TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE SELF ASSESSMENT SCALE (TPACK-SAS) FOR PRE-SERVICE TEACHERS: DEVELOPMENT, VALIDITY AND RELIABILITY

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ABSTRACT

TPACK has been a new issue of interest for the last decade. Koehler and Mishra (2005) suggested TPACK framework to address the knowledge needed for teachers to integrate technology in their classrooms. Self-reported scales are the most common measurement tools for TPACK. Surveys can inform about participants' beliefs, views, attitudes, and dispositions that are the most effective on their decisions related to teach with or without technology. Most of the TPACK surveys have lack about reliability and validity. In this study, a valid and reliable survey called TPACK Self Assessment Scale (TPACK-SAS) was developed to identify pre-service teachers' self-perceptions and self-assesments of their TPACK. The steps (item pool, expert review, item performance analyses, validity, reliability and factor analyses) suggested by DeVellis (2003) were followed in the scale development process. TPACK-SAS was administered to 754 preservice teachers. After the analyses process, it consisted of seven subdomains, similar with the original framework, and 67 items. Pre-service teachers were also asked whether they have their own computers or not, where they access internet, amount of time they spend using computers, proficiency of using computers and their intentions to use computers. The relationships between these variables and TPACK subdomain were investigated.

Keywords: Technological pedagogical content knowledge (TPACK), survey, pre-service teachers

ÖĞRETMEN ADAYLARI İÇİN TEKNOLOJİK PEDAGOJİK ALAN BİLGİSİ ÖZ DEĞERLENDİRME ÖLÇEĞİ (TPAB-ÖDÖ): GELİŞTİRİLMESİ, GEÇERLİK VE GÜVENİRLİK ÇALIŞMALARI

ÖZ

TPAB son on yıldır var olan yeni bir kavramdır. Koehler ve Mishra (2005) TPAB'ı öğretmenlerin sınıflarına teknolojiyi entegre edebilmeleri için ihtiyaçları olan bilgi olarak tanımlamıştır. En yaygın olarak kullanılan TPAB ölçme araçları öz bildirim ölçekleridir. Ölçekler katılımcıların teknoloji ile öğretim yapıp yapmayacaklarına dair kararları üzerinde en fazla etkisi olan inanç, fikir, tutum ve eğilimleri hakkında bilgi vermektedir. TPAB ölçeklerinin çoğu geçerlik ve güvenirlik çalışmaları konusunda eksiktir. Bu çalışmada, öğretmen adaylarının TPAB düzeylerine dair öz algı ve öz değerlendirmelerini belirlemek amacıyla bir ölçek (TPAB-ÖDÖ) geliştirilmiştir. Ölçeğin geliştirilmesi sürecinde DeVellis (2003) tarafından önerilen adımlar (örn. madde havuzu, uzman görüşü, madde performansı analizleri, geçerlik, güvenirlik, faktör analizi…) takip edilmiştir. TPAB-ÖDÖ 754 öğretmen adayına uygulanmıştır. Analizler sonucunda ölçek modelin orjinaliyle uyumlu olarak yedi boyut ve 67 maddeden oluşmaktadır. Ayrıca öğretmen adaylarına kendi bilgisayarlarına sahip olup olmadıkları, internete erişim yerleri, bilgisayar kullanma süreleri ve yeterlikleri ile bilgisayarı kullanma amaçları sorulmuştur. Bu değişkenler ile TPAB alt boyutu arasındaki ilişkiler incelenmiştir.

Anahtar kelimeler: Teknolojik pedagojik alan bilgisi (TPAB), ölçek, öğretmen adayları

1. INTRODUCTION

Students can improve their critical thinking (Bingimlas, 2009), high-order thinking and metacognitive skills required for meaningful learning (Wang, Kinzie, McGuire & Pan, 2010) with the help of technolgy. It also affects scores, self-conception, motivation, learning efficacy, curiosity and creativity of students (Hew & Brush, 2007; Liu, Tsai & Huang, 2015). It is suggested that easy and low-priced availability of technology for young people would balance disparities, improve learning chances, and cause to academic and career success (Shank & Cotten, 2014). As a result of these, technology has indisputably become an integral part of education.

In the 21st century children come to school knowing how to use almost all of the technological tools. Prensky (2001) called children who have more experiences about information communication technology (ICT) than their teachers as digital natives. At this point we meet the main problem. How can a teacher who did not have enough experience in a technology-rich environment to teach with technology to digital natives? Countries such as USA (Ringstaff, Yocam & Marsh, 1996; Tondeur, Van Braak, Sang, Voogt, Fisser & Ottenbreit-Leftwich, 2012), Cyprus (Eteokleous, 2008), Singapore (Hew & Brush, 2007) and Turkey (Ministry of National Education [MNE], 2013) have changed their educational policies and developed some projects to integrate technology in learning environments. Researches showed that teachers did not use technology at an expected level for their teaching even if they had enough opportunity (Chen, 2010; Dawson, 2008; Liu et al., 2015; Rehmat & Bailey, 2014; Tondeur et al., 2012). Because most of them have not got technology-integrated learning experience as present day (Niess, 2008; Thompson, Boyd, Clark, Colbert, Guan, Harris & Kelly, 2008) and so lack in skills and knowledge about technology integration (Inan & Lowther, 2010). Use of technology in teacher education has been primarily focused on learning about different technologies (Mishra, Koehler & Kereluik, 2009; Thompson et. al., 2008). But it has been seen that having a strong technological knowledge is not enough for technology integration (Ertmer & Ottenbreit-Leftwich, 2010; Koehler, Mishra & Yahya, 2007; Lee & Lee, 2014). Alhashem and Al-jafar (2015) asked science teachers why they used technological tools, but teachers failed to relate technology with pedagogy and students' learning. This issue made education community to reflect upon how to overcome this problem. To guide successful technology integration, ISTE (2008) developed standards for teachers, students and administers. According to these standards, teachers should *facilitate and inspire student learning and creativity; design and develop digital age learning experiences and assessments; model digital age work and learning; promote and model digital citizenship and responsibility and engage in professional growth and leadership* (ISTE, 2008). Mishra and Koehler (2006) proposed a framework called Technological Pedagogical Content Knowledge (TPACK) that refers to knowledge of teachers to be able to integrate technology effectively in their teaching practices. This study aims to develop a valiable and reliable TPACK survey to measure pre-service teachers' perceptions about use of technology in teaching.

