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Adaptation of Technological Pedagogical Content Knowledge Scale to Turkish*

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Abstract

The purpose of this study was to adapt "Survey of Pre-service Teachers' Knowledge of Teaching and Technology" in order to assess pre-service primary teachers' Technological Pedagogical Content Knowledge (TPACK) to Turkish. 407 pre-service primary teachers (227 female and 180 male) in their final semester in Education Faculties in Turkey participating in this study were selected with criteria sampling which is the method of purposeful sampling. Exploratory and confirmatory factor analyses, including Cronbach's alpha and item-total correlation coefficients, were used for checking the psychometric properties of the adapted scale. Exploratory factor analysis (EFA) identified eight factors accounting for 59.44% of the variance, Cronbach's alpha coefficient was found to be .89 for the overall scale, and item-total correlation coefficients were between .42 and .74. The results obtained from the EFA supported by confirmatory factor analysis showed that there were new four factors based on the subject matter (science, mathematics, social studies and literacy) although four factors were the same as in the original scale. It was concluded that the adapted scale should not be used in academic studies focusing on Turkish pre-service primary teachers' TPACK. The unexpected results of this study were discussed for researchers and program developers in Turkish teacher education.

Key Words

Technological Pedagogical Content Knowledge, Pre-service Teacher Education, Pre-service Primary Teachers, Turkish Teacher Education.

Today, the most important need of societies is to have qualified work force. As bringing up qualified individuals can be only possible in learning-teaching environments to be created by qualified teachers, many researchers have focused on the question "What is the knowledge that a qualified teacher should have?" in recent years. Although there are some different views on this issue, the common view is that a qualified teacher should have in-depth content knowledge and should know how to transfer this knowledge for students in a comprehensible way in the classroom (Feiman-

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Nemser & Buchman, 1987). In this scope, studies conducted within last 25 years have focused on the Pedagogical Content Knowledge (PCK) which was developed by Shulman in 1986. According to Shullman (1986; 1987), PCK refers to transforming the content knowledge in the most comprehensible way for students in learning environments. As PCK is a concept generated from the combination of different types of knowledge, there are different views on the definition and components of it (Gess-Newsome, 1999; Grossman, 1990; Magnusson, Krajcik, & Borko, 1999). Many researchers extended the concept of PCK by adding new components to it, while others interpreted the PCK in a very different manner and renamed it (Geddis, Onslow, Beynon, & Oesch, 1993; Gess-Newsome, 1999; Grossman, 1990). For example, Grossman (1990) explained her view of PCK consisting of knowledge of content, general pedagogy and context that are connected to each other, while Cochran, DeRuiter, and King (1993) renamed PCK as Pedagogical Content Knowing based on the dynamic nature of PCK and constructivism. Pursuant to the results of studies conducted on the effects of instructional technologies on teaching-learning process particularly within last 10 years, the concept of PCK has been redefined as Technological Pedagogical Content Knowledge (TPACK). In particularly as a result of continuous improvement in information and communication technologies during the last decade, it is claimed that teachers should be technology literate without doubt and integrate technologies into classrooms in a meaningful and appropriate manner in order to allow their students to be technology literate (Koehler, Mishra, & Yahya, 2007; Mishra & Koehler, 2006). TPACK is a model for teacher knowledge which was put forward by Mishra and Kohler (2006) as the merge of technological knowledge in parallel with the Shullman's PCK (1986; 1987) and technological developments. TPACK explains the relationships and interactions among content knowledge, pedagogical knowledge and technological knowledge which are all equally important characteristics that teachers should have.

