International Online Journal of Educational Sciences, 2014, 6 (3), 544-557

iojes
www.iojes.net

International Online Journal of Educational Sciences

ISSN: 1309-2707

The Psychometric Properties of the Technological Pedagogical Content Knowledge Scale

Mehmet Barış Horzum[1], Özcan Erkan Akgün[1] and Ergün Öztürk[2]

[1] Computer and Instructional Technology Department, Sakarya University, Sakarya, Turkey; 2 Department of Elementary Education, Sakarya University, Sakarya, Turkey

ARTICLE INFO

Article History:
Received 20.12.2013
Received in revised form 05.07.2014
Accepted 12.07.2014
Available online 02.12.2014

ABSTRACT

The aim of this study is to develop a scale based on Technological Pedagogical Content Knowledge (TPACK) model with giving more importance to learner centered education and teachers' facilitator role in constructivist learning comparing by previous TPACK scales. In order to prepare item-pool, first we examined previous research and scales and we add additional and novel items to include constructivist view of learning. The new scale developed within this study applied on 724 pre-service teachers, who were selected with stratified sampling. We used confirmatory factor analysis to examine construct validity. Additionally we also performed a criterion validity study to confirm validity of the scale. We calculated Cronbach alpha coefficients, and corrected item-total correlations for reliability. According to validity analyzes we concluded that the scale has a construction with 51 items under 7 factors. Internal consistency coefficients and test-retest reliability coefficients showed that the reliability of the scale is at an acceptable level.

© 2014 IOJES. All rights reserved

Keywords:
TPACK, technology, pedagogy, content, validity, reliability.

Introduction

Nowadays, technology should be used efficiently in education. So, technology should be integrated within the process in any educational environment, in school management, in guidance services and libraries. This integration increases the quality of education by supporting teachers in the conduct of their duties efficiently, and in offering students more effective learning. In this context, skills that teachers, who are able to implement and integrate technologies, should possess and levels of these skills are of great importance (Goktas, Yildirim, & Yildirim, 2009). In order to equipping teachers with necessary skills for effective technology integration are laid in the institutions that train and nurture teachers. In this respect, a process which provides for effective integration is possible only if the teachers acquire the required knowledge and skills (Earle, 2002).

It is possible to encounter many models in the literature which suggest provision for technology integration in education. In some of these model studies, technology integration is discussed within the context of school, in some of them it is discussed within the context of the student, in some of them it is discussed within socio-cultural concepts, and in others it is discussed within the context of the interaction of several factors within the process (Mazman & Koçak Usluel, 2011). When teachers and pre-service teachers are examined in these models, TPACK framework is at the forefront. This model describes the components of knowledge and self-efficacy that teachers and pre-service teachers should possess in order to use the technologies in education.

[1] Corresponding author's address: Özcan Erkan Akgün, Sakarya Üniversitesi Eğitim Fakültesi 54330 Hendek/Sakarya, Turkey.
Telephone: 02646141033
Fax: 02646141034
e-mail: oakgun@sakarya.edu.tr
DOI: http://dx.doi.org/10.15345/iojes.2014.03.004

© 2014 International Online Journal of Educational Sciences (IOJES) is a publication of Educational Researches and Publications Association (ERPA)

TPACK model was designed by Koehler and Mishra (2005a, 2005b) with the addition of technology component to the existing components of pedagogical content knowledge of Shulman and it eventually consists of 7 components based on 3 basic components. The main purpose of the TPACK model was to create a practical framework which will provide for efficient technology integration in schools (Koehler & Mishra, 2005a, 2005b). TPACK framework suggests the components that the teachers who will realize this technology integration should possess (Lee & Tsai, 2010; Horzum, 2011). Teacher training programs, in-service education programs and development applications can be prepared based upon these components (Koehler & Mishra, 2009).

There are three basic components in the TPACK model: technology (TK), pedagogy (PK) and content knowledge (CK). Together with the intersected set of these three basic components, 4 more components are formed - pedagogical content (PCK), technological content (TCK), technological pedagogy (TPK) and technological pedagogical content knowledge (TPCK) (see detailed information in Koehler, Mishra & Yahya, 2007; Mishra & Koehler, 2006, 2008; Niess, 2008).

The TPACK model is a considerably effective model in monitoring quality of teachers and assessment of pre-service teachers. This is because this model involves necessary knowledge and skills of interconnected teaching-learning and technology components that teachers and pre-service teachers should possess (Horzum, 2013). TPACK model presents a practical structure in which teachers and pre-service teachers should have knowledge concerning the use and integration of technology into teaching considering content and pedagogy. It is important to have an instrument to measure teachers' qualifications in terms of TPACK.

When the literature is examined, it can be concluded that the semi-structured interview (Doering, Veletsianos, Scharber & Miller, 2009) rubric (Harris, Grandgenett, & Hofer, 2010; Hofer, Grandgenett, Harris, & Swan, 2011) and scales (Archambault & Crippen, 2009; Koehler & Mishra, 2005a; Schmidt, et al., 2009a) were used for assessing TPACK. Graham, Cox & Velasquez (2009) compared the strong and weak features of self-report scales, semi-structured interviews and rubrics which are used to measure TPACK. They said that scales made it possible to collect data from a large population over a short period of time. However, it was concluded that it is difficult to form the questions for presenting the framework of TPACK and the items could be misinterpreted. In addition, it was also stated that the performance assessment presented clearer information; but it took so much time for the participants and the researcher, and it was not suitable for large groups. The scales gained prominence since more information could be collected in a shorter period of time between these two instruments. However, the missing aspects of scales should not be ruled out while forming the scales. In the literature, scales are mostly used to measure the framework of TPACK and there are many scales by difference. It is important to elaborate on these scales and development studies in detail.

Koehler and Mishra (2005a) conducted the first scale development study with 13 participants. In the study, the first assessment instrument which lay the foundation of TPACK was used. The scale was inadequate with present studies because it did not include all the seven components of the TPACK framework.