1.1. LITERATURE REVIEW

1.1.1. Technological Pedagogical Content Knowledge (TPACK)

To prepare pre-service teachers (PSTs) with skills and knowledge needed to use technology in an effective, flexible and productive way, teacher educators should provide PSTs the opportunity to learn to teach with technology, and consider learning to teach as a ''constructive and iterative'' process where they must interpret ''events on the basis of existing knowledge, beliefs, and dispositions'' (Borko & Putnam, 1996, p. 674). Koehler and Mishra (2008) defined teaching with technoloy as a wicked problem which has incomplete, contradictory and changing requirements (Rittel & Webber, 1973). They suggested that regarding these problems as "normal" is a big mistake, and it is so difficult to solve them in traditional ways. Therefore, it is necessary to develop new ways of overcoming the problem of teaching with technology. The problem in teaching with technology is to decide, select and use the most useful and appropraite subject-specific technologies for students.

Within this context, Mishra and Koehler (2006) outlined TPACK as a framework for teacher knowledge to integrate technology. TPACK is the integration of knowledge of subject matter, technology and teaching-learning (Niess, 2005). TPACK framework has three main components; knowledge of pedagogy, technology and content. But the dynamic, complex relationships and interplays between these domains are more important. The framework has seven subdomains called content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK) (Figure 1).

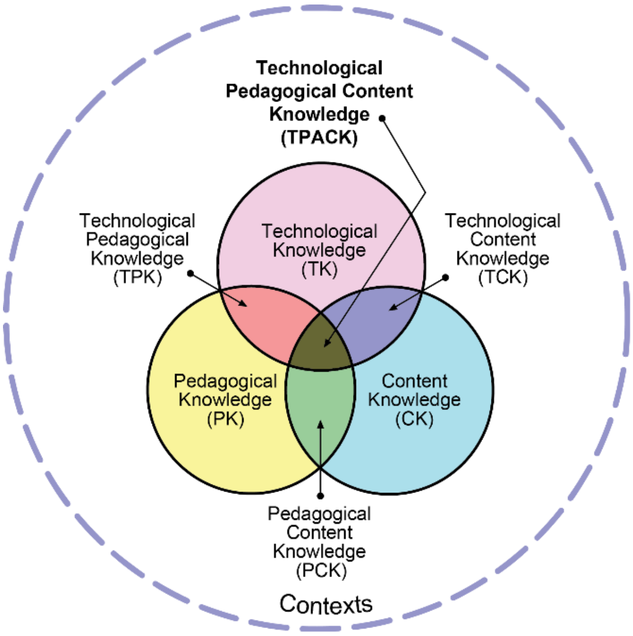

Figure 1. Components of the TPACK Framework (Mishra & Koehler, 2006)

The subdomains mentioned above can be explained as follows:

Content Knowledge (CK) is the knowledge about subject matter that is taught such as science, history or mathematics. Content knowledge varies according to both level and subject matter. It is important that teachers need to have a deeper understanding about the facts, conceptions, theories, and ideas of the disicpline in which they teach (Koehler & Mishra, 2008). Otherwise, lack of this knowledge may lead students receive incorrect information and develop misconceptions about the content (National Research Council [NRC], 2000).

Pedagogical Knowledge (PK) is the knowledge related with teaching processes and practices. It includes classroom management, student evaluation, student learning, lesson plan development and implementation and methods for these (Koehler & Misha, 2008). Pedagogical knowledge is important because a teacher with strong pedagogical knowledge knows how students learn and construct knowledge and then he/she can organize his/her teaching according to students.

To specify *Technological Knowledge (TK)* is difficult because of its rapid rate of changes. Technological knowledge provides people opportunities to utilize itself for completing a given task and reaching goals.

Pedagogical Content Knowledge (PCK) is consistent with and similar to Shulman's idea of pedagogical content knowledge (Koehler & Mishra, 2008). When considering the relationship between pedagogy and content, the main focus should be on how disicplines differ from each other and whether different disicplines can be taught with the same instructional strategies (Mishra & Koehler, 2008). PCK is an understanding in which teachers interpret the topics, present it in different ways, and adopt instructional materials to alternetive conceptions and students' pre-existing knowledge.

Technological Content Knowledge (TCK) is an understanding of the manner in which technology and content influence and constraint one another (Koehler & Mishra, 2008). Technology and content affect each other. The choice of which technology can be used affects the presentation of content. But, technology can provide flexibility in navigating across these representations (Koehler & Mishra, 2008). With this flexibility, the teacher can help students decide which the best presentation for their learning is. Thus teacher can reach most of the students' learning styles and provide as much students as possible to learn. On the other hand, content constrains the type of technology that can be used. Teachers do not need only subject matter knowledge, instead they should be aware of these interplay and use in their disicplines.

Technological Pedagogical Knowledge (TPK) requires understanding how learnig and teaching changes when particular technologies are used. The choice and usage of the technology can influence the replacement of the students and teacher in the classroom, student-teacher interaction and the one who is more active: students or teacher. TPK is important because it gives teachers an ability to repurpose technological tools for education. TPK requires a forward-looking, creative, and open-minded seeking of technology to advance student learning (Koehler & Mishra, 2008).

Lastly, Koehler and Mishra (2008) have identified *Technological Pedagogical Content Knowledge (TPACK)* as follow:

> "TPACK is an understanding that emerges from an *interaction* of content, pedagogy and technology. TPACK requires an understanding of the representation of the conceptions using technologies; pedagogical techniques that use technology in constructive ways to teach content; knowledge of what makes conceptions difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students'prior knowledge and theories epistemology; and knowledge of how Technologies can be used to build on existing knowledge and to develop new epistemologies or stregthen old ones "(p. 18).

It is important to note that TPACK is not only for newer technologies, but also for all previous technologies. Effective technology integration for teaching subject matter requires knowledge not just of content, technology and pedagogy, but also of their relationships between them (Koehler et al., 2007). The interaction and intersection between technology, pedagogy and content and the dynamic relationships between these components have a great importance on successful technology integration. The main goal of the teacher educators should be helping PSTs realize, comment and utilize these relationships.

1.1.2. Measurement of TPACK

It is necessary to measure and assess TPACK considering its components to better understand whether professional development programs are effective on the TPACK development or not (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009). PSTs should have a well-supported understanding in each individual domain for the development of TPACK (Koehler & Misha, 2008). This can be a starting point for educators about what to do for PSTs' TPACK development. They can examine PSTs' knowledge in all domains and the relationships between these domains. According to the results the researchers can plan, organize and apply education programs that will encourage PSTs to use technology in their future teaching. Therefore, the measurement of TPACK is crucial. To examine the TPACK framework, researchers need to develop instruments. Researchers have used self-report measures, open-ended questions, performance assessments, interviews or observationa for measurement of TPACK (Koehler, Mishra, Kereluik, Shin & Graham, 2014; Voogt, Fisser, Roblin, Tondeur & Van Braak, 2013). But there is a lack about reliability and validity in most of these assessment tools (Abbitt, 2011).