When considering the complex structure of TPACK; researchers have focused on developing data collection tools as a beginning in order to determine and monitor development of TPACK. In most studies Likert scales which consist of all main and sub elements of TPACK were developed (e.g., Archambault & Crippen, 2009; Graham et al., 2009; Lee & Tsai, 2010; Makinster, Boone, & Trautman, 2010). For example; having planned a lesson with integrated instructional technologies, Mishra and Koehler (2006) developed a TPACK scale with 33 items, including 2 short answer questions, in order to determine the change in the level of pre-service teachers' TPACK. Graham et al. (2009) developed a TPACK scale consisting of 4 factors with items in Likert format, with the purpose of determining teachers' TPACK self-confidence especially for science teaching. Schmidt et al. (2009) developed a Likert scale consisting of 7 dimensions of TPACK in order to determine TPACK levels of pre-service primary teachers. Studies on adaptation and validation of different TPACK scales into Turkish have been recently carried out by Turkish researchers (e.g., Savaş, 2011; Temur & Taşar, 2011). The purpose of this study is to adapt the TPACK scale named ""Survey of Pre-service Teachers' Knowledge of Teaching and Technology" which was developed by Schmidt et al. (2009) to determine TPACK of particularly pre-service primary teachers into Turkish, to test its validity and reliability and to research its conformity with Turkish sample.

Method

Universe and Sampling

The universe of this study consisted of all pre-service primary teachers in their final year in primary teacher education programs in all state universities in Turkey. 407 students in the final year of Primary Teaching Programs of the Faculty of Education in Fırat, Mustafa Kemal, Adıyaman and Cumhuriyet Universities in academic year of 2011-2012 participated in this study utilizing criteria sampling which is the method of purposeful sampling. 227 of pre-service teachers are female (55.88%) and 180 of them are (44.22%) male. Among pre-service teachers, students having completed the courses of School Experience and Teaching Practice I and II are selected in this study.

Data Collection Tool

The scale originally named "Survey of Pre-service Teachers' Knowledge of Teaching and Technology" was developed by Schmidt et al. in 2009. The original language of the scale is English. The original form of the scale can be reached through the following link: "http://mkoehler.educ.msu.edu/unprotected_readings/TPACK_Survey/tpack_survey_v1point1.pdf". The purpose of the scale is to determine how pre-service primary teachers use and develop TPACK in classrooms. In this scale,

TPACK consists of seven categories: Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK) Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). The study has been conducted with 124 (116 female and 8 male) pre-service teachers. Exploratory Factor Analysis (EFA) is implemented on each factor while determining factor structure of the survey. As a result, a 5-point Likert scale with 47 items is obtained. Cronbach's alpha coefficients of the scale consisting of seven factors; namely, TK, CK, PK, PCK, TCK, TPK and TPACK were found between .75 and .87. The first step of this kind of scale-adaptation study should be getting permission from the developers of the original scale (Baş, 2006; Öner, 1987; Savaşır, 1994). Before starting any work, authors got permission from Dr. Denise Schmidt via e-mail to translate the TPACK scale into Turkish.

Language Adaptation: The following steps are important in order to adapt a scale from one language and culture to another (Aksayan & Gözüm, 2002; Öner, 1987). First, the scale was translated from English to Turkish by two researchers, who know source and target languages well and have experience in both cultures, independently from each other. After the translation is completed, Back-Translation Method is used to check over the equivalence of words and expressions in the draft form with the original scale. Then the final form was re-evaluated by a Turkish language expert. Before the adaptation process of the scale was completed, the last version of the scale was administered to 120 preservice primary teachers who are in their final years in the program and randomly selected 30 preservice teachers were interviewed in order to evaluate its appropriateness for undergraduate students.