Angeli and Valanides (2009) devised the Information and Communication Technologies (ICT)-TPACK framework in 5 component in their studies; ICT, content, pedagogy, students and context. Another TPACK scale was developed in a study conducted by Graham, Burgoyne, Cantrell, Smith, Clair and Harris (2009), with 4 factors and 31 items for science teachers. Their scale is consisting of TK, TCK, TPK and TPCK components. In the research, the components of the model are taken in only associated with technology knowledge by authors.

Schmidt et al. (2009a) produced the first scale that included 7 theoretical components of the TPACK framework in their study which was conducted with 124 pre-service teachers who studying at mathematics, primary school reading, science and social studies education. The scale is composed of 47 items under 7 components. It is a 5 point Likert type scale. In spite of being composed of seven components, the scale does not include a sufficient number of items because a same item was used for different subject matters in a component. It is seen that the scale does not have an integrated structure, because factor analysis were separately conducted for each factor with excluding complete construction with 7 factors. This scale is the most one used in the literature. Schmidt et al. (2009b and 2009c) and Shin et al. (2009) used the scale directly,

while Koh, Chai and Tsai (2010), Landry (2010) and Doukakis, et al. (2010) used the scale by adapting to different fields.

Koh, Chai and Tsai (2010) conducted a study on developing a scale to measure the self-efficacy perception of teachers based on TPACK framework in Singapore. At the end of their studies, they developed a scale that is of a 7 point Likert type (1=completely agree, 7=completely disagree) and it is composed of 29 questions.

Kuşkaya Mumcu and Koçak Usluel (2010) developed an assessment instrument in the framework of the TPACK model on the integration of teachers in the learning-teaching process of information and communication technologies. In this study, a scale that is composed of 4 components and 15 items on a 10 point Likert type was developed. The components of the scale are consisting of four sections: TK, TCK, TPK and TPCK. People to fill the questionnaire scored the items in the scale with points from 1 to 10 according to the criteria of "Completely disagree: 1" and "Completely agree: 10". The reliability coefficient of the scale was calculated as .96. Ward and Benson (2010) developed a TPACK framework scale including 24 items under 7 factors for on-line learning. These factor names are same as the seven factors of the TPACK framework.

Chai, Koh and Tsai (2011) developed a scale that is consisting of items including ICT use in self-orientation and co-operative learning on the basis of a constructivist structure in their studies conducted with 214 pre-service teachers. This scale is a Likert type and consists of 8 factors including 7 components of TPACK framework consisting of 34 items. The CK is consisting of 2 different factors in this scale and so the scale includes 8 factors. Chai, Ng, Hong and Koh (2013) modified the scale of Chai, Koh and Tsai (2011) for Asian teacher candidates and validate their model with 7 factors and totally 36 items on this sample. In the study of Chai, Koh, Tsai and Tan (2011), they developed a scale which including 5 factors and 31 items. These factors were named as TK, PK, CK, TPK and TPCK. In the study conducted by Sahin (2011), the aim was to develop a scale to assess the TPCK framework. A Likert type scale including 32 questions under 7 factors was developed in this study.

Moreover, there are researchers who have used the scale for instructors who give education via on-line environments. Archambault and Crippen (2009) developed a TPCK in a 5 point Likert type scale (1= weak, 5= perfect) and they have included 24 items to better assess the instructors who deliver education in on-line environments. Lee & Tsai (2010) developed a scale for Web TPACK, consisted of 5 factors including 30 items.

Kabakçı-Yurdakul et al. (2012) conducted a study to determine the components of teacher self-efficacy which forms the background of a TPACK framework. At the end of the study, they found that there are 4 components in the background of the model with 7 factors according to the exploratory factor analysis. These components are design, effort, ethics and skill.

The use of TPACK in different fields, with different aims, and the use of different instruments indicate the importance of the TPACK framework. In addition, when the structure of developed scales and the items included in these scales were examined, it could be concluded that these items presented a teacher-centered approach but they did not include items that refer and assess knowledge about constructivist approach that focused on student active participation in the learning process, and guidance and facilitator role of teachers. Moreover, there exists no scale that exactly reflects the structure including the 7 basic components which are put forward in the theoretical model. So, there is a need for a scale which takes student-centered and constructivist learning into account, while putting the TPACK model to work into consideration, and which adequately represents the model. This kind of scale will provide the determination of the needed competence for pre-service teachers. Thus, achieved levels of these competences in the teacher training programs will be put forward and students of teaching departments will be enabled to receive a more student-centered education oriented to active learning. In this context, the aim of the present study is to develop a scale which takes the guidance role of constructivist teachers as a basis, depending on the TPACK theoretical model that is confirmed by many research results, and to put forward the psychometric features of this scale.

Method

This is a study of scale development. While conducting the study, cultural features and innovations in the processes of learning-teaching were considered, and new items were added to the scale to especially provide for the active participation of students. Within the scope of the study, related scales in the literature were examined. Taking these scales into consideration and adhering to the theoretical base in the concept of development study, an item pool was created with additional items. Permission was taken by e-mail from the people who developed the first TPACK scale to develop the model by presenting the theoretical base as practicable while adhering to the theoretical model. After completing with expert reviews for appropriateness of items in item pool we tested the clarity of the items with interviews conducted with 6 students (3 female and 3 male) from different grade, and at different success levels, from the classroom teacher students. After this work, expert opinion was sought again and taken for the scale form which is well-structured, and the theoretical structure of which was laid down by previous researches. The content validity indexes and content validity ratios of expert opinions were calculated to determine the level of agreement among the expert opinions as well as the validity of the structure. The validity of scale was also tested statistically by confirmatory factor analyzes. The results obtained are discussed in the section on findings below.

Participants

Participants of the study were pre-service teachers enrolled in College of Education in Sakarya University. We used stratified sampling method. The sample was selected considering program type students enrolled (teaching programs of: classroom teaching, early childhood, social studies, science, mentally retarded, guidance and counseling, mathematics, computer, and Turkish language), grade and gender. We used equal sampling ratio with considering these variables with random selection. To determine the sample size, the ratio of the sample/population was taken as 10%. The questionnaire was applied to 747 pre-service teachers in total. However, after eliminating those questionnaires which were incompletely filled in, the analyses were carried out with the data collected from 724 questionnaires. 433 of the participants were female and 291 of them were male pre-service teachers. The average age of the participants was 21 and their ages ranged from 18 to 30.

