching strategies, (*vi*) applying ICT to instructional management, (*vii*) infusing ICT into teaching contexts, and (*viii*) using ICT to assess students (Yeh et al., 2013).

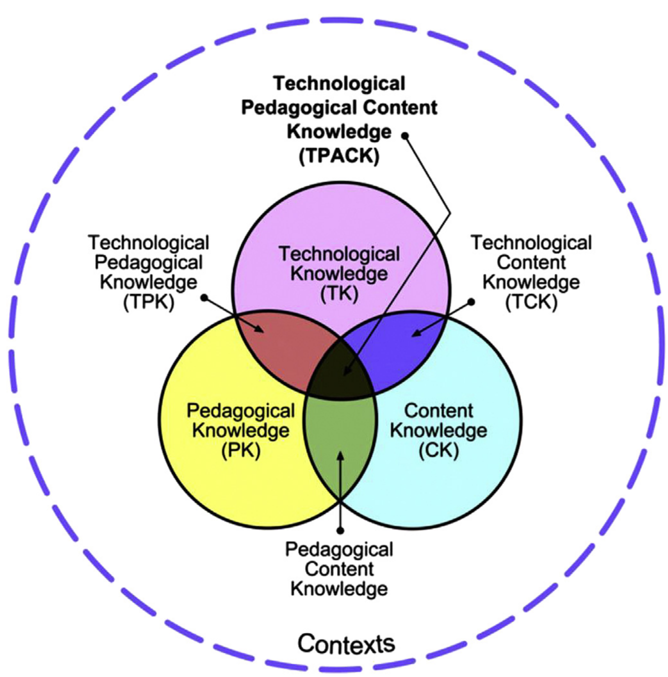

Fig. 1. Graphic representation of technological pedagogical content knowledge (TPACK).

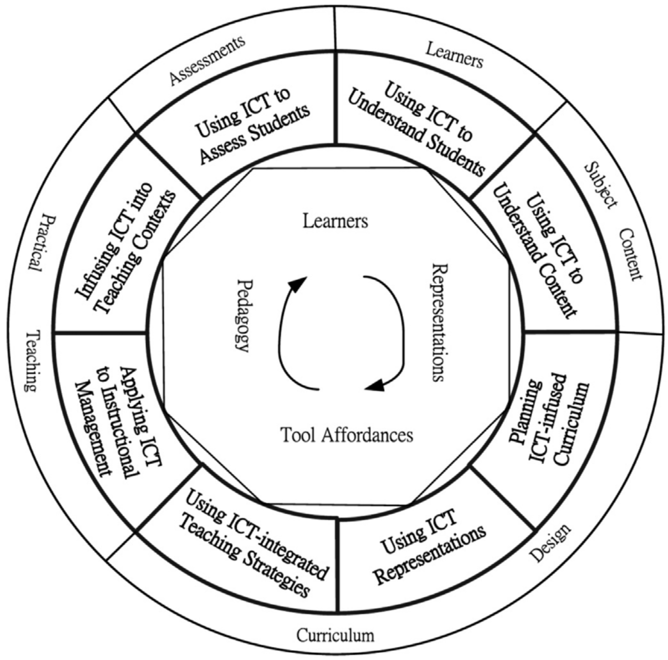

Fig. 2. The framework of the TPACK-Practical model.

According to Wang, Haertel, and Walberg (1993), classroom management is a critical factor that affects student learning. Accordingly, the TPACK-Practical model considers the teaching process as a whole, i.e., it evaluates the unique designs of the discipline, classroom management, and the skills and practices of an area together (Yeh et al., 2013).

With the development of the TPACK models, scales that aim to assess the TPACK knowledge of teachers and teacher candidates have been designed according to the frameworks of these models. In the literature, the first and most commonly used scale was developed by Schmidt et al. (2009). This scale is a Likert-type scale for classroom teachers that contain 47 items. This scale was adapted by Doukakis et al. (2010) to contained 29 items and applied to computer teachers and has been revised by Lee and Tsai (2010) to 30 items. A review of the literature revealed a 24-item Likert-type scale about distance education that was developed by Archambault and Crippen (2009). Additionally, there is a 30-item TPACK scale for science teachers that was first developed by Graham et al. (2009) and was subsequently adapted for mathematics teaching students by augmenting the number of items to 31. The literature also includes scales developed by Koh, Chai, and Tsai (2010), Kuşkaya Mumcu and Koçak Usluel (2010), and Sahin (2011).

In addition to the studies featuring the scales that allow measurements of the TPACK knowledge among teachers and teacher candidates, the literature also contains theoretical studies about the conceptualization of TPACK (Angeli & Valanides, 2005, 2009; Cox & Graham, 2009) and qualitative studies that have monitored the progress of teachers and teacher candidates (Graham et al., 2009; Guzey & Roehrig, 2009; Harris & Hofer, 2011; Jaipal & Figg, 2010; Jang & Chen, 2010; Kaya, 2010; Niess, 2005; Terpstra, 2009; Wilson & Wright, 2010). In the current study, the TPACK-Practical model developed by Yeh et al. (2013) for teachers that consists of eight knowledge factors from five pedagogic areas was examined for validity in Turkish culture using structural equation modeling.