Validity and Reliability: In order to determine the feasibility of translated Turkish scale in Turkey, some psychometric features such as construct validity (exploratory and confirmatory factor analysis) and internal consistency (Cronbach's alpha) are tested (Büyüköztürk, 2010). Before Explanatory Factor Analysis (EFA), Kaiser-Mayer-Oklin (KMO) test and Barlett Sphericity test are implemented to determine whether data are applicable for factor analysis. EFA is conducted by using Principal Components Analysis and Varimax Vertical Rotation Technique. Factor structures determined with EFA are subjected to CFA to examine the model claimed by the EFA and test propriety of the model, as well. In CFA, RMSEA, AGFI, CFI, NFI and GFI indexes are used frequently. In CFA, there are a lot of fit indexes used to evaluate the validity of the model. One of the most used fit indexes is the ratio of chi square to its degrees of freedom, which is less than 3, is appropriate for the model (Bentler & Bonett, 1980; Brown & Cudeck, 1993; Kline, 2005; Tabachnick & Fidell, 2007). In order to determine the distinctive validity of the adapted TPACK scale, a 27% top-bottom group comparison was also carried out (Tezbaşaran, 1996). In order to find the capability of the scale to differentiate people at high and low level with regard to TPACK and its components, item analysis and item total correlations based on group averages of 27% are examined. Finally, Cronbach Alpha coefficients are calculated for each factor in the scope of reliability study in order to test the consistency of scale items with each other for dimensions and sub dimensions which were adapted into Turkish and factor structure of which were determined.

Results

Findings on Language Adaptation

Considering the content of the scale, Turkish name of the scale has been changed to "Technological Pedagogical Content Knowledge Scale of Pre-service Primary Teachers (TPACKs- PPT)". TPACKs-PPT is made applicable in 5 point Likert with 47 items consisting of seven factors; namely, TK, SCK, PK, PCK, TCK, TPK and TPACK.

Findings on Validity

Following the analysis of data obtained with TPACKs-PPT which has been conducted on 407 pre-service primary teachers, explanatory and confirmatory factor analyses are conducted to test construct validity.

Explanatory Factor Analysis (EFA)

Frequently used in social sciences, Principle Component Analysis is used as a factoring method in EFA. Varimax vertical rotation technique is implemented in order to ensure the independence of the factors, clearness and significance in interpretation and while determining the number of factors, only factors with Eigen values greater than 1.0 are retained in this study (Büyüköztürk, 2010; Tabachnick & Fidell, 2007).

Data obtained from the sample which have been selected in accordance with the Barlett test result ($\chi 2$ = 9966,125, p<.001) and KMO coefficient of TPACKs-PPT which is .92, are found applicable for factor analysis.

Following the Principal Components Analysis and Varimax Vertical Rotation conducted with the purpose of defining factor structure of the scale, no item having common factor variance below .40 is found. On grounds that, although a 10-factor structure having Eigen value over 1 is obtained initially, the contribution of the last three factors to the variance is low and TPACK consists of seven main components theoretically; the analysis is performed again to ensure forming a seven-factor structure. However, it is detected that items which are included in the dimensions obtained are grouped insignificantly in terms of TPACK framework. For that reason, regarding theoretic grounds of the study; it decided to conduct the analysis one more time in a way to ensure forming a eight-factor structure. According to the last analysis, EFA identified eight factors accounting for 59.44% of the variance. Results of the EFA analysis reveal that unlike the original scale, the adapted TPACKs-PPT consists of eight dimensions in total with four new factors depending on the subject matter. The factors are detected by taking goal of the study, content of the scale and pertinent literature on TPACK into consideration and presented in Table 1.

Table 1.
Eight-Factor Structure of TPACKs-PPT

Factors of TPACK Being Independent of Content	1. Pedagogical Knowledge (PK) 2. Technological Knowledge (TK) 3. Technological Pedagogical Knowledge (TPK)
Factors of TPACK Being Dependent on Content	4. Science Related - CK, TCK, PCK 5. Literacy Related - CK, TCK, PCK 6. Social Studies Related - CK, TCK, PCK 7. Mathematics Related - CK, TCK, PCK
TPACK	8. Technological Pedagogical Content Knowledge

Confirmatory Factor Analysis (CFA)