Instrument

We created item pool by examining previous scales developed by Albion, Jamieson-Proctor and Proctor (2010), Angeli and Valanides (2009), Archambault and Barnett (2010), Archambault and Grippen (2009), Koehler and Mishra (2005b), Koh, Cha and Tsai (2010), Landry (2010), Schmidt et al. (2009a, 2009b), Shin et al. (2009), Ward and Benson (2010). The common characteristic of these scales is that they have structures for assessing TK, PK and CK in the theoretical structure and their intersection sets. However, when these scales are examined, it is concluded that these scales have items representing a teacher-centered approach in terms of learning process and insufficient in terms of items related to the constructivist approach. So, new scale was developed due to the need for a scale which refers constructivist view of teaching and learning. For realizing our point of view for developing the scale, we wrote items as much as possible in a student-centered approach. Some exemplary items of our approach are “I know enough technology knowledge to help my students when they face a problem. I can adapt my teaching according to students’ needs. I make my students use technologies within the content”. The difference of these kinds of items from items of previous scale (e.g. “I know how to solve my own technical problems. I can learn technology easily) is that they not only consider teachers’ point of view but also take into account for students’ part in teaching and learning environment. Initially after reading the literature and examining previous scales, we wrote 122 items considering 7 components model of the TPACK. After taking expert views and pre-application interviews with students, we excluded 71 items. Most of the excluded items were the items having similar meaning with other items. For example we preferred “Item 39: I can choose technologies to help my students learn better” instead of “Excluded: I can choose technologies to let students gain new knowledge and skills”. We tried hard to choose the most suitable items in clarity and meaning according to experts and target audience sample views. The psychometric properties of the scale are given in next sections. The TPACK scale consists of 51 items and 7 latent factors which exactly match TPACK framework.

The TPACK scale developed in this study is a five point Likert type scale. Rating "1" refers to strongly disagree, and "5" refers to strongly agree. Scores of the scale is calculating by adding all items' points in a factor for each factors. Therefore there is not a total score of the scale. The scale produces sub scores (factor scores) for each TPACK components. Higher scores mean higher perception in measured component. There is no reverse question in the scale. Exemplary questions of the TPACK scale were presented in Table 1.

Table 1. Exemplary Items of the TPACK Scale

Component	Exemplary Item*
TK	6. I have enough knowledge to help my students when they face a problem with using technology.
PK	8. I know how to assess student performance.
CK	20. I know appropriate primary resources to be suggested for my students.
TCK	23. I know how to use existing software on my field.
PCK	34. I know difficult to learn subjects for my students.
TPK	39. I can select appropriate technologies for my students to make learning better.
TPCK	50. I make students use technologies to enhance learning method in order to learn content better.

*These items were translated from Turkish. Language of the scale is Turkish.

Data Analysis

We examine face validity of the scale first with calculating content validity ratio and content validity index (Lawshe, 1975; Yurdugul, 2005) based on expert views. We confirmed construct validity of the scale with confirmatory factor analysis with data of 724 participants. Finally we calculate Cronbach alpha internal consistency coefficients and corrected item-total correlations. We analyzed data by SPSS and Lisrel.

Findings

Content Validity

An expert opinion form was created with the items included in the item pool to enable experts to review the items in terms of content and face validity. This expert opinion form includes 77 items. These items were broached with 12 people in total including educational technologists, curriculum development experts, assessment and evaluation experts, science and technology experts, and experts working on TPACK in Turkey.

Experts gave their views on each item by marking the choices of "appropriate", "can be used after correction", and "not appropriate". The experts who marked the choice of can be used after corrections were asked to write their suggestions for correction. To examine the content validity, the content validity ratio (CVR) for items and content validity index (CVI) for factors were calculated using the data collected from the experts (Lawshe, 1975, Yurdugül, 2005). The content validity ratio and content validity index took the value between "-1 and 1". When this coefficient gets close to 1, it shows better fit as does the correlation coefficient. Lawshe (1975, 568) stated that the minimum coefficient was .56 which showed the harmonization of expert opinions in the studies in which 12 expert opinions were taken. The values of content validity ratio (CVR) of the items of the new TPACK scale changes between .64 and 1. Item 4 gets the lowest CVR value with .64 and this value is higher than .56. The lowest coefficient except for this item is .82. In other words, the CVR values of items included in the scale is above .82 except for item 4. The CVI values for factors in the scale changed between .82 and .94. According to these findings, both the content validity ratios and content validity indexes that are calculated depending on the expert opinions, confirm that the experts views showed a well fit, therefore they have an agreement on the content validity of the scale.

Criterion Validity

For criterion validity of the scale, a previous TPACK Scale which was originally developed by Schmidt et al. (2009a) and adapted to Turkish by Öztürk and Horzum (2011) was used. For criterion validity, this scale and the scale which was previously developed and adapted to Turkish by Öztürk and Horzum (2011) were applied to a group including 30 pre-service classroom teachers with one week interval. To examine the

criterion validity of the developed scale, the correlation coefficients were calculated to compare them factor score by factor score between same factors of both scales. These coefficients were TK component .757 ($p < .01$), CK component .451 ($p < .05$), PK component .699 ($p < .01$), PCK component .588 ($p < .01$), TCK component .661 ($p < .01$), TPK component .867 ($p < .01$) and TPCK component .740 ($p < .01$). The correlation coefficient between the total scores obtained from the two scales was calculated as .817 ($p < .01$). It was concluded that the correlation values obtained from two components from different scales were statistically significant and they are positively related and without CK their values are high. CK component have middle level positive and significant correlation.

We also planned and conducted a second study for the criterion validity. The relationship between the scores obtained from the new scale and from teacher profession-oriented self-efficacy scale was examined. There are studies on the relationship between teacher self-efficacy and TPACK framework in the literature (Mazman & Koçak Usluel, 2011). The teacher self-efficacy scale was developed by Yılmaz, Köseoğlu, Gerçek & Soran (2004). This scale is consisting of 8 items. The scale which was developed for criterion validity and teacher self-efficacy scale were applied to a group including 30 pre-service teachers. To calculate the criterion validity of the developed scale, the correlation coefficient was examined. The correlation coefficient between the total scores obtained from the two scales was calculated as .517 ($p < .01$). The statistically significant and positive relationship between these two scales indicates that the scale has criterion validity.