3. Material and methods

3.1. Participants

This study was conducted with 318 teachers from 13 different schools (3 high schools, 4 secondary schools and 6 primary schools) that were identified by deliberate sampling. The data obtained from 22 teachers were likely to adversely affect the reliability of the study and were removed before beginning the analysis (these teachers gave the same scores to all of the items). Therefore, the data obtained from 296 participants were used in the study. Information about the demographic characteristics of the participant group is presented in Table 1.

3.2. Data collection tool

The TPACK-Practical Scale consists of 22 items that are rated on a 5-point Likert scale ranging from 1 (definitely insufficient) to 5 (definitely sufficient). The items were obtained from the Delphi study conducted by Yeh et al. (2013), which was performed in two stages with the participation of 6 researchers and 54 specialists. The scale consists of eight knowledge dimensions from five pedagogical areas. These pedagogical areas are as follows: (*i*) learners, (*ii*) subject content, (*iii*) curriculum design, (*iv*) practical teaching, and (*v*) assessments. The knowledge dimensions belonging to these areas are as follows: (*i*) using ICT to understand students, (*ii*) using ICT to understand subject content, (*iii*) planning ICT-infused curricula, (*iv*) using ICT representations, (*v*) using ICT-integrated teaching strategies, (*vi*) applying ICT to instructional management, (*vii*) infusing ICT into teaching contexts, and (*viii*) using ICT to assess students (Yeh et al., 2013). The Delphi study that was applied in two stages using the original scale revealed that the correlations of the individual scale items between the first and

Table 1
Demographic data of the participants.

Gender		Male	Female			Total
	n	123	173			296
	%	41.6	58.4			100
School Type		Primary school	Secondary school	High school		
	n	6	4	3		13
	%	46,1	30,7	23,2		100
Age Range	Year	21–30	31–40	41–50	51 or above	Total
	n	104	80	82	30	296
	%	35.1	27.1	27.7	10.1	100
Career year	Year	1–10	11–20	21–30	31 or above	Total
	n	120	92	69	15	296
	%	42.6	31.4	23.3	3.7	100

second steps were between .50 and .73. Additionally, the 8 dimensions obtained from the Delphi study were evaluated by the specialists according to their level of importance on a 5-point Likert scale; 95.83% of the items had an importance score of 4 or more.

3.2.1. Procedure

The data in the study were obtained by applying the scale to the participants. The participants first completed the first part of the scale consisting of demographic information questions, and they then reported their level of agreement with each of the scale items. Completing the scale was optional, and during the application of the scale, permission was obtained from the teachers and school administrators. The statistical methods employed in this study were as follows: (*i*) *correlation and paired sample t-tests* were used in the bilingualism portion; (*ii*) *confirmatory factor analysis* was performed using the data obtained from the teachers in the factor analysis portion; (*iii*) *Cronbach's alpha reliability analysis* was used to check the internal consistency, and (*iv*) *correlation analyses were* used to determine the relationships between the scale factors.

4. Findings

4.1. Translation validity

The TPACK-Practical Scale's items were independently translated into Turkish by two persons who had received English education beginning in secondary school. Next, the two specialists met, compared each item, and selected the statement to be used for each item to form the Turkish translation of the questionnaire. The translations of the items were then checked by a specialist with several works in the field of educational technology. Next, the items were listed on the left side of the page in English, and the translated expressions were listed on the right of the same page in such a manner that the same expression in the different languages were on the same line. A 10-point scale was placed in the middle of the page and indicated the *Translation Validation Compliance Degree* (Baloğlu & Karadağ, 2008). Four English language specialists were asked to read first the original items in English and then the Turkish translations. Subsequently, they were asked to assess to extent to which the Turkish translations fit the original English materials in terms of meaning and content on a range of 0–10. Consequently, the English language specialists' assessments of the compliance of the Turkish translations with the original English ranged from 6.75 to 9.25. The compliance levels of 17 of the 22 items were 8.00 (see Table 2).

The examination of the translation validity of English-Turkish adaptation scores revealed that 21 items scored above 8.00. Only item 7 had an average evaluation score below 7.00. Accordingly, the problematic items were revised in line with the suggestions of the English language specialist. After this revision process, the translation of the scale was deemed sufficient. The scale items were translated back into English by a multilingual specialist (who knew English and Turkish at advanced levels) who was not familiar with educational technology (with the aim of not having the information related to the previous scale). After this final back translation, the items were sent to the developers of the original scale for their opinions. The scale items were revised again, and the required changes were made according to the recommendations of the developers.

4.2. The bilingual study

To ensure that equal information flow was available in both the English and Turkish versions of the scale, a bilingual study was performed. Despite providing valuable information, the results of bilingual studies are not conclusive because there are many explanations for differences between forms. The translation process, which is one of the reasons that test results may be different, may have oriented test items in different directions. The second possible reason is that bilingual participants may not be equally fluent in both languages, and their results may consequently be affected by incorrect interpretations of the items in the language in which they are less fluent. The third reason is that the test language creates a cultural frame, and participants are likely to react with that culture's expectations. If cultural frameworks are sufficiently distinct, the patterns of response will be different. In such situations, the response patterns are expected to change in the same direction for all participants. Finally, cultural differences can create language differences. Over time, the results of research have revealed that individuals express themselves differently in different languages (*see* Gülgöz, 2005; Schrauf, 2000). The absence of a difference between the results of two different languages supports the notion that both forms were equivalent, and the beliefs about teaching and its importance are culturally context-free and consistent.