CFA is implemented on the scale in order to reveal whether the eight-factor structure of TPACKs-PPT obtained as a result of EFA will be confirmed in Turkish sample or not. In CFA, a variety of fit indexes are used to evaluate the validity of the model claimed by the EFA or theoretical perspective found in the literature (Gizir, 2005). During the CFA process of this study, values of Chi-Square Goodness-$\chi 2$, Goodness of Fit Index-GFI, Adjusted Goodness of Fit Index-AGFI, Comparative Fit Index-CFI, Normed Fit Index-NFI, Root Mean Square Error of Approximation-RMSEA and Relative Fit Index -RFI are considered by acceptable ranges in the literature (Akın & Çetin, 2007; Bentler & Bonett, 1980; Hoe, 2008; Hooper, Coughlan, & Mullen, 2008; Küçükturan, 2005; Marsh, Hau, Artelt, Baumert, & Peschar, 2006; Tosun & Irak, 2008). Results of the CFA of TPACKs-PPT (RMESA=.067, GFI=.92, AGFI=.89, NFI=.93, CFI=.96, RFI=.93) show that the model adjusts at acceptable level. Eight-factor structure obtained in EFA is supported by the results of CFA. Following standard solutions, t values between factors and items are reviewed and it is detected that all items are significant at the level of .05 (Jöreskog & Sörbom, 1996).

Findings on Reliability

In reliability study on TPACKs-PPT, Cronbach alpha coefficients for factors are found between .76 and .87. In addition, item-total correlations are calculated by using Pearson Product-Moment Correlation Coefficient.

Findings on Item Analysis of TPACKs-PPT

For item analysis of the scale, 27% top-bottom group comparisons are made and item-total correlation is conducted. Item total correlations are found between changing values of .42 and .74. independent samples t-test is performed to detect whether there is a significant difference between bottom 27% group and top 27% group. The fact that t values on the difference between average scores that bottom and top 27% groups of the sample for each item in TPACKs-PPT are between 9.51 (p< .001) and 22.11 (p< .001) reveals that the items of the scale are capable of recognizing at high level.

Discussion and Conclusion

The first EFA data reveal items and relationships between factors that are hard to explain. Having examined the first EFA results of Turkish scale which is not compatible with the factor structure of the original scale, it is understood that an eight-factor structure can be formed and the analysis is performed again.

Results of the last EFA are partly compatible with the findings obtained from the study on the original scale. While only four of the seven factors of the original scale maintain, the rest three factors are divided into four factors in this study. In addition

to the fact that there is no change in the number of items, newly emerged four factors being dependent on the content knowledge which is also supported with CFA results differ from the study of original scale. For example, related to the items of subject of science included in different factors of TPACK; CK (e.g. 14. I have sufficient knowledge about science.), PCK (e.g. 29. I know how to select effective teaching approaches to guide student thinking and learning in science.) and TCK items (e.g. 33. I know about technologies that I can use for understanding and doing science.) in the original scale fall under the same factor in Turkish scale. It is also case for social sciences, mathematics and literacy contents. Internal consistency implemented on TPACKs-PPT and results of item analysis and item-total correlation analysis reveal that values of the scale are over the levels determined statistically. Different structure of TPACKs-PPT detected in this study, can also be found in a different way in the study conducted on the same original scale by Koh, Chai, and Tsai (2010). In this study conducted in Singapore within Asian culture and teacher education system, the scale is reduced to 27 items consisting of different factors. In this current study, it is thought that the reason of the newly emerged four factors being dependent on the content in the scale results from the differences between USA and Turkish teacher training systems (Yükseköğretim Kurulu, 2008).

It is known that while the content knowledge in teacher education programs of the US are limited with main concepts and basic practices, these lessons are very intense in Turkish teacher training programs. Additionally, with regard to courses of pedagogy, it is remarkable that methods courses and especially practice oriented courses for content teaching in teacher education programs of the US are more in number and more intense compared to those of Turkey (Meriç & Tezcan, 2005). In the most of the teacher education programs in USA which is analyzed by National Council for Accreditations of Teacher Education it is known that pre-service teachers take full time practicing courses at least ten weeks and do not take any course during the this time (National Council on Teacher Quality, 2011). Also these practicum courses are designed based on national standards or criteria. For instance, mentors' competency, tasks of pre-services' teachers and structure of assessment exams for the practicum course are considered as a standard (National Council on Teacher Quality, 2011). These requirements immediately put into practice by universities in USA. For examples, in Oregon State University, desired changes by National Council for Accreditations of Teacher Education in 1995-1996 academic year put into practice beginning of the 1996-1997 academic year (Niess & Scholz, 1999).