Confirmatory Factor Analysis

First level confirmatory analysis was conducted with 724 participants' data to confirm the construct validity of the TPACK model which is comprised of 7 factors. At the end of the analysis, it was concluded that the observed data fitted the TPACK framework which represents the 7 factor theoretical model. It was concluded that the chi-square value that was calculated for the model was statistically significant because of the high number of participants. "χ^2/sd" ratio was calculated as 2.40 and this value was remarked on as an indication of the acceptability of the model. Goodness of fit indexes of the scale were calculated as RMSEA=0.04, GFI=0.86, AGFI=0.85, CFI=0.99, NNFI=0.99, RMR=0.02 and SRMR=0.04. The values of RMSEA and RMR are expected to be close to 0 and the values being equal to or less than 0.05 indicate the good fitness of the scale. When the complexity of the model was concerned, the values being less than 0.08 (Dilalla, n.d.; Garson, n.d.; Newsom, n.d.; Sumer, 2000) or less than 0.10 (Anderson & Gerbing, 1984; Cole, 1987; Marsh, Balla & McDonald, 1988) showed that the model was acceptable. The indexes of GFI and AGFI being 0.95 or above indicated a good fitness. The GFI value being 0.85 and the AGFI value being above 0.80 indicate the acceptable fitness (Anderson & Gerbing, 1984; Cole, 1987; Marsh, Balla & McDonald, 1988). When the values of CFI and NNFI are above 0.95, this shows the good fitness. When the obtained values of the model are examined, it can be concluded that the structural model of the TPACK scale is acceptable.

When the modification indexes were examined, it was concluded that there was a strong relationship between the error covariances of items 15 and 16 which are under the same latent variable. In this context, it was decided to set error covariances of these items free. The confirmatory factor analysis was re-conducted.

It was concluded that the chi-square value (χ^2=2735.09, N=724, df=1202, p=.000) that was obtained from the second confirmatory factor analysis was statistically significant too. "χ^2/sd" ratio was calculated as 2.28 and this value show the good fit. Fitness indexes of the model was calculated as RMSEA=0.04, GFI=0.87, AGFI=0.86, CFI=0.99, NNFI=0.99, RMR=0.02 and SRMR=0.04. Standardized correlation coefficients varied between .41 and .77. All t values were found to be statistically significant. The path diagram is given in Figure 1. When all the obtained findings were considered, it can be concluded that the structural model of TPACK, comprising of 7 factors, indicated a good fitness in terms of Turkish culture and the participants in the study.

To examine the relationship and construct validity with TPACK total score and aforementioned latent variables' scores, second level confirmatory factor analysis was conducted. The obtained values are given in Figure 2. Chi-square value (χ^2=3823.81, N=724, df=1267, p=.000) was found to be statistically significant at the end of the analysis. "χ^2/df" ratio was calculated as 3.02 and this value indicated that the model had an acceptable fitness. Fitness indexes of the model were found to be RMSEA=0.05, GFI=0.83, AGFI=0.82, CFI=0.97, NNFI=0.97, RMR=0.09 and SRMR=0.05. Standardized correlation coefficients ranged between .75 and .93 and all the values were found to be statistically significant (See Figure 1). The

standardized coefficients between the total score and TPCK, and TPK were found to be above .90 that it means they have a significant, high positive correlation. The factors of PCK, CK and PK were found to be above .80 and the TK factor was found to be .75. This indicates that the factors are significantly related to TPACK total score of the scale. All t values between the variables were also found to be statistically significant. These results indicated that the structure of the scale is valid.

Correlation Values between Factors of the Scale

Table 3. The Correlation Values between the factors of TPACK Scale

Latent Variables (Factors)	Standardized Coefficients*						
	F1	F2	F3	F4	F5	F6	F7
F1:TK	1						
F2:PK	.51*	1					
F3:CK	.49*	.71*	1				
F4:TCK	.76*	.61*	.73*	1			
F5:PCK	.41*	.81*	.74*	.69*	1		
F6:TPK	.67*	.65*	.64*	.86*	.76*	1	
F7:TPCK	.60*	.70*	.66*	.82*	.77*	.92*	1

*p < 0.05.

The correlations between the factors of TPACK scale were examined via Pearson correlation. It is concluded from Table 3 that the correlations between the factor scores of the scale change between .41 and .92 and have a significant relationship at the level of .05. These findings show that the fix and relatedness between the factors are at a high level.