The participants involved in this part of the research were 21 English learning fourth grade students who were identified by purposive sampling. The requirement for participation was to be equally comfortable in both languages. Participation was voluntary, and confidentiality was protected. The native language of all participants was Turkish. The Turkish and English versions of the scale were given to the

Table 2
English-Turkish compliance scores for the TPACK-Practical model items.

Item Number	$\overline{X}$	SS	Item Number	$\overline{X}$	SS
Item 1	8.25	.95	Item 12	8.25	1.70
Item 2	7.25	1.50	Item 13	8.00	1.41
Item 3	7.75	1.25	Item 14	8.75	.50
Item 4	8.25	.95	Item 15	8.50	.57
Item 5	9.25	.50	Item 16	8.00	1.63
Item 6	8.00	1.82	Item 17	9.00	1.15
Item 7	6.75	1.70	Item 18	8.00	.81
Item 8	7.75	1.25	Item 19	8.00	.81
Item 9	7.25	1.70	Item 20	8.75	.95
Item 10	8.75	1.25	Item 21	8.00	.81
Item 11	9.00	.81	Item 22	9.00	.81

participants over two weeks. Correlation analyses were performed on the data obtained from the bilingual participants. The correlations between the scores of the Turkish and English versions of the scale were found to be generally strong and high for nearly all of the items ($r = 0.42$–0.92, $p < .01$). The other analysis group was utilized for the comparison of the Turkish and English forms. Before this analysis, the effect of taking the test in one language before the other was examined using a dependent group t-test, and no evidence of an effect on any factor was found (*See* Table 3). These results indicate that the Turkish and English forms led to similar results.

4.3. Item distinctiveness

To determine the item-total and item-rest correlation coefficients of the items covered in the Turkish version of the scale, the data collected from 296 teachers were used. The correlation coefficients obtained from the item-total correlations ranged from .44 to .65 and were significant for all items ($p < .01$). The correlation coefficients obtained from the item-rest correlations ranged from .41 to .63 and were significant for all items ($p < .01$). Table 4 presents the item-total and item-rest correlation coefficients for all items.

To determine the differentiation power of the scale items, the raw scores were listed in decreasing order. Next, the average scores for different groups that included the top and bottom 27% were compared using independent t-tests. Consequently, significant differences were found between the averages for the top and bottom groups for all scale items ($p < .01$). This result indicates that the higher and lower scores obtained from the scale distinguished the feature that was intended to be measured by the scale. Table 5 shows the results of independent t-tests that were conducted to determine the differentiation powers of all of the items.

4.4. Confirmatory factor analysis

The LISREL 8.51 program was used to conduct the confirmatory factor analysis using the data obtained from the participant group. Confirmatory factor analysis (CFA) is a statistical technique that is used to verify the factor structure of a set of observed variables. CFA allows a researcher to test the hypotheses that relationships between observed variables and their underlying latent constructs exist. The researcher uses knowledge about theory, empirical research, or both to postulate the pattern of relationships a priori and then tests the hypotheses statistically. CFA requires the specification of (*i*) an a priori model, (*ii*) the number of factors, (*iii*) which items load on each factor,

Table 3
Paired sample t-test results for linguistic equivalence.

Item	Language	$\overline{X}$	SS	t	p	Item	Language	$\overline{X}$	SS	t	p
Item 1	TR	3.86	.79	−.44	.66	Item 12	TR	4.10	.77	.46	.65
	ENG	3.95	.59				ENG	4.00	.55		
Item 2	TR	3.52	.93	.67	.51	Item 13	TR	4.24	.62	1.85	.07
	ENG	3.33	.91				ENG	3.90	.54		
Item 3	TR	4.00	.71	.68	.50	Item 14	TR	4.00	.71	1.19	.24
	ENG	3.86	.65				ENG	3.71	.85		
Item 4	TR	4.24	.54	1.93	.06	Item 15	TR	3.67	.48	1.72	.09
	ENG	3.76	1.00				ENG	3.38	.59		
Item 5	TR	4.24	.62	.79	.43	Item 16	TR	3.86	.91	.19	.85
	ENG	4.10	.54				ENG	3.81	.75		
Item 6	TR	3.67	.73	−1.00	.32	Item 17	TR	4.14	.65	−.48	.63
	ENG	3.86	.48				ENG	4.24	.62		
Item 7	TR	4.29	.56	.53	.60	Item 18	TR	4.29	.56	1.83	.08
	ENG	4.19	.60				ENG	4.00	.45		
Item 8	TR	3.81	.93	.86	.40	Item 19	TR	3.95	.67	1.65	.11
	ENG	3.57	.87				ENG	3.52	.98		
Item 9	TR	4.24	.62	1.73	.09	Item 20	TR	4.00	.71	1.28	.21
	ENG	3.90	.62				ENG	3.67	.97		
Item 10	TR	3.86	.79	1.88	.07	Item 21	TR	4.05	.74	−.23	.82
	ENG	3.43	.68				ENG	4.10	.62		
Item 11	TR	3.95	.50	.84	.41	Item 22	TR	4.48	.51	1.99	.06
	ENG	3.81	.60				ENG	4.14	.57		

$n = 21$, $SD = 20$.

Table 4
Item-total and item–remainder correlations.