In this scope, one of the rare views on which researchers agree in PCK/ TPACK literature is that PCK/TPACK of pre-service teachers will improve by means of significant practices to be performed in real classrooms (Kaya, 2009). Because the only environment in which in-service teachers and pre-service teachers can use and develop all sub-components of their PCK/TPACK simultaneously is classroom. We can say that the main reason of the conclusion of this study results from significant differences between teacher training systems of two countries. Although there are positive modifications in teacher education programs in Turkey, updating available programs are required based on the last scientific data and should be revision (Şimşek, 2005).

It is thought that another important reason for the different structure of TPACKs-PPT being dependent on the content knowledge is related to the structure and content of primary teacher education programs in which our pre-service teachers are trained. Having examined undergraduate program of primary teacher education (Yükseköğretim Kurulu, 2009), it can be seen that total 65 courses are divided into three categories; namely, content and content training, professional teaching knowledge and general pedagogy courses. Having examined the program in terms of theory and practice, it is clear that 25% of courses are practice oriented and 75% of them are theory oriented. Having analyzed primary teaching program in terms of TPACK framework, it can be seen that 28 courses in relation to CK (43%), 10 courses related to PK (15.4%), 2 courses related to TK (3%), 15 courses related to PCK (23%), 2 courses related to Contextual Knowledge (CxK) (3%) and 1 course related to TPK (1.5%) are included in this program and there is no course related to TCK. Included in the program, courses named School Experience and Teaching Practice I-II (4.5%) can be regarded as lessons that pre-service teachers can use and improve all knowledge types consisting of their TPACK simultaneously in classroom environment. In order to comprehend the different structure of TPACKs-PPT revealed in this study, it is necessary to analyze which course in relation to TPACK components is given in which academic semester. For example, it is very remarkable that within first four academic semester pre-service teachers take 26 of 28 CK courses and only 2 PK and 2 TK

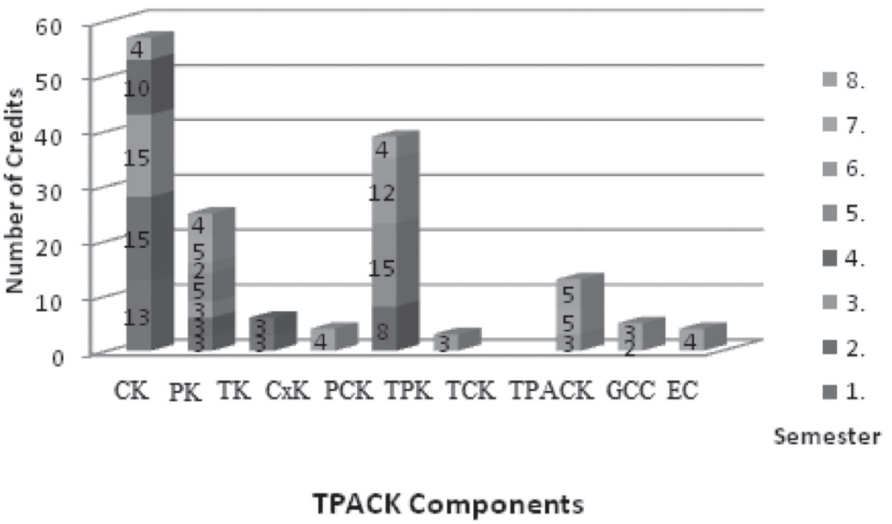

Figure 1.
Number of Credits of Courses in Primary Teacher Education Program in Terms of TPACK Framework

courses and they take PCK courses which are merge of pedagogy and content in 5th-7th semesters, especially after CK courses.