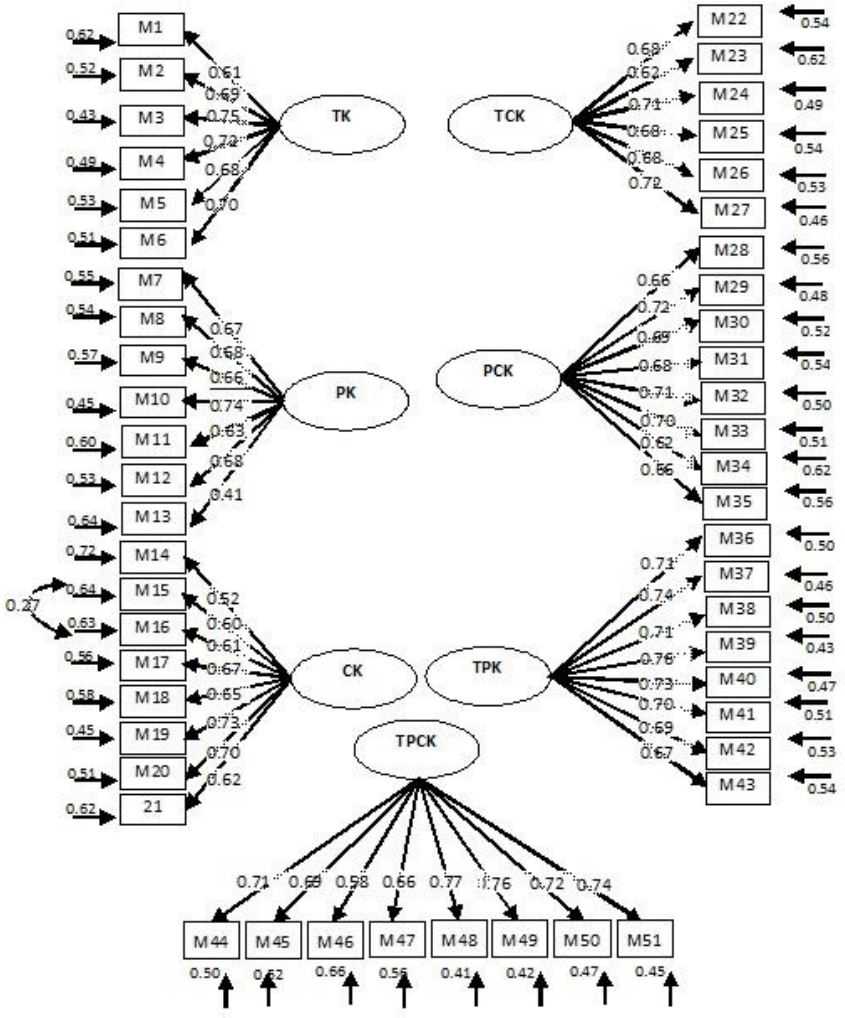


Figure1. Confirmatory Factor Analysis Results

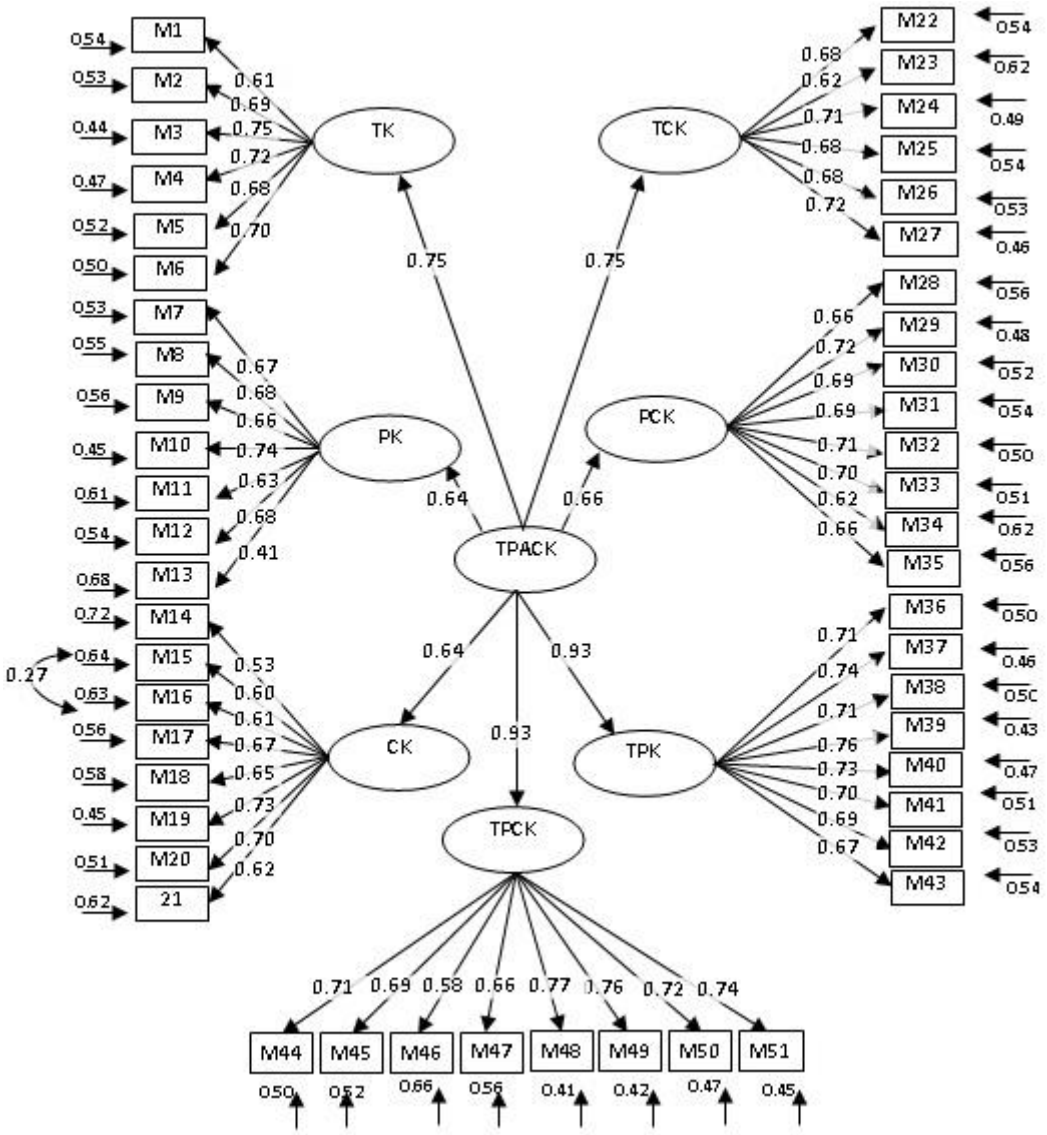


Figure2. TPACK Scale's Second Level Factor Analysis Results

Reliability

The reliability of the scale was examined via both test re-test and internal consistency coefficient methods. In addition, we calculated corrected item-total correlations, and conducted t test to determine whether there is a difference between means of lower 27% group and the upper 27% group. Test re-test study was conducted through 21 students being asked to fill the same scale two times with one week interval. At the end of test, re-test study correlation coefficients values between the items were found significant and positive. These values varied between .65 and .92. When the correlations between the factors' scores were examined, the values varied between .91 and .95 and all the values were found to be significant and positive. In addition, correlation coefficient of the total scores was calculated as .98. These significant, positive high values show that the scale has test-test reliability. When Table 5 was examined, it was concluded that the Cronbach alpha internal consistency value of 7 factors which constituted the scale varied between .84 and .89. Item total correlations of the scale varied between .35 and .73 for items (see Table 5).