Item number	Item-total [r]	Item-remainder [r]	Item number	Item-total [r]	Item-remainder [r]
Item 1	.46*	.42*	Item 12	.44*	.41*
Item 2	.53*	.50*	Item 13	.45*	.42*
Item 3	.44*	.41*	Item 14	.47*	.44*
Item 4	.47*	.43*	Item 15	.59*	.57*
Item 5	.55*	.52*	Item 16	.53*	.51*
Item 6	.59*	.56*	Item 17	.65*	.63*
Item 7	.48*	.44*	Item 18	.58*	.56*
Item 8	.48*	.45*	Item 19	.61*	.59*
Item 9	.44*	.41*	Item 20	.56*	.54*
Item 10	.57*	.54*	Item 21	.57*	.55*
Item 11	.49*	.46*	Item 22	.61*	.58*

$n = 296$, *$p < .01$.

Table 5
Independent group t-Test results for the power of item discrimination.

Item	Groups	$\bar{X}$	SS	t	p	Item	Groups	$\bar{X}$	SS	t	p
Item 1	Top$_{\%27}$	4.46	.50	13.03	.00*	Item 12	Top$_{\%27}$	4.58	.50	1.93	.00*
	Bottom$_{\%27}$	3.14	.76				Bottom$_{\%27}$	3.39	.83		
Item 2	Top$_{\%27}$	4.66	.48	13.80	.00*	Item 13	Top$_{\%27}$	5.00	.00	17.93	.00*
	Bottom$_{\%27}$	3.09	.90				Bottom$_{\%27}$	3.73	.64		
Item 3	Top$_{\%27}$	4.84	.37	16.09	.00*	Item 14	Top$_{\%27}$	4.46	.50	15.81	.00*
	Bottom$_{\%27}$	3.51	.64				Bottom$_{\%27}$	2.84	.77		
Item 4	Top$_{\%27}$	4.71	.46	14.23	.00*	Item 15	Top$_{\%27}$	4.55	.50	12.87	.00*
	Bottom$_{\%27}$	3.36	.72				Bottom$_{\%27}$	3.26	.74		
Item 5	Top$_{\%27}$	4.75	.44	17.34	.00*	Item 16	Top$_{\%27}$	4.61	.49	14.24	.00*
	Bottom$_{\%27}$	3.26	.63				Bottom$_{\%27}$	3.38	.60		
Item 6	Top$_{\%27}$	4.41	.50	16.91	.00*	Item 17	Top$_{\%27}$	4.83	.38	16.43	.00*
	Bottom$_{\%27}$	2.94	.60				Bottom$_{\%27}$	3.46	.64		
Item 7	Top$_{\%27}$	5.00	.00	18.19	.00*	Item 18	Top$_{\%27}$	4.64	.48	11.50	.00*
	Bottom$_{\%27}$	3.68	.65				Bottom$_{\%27}$	3.51	.73		
Item 8	Top$_{\%27}$	4.46	.50	13.34	.00*	Item 19	Top$_{\%27}$	4.39	.49	18.85	.00*
	Bottom$_{\%27}$	2.94	.89				Bottom$_{\%27}$	2.45	.78		
Item 9	Top$_{\%27}$	4.74	.44	14.44	.00*	Item 20	Top$_{\%27}$	4.35	.60	21.11	.00*
	Bottom$_{\%27}$	3.51	.62				Bottom$_{\%27}$	2.44	.55		
Item 10	Top$_{\%27}$	4.60	.49	14.33	.00*	Item 21	Top$_{\%27}$	4.88	.33	15.54	.00*
	Bottom$_{\%27}$	3.30	.64				Bottom$_{\%27}$	3.61	.65		
Item 11	Top$_{\%27}$	5.00	.00	19.69	.00*	Item 22	Top$_{\%27}$	4.43	.50	17.06	.00*
	Bottom$_{\%27}$	3.56	.65				Bottom$_{\%27}$	2.66	.78		

$n = 80 + 80 = 16$, $SD = 158$, *$p < 0.01$.

(*iv*) a model supported by theory or previous research and (*v*) explicit error (Suhr, 2006). Confirmatory factor analyses were performed in this research to confirm a model supported by theory and previous research. To perform the confirmatory factor analysis, the fit statistics were examined using the *maximum likelihood method*. The chi-square ($\chi2$) value and the statistical significance level of the confirmatory factor analysis were determined [$\chi2 = 413.12$, df $= 198$, $p < .01$]. The low chi-square ($\chi2$) value in combination with the degrees of freedom indicated that the collected data were appropriate for the proposed model. Additionally, the other goodness of fit parameters of the model [GFI = 0.89, AGFI = 0.86, PGFI = 0.69, RMSEA = 0.06, CFI = 0.92, NFI = 0.87] indicated that the proposed model was appropriate for the scale (see Table 6). According to these results, an examination of the values obtained for the model revealed that they validated the factor structure of the model within the scope of standard fit values.

The standardized coefficients obtained from the confirmatory factor analysis, which indicate the relationships between factors and items, were between 0.43 and 0.84 (see Fig. 3).

Table 6
Fit parameters of the confirmatory factor analysis model.