One of the most common used assessment tools is self-report instruments, but less than half provided clear reliability and validity (Koehler et al., 2011). TPACK surveys can inform us about pre-service or in-service teachers' perceptions and TPACK development. Teachers' ideas, beliefs, knowledge, histories and personalities have strong effects on their teaching with or without technology (Koehler & Mishra, 2008). Ertmer, Ottenbreit-

Leftwich and York (2006) suggested that beliefs, confidence and commitments of teachers about technology are stronger than time, support, and access to technology in affecting teachers' use of technology. The main factor that affects use of technology is teachers' perceptions about technology (Schmidt & Gurbo, 2008). Therefore, self-report measures such as surveys can provide us to see their beliefs and views about technology, examine their development of TPACK, and it may be examined whether the survey scores predict how they will behave when integrating technology in clasrooms. In the Table 1, some TPACK surveys from literature and their structural properties are given present a comprehensive picture and most of them are referred in detail in the next section.

1.1.3. TPACK Surveys

The first TPACK survey was developed by Koehler and Mishra (2005). In their study, 4 faculty members and 14 students worked together in small groups to develop online courses that will be taught following year. Participants completed an online survey four times during semestr. Survey included 35 items; 33 of them were 7-point Likert Scale and 2 were quesions with short answer in which they are asked to write a paragraph about their roles in groups and functions of their groups' in the design course. At first, participants showed that they have seen pedagogy, content and technology knowledge as independent, but during the course they developed a deeeper understanding about complex relationships between these domains of knowledge.

The survey that Koehler and Mishra (2005) developed was specific to design course in their study, so it is difficult to generalize it to other programs or content areas (Schmidt et al., 2009). Therefore Schmidt et al. (2009) proposed to develop a reliable and valid survey to measure PSTs' understandings about each component of the TPACK framework. Survey was developed to represent PSTs' self assessment of TPACK. Survey included 75 questions which are 5-point Likert Type, demographic questions and questions about PK–6 teacher models of TPACK. After the measurement of reliability and validity 28 items removed from survey. At last they examined the relationships of TPACK components and found that the highest correlation was observed between TPK and TPACK. They stated their sample size was small to perform factor analyses.

Archambault and Crippen (2009) revised a survey which had been developed earlier by these researchers to measure the TPACK levels of K-12 online teachers. In the previous study (Archambault & Crippen, 2006) they wrote three to five items for each domains of TPACK based on definitions of Koehler and Mishra (2005) and Shulman (1986). For the plot study they applied a different method from other survey studies. They asked 6 online teachers to read the items aloud and explain what they understood. The main purpose was to ensure that survey questions were being understood in the same manner and to gather suggested changes that would make specific items clearer and easier to understand (p. 76).

Koh, Chai and Tsai (2010) examined the profile of Singaporean PSTs in terms of their technological pedagogical content knowledge. 1185 PSTs were studied with a TPACK survey. The survey was composed of 29 items. Seven-point Likert-type scale was used in this study. In addition to TPACK items, they also collected information about

PSTs' gender, age and teaching level (i.e. primary or secondary). An exploratory factor analysis found five distinctive constructs: *technological knowledge, content knowledge, knowledge of pedagogy, knowledge of teaching with technology* and *knowledge from critical reflection*. The participants of this study did not make conceptual distinctions between TPACK constructs such as technological content knowledge and technological pedagogical knowledge. In this study, it is seen that TK and CK are the only distinctive domains within PSTs' perceptions. KP, KTT and KCR were the other sources of their perceptions. While PK, PCK, TPK, TCK and TPACK were postulated to be distinct constructs, these have not been perceived like this by the participants of this study. TPACK perceptions were not strongly related to age, gender or teaching level. Even there was a negative correlation between age and TPACK.

Sahin (2011) developed a 47-item TPACK survey. First, a pool of 60 items is formed and reduced to 47 items after expert evaluation. Validity and reliability studies of the survey are conducted with 348 (44.5% female; 55.5% male) PSTs. The discriminant validity study of the TPACK survey is conducted with 205 (46.4% female; 53.6% male) PSTs. Test-retest reliability analysis is conducted with 76 (44.8% female; 55.2% male) PSTs.

Chai, Koh, Tsai and Tan (2011) developed a TPACK survey to examine what factors of TPACK are perceived by Singapore PSTs and how these factors related before and after the ICT course. At first they used 28 items from Schmidt et al.'s (2009) survey inluding six componentst of TPACK (TK, CK, PCK, TPK, TCK, and TPACK). They created 13 items related with "meaningful learning"-the framework they used in their ICT courses; and labeled these items as Pedagogical Knowledge of Meaningful Learning. They replaced PK items of Schmidt et al. (2009) with these items. Finally the researchers added 5 web-based items to TK and developed a 46-item survey. This survey was administered to 834 pre-servise primary school teachers by e-mail both at the begining and end of the ICT course. After EFA, five factors except PCK and TCK have been found.

Yurdakul, Odabasi, Kilicer, Coklar, Birinci and Kurt (2012) developed a survey based on the central component of TPACK framework. They created the item pool with the opinions of expert who studied about educational technology. The validity and reliability studies of the scale were carried out with 995 Turkish PSTs. The sample was split into two subsamples on random basis (n_1=498, n_2=497). The first sample was used for Exploratory Factor Analysis (EFA) and the second sample for Confirmatory Factor Analysis (CFA). After the EFA, the TPACK-deep scale included 33 items and had four factors named *design, exertion, ethics and proficiency.*

Table 1. TPACK Surveys And Their Structural Properties

Researchers	Number of Items	Validity	Participants	Reliability	Statistics	Number of Factor
Koehler and Mishra (2005)	35 (33 of items were 7-point Likert scale and 2 questions were short answer)	-	13 of participants are masters students and 4 of them are faculty members (17)	Cohen's alpha, p-values, holm procedure	t-test for 33 items	7
Schmidt et al. (2009)	47 (5-point Likert scale)	Expert evaluation	PSTs (121)	Cronbach's alpha, kaiser normalization	EFA, pearson product-moment correlations	7
Graham, Burgoyne, Cantrell, Smith, Clair and Harris (2009)	31 items and 2 open-ended questions	-	In-service teachers (15)	Cronbach's alpha	t-test, effect size	4
Archambault and Crippen (2009)	24 (5 point Likert scale)	Think aloud	K-12 online teachers (596)	-	-	-
Koh et al. (2010)	29 (5-point Likert scale)	Expert evaluation	PSTs (1185)	Cronbach's alpha	EFA, pearson correlation, t-tests	5
Lee and Tsai (2010)	30 (6-point Likert scale)	Expert evaluation	In-service teachers (558)	Cronbach's alpha	EFA, CFA	5
Sahin (2011)	47	Expert evaluation	PSTs (348)	Cronbach's alpha, criterion-related validity, item-total correlations, test-retest	EFA, kaiser-meyer-olkin, bartlett's test of sphericity	7
Yurdakul et al. (2012)	36 (5-point Likert scale)	Expert evaluation	PSTs (995)	Cronbach's alpha, test-retest	EFA, CFA	4
Yeh, Hsu, Wu, Hwang and Lin (2014)	22 (5-point Likert scale)	Expert evaluation	15 of participants are college faculty and 39 of them are science teachers (54)	-	Kruskal–wallis test	-
Ay, Karadag and Acat (2015) (adapted TPACK-Practical Model Scale developed by Yeh et al., 2014)	22 (5-point Likert scale)	Expert evaluation	In-service teachers (296)	Cronbach's alpha	Item-total correlation, item-test correlation, item discrimination, CFA, correlation and t-test	-
Saengbanchong, Wiratchai and Bowarnkitiwong (2014)	180 (5-point Likert scale)	-	PSTs (135)	Cronbach's alpha	CFA	15