Table 4. The Scores of Test Re-test and Pearson Correlation According to Item, Factor and Total Score.

Items	r	Items	r	Items	r	Items	r	Items	r
1	.84**	11	.80**	21	. 86**	31	.77**	41	.66**
2	.74*	12	.92**	22	.84**	32	.67**	42	.82*
3	.84**	13	.77**	23	.74**	33	.78**	43	.71*
4	.75*	14	.74**	24	.78**	34	.82**	44	.79**
5	.73**	15	.71**	25	.83**	35	.83**	45	.80**
6	.71**	16	.77**	26	.92**	36	.63**	46	.72**
7	.74**	17	.76**	27	.79**	37	.79**	47	.76**
8	.74**	18	.81**	28	.70*	38	.70**	48	.71**
9	.76**	19	.74**	29	.71**	39	.65**	49	.73*
10	.85**	20	.72*	30	.81**	40	.61**	50	.71**
51	.71**	**TK**	. 93**	**CK**	.95**	**PK**	.91**	**TCK**	.95**
PCK	.86**	**TPK**	.95**	**TPCK**	.92**	**TPACK**	.98**		

*Significant at p< .05. ** Significant at p< .01.

Table 5. Internal Consistency Coefficients and Corrected Item-Total Correlations

Factor	Items	Item-Total r.	Cronbach Alpha
TK	1	.55	.85
	2	.65	
	3	.69	
	4	.65	
	5	.61	
	6	.61	
PK	7	.60	.82
	8	.61	
	9	.61	
	10	.67	
	11	.55	
	12	.59	
	13	.35	
CK	14	.47	.85
	15	.60	
	16	.61	
	17	.61	
	18	.59	
	19	.66	
	20	.62	
	21	.54	
TCK	22	.59	.84
	23	.58	
	24	.69	
	25	.61	
	26	.62	
	27	.61	
PCK	28	.60	.87
	29	.66	
	30	.65	
	31	.63	
	32	.66	
	33	.64	
	34	.58	
	35	.62	
TPK	36	.66	.89
	37	.68	
	38	.67	
	39	.71	
	40	.68	
	41	.67	
	42	.64	
	43	.62	
TPCK	44	.64	.88
	45	.63	
	46	.55	
	47	.63	
	48	.73	
	49	.71	
	50	.68	
	51	.69	

We carried out t test to determine whether there existed a difference between the lower 27% group and the upper 27% group for each item and factors. It was concluded that all of these values indicated a significant difference (p<.01). When we consider these findings, we can say that The TPACK is a reliable instrument.

Discussion

In this study, we aimed to develop a new TPACK scale with considering learner centered teaching and we examined psychometric features of this new scale. We precisely work throughout of the study to assess the 7 components of the TPACK model (Schmidt et al., 2009a, 2009b, 2009c, Niess, 2008, Koehler & Mishra, 2008) with adding new needed items. According to findings it can be seen that the new TPACK scale exactly match the theoretical TPACK framework and it is a valid and reliable instrument. This new TPACK scale consisted of 51 items under 7 well defined components of TPACK framework (Harris et al., 2007; Koehler & Mishra, 2005a, 2005b; Mishra Koehler, 2006, 2007; Niess, 2005; Schmidt et al., 2009a; Shin et al., 2009): TK, CK, PK, TCK, PCK, TPK and TPCK. When the distribution of 51 items is examined, the TK component is comprised of 6 items, the CK component of 8, PK of 7, the TCK component of 6, the PCK component of 8, the TPK component of 8 and the TPCK of 8 items. In this respect, this scale is consistent with the 7 factors in the scales within the studies of Schmidt et al., (2009a), Koh, Chai and Tsai (2010), Ward & Benson (2010) and Sahin (2011) in the literature. However scales in the literature get these results by analyzing seven factors one by one not together. This aspect of the study is important because it brings TPACK model together.

When scales in the literature examined, some only contain teacher centered items (Schmidt et al., 2009a; Sahin, 2011), and others only contain student centered items (Koh, Chai & Tsai, 2010). Scale developed in this study differs from existing scales since it contains both student centered and teacher centered items. This aspect of the scale makes it important since in this way two different approaches of learning of the teachers' and pre-service teachers' technology usage and integration can be handled.

Furthermore if the literature examined, some studies are specific to subject area (such as web based learning, mathematics and classroom teachers) (Archambault & Crippen, 2009; Lee & Tsai, 2010; Schmidt et al., 2009a), some are non-specific to any subject area (Shin et al., 2009). This scale can be used both in areas like mathematics, physics, music and also in all other areas to compare students' and teachers' TPACK self-efficacy. The scale developed in this study can be used to compare TPACK framework based self-efficacy of teachers or pre-service teachers from different and/or same subject area.

In addition to these, it is thought that the number of Turkish TPACK framework based self-efficacy scales is limited and this study is important to fill this gap. One of the important aspect of this Turkish scale developed in this study is that it can be used in Turkey and in Turkish culture which is between Europe and Asia and has unique characteristics. Today in Turkey where FATIH project is being implemented, importance of technology usage and integration in education is gaining importance each day and the information that will be gathered by using this scale can be used to shape pre-service and in-service teacher education programs.

According to the criterion validity results, correlations between the new TPACK scale factor scores and criterion validity variables which were factors of two independent scales related with TPACK are significant, positive and mostly high level. This result showed that the new scale has a concurrent validity. Reliability results of test-retest and internal consistency methods are mostly better than acceptable levels. Corrected item-total correlations are significant, positive and high level. All t test results between means of upper 27% and lower 27% are significant. These findings reinforced that the all items in the scale contribute well to their factors and scores of the scale discriminate enough persons whether have better or worse perceptions about their level of TPACK. On the other hand, correlations between factors of the scale are very high, for example the coefficient for TPK and TPCK is .92. Participants' perceptions on understanding these factors conceptually should be examined in future studies.