Fit Parameters	Good fit	Acceptable coefficient	Coefficient	Reference
GFI	$.95 < \text{GFI} < 1.00$	$.90 < \text{GFI} < .95$	.89	(Baumgartner & Homburg, 1996; Bentler, 1980)
AGFI	$.90 < \text{AGFI} < 1.00$	$.85 < \text{AGFI} < .90$	.86	(Anderson & Gerbing, 1984; Schermelleh-Engel & Moosbrugger, 2003)
PGFI	$.50 \le \text{PGFI} \le .95$	$95 \le \text{PGFI} \le 1.00$	.69	(Meyers, Gamst, & Guarino, 2006)
RMSEA	$.00 < \text{RMSEA} < .05$	$.05 < \text{RMSA} < .08$	.06	(Browne & Cudeck, 1993)
CFI	$.95 \le \text{CFI} \le 1.00$	$.90 \le \text{CFI} \le .95$	.92	(Baumgartner & Homburg, 1996)
NFI	$.95 \le \text{NFI} \le 1.00$	$.90 \le \text{NFI} \le 95$	.87	(Baumgartner & Homburg, 1996; Bentler, 1980)
df			198	
$\chi2$	$0 \le \chi2 \le 2\text{df}$	$2\text{df} \le \chi2 \le 3\text{df}$	413.12	(Kline, 2011)
$\chi2/df$	$0 \le \chi2/\text{df} \le 2$	$2 \le \chi2/\text{df} \le 3$	2.08	(Kline, 2011)

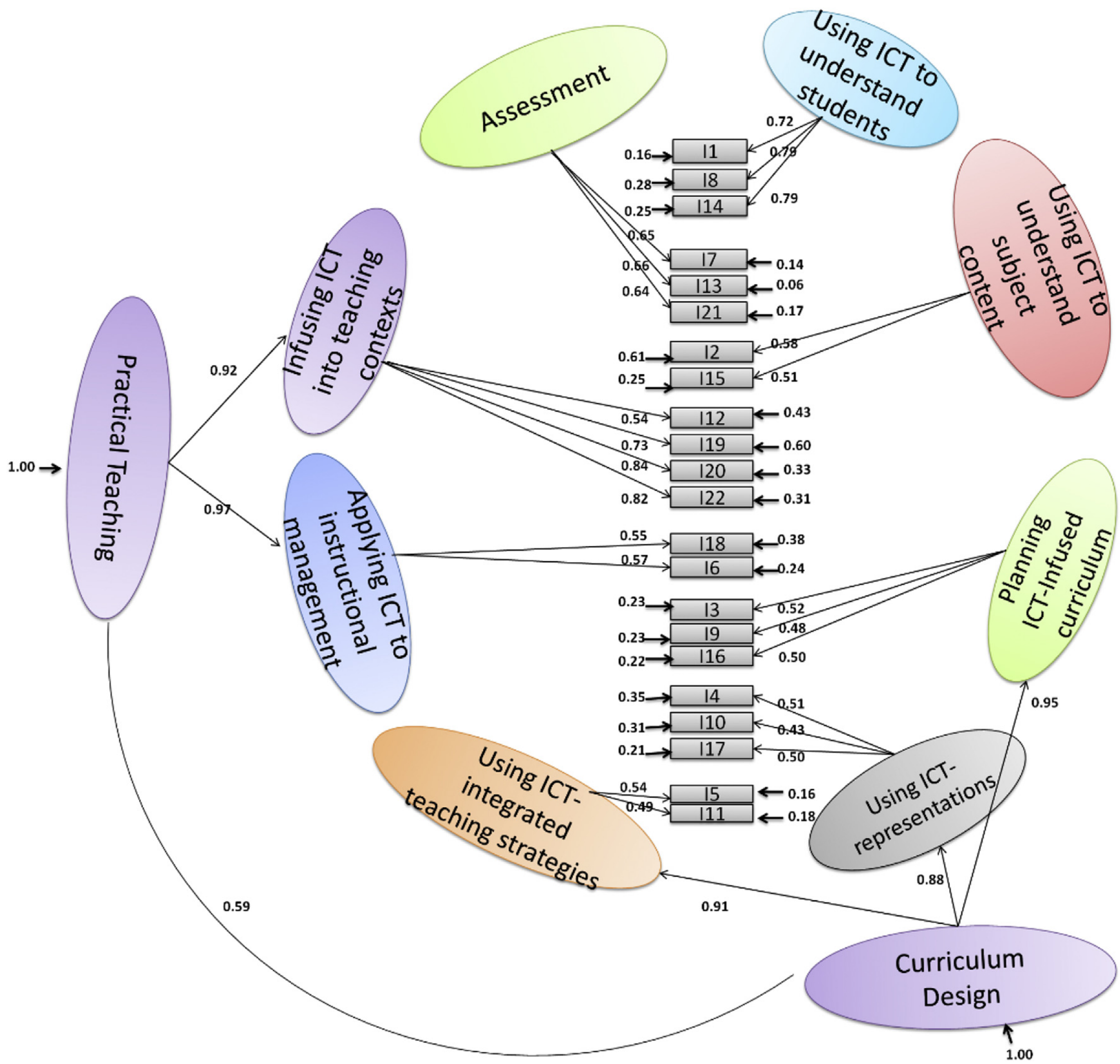

Fig. 3. Confirmatory factor analysis path diagram.

4.5. Reliability analysis

Cronbach's alpha reliability coefficients were calculated for each factor obtained after determining the factorial structure of the scale. Following the confirmatory factor analysis, the reliability of the scale was checked via the internal consistency method. The Cronbach's alpha internal consistency coefficient of the scale was found to be between .78 and .89 (*see* Table 7).

To determine the relationships of the scale factors, correlation analysis was conducted, and the correlations between the scores of the subscales were found to be significant and within the range of .11–.68. Table 8 shows that the lowest correlation was observed between the factors '*Using ICT to assess students*' and '*Applying ICT to instructional management*' ($r = .11$, $p < .05$), and the highest correlation was observed to be between '*Infusing ICT into teaching contexts*' and '*Applying ICT to instructional management*' ($r = .68$, $p < .01$).