In such a program in which only 3 courses are included in terms of TK and TPK, pre-service teachers are expected to improve their own TPACK by blending the components of TPACK which they learn in different courses and periods of time for 4 years. In light of the results obtained from this study, current primary teaching program is analyzed with regard to TPACK framework in Figure 1 and 2. Consequently, it is thought that pre-service teachers which are impressed by CK courses for the first 2 years perceive that a ideal primary teacher should have a content knowledge and this perception reflects on the results of this study. In this scope, TPACK and its components should be discussed as complementary elements for each course rather than independent and competing ones in teacher training programs. For example, in order to ensure pre-service teachers to better understand the concepts of general chemistry; an instructor of general chemistry course should know the content, objective and gain of the course, consider learning difficulties of pre-service teachers in general chemistry topics and use the most suitable technologies (pH, CO_2 probe, temperature sensor, Excel, animation, simulations etc.), contemporary teaching methods and techniques (project based learning, argumentation, predict-explain-observe-explain etc.), evaluation tools (self, peer assessment, poster, concept map etc.) in his/her lesson and thus provide an example TPACK for pre-service teachers (Kaya, 2010).

In addition, another remarkable point is that data to be obtained with TPACKs-PPT is not TPACK of teachers or pre-service teachers. The data only reflect their perceived knowledge levels or self-confidence within TPACK. Another important point about TPACKs-PPT, the scale only focuses on general or content-specific TPACK in terms of each subject (science, math, social sciences and literacy) and thus cannot detect topic-specific TPACK (e.g. photosynthesis, fractions). In this scope, it is clear that in the literature, PCK/TPACK studies are conducted in a teaching process during which teachers teach certain topics or concepts (e.g. electricity) in a certain subject (e.g. science) to their students. For example, TPACK levels of the same teachers or pre-service teachers at the same subject vary in very close topics such ozone layer depletion, global warming and acid rain (Karakaya, 2012). For that reasons, results of the Likert scales which are not specific to a certain topic or concept can be highly controversial. Researchers, who want to examine the TPACK as knowledge that pre-service or in-service teachers have instead of their TPACK self-confidence or perceived knowledge