1.2. THE CONTEXT: TEACHER PREPARATION PROGRAMS IN TURKEY

As known, Koehler and Mishra (2005) introduced TPACK framework with seven components-PK, CK, TK, TPK, TCK, PCK, and TPACK. But recent researches have showed that it is difficult to distinguish these seven components (Archambault & Barnett, 2010; Chai et al., 2011; Koh et al., 2010; Lee & Tsai, 2010; Shinas, Yılmaz-Ozden, Mouza, Karchmer-Klein &, Glutting, 2013). Almost all of these surveys have found different distinct domains from each other. This may be due to different samples and different teacher education programs and their features. This case refers to importance of context. Kelly (2008) indicated the components of TPACK context as *School philosophy and expectations; Demographic characteristics of students and teacher; Teacher knowledge, skills and disposition; Cognitive, experimental, physical, psychological, social characteristics of students and teacher; Physical features of the classroom.* As seen, components of context are classifed as physical, cognitive, linguistic, social, physchological and cultural. TPACK can help teachers to provide differentiated experiences and activities according to students' needs and learning styles. This can provide teachers to teach so many students (Thompson et al., 2008). Here we think referring to Turkish context of teacher preparation programs is essential and crucial. Because it might give a comprehensive insight into results and provide detailed information about participants. We examined the Turkish context according to components mentioned above by Kelly (2008).

School philosophy and expectations: Faculties of Education are supervised by the Council of Higher Education (CoHE) in Turkey. CoHE stated some qualifications for higher education in 2010. According to these qualificaions related with teacher preparation programs, teachers should be prepared in the manner that they can have knowledge, skills, values and competences required for future; be aware of their roles related with changing conditions; see the national priorities in education and connect theory with practice in educational sciences (CoHE, 2015). To accomplish these goals, it is an indisputable fact that technology and its applications in education are necessary.

Demographic characteristics of students and teacher: Especially girls usually prefer to Faculty of Education in Turkey. According to statistics about total student numbers in 2014-2015 in Faculties of Education, it is seen that the number of girls are more than the number of boys (CoHE, 2015). Students usually come from countryside and middle income families. The Faculty of Education, in which this study was carried out, has about a forty-year history. Almost all of the faculty members have not learned their content areas with technology and it is assumed that this would affect their technology utilizations.

Teacher knowledge, skills and disposition: Researches about teachers (MNE, 2014) and faculty members (Sadi, Sekerci, Kurban, Topu, Demirel, Tosun, Demirci & Goktas, 2012) show that a great majority of them felt themselves uncomfortable about using technology. Only 44% of teacher educators stated that they used technological tools in their courses (Karakutuk, Tunc, Ozden & Bulbul, 2008). The main reasons about why they do not use technology effectively are lack of time and equipment and unappropriate classroom environments (Sadi et al., 2008).

Physical features of the classroom: There are approximately 40-50 PSTs in a class and classrooms are big enough. The place of the instructor is front of the class and PSTs sit right across the instructor along parallel desks. Each department has at least one class with a great number of materials, and artifacts. Most of the classrooms have interacitve whiteboards, but to be honest, they have been used mostly just for presentations, searching the web or watching videos.

There is a gap about the relationships between TPACK levels and demographic variables of participants. This study addresses this gap taking the context into account. One of the most important points in the survey is to investigate PSTs' intentions to use computer and relate these to their TPACK levels. Also the item pool is created after a detailed literature review and the validity and reliability is provided meticulously. For the reasons mentioned, this study is expected to make a significant contribution to the educational society.

2. METHODOLOGY

In this study Technological Pedagogical Content Knowledge Self-Assessment Scale (TPACK-SAS) was developed to determine the perceptions of PSTs about TPACK. DeVellis (2003) suggested 8 steps as a guideline for scale developers. These steps are; *(i) determine clearly what it is you want to measure, (ii) generate an item pool, (iii) determine the format for measure, (iv) have the initial item pool reviewed by experts, (v) consider inclusion of validation items, (vi) administer items to a development sample, (vii) evaluate the items,* and *(viii) optimize scale length.* These are followed step-by-step.

Step 1: Determine clearly what it is you want to measure

DeVellis (2003) emphasized that determining the construct desired to be measured is the most essential thing for scale developers. In determining what to measure, a theory and specification can be considered to contributors to achieve this purpose. Limits of the phenomena should be recognized so that dragging the scale content to undesired domains may be hindered. Theory is a great assistant for clarity. In essence, at least a temporary theory should be identified serving as a guide in developing scale. This process may be as easy as well-structured definition of the measurement phenomena. Giving a definition about how the new structure is related with existing phenomena and its processes may be better.

In this study, the construct desired to be measured is TPACK. The TPACK framework suggested by Koehler and Mishra (2005) is the reference point for this study. As known, Koehler and Mishra (2005) proposed TPACK framework as the knowledge of teachers needed to integrate technology effectively in their teaching. TPACK consists of seven subdomains (TK, PK, CK, TPK, TCK, PCK, and TPACK) and the formulations and indicators of each subdomain are present in the literature. TPACK is a new conception for educational society. The models and approaches about TPACK has been increasing day by day (Angeli & Valanides, 2009; Niess, 2013). These enable understanding TPACK in a better way. Most of the self-reported measures developed for TPACK were investigated to get a more comprehensive perception in this study. Because conceptualizing the phenomena is essential for measurement.

Step 2: Generate an item pool

After determining the purpose of the scale, researchers become ready for the next step: generating an item pool. What is indented with the scale should guide this step. DeVellis (2003) addressed the important points that should be taken into consideration as *choosing items that reflect the scale's purpose, redundancy, number of items, beginning the process of writing items, characteristics of good and bad items, positively and negatively worded items*, and *conclusion.* To have a good set of items theoretically, it is required to select items randomly from the universe related with the construct of measurement. When selecting items, it should not be thought that redundancy is a bad thing. Scale developers try to capture the construct of interest by using a set of items that are related with construct in different ways. As it is understood from all of these, it is nearly impossible to specify the number of items. Having a large number of items would support internal consistency (reliability). The more items developers have the better results they find.