Table 7
Cronbach's alpha reliability coefficient of the TPACK-Practical model.

Factors		Cronbach alpha	
Learners	Using ICT to understand students	.88	
Subject Content	Using ICT to understand subject content	.78	
Curriculum Design	Planning ICT-infused curriculum	.76	.87
	Using ICT representations	.79	
	Using ICT-integrated teaching strategies	.74	
Practical Teaching	Applying ICT to instructional management	.72	.85
	Infusing ICT into teaching contexts	.82	
Assessment	Using ICT to assess students	.89	
Total		.89	

Table 8
Correlation values between scale factors.

Factors			1	2	3	4	5	6	7	8
Learners	1	Using ICT to understand students	1							
Subject Content	2	Using ICT to understand subject content	.18*	1						
Curriculum Design	3	Planning ICT-infused curriculum	.24**	.24**	1					
	4	Using ICT representations	.41**	.28**	.27**	1				
	5	Using ICT-integrated teaching strategies	.32**	.39**	.30**	.65**	1			
Practical Teaching	6	Applying ICT to instructional management	.19**	.18**	.31**	.30**	.39**	1		
	7	Infusing ICT into teaching contexts	.26**	.19**	.30**	.34**	.38**	.68**	1	
Assessment	8	Using ICT to assess students	.31**	.21**	.25**	.39**	.35**	.11*	.14**	1

*p < .05, **p < .01.

According to these findings, we concluded that the scale prepared according to the TPACK- Practical model was a reliable and valid scale for measuring the teachers' TPACK practice skills.

4.6. Scoring and interpretation of the results of the scale

The TPACK-Practical scale consists of 22 Likert type items that are rated from 1 (totally insufficient) to 5 (totally sufficient). There are no negative item, and the maximum possible score 110, which indicates the highest level of TPACK-Practical skills. The minimum possible score is 22, which is indicative of the lowest level of TPACK-Practical skills. As mean teacher scores increase from 22 to 110, the integration of ICT into the teaching process also increases.

The scale factors can be explained as follows:

(i) *Learners:* High scores for this factor indicate that the teacher has gained skills such as recognizing the students using ICT, identifying and resolving the students' difficulties in the learning process (e.g., misconceptions), identifying the students' learning styles and following up on their improvement levels.

The following are sample items related to this factor:

(1) I know how to use ICT to identify students' learning difficulties
(2) I am able to use different technology-infused instruction to assist the students with different learning characteristics

(ii) *Subject Content:* High scores for this factor indicate that the teacher has gained skills such as using ICT to learn the content. The following are sample items related to this factor:
 (1) I am able to use ICT to better understand the subject content
 (2) I am able to identify the subject topics that can be better presented with ICT
(iii) *Curriculum Design:* High scores for this factor indicate that the teacher has gained skills such as planning a curriculum integrated with ICT, using ICT designs and teaching strategies integrated with ICT. The following are sample items related to this factor:
 (1) I am able to evaluate the factors that influence the planning of an ICT-infused curriculum
 (2) I use appropriate ICT representations to present instructional content
 (3) I am able to apply appropriate teaching strategies in technology-integrated instruction
(iv) *Practical Teaching:* High scores for this factor indicate that the teacher has skills such as using ICT in instructional management and facilitating the achievement of the students. The following are sample items related to this factor:
 (1) I am able to indicate the advantages and disadvantages of ICT for instructional management
 (2) I am able to use ICT to facilitate the achievement of teaching objectives
(v) *Assessment:* High scores for this factor indicate that the teacher has gained skills such as using ICT technologies to assess student learning. The following are sample items related to this factor:
 (1) I know the types of technology-infused assessment approaches
 (2) I am able to use ICT to assess students' learning progress

From Table 9, it can be seen that the mean total score of the participating teachers was 86.15 and the standard deviation was 9.90. Additionally, the mean scores of the sub-factors of the scale ranged from 7.71 (SD = 1.36) to 14.39 (SD = 3.19). Moreover, it can be seen that the competence with the lowest average was the *"Infusing ICT into teaching Contexts"* in the *Practical Teaching* content ($\overline{X} = 3.59$, $SD = .79$). The competency with the highest average was the *"Using ICT-integrated teaching Strategies"* in the *Curriculum Design* content ($\overline{X} = 4.07$, SD = .59). Regarding the scores of the teachers, the highest average scores were in the *program design* content. The *practical teaching* content exhibited the lowest average score. In this context, it can be concluded that the teachers had high levels of integration of design skills, which the integration level in the practical processes was quite low.

5. Discussion

In this study, we aimed to adapt the TPACK-Practical Model Scale (Yeh et al., 2013) to Turkish culture utilizing a working group consisting of 296 teachers. The research was performed in the following seven stages: (*i*) English – Turkish translation validation, (*ii*) establishment of the language equivalence between the English and Turkish forms, (*iii*) item-total and item-rest correlations, (*iv*) item discrimination, (*v*) construct validity, and (*vi*) internal consistency check and review of the correlations between the subscales. Similar to the original form, we confirmed that the scale has a frame consisting of eight knowledge dimensions from five pedagogical areas for Turkish teachers.

Table 9
Descriptive statistics for the teachers' TPACK-Practical scores.