The scale has two important features. One of them is highlighting the technology integration into education with TPACK framework. The other one is emphasizing student centered education with new and novel items of the scale. This study has some limitations. The participants consisted only of one faculty of education. In addition, the validity and reliability level of the scale can be tested for different samples.

Conclusion and Recommendations

In conclusion, our study contributes to the knowledge about TPACK framework and instruments. Future work should further investigate TPACK framework using by this scale. This scale is expected to be used for future studies due to its having acceptable psychometric features. In addition, it can be stated that

the validity and reliability of the scale can be examined with different sample groups (teachers, pre-service teachers studying at faculties) and also can be used in related studies taking different variables into consideration.

References

Albion, P., Jamieson-Proctor, R., & Finger, G. (2010). Auditing the TPACK competence and confidence of Australian teachers: The teaching with ICT audit survey (TWictAS). Paper presented at the *Society for Information Technology & Teacher Education International Conference (SITE)*, San Diego, California, March 29-April 2, 2010.

Anderson, J. C., & Gerbing D. W. (1984). The effect of sampling error on convergence, improper solutions, and goodness-of-fit indices for maximum likelihood confirmatory factor analysis. *Psychometrika, 49*, 155-173. http://dx.doi.org/10.1007/BF02294170

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*(1), 154-168. http://dx.doi.org/10.1007/BF0229417010.1016/j.compedu.2008.07.006

Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education, 55*, 1656-1662. http://dx.doi.org/10.1016/j.compedu.2010.07.009

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States *Contemporary Issues in Technology and Teacher Education*, *9*(1). Retrieved 6 December, 2010 from http://www.citejournal.org/vol9/iss1/general/ article2.cfm.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2011). Exploring the factor structure of the constructs of technological, pedagogical, content knowledge (TPACK). *The Asia-Pacific Education Researcher*, *20*(3), 607-615.

Chai, C. S., Koh, J. H. L., Tsai, C. C., & Tan, L. L. W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education, 57*, 1184–1193. http://dx.doi.org/10.1016/j.compedu.2011.01.007

Chai, C. S., Ng, E. M., Li, W., Hong, H. Y., & Koh, J. H. (2013). Validating and modelling technological pedagogical content knowledge framework among Asian preservice teachers. *Australasian Journal of Educational Technology*, *29*(1), 41-53.

Cole, D. A. (1987). Utility of confirmatory factor analysis in test validation research. *Journal of Consulting and Clinical Psychology, 55*, 1019-1031. http://dx.doi.org/10.1037/0022-006X.55.4.584

DiLalla, L. (n.d.). Psychology 529 Structural equation modelling. Retrieved 29 May, 2013 from http://www.siu.edu/~psycho/sem/notes_92402.rtf.

Doering, A., Veletsianos, G., Scharber, C., & Miller, C. (2009). Using the technological, pedagogical, and content knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research*, *41*(3), 319-346. http://dx.doi.org/10.2190/EC.41.3.d

Doukakis, S., Psaltidou, A., Stavraki, A., Adamopoulos, N., & Tsiotakis, P. (2010). Measuring the technological pedagogical content knowledge (TPACK) of in-service teachers of computer science who teach algorithms and programming in upper secondary education. *Readings in Technology and Education: Proceedings of ICICTE 2010*. Retrieved 7 December, 2010 from http://sdoukakis.files.wordpress.com/2010/09/icicte_paper_aepp.pdf.

Earle, R. S. (2002). The integration of instructional technology into public education: promises and challenges. *ET Magazine, 42*(1), 5-13.

Garson, G. D. (n.d.). PA765 quantitative research in public administration course notes. Retrieved 24 May, 2004 from http://www2.chass.ncsu.edu/garson/pa765/structur.htm.

Goktas, Y., Yildirim, S., & Yildirim, Z. (2009). Main barriers and possible enablers of ICT's integration into pre-service teacher education programs. *Educational Technology & Society*, *12* (1), 193–204.

Graham, C., Cox, S. & Velasquez, A. (2009). *Teaching and Measuring TPACK Development in Two Preservice Teacher Preparation Programs.* In I. Gibson et al. (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2009 (pp. 4081-4086). Chesapeake, VA: AACE. Retrieved 24 November, 2013 from http://www.editlib.org/p/31297.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., Clair, L. S., & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of inservice science teachers. *TechTrends, 53*(5), 70-79. http://dx.doi.org/10.1007/s11528-009-0328-0

Harris, J., Grandgenett, N., & Hofer, M. (2010). Testing a TPACK-based technology integration assessment rubric. In C. D. Maddux, D. Gibson, & B. Dodge (Eds.). *Research highlights in technology and teacher education 2010* (pp. 323-331). Chesapeake, VA: Society for Information Technology & Teacher Education (SITE).

Harris, J. B., Mishra, P., & Koehler, M. J. (2007). Teachers' technological pedagogical content knowledge: Curriculum-based technology integration reframed. *In Annual Meeting of the American Educational Research Association*, Chicago, IL.

Hofer, M., Grandgenett, N., Harris, J., & Swan, K. (2011). Testing a TPACK-based technology integration observation instrument. In C. D. Maddux, D. Gibson, B. Dodge, M. Koehler, P. Mishra, & C. Owens (Eds.). *Research highlights in technology and teacher education 2011* (pp. in press). Chesapeake, VA: Society for Information Technology & Teacher Education (SITE).

Horzum, M. B. (2011). Web pedagojik içerik bilgisi ölçeği Türkçe formunun geçerlik ve güvenirlik çalışması [Adaptation of web pedagogical content knowledge survey to Turkish]. *İlköğretim Online [Elementary Online], 10*(1), 257-272.

Horzum, M. B. (2013). The investigation of technological pedagogical content knowledge of pre-service teachers. *Technology, Pedagogy and Education*. doi:10.1080/1475939X.2013.795079.

Kabakçı-Yurdakul, I., Odabaşı, H. F., Kilicer, K., Coklar, A. N., Birinci, G., & Kurt, A. A. (2012). The development, validity and reliability of TPACK-deep: A technological pedagogical content knowledge scale. *Computers & Education, 58*, 964-977. http://dx.doi.org/10.1016/j.compedu.2011.10.012

Koehler, M. J., & Mishra, P. (2005a). Teachers learning technology by design. *Journal of Computing in Teacher Education*, *21*(3), 94–102.