Researches generated an initial item pool reviewing the literature about measurement of TPACK (Koehler & Mishra, 2005; Schmidt et al., 2009; Archambault & Crippen, 2009; Archambault & Barnett, 2010; Koh et al., 2010; Lee & Tsai, 2010; Lux, 2010; Chai et al., 2011; Sahin, 2011; Yurdakul et al., 2012). Then some items for subdomains were written by researchers based on the definitions of Koehler and Mishra (2005). At the beginning, items were written quickly and without critique, after this stage it was elaborated that written items reflect the construct and the extent to which they are clear.

In the initial item pool, there were some similar items. Because expressing an idea in different ways with the aid of redundancy allow the developers compare the items and state a choice. Because of correlation between items could not be known before implementation, having in item pool with a great number of items is a precaution to increase the internal consistency (DeVellis, 2003). As there are many items in the item pool so researchers can be careful in selecting items. But it should not be forgotten that items with a high length may lead to complexity. Taking the relation of items with TPACK, the length and clarity of items into consideration, 140 items [CK (15), PK (31), TK (22), TCK (11), TPK (21), PCK (24), and TPACK (16)] included in the initial item pool. Researches made the first evaluation of items; they read the items individually and then come together and discussed their views about items. The aim of this stage is to evaluate each of the items in terms of their meaningfulness and relevance. Items that all of the researchers thought they should be in the scale were included and 119 items [CK (13), PK (24), TK (21), TCK (10), TPK (16), PCK (21), AND TPACK (14)] remained in the item pool. Negative items were not included in the TPACK-SAS. DeVellis (2003) stated that reversals in the items polarity may be confusing if participants are administered a long scale. In such a case, participants may be undecided about the difference between agreement degree and expressing the power of construct of measurement.

Step 3: Determine the format for measurement

While generating the items researchers should consider the format for scale. Determining the format earlier can avoid waste of time. In this step the key components are addressed by DeVellis (2003) as such; *thurstone* *scaling, guttman scaling, scales with equally weighted items, optimum number of response categories, and specific types of response formats.* DeVellis (2003) addressed an important point as follows: "The selection of items to represent equal intervals across items would result in highly desirable measurement properties because scores would be amenable to mathematical procedures based on interval scaling (p.72)." Variability is another requested feature for scales. To provide variability, there are two ways; having lots of scale items and numerous response options. The number of response options is related with respondents' ability to discriminate meaningfully (and this depends on the specific wording or physical placement of options) and the investigator's ability and willingness to record a large number of values. Another issue is that whether having an odd or even number of response option is better. Odd number provides neutrality for respondents, as well as even number forces respondents to make a preference. Likert scaling is commonly used in instruments that aimed to measure opinions, beliefs and attitudes (DeVellis, 2003) and the reasons that they are chosen for are their ease of use and more reliable results they gave than other methods (Edvvards & Kenny, 1967).

The researchers aimed to identify the self-perception of PSTs regarding TPACK. It is important to consider that PSTs have limited teaching experience and they would get out of their beliefs and predictions about their future teaching. Therefore, they feel indecisive in answering some items. Forcing them to make a preference whether they agree or disagree with the item may lead to incorrect and insincere answers. To avoid this, Likert items with odd number for response option were chosen. Some surveys used 5-point Likert Type scales (Archambault & Barnett, 2010; Schmidt et al., 2009) while some others used 7-point Likert type (Koh et al., 2010; Koehler & Mishra, 2005). Weng (2004) suggested that using 6 or 7 point Likert type item can provide consistent and reliable results if participants' cognitive abilities are about college level. Based on this suggestion, responses were given in the form of 7 point Likert type (1=I strongly disagree, 7= I strongly agree).

Step 4: Have the initial item pool reviewed by experts

Asking knowledgeable people to review item pool help developers ensure content validity. This may be provided by asking experts to rate items the extent to which they are relevant with the construct of measurement. Getting opinions of experts is especially useful if developers attempt to measure separate scales. Another issue that developers have to consider is evaluating items' clarity and conciseness. Developers can also want experts to declare for each item if they see something incorrect or unnecessary in the items. As researchers develop items carefully so experts have less trouble in deciding which items correspond with construct (DeVellis, 2003).

119 items were reviewed by three experts who studied about TPACK and two of them developed TPACK survey. Three options ("match with construct", "not match with construct", and "should be modified") were presented to experts for each item and they were asked for their comments about clarity and briefness of items (Miles & Huberman, 1994). The items which all of the experts thought that did not match with the construct were omitted from scale and which experts thought that should be modified were reconsidered and

enhanced due to experts' feedbacks. After expert reviews the scale consisted of 96 items [CK (9), PK (21), TK (17), TCK (9), TPK (12), PCK (16), TPACK (12)].

Step 5: Consider inclusion of validation items

Developers may choose items that determine the flaws or problems. It is suggested that incorporating validation of items in this step may avoid spending extra time for this after constituting the final scale (DeVellis, 2003). Developers should decide which construct-related and validity items they include in their scales. While expert review provides content validity, construct validity can be ensured with think aloud strategy in which participants read, think and answer the items loudly (Bowles, 2010; Ericsson & Simon, 1998; Miller & Brewer, 2003; Ruane, 2005; Dillman, 2011). For this purpose, Four PSTs from each grade level in teacher preparation program were chosen. They were asked to read scale items and think about them loudly and expressed what they understood from items in just the same way as Archambault and Crippen (2009). These think aloud interviews were video and audio recorded to transcript word by word (Creswell, 2005; 2014; Patton, 1990). The aim is to be sure that items are understood in the same way with this strategy. Also PSTs' comments are considered to make items clearer and more understandable. Within the frame of feedbacks of PSTs, essential structural and linguistic adjustments were made on seven items.

Step 6: Administer items to a development sample

Developers need a large primary sampling to administer the scale. Although sample size plays an important role in representing the population, it is difficult to find consensus about the sample size. DeVellis (2003) stated that sample should be large enough to focus on the efficacy of items and to remove participant variance. Regardless the sample size, there is a risk about nonrepresentativeness of the population. One of the reasons of this case is that the sample may not have same characteristics with population.

96 items in the scale were administered to a sample of 754 PSTs (34% male, 66% female). The participants are juniors and seniors from different departments in a teacher preparation program in a middle Anatolian university. Random sampling was used because it is the best and valid way in having a representative sample. It can be accepted as sample represents the population qualitatively in respect to faculty education they receive, instructional opportunities provided for them, socio-economic levels of PSTs. Also, sample size is big enough to represent the population quantitatively (Cohen, Manion & Morrison, 2007; DeVellis, 2003).