Factors		n	Total Score		Mean Score	
			$\overline{X}$	SS	$\overline{X}$	SS
Learners	Using ICT to understand students	296	11.18	2.45	3.72	.81
Subject Content	Using ICT to understand subject content	296	7.68	1.45	3.87	.71
Curriculum Design	Planning ICT-infused curriculum	296	12.20	1.71	4.06	.57
	Using ICT representations	296	12.09	1.71	4.03	.57
	Using ICT-integrated teaching strategies	296	8.15	1.18	4.07	.59
Practical Teaching	Applying ICT to instructional management	296	7.71	1.36	3.85	.68
	Infusing ICT into teaching contexts	296	14.39	3.19	3.59	.79
Assessment	Using ICT to assess students	296	12.71	2.02	4.02	.82
TPACK-Practical		296	86.15	9.90	3.91	.45

These pedagogical areas are the following: (*i*) learners, (*ii*) subject content, (*iii*) curriculum design, (*iv*) practical teaching, and (*v*) assessments. The knowledge dimensions belonging to these areas are the following: (*i*) using ICT to understand students, (*ii*) using ICT to understand subject content, (*iii*) planning ICT-infused curricula, (*iv*) using ICT representations, (*v*) using ICT-integrated teaching strategies, (*vi*) applying ICT to instructional management, (*vii*) infusing ICT into teaching contexts, and (*viii*) using ICT to assess students. These dimensions allow for a multidimensional measurement of TPACK skill practices. Because the *curriculum design* and *practical teaching* areas included more than one knowledge dimension, there were opportunities to clearly demonstrate the targeted skills. Similar to the original structure, the pedagogy, technology and content knowledge skills that are included in the TPACK's construct were transformed in the form of learners, subject content, curriculum design, practical teaching, and assessment knowledge.

The translation validation findings indicate that the scale is accordance with the original English material. During the language equivalence test, the specialists rated the degrees of conformity between the Turkish and original forms between 6.75 (*I know the types of technology-infused assessment approaches)* and 9.25 (*I am able to indicate the strategies that are appropriate for use with ICT-integrated instruction)*, which indicates that both versions aimed to measure the same skills. The absence of a difference between the scores following the applications of both forms to the same group and the high and significant correlations between the scores ($r = .42-.92$, $p < .01$) support our notion that the forms aimed to measure the same skills. Regarding the differentiation of the Turkish version, the item-total correlations ($r = 0.44-.65$, $p < .01$) and item-rest correlations ($r = .41-.63$, $p < .01$) were significant for all items. Moreover, the differences in all scale items between the averages of the top and bottom 27% were significant ($p < .01$), which indicates that the scale items successfully measured the terms they were meant to measure. Based on these results, we conclude that the scale's item-total, item-rest and item discrimination properties are sufficient (Fieding & Gilbert, 2006).

Confirmatory factor analysis revealed that the GFI, AGFI, CFI and PGFI values varied between 0 and 1. Although there is not exact consensus in the literature, coefficients over 0.85 are considered to be indicative of good fits (Anderson & Gerbing, 1984). The parsimony goodness of fit index (PGFI) is based on the GFI and adjusts for losses in the degrees of freedom. PGFI values closer to 1 are better, although these values are typically lower than those of other indexes (.50 or greater is deemed acceptable; Mulaik et al., 1989) and are sensitive to model size (Schreiber, Nora, Stage, Barlow, & King, 2006). Moreover, the RMSEA values ranged from 0 to 1; for comparison, these values are required to be close to 0. $\chi 2$/df ratios between 2 and 5 represent good fits, whereas ratios less than 2 represent perfect fits. Considering fit index limits of the DFA scale, the model can be said to have provided a good fit [($\chi 2 = 413.12$, $df = 198$, $p < .01$), (GFI = .89, AGFI = .86, PGFI = .69, RMSEA = .06, CFI = .92, NFI = .87)]. Regarding the reliability data of the model, Cronbach's alpha reliability coefficient was found to be .89 for the entire scale. The values for the five dimensions ranged from .78 to .89. The correlation analysis to reveal the relationships between the scale factors, revealed that the correlations between the subscales scores were significant and ranged from .11 to .68 ($p < .05$).

Given the Turkish teacher education system, general culture, subject area and teaching knowledge, the courses are given independently in the first years. The teachers are expected to combine these independent pedagogy, technology and general culture courses in subsequent years in courses, such as *Instructional Technology and Material Design* and *Special Teaching Methods,* and during their professional life (Çoklar, Kılıçer, & Odabaşı, 2007; Gündüz & Odabaşı, 2004). When this situation is considered within the scope of TPACK, researchers are tasked to measure the extent to which the skills that were sought to be imparted in the different theoretical processes can work together. The TPACK-Practical model scale considers pedagogy, technology and content skills with respect to teaching processes (planning, implementation, evaluation, etc.) in a practice-based manner and is viewed as an alternative for measuring TPACK skills.

From the theoretically perspective, among the findings obtained from the scale, *Curriculum Design* is the highest TPACK skill of teachers. According to the model, this factor, which includes planning, design and strategy skills, is the first step that is faced in a teacher's technology integration process. In this study, the different levels of the teachers' *Curriculum Design* and *Practical Teaching* skills indicated that they use of pedagogical-based technology. Moreover, this study showed that the teachers were in the early stages of the integration process and could not demonstrate effective integration in the process of transforming. After selecting the goals for technology integration, the teachers decided on the ICT Integration model of Roblyer and Doering as a teaching strategy (2010). However, in the ICT Integration model of Roblyer and Doering (2010), it is also determined that while the teachers identify the purposes with methods of assessment, it can be said that they experience integration problems when deciding on the assessment methods in this study. According to Keating and Evans (2001), to integrate technology into education, teachers should focus on appropriate program design and planning.