Koehler, M. J., & Mishra, P. (2005b). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, *32*(2), 131-152. http://dx.doi.org/10.2190/0EW7-01WB-BKHL-QDYV

Koehler, M. J., & Mishra, P. (2008). Introducing TPACK. In AACTE Committee on Innovation & Technology (Eds.). *Handbook of Technological Pedagogical Content Knowledge For Educators* (pp. 3-29). New York: Routledge.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge. *Contemporary Issues in Technology and Teacher Education*, *9*(1). Retrieved 29 May, 2013 from http://www.citejournal.org/vol9/iss1/general/article1.cfm.

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education*, *49*(3), 740-762. http://dx.doi.org/10.1016/j.compedu.2005.11.012

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning, 26*(6), 563-573. http://dx.doi.org/10.1111/j.1365-2729.2010.00372.x

Kuşkaya Mumcu, F., & Usluel, Y. K. (2010). Teknolojik pedagojik içerik bilgisi modeline göre BİT'in öğrenme-öğretme sürecine entegrasyonuyla ilgili ölçek geliştirme çalışması. Presented at the10th International Educational Technology Conference (IETC), 26th-28th April, İstanbul, Turkey.

Landry, G. A. (2010). Creating and validating an ınstrument to measure middle school mathematics teachers' technological pedagogical content knowledge (TPACK). PhD dissertation. University of Tennessee, 2010. Retrieved 29 May, 2013 from http://trace.tennessee.edu/utk_graddiss/720.

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, *28*, 563-575. http://dx.doi.org/10.1111/j.1744-6570.1975.tb01393.x

Lee, M. H. & Tsai, C. C. (2010). Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the world wide web. *Instructional Science: An International Journal of the Learning Sciences*, *38*(1), 1-21. http://dx.doi.org/10.1007/s11251-008-9075-4

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit indexes in confirmatory factor analysis: The effect of sample size. *Psychological Bulletin, 103*, 391-410. http://dx.doi.org/10.1037/0033-2909.103.3.391

Mazman, S. G. & Koçak Usluel, Y. (2011). Bilgi ve iletişim teknolojilerinin öğrenme-öğretme süreçlerine entegrasyonu: modeller ve göstergeler [ICT integration into learning-teaching process: Models and indicators]**.** *Eğitim Teknolojisi Kuram ve Uygulama [Educational Technology Theory and Practice], 1*(1), 62-79.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *The Teachers College Record*, *108*(6), 1017–1054.

Mishra, P., & Koehler, M. (2007). Technological pedagogical content knowledge (TPCK): Confronting the wicked problems of teaching with technology. In C. Crawford et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference* 2007 (pp. 2214-2226). Chesapeake, VA: AACE.

Mishra, P., & Koehler, M. J. (2008). Introducing technological pedagogical content knowledge. In AACTE (Eds.). *The Handbook of Technological Pedagogical Content Knowledge for Educators* (pp. 3- 29). London, UK: Routledge.

Newsom, J. T. (n.d.). SEM Class course notes. Retrieved 29 May, 2013 from http://www.ioa.pdx.edu/newsom/ semclass/ho_fit2.doc.

Niess, M. L. (2008). Guiding preservice teachers in developing TPCK. In AACTE (Eds.). *The Handbook of Technological Pedagogical Content Knowledge for Educators* (pp. 223- 250). London, UK: Routledge.

Niess, M. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education: An International Journal of Research and Studies*, *21*(5), 509-523. http://dx.doi.org/10.1016/j.tate.2005.03.006

Ozturk, E., & Horzum, M. B. (2011). Teknolojik pedagojik içerik bilgisi ölçeği'nin türkçeye uyarlaması [Adaptation of technological pedagogical content knowledge scale to Turkish]. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi [Ahi Evran University Kırşehir Education Faculty Journal], 12*(3), 255-278.

Sahin, I. (2011). Development of survey of technologıcal pedagogıcal and content knowledge (TPACK). *Turkish Online Journal of Educational Technology, 10*(1), 97-105.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009a). Technological Pedagogical Content Knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123-149. http://dx.doi.org/10.1080/15391523.2009.10782544

Schmidt, D., Baran, E., Thompson, A., Koehler, M., Punya, M., & Shin, T. (2009b). Examining preservice teachers' development of technological pedagogical content knowledge in an introductory instructional technology course. In I. Gibson et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* 2009 (pp. 4145-4151). Chesapeake, VA: AACE.

Schmidt, D., Baran, E., Thompson, A., Koehler, M. J., Mishra, P., & Shin, T. (2009c). Examining preservice teachers' development of technological pedagogical content knowledge in an introductory instructional technology course. Paper presented at the 2009 *International Conference of the Society for the Information and Technology & Teacher Education*. March 2-6, Charleston, South Carolina.

Shin, T., Koehler, M. J., Mishra, P., Schmidt, D., Baran, E., & Thompson, A. (2009). Changing technological pedagogical content knowledge (TPACK) through course experiences. *Society for Information Technology & Teacher Education International Conference*, Charleston, South Carolina.: SITE.

Sümer, N. (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar [Structural Equation Modeling: Basic concepts and sample practices]. *Türk Psikoloji Yazıları [Turkish Psychological Articles], 3*(6), 49-74.

Ward, C. L., & Benson, S. N. K. (2010). Developing new schemas for online teaching and learning: TPACK. *MERLOT Journal of Online Learning and Teaching, 6*(2), 482-490.

Yılmaz, M., Köseoğlu, P., Gerçek, C., & Soran, H. (2004). Yabancı dilde hazırlanan bir öğretmen öz-yeterlik ölçeğinin Türkçe'ye uyarlanması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 27*, 260-267.

Yurdugül, H. (2005). Ölçek geliştirme çalışmalarında kapsam geçerliği için kapsam geçerlik indekslerinin kullanılması. 14. Ulusal Eğitim Bilimleri Kongresinde Sunulan Bildiri. Pamukkale Üniversitesi, Denizli.