Step 7: Evaluate the items

After developing the item pool, examining them clearly and administering it to an appropriate sample, it is time to move on the next step. The key points researchers should consider in this step are; *initial examination of items' performance (item-scale correlation, item variance, item means), factor analysis, and coefficient alpha.* The first quality required for a set of items is that they should have a high intercorrelation among themselves. The higher correlation means higher reliability of individual items. Highly intercorrelated items require that each individual item needs to correlate significantly with the remaining items.

Statistical Package for the Social Sciences (SPSS) was used in analyzing data. Participants' responses were examined one by one for each item and the null ones were omitted from data set. Validity and reliability studies were performed step-by-step. The 27% of who had the highest scores (n_1=204) constituted *higher group* and the 27% of who had the lowest scores (n_2=204) constituted *lower group*. The significance of differences between higher and lower groups for each item was tested with t-test and Pearson moment product was used to calculate the item-total correlation (Tabachnick & Fidell, 2013).

Exploratory Factor Analyses (EFA) with SPSS and Confirmatory Factor Analyses (CFA) with LİSREL were utilized for construct validity. Factor Analyses aims to get a few unrelated and new factors, gathering lots of variables related with each other (Field, 2009; Tabachnick & Fidell, 2013). A sample of 300 is assumed as acceptable to get reliable factors (Comrey & Lee 1992; Field, 2009; Kline, 1994; Nunnally, 1978; Tabachnick & Fidell, 2013). The sample of this study is large enough for factor analysis. Before starting EFA, the appropriateness of data set for factor analyses was examined with (1) sample size and missing data, (2) normality, (3) linearity, (4) Kaiser-Meyer-Olkin and Barlett's test of sphericity, (5) outliers, (6) multicollinearity and singularity, (7) factorability of R (Tabachnick & Fidell, 2013). Descriptive measures of overall model fit and descriptive measures based on model comparisons were used in CFA for model-data fit (Brown, 2015; Chermelleh-Engel & Moosbrugger, 2003; Jöreskog & Sörbom, 1993) and Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Root Mean Squares Residuals (RMR), Normed Fit Index (NFI), Nonnormed Fit Index (NNFI), Comparative Fit Index (CFI), Goodness of Fit (GFI), Adjusted Goodness of Fit-Index (AGFI) were calculated.

Step 8: Optimize scale length

The extent of covariation among items and the number of items have an effect on a scale's reliability. Shorter scales are good because they lay a less burden on participants. On the other hand longer scales tend to be more reliable in accordance with shorter ones. These two cases affect each other and one of the gains decrease the other (DeVellis, 2003). Dropped items' degree of poorness and number of the items in the scale are important factors in determining whether dropped "bad" items would increase or lower the alpha. The items whose contributions to overall internal consistency are least should be first dropped from scale. 67 items [PK (15), TK (11), CK (8), TCK (5), TPK (10), PCK (11) and TPACK (7)] remained in the last form of scale after considering shortness, reliability and evaluation of the items.

3. FINDINGS

Analyses about items are given in Table 2. The items which have the lowest (TK-19) and highest (TCK-35) item-total correlation are as follows:

TK-19: I think I do not have trouble in using technology. ($r=.583$; $p<.01$)

TCK-35: I think I know technologies which can be used in my content area (e.g lecturing video, materials and models, interactive softwares…) ($r=.835$; $p<.01$).

It is seen that items have a high discrimination level from the results of independent sample t-test ($p<.01$). Items are compatible with the scale and are expected to measure the construct of measurement well.

Table 2. Item Analyses of TPACK-SAS

Number of Item	Factors	Mean	Sd	t- test (27% Lower and Higher Group)	Item-Total Correlation
1	PK	5.603	1.207	14.405*	.714*
2	PK	5.640	1.109	15.065*	.686*
3	PK	5.709	1.126	14.537*	.718*
4	PK	5.708	1.118	13.750*	.712*
5	PK	5.671	1.139	16.283*	.705*
6	PK	5.732	1.137	14.657*	.679*
7	PK	5.836	1.108	15.075*	.728*
8	PK	5.933	1.171	14.041*	.701*
9	PK	5.651	1.153	13.232*	.670*
10	PK	5.632	1.122	14.937*	.711*
11	PK	5.684	1.091	14.421*	.697*
12	PK	5.618	1.194	14.262*	.718*
13	PK	5.818	1.131	15.098*	.734*
14	PK	5.770	1.133	15.490*	.739*
15	PK	5.787	1.067	13.083*	.654*
16	TK	4.669	1.679	19.929*	.730*
17	TK	4.844	1.625	18.654*	.680*
18	TK	4.685	1.665	19.202*	.686*
19	TK	5.059	1.703	12.705*	.583*
20	TK	5.515	1.339	18.218*	.778*
21	TK	5.092	1.470	19.387*	.738*
22	TK	4.928	1.586	19.642*	.718*
23	TK	5.011	1.667	20.791*	.730*
24	TK	5.212	1.496	15.052*	.646*
25	TK	5.257	1.425	13.877*	.660*
26	TK	5.714	1.318	15.805*	.729*
27	CK	5.452	1.233	18.000*	.750*
28	CK	4.801	1.389	17.524*	.657*
29	CK	5.069	1.335	17.174*	.668*
30	CK	5.123	1.354	18.358*	.714*
31	CK	4.844	1.351	14.761*	.604*
32	CK	4.787	1.363	16.069*	.646*
33	CK	5.118	1.272	18.312*	.707*
34	CK	5.201	1.238	17.040*	.707*
35	TCK	5.759	1.149	19.446*	.835*
36	TCK	5.698	1.111	17.636*	.796*
37	TCK	5.575	1.140	19.168*	.812*
38	TCK	5.498	1.135	21.808*	.818*
39	TCK	5.615	1.253	17.806*	.807*
40	TPK	5.547	1.336	17.902*	.751*
41	TPK	5.526	1.279	17.446*	.755*
42	TPK	5.640	1.127	18.748*	.775*
43	TPK	5.473	1.163	18.520*	.791*
44	TPK	5.637	1.155	21.546*	.825*
45	TPK	5.668	1.133	20.655*	.792*
46	TPK	5.608	1.099	22.700*	.810*
47	TPK	5.626	1.111	21.947*	.805*
48	TPK	5.643	1.163	20.401*	.784*
49	TPK	5.656	1.154	19.256*	.749*