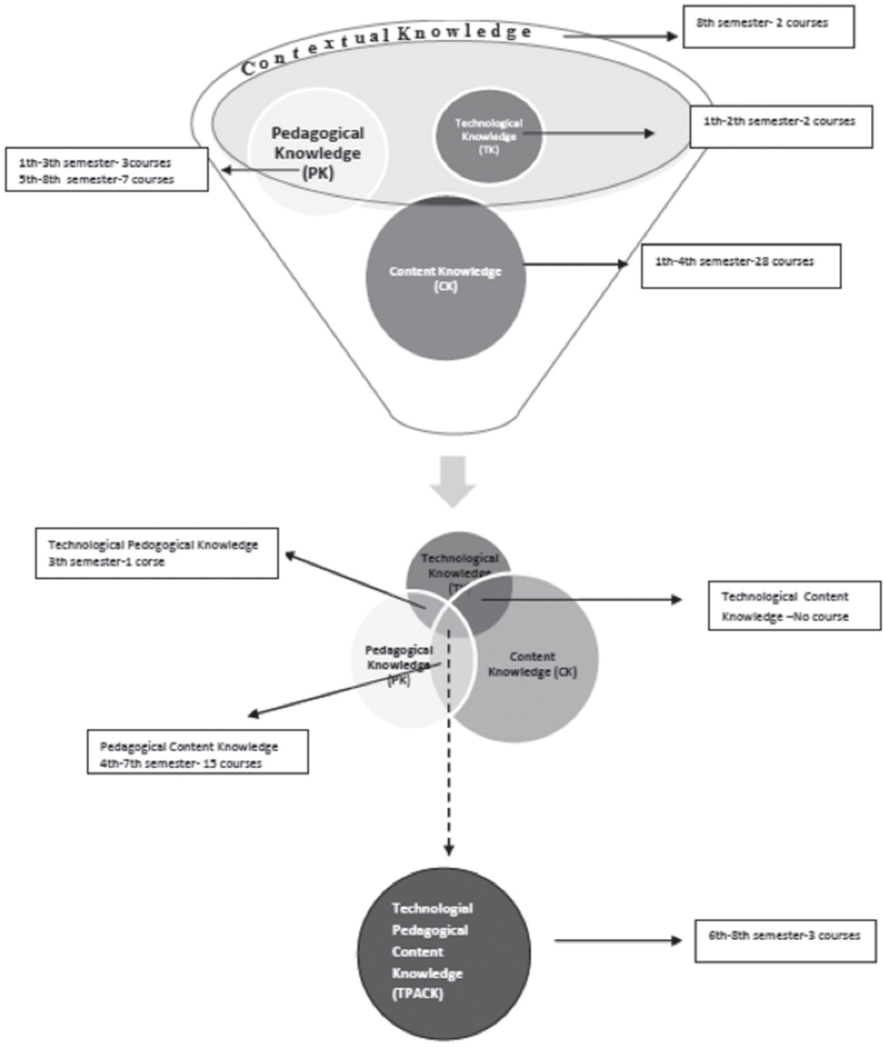

Figure 2.

Content Analysis of the Courses in Primary Teacher Education Program in terms of TPACK Framework

in any subject and topic, should use multiple data collection tools such as vignette, interview and lesson plan by considering the complex nature of PCK/TPACK (Kaya & Kaya, 2013). This study has concluded that the use of adapted TPACKs-PPT on academic studies related to TPACK of pre-service teachers in Turkey is not suitable and the perception of Turkish pre-service primary teachers about knowledge of an ideal or excellent teacher develops in a content-oriented way.

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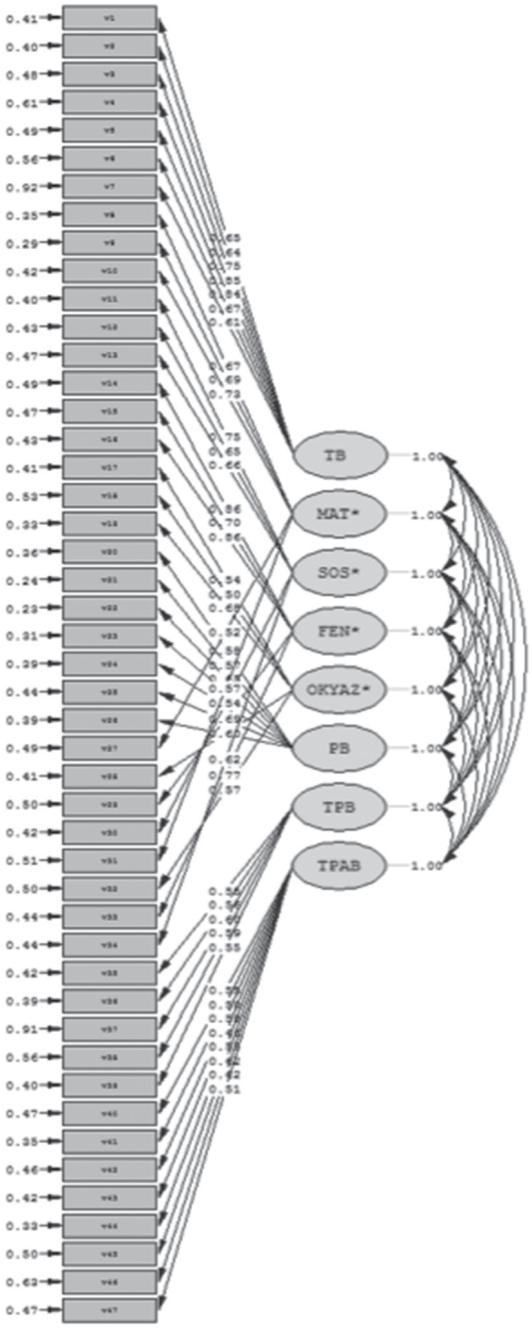

Ek 1.