The findings of this study also indicate that the lowest average was for the *"Infusing ICT into teaching Contexts"* subfactor; this subfactor includes *Practical Teaching* content, and the *Practical Teaching* content competence scores were lower than those for the other contents among the teachers. According to Yeh et al. (2013), *Practical Teaching* is the most interactive process of teaching, learning and context. According to Jang and Tsai (2012), *Practical Teaching* is a process of using BIT for the purpose of the education program. In this context, practical teaching can be viewed as the most compelling technology integration process for teachers.

Regarding the literature in terms of the integration of technology with education, the greatest shortcoming, as mentioned by many researchers, is the lack of a theoretical and conceptual framework that can inform and guide the integration of technology. In the context of the integration of technology, it should be noted that the adoption of an innovation is realized in different manners by different groups and that each individual follows different processes during this integration stage (Angeli & Valanides, 2009; Gündüz & Odabaşı, 2004; Mishra & Koehler, 2006). In this context, our demonstration of the suitability of a model for a culture different than the one that the model was developed for provides a significant contribution to the literature.

Our findings also indicate that the adapted form of the Turkish version exhibited the same item-factor harmony and structure as the original form. According to Hambleton, Merenda, and Spielberger (2005), the main reasons for such a finding is that the translation of a scale involves more than just the translation from one language to another; the transfer of a scale to another culture involves the adaptation process that is carried out in the cultural change. Thus, this result indicates that in Turkey and Singapore, where the original model and scale were developed and adopted, teachers have had similar experiences in the technology integration process. In this context, the validity and structure of the model should be investigated with teachers working in EU countries and the United States because these regions have different teacher training programs and technology applications.

Overall, similar to the original material, the Turkish version of the TPACK-Practical scale can be used as a scale with sufficiently reliable coefficients and an acceptable validity indicator values. The scale was developed for teachers and was adapted to Turkish. Considering the workgroup used in the scale adaptation stage, this scale can be used in other educational technology and teacher training research on male and female teachers who are working on different disciplines, have different seniorities, and are teaching at different levels.

6. Directions for future research and limitations

Based on the results of this research, the following suggestions related to ICT applications, the process of teacher training, technology integration and contributions to effective teaching can be made:

- The approaches for the integration of technology with education may vary according to society, culture and social structure. The first application of the TPACK-Practical model was realized in teachers working in Singapore, and its construct validity among Turkish teachers was demonstrated. Therefore, the TPACK-Practical model can be examined in different cultures, and its construct validity can be demonstrated.
- In the original study, the opinions of the specialists regarding the teachers' TPACK skills were obtained via the Delphi technique, which consists of several stages, and through a research panel. The construct of the TPACK-Practical model among Turkish teachers was shown via structural equation modeling. Considering the limitations of these techniques and analyses, the TPACK-Practical model should be investigated with different research methods and techniques.
- In the original scale development study, it was stated that there were differences between disciplines; this study did not intend to reveal the differences between teacher *content knowledge* skills according to discipline. In this context, these differences can be addresses in future research.
- The scale developed according to the TPACK-Practical model includes the main skills covered by the existing TPACK scales, but it considers them under 5 pedagogic areas and 8 knowledge dimensions. Therefore, the interactions of these pedagogical areas and the reflections of the knowledge dimensions on the teaching process can be addressed via qualitative methods.
- In the study, the data were obtained from the teachers. The investigation of the TPACK-Practical skills of students in the teacher training system may enable the prediction of their abilities to reflect the courses taken during their education on their performance.
- In studies featuring teachers' TPACK-Practical skills, variables, such as the type of school in which they work, the reflections on different grade levels, the years of seniority of the teachers, problems encountered in the integration process and student profiles, can also be taken into account.

Overall, it can be argued that the findings obtained from the model tested in this study contributed to revealing the perceptions of the teachers regarding the practical dimensions of their technological pedagogical content. In this respect, efforts to address the development of teachers' pedagogical technological knowledge can be implemented. Additionally, to examine the effectiveness and sustainability of the FATIH project that has been implemented in Turkey, the results can be further examined considering the suggestions mentioned above.

Considering that the standardized coefficients that indicated the relationships of the factors with the items covered in the study were between 0.43 and 0.84, and the survey data were collected from only one city centre in Turkey, the generalizability of the results is limited. Additionally, the data in this study were collected via self-report, which might have caused subjectivity and biases in the relationships between the variables. The most important methodological limitation of this research is *common method bias*. The main reason for this limitation was the collection of the research data from a single source (teachers), which may have led to artificial increases in the observed correlations. Although it was not possible to fully eliminate the mentioned limitations of this research, we sought to minimize the error level. Therefore, the necessary measures, within the scope of the research, were taken during the data collection phase. First, the validity and reliability of the scale used for the data collection phase of the study were tested. Second, during the face-to-face interviews, it was clearly expressed that the responses would kept completely confidential and would not be revealed in any way. Additionally the questionnaire was designed in a manner such that the scale items related to independent variables came before the items related to dependent variables.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.compedu.2015.04.017.

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