*$p < .01$; $n=754$, $n_1=n_2=204$

Table 2 Continued

Number of Item	Factors	Mean	Sd	t- test (27% Lower and Higher Group)	Item-Total Correlation
50	PCK	5.821	1.194	15.549*	.775*
51	PCK	5.936	1.133	13.805*	.758*
52	PCK	5.527	1.123	15.927*	.757*
53	PCK	5.700	1.041	16.761*	.773*
54	PCK	5.610	1.127	17.239*	.741*
55	PCK	5.701	1.087	16.547*	.738*
56	PCK	5.688	1.229	13.782*	.666*
57	PCK	5.698	1.115	15.777*	.731*
58	PCK	5.759	1.083	15.021*	.729*
59	PCK	5.774	1.100	15.413*	.738*
60	PCK	5.759	1.128	16.087*	.761*
61	TPACK	5.664	1.138	16.551*	.736*
62	TPACK	5.700	1.109	14.548*	.736*
63	TPACK	5.749	1.047	16.450*	.724*
64	TPACK	5.708	1.084	14.447*	.732*
65	TPACK	5.492	1.146	14.882*	.717*
66	TPACK	5.647	1.097	15.729*	.755*
67	TPACK	5.697	1.121	16.323*	.768*

*$p < .01$; n=754, $n_1=n_2=204$

The items which have the highest (PCK-51) and lowest (TK-16) mean scores are as follows:

PCK-51: I think I can develop and use different representations (e.g. visual, audial…) related with my content area (Mean=5.936; Sd=1.133).

TK-16: I think I can solve technical problems (e.g. network connection, Windows system file error…) related with hardware (Mean=4.669; Sd=1.679).

Pearson product moment correlation and effect size results are given in Table 3. There is a positive and strong correlation between TPACK subdomain and other subdomains (Cohen, 1992, 1994; Field, 2009; Rosnow & Rosenthal, 1996). Also, PSTs' PCK have a positive correlation with their PK, TK, and CK. Participants have the lowest score in CK (Mean=5.049; Sd=1.064) and the highest score in PCK (Mean=5.725; Sd=.902).

Table 3. Correlations Between Scale Subdomains

Sub-domains	PK (15 items)		TK (11 items)		CK (8 items)		TCK (5 items)		TPK (10 items)		PCK (11 items)		TPACK (7 items)	
		r^2		r^2		r^2		r^2		r^2		r^2		r^2
PK	-		.424*	.179	.438*	.191	.604*	.364	.574*	.329	.654*	.427	.573*	.328
TK			-		.566*	.320	.643*	.413	.631*	.398	.475*	.225	.511*	.261
CK					-		.563*	.316	.609*	.370	.574*	.329	.519*	.269
TCK							-		.859*	.737	.781*	.610	.777*	.603
TPK									-		.755*	.570	.758*	.574
PCK											-		.762*	.580
TPACK													-	
Mean	5.719		5.090		5.049		5.629		5.602		5.725		5.665	
Sd	.930		1.194		1.064		1.001		.967		.902		.918	

*$p < .01$

Data obtained from a large sample is thought as enough for factor analyses (Field, 2009; Kline, 1994; Tabachnick & Fidell, 2013). According to Kolmogrow-*Simirnov (Lilliefors)* test, data has normal distribution

(Z=.726, p>.05). KMO and BToS were used to examine the linearity of data. KMO value was calculated as .972. KMO value which is greater than or equal to .90 is assumed as *excellent*. When BToS results are examined (Chi-Square = 46057,977; df = 2211; p<.001) and they show that data is available for factor analyses (Sharma, 1996; Tabachnick & Fidell, 2013).

After EFA seven factors (PK, TK, CK, PCK, TPK, TCK, and TPACK) were obtained. These seven factors contributed to 67,094% of the total item variance. The factor which has the highest percentage of variance is PK (15.593%), and the lowest is TPACK (5.867).

Table 4. Eigenvalue, Percentage of Variance and Percentage of Total Variance

Factors	Eigenvalue	Percentage of Variance (%)	Percentage of Total Variance (%)
Pedagogical Knowledge (PK)	10.448	15.593	15.593
Technological Knowledge (TK)	9.439	14.088	29.681
Content Knowledge (CK)	6.179	9.222	38.903
Technological Content Knowledge (TCK)	4.834	7.214	46.117
Technological Pedagogical Knowledge (TPK)	4.524	6.752	52.869
Pedagogical Content Knowledge (PCK)	5.600	8.358	61.227
Technological Pedagogical Content Knowledge (TPACK)	3.931	5.867	67.094

Cronbach's alpha was calculated .965 for PK; .932 for TK; .924 for CK; .963 for TCK; .936 for TPK; .944 for PCK and .925 for TPACK (Table 5).

Table 5. Factor Loadings and Reliability

		Common Factor Loadings	Rotated Factor Loadings
Factor 1: Pedagogical Knowledge (n=15) (PK, α=.965)			
1	PK2- I think I can use various instructional strategies that will help students associating different conception.	.662	.749
2	PK3- I think I can determine teaching methods according to students' level.	.650	.733
3	PK4- I think I can assess student learning.	.677	.742
4	PK5- I think I can make change(s) in my teaching due to students' different learning styles.	.652	.747
5	PK6- I think I can teach using a great variety of effective teaching approaches (e.g. constructivist, multiple intelligence) to guide student learning.	.657	.747
6	PK7- I think I can use teaching practices, strategies and methods effectively.	.649	.785
7	PK8- I think I can motivate students.	.672	.763
8	PK9- I think I can communicate with students in an effective way.	.621	.778
9	PK11- I think I can make classroom suitable for learning and teaching activities.	.614	.769
10	PK12- I think I can use the time well.	.656	.726
11	PK13- I think I can plan my teaching due to student outcomes.	.649	.772
12	PK14- I think I can teach based on students' individual differences.	.657	.751
13	PK15- I think I can call students' attention to lesson.	.692	.780
14	PK16- I think I can remind students' prior knowledge.	.682	.783
15	PK17- I think I can meet the requests, expectations and needs of students.	.608	.754

Table 5 Continued

		Common Factor Loadings	Rotated Factor Loadings
Factor 2: Technological Knowledge (n=11) (TK, α=.932)			
16	TK1- I think I can solve technical problems (e.g. network connection, Windows system file error…) related with hardware.	.566	.774
17	TK2- I think I can solve problem related with software (e.g. downloading proper adds-on, program loading…).	.503	.815
18	TK3- I can help people around me solve their technical problems about computers.	.512	.787
19	TK4- I think I do not have trouble in using technology.	.546	.557
20	TK5- I think I have knowledge and skills required for using technology in daily life.	.660	.585
21	TK9- I think I have enough knowledge about different technologies (e.g. computers, interactive whiteboard, tablet…).	.616	.626
22	TK10- I think I have enough knowledge about main computer hardwares (e.g CD-Rom, mainboard, RAM) and their functions.	.565	.722
23	TK11- I think I have enough knowledge about main computer softwares (e.g Windows Media Player, Abode Reader, Foxit,…) and their features.	.575	.784
24	TK12- I can use word processor program(s) (e.g Microsoft Word, LibreOffice, Apache OpenOffice, Calligra…).	.516	.708
25	TK13- I can use spreadsheets (e.g Microsoft Excel…).	.548	.690
26	TK14- I can communicate via internet tools such as e-mail, Skype, Hangouts etc.	.634	.554
Factor 3: Content Knowledge (n=8) (CK, α=.924)			
27	CK1- I think I have enough knowledge in my content area.	.651	.570
28	CK2- I think I am expert in my content area.	.530	.734
29	CK3- I think I know topic I will teach extensively.	.572	.766
30	CK4- I think I follow the current developments in my content area.	.619	.686
31	CK5- I think I know famous people in my content area.	.539	.757
32	CK6- I think I follow contemporary resources (e.g books, journals…) and activities in my content area.	.523	.756
33	CK7- I think I have enough knowledge about outcomes in the curriculum.	.607	.691
34	CK8- I think I know conceptions, rules, and generalizations in my content area.	.623	.703
Factor 4: Technological Content Knowledge (n=5) (TCK, α=.963)			
35	TCK2- I think I know technologies which can be used in my content area (e.g lecturing video, materials and models, interactive softwares…).	.786	.543
36	TCK6- I think I can use technology to help abstract concepts to be learned.	.756	.602
37	TCK7- I think I can decide which topics in my content area technology support.	.765	.596
38	TCK8- I think I can decide which topics in my content area technology constrain.	.767	.594
39	TCK9- I can reach online resources related with subject matter.	.751	.671
Factor 5: Technological Pedagogical Knowledge (n=10) (TPK, α=.936)			
40	TPK1- I think I can design an online environment (e.g. blogs, Google groups, Facebook groups…) to develop students' knowledge and skills, using different teaching methods.	.678	.661
41	TPK2- I think I can guide students to interact with each other in an online environment.	.707	.709
42	TPK3- I think I know how technology affects teaching and learning.	.744	.680
43	TPK4- I think I know how to integrate technology to teaching and learning.	.738	.661
44	TPK5- I think I can use technology effectively to meet students' learning needs.	.774	.647
45	TPK6- I think I can decide which technology can be used to enhance learning.	.765	.698
46	TPK7- I think o know how to use specified technologies to enhance learning.	.777	.619
47	TPK8- I think I know how to use technology in different teaching activities.	.763	.640
48	TPK9- I think I can use computer applications that support learning.	.748	.657
49	TPK10- I think I can decide whether a new technology is appropriate or not for teaching and learning.	.712	.644

Table 5 Continued

		Common Factor Loadings	Rotated Factor Loadings
Factor 6: Pedagogical Content Knowledge (n=11) (PCK, α=.944)			
50	PCK3- I think I can use teaching methods (e.g. collaborative learning, problem solving, demonstration, inquiry-based learning, discussion, lecturing, case study…) specific to my content area.	.746	.547
51	PCK4- I think I can develop and use different representations (e.g. visual, audial…) related with my content area.	.733	.557
52	PCK5- I think I am familiar with students' misconceptions about a specific topic.	.705	.594
53	PCK6- I think I can adopt a material due to students learning (e.g. students' abilities, prior knowledge, misconceptions, bias…).	.734	.593
54	PCK7- I think I am aware of difficulties particular to a topic that students may encounter.	.691	.635
55	PCK8- I think I can use essential and effective approaches (e.g. constructivism, multiple intelligence…) to guide students' thinking and learning.	.714	.639
56	PCK9- I think I can develop traditional measurement tools (e.g. multiple choice, true-false question, open-ended questions) related with my content area.	.632	.665
57	PCK10- I think I can develop alternative measurement tools (e.g. portfolio, performance, project…) related with my content area.	.680	.681
58	PCK11- I think I can prepare a comprehensive lesson plan that includes attractive activities, different materials.	.684	.688
59	PCK12- I think I can reach gains identified in the lesson plan.	.708	.634
60	PCK13- I think I can link interrelated topics in my content area.	.741	.640
Factor 7: Technological Pedagogical Content Knowledge (n=7) (TPACK, α=.925)			
61	TPACK6- I think I can use technology in determining the reasons of student difficulties when learning specific conceptions.	.685	.541
62	TPACK7- I think I can use technology in removing students' difficulties when teaching specific conceptions.	.687	.610
63	TPACK8- I think I can use technology to help students build new knowledge on the existing ones.	.692	.615
64	TPACK9- I think I can decide which technologies affect positively teaching and learning.	.711	.636
65	TPACK10- I think I can make leadership for my colleagues to help them use their content, pedagogy (e.g. teaching methods, misconceptions, classroom management…) and technology knowledge together.	.655	.646
66	TPACK11- I think I am aware of the relationships between knowledge of content, pedagogy (e.g. teaching methods, misconceptions, classroom management…) and technology.	.707	.617
67	TPACK12- I think I can use technology effectively to meet the pedagogical needs (teaching methods, instructional materials, classroom management, student learning…) when teaching a particular topic.	.722	.626

Results of the model fit indexes are given in Table 6. χ^2 was calculated as 9,459.68 (p=.01) and this means that there is a significant difference at an acceptable level. It is compared with expected value of sample distribution (e.g., df) instead of using χ^2 alone (Jöreskog & Sörbom, 1993). χ^2/df value is at the acceptable fit level. However intervals related with *good fit values and acceptable fit values* and fit values obtained from TPACK-SAS are given in the Table 6. RMSEA was found as .067; SRMR as .057; RMR as .094; NFI as .97; NNFI as .98; CFI as .98; GFI as .93; AGFI as.89. These results show that EFA model is confirmed.

Table 6. Fit İndexes of Confirmatory Factor Analysis

Fit Values	Good Fit Values	Acceptable Fit Values	TPACK-SAS Fit Values
χ^2	$0 \leq \chi^2 \leq 3df$	$3df < \chi^2 \leq 5df$	9,459.68
p value	0.05≤ p ≤ 1.00	0.01≤ p ≤ 0.05	.010
χ^2/df	$0 \leq \chi^2/df \leq 3$	$3< \chi^2/df \leq 5$	2.759
RMSEA	0 ≤ RMSEA ≤ 0.05	0.05 < RMSEA ≤ 0.08	.067
SRMR	0 ≤ SRMR ≤ 0.05	0.05 < SRMR ≤ 0.10	.057
RMR	0 ≤ RMR ≤ 0.05	0.05 < RMR ≤ 0.10	.094
NFI	0.95 ≤ NFI ≤ 1	0.90<NFI < 0.95	.97
NNFI	0.97 ≤ NNFI ≤ 1	0.95 ≤ NNFI < 0.97	.98
CFI	0.97 ≤ CFI ≤ 1	