SÖA-TPABÖ'nün DFA Sonuçları

* Fen, Matematik, Sosyal Bilgiler ve Okuma-Yazmaya İlişkin AB, PAB ve TAB anlamındadır.

Ek 2.

SÖA-TPABÖ Maddeleri İçin Toplam Madde Korelasyonu ve %27'lik Alt ve Üst Grupların t-tesi Sonuçları

Madde	Toplam Korelasyonu (N=407)	t (Alt %27-Üst%27) (N=220)	X	ss
24	.56	8,68*	3,61	0,96
			4,55	0,60
25	.56	11,82*	3,14	0,88
			4,34	0,59
26	.55	10,84*	3,38	0,90
			4,48	0,57
27	.58	9,78*	3,29	0,98
			4,42	0,71
28	.64	11,36*	3,35	0,97
			4,56	0,57
29	.56	15,07*	2,65	0,96
			4,34	0,67
30	.64	10,86*	3,21	0,94
			4,36	0,60
31	.57	14,94*	2,94	0,80
			4,43	0,67
32	.63	12,23*	3,18	0,90
			4,46	0,63
33	.62	13,42*	2,61	1,02
			4,21	0,72
34	.57	12,11*	2,97	0,94
			4,30	0,66
35	.52	11,96*	3,22	0,86
			4,45	0,66
36	.45	10,75*	3,34	0,90
			4,47	0,65
37	.56	9,14*	2,90	1,09
			4,16	0,95
38	.52	10,96*	3,05	1,07
			4,36	0,65
39	.57	10,48*	3,25	0,93
			4,38	0,64
40	.51	11,30*	3,14	0,89
			4,33	0,65
41	.61	10,26*	3,38	0,82
			4,38	0,61
42	.49	13,32*	2,83	0,83
			4,18	0,67
43	.59	9,91*	3,35	0,77
			4,34	0,69
44	.55	11,80*	3,38	0,81
			4,51	0,59
45	.57	10,33*	3,04	1,01
			4,26	0,73
46	.50	11,43*	2,88	1,06
			4,29	0,75
47	.74	9,08*	3,44	0,90
			4,41	0,67

Madde	Toplam Korelasyonu (N=407)	t (Alt %27-Üst%27) (N=220)	X	ss
1	.52	10,03*	3,10	1,00
			4,25	0,67
2	.48	8,91*	3,33	0,96
			4,35	0,74
3	.53	10,38*	2,85	1,01
			4,14	0,83
4	.48	11,19*	2,55	1,04
			4,02	0,90
5	.54	11,14*	2,53	1,00
			3,91	0,83
6	.43	11,84*	2,75	1,04
			4,14	0,64
7	.43	9,41*	2,55	1,11
			3,85	0,94
8	.48	7,50*	3,51	0,98
			4,37	0,70
9	.52	9,23*	3,39	0,91
			4,38	0,66
10	.48	11,68*	3,19	0,97
			4,49	0,65
11	.42	9,51*	3,04	1,04
			4,19	0,74
12	.42	8,57*	3,24	1,01
			4,25	0,71
13	.53	9,51*	3,08	0,95
			4,16	0,72
14	.59	11,83*	2,35	1,02
			3,88	0,91
15	.60	11,25*	2,69	0,99
			4,07	0,82
16	.48	12,68*	2,38	1,01
			3,99	0,86
17	.42	7,79*	3,52	0,91
			4,38	0,73
18	.55	7,46*	3,47	0,90
			4,29	0,72
19	.48	9,70*	3,36	0,95
			4,44	0,67
20	.54	10,25*	3,41	0,95
			4,51	0,60
21	.60	10,05*	3,67	0,83
			4,62	0,54
22	.53	10,63*	3,46	0,93
			4,56	0,57
23	.51	10,00*	3,46	0,91
			4,50	0,60

*p <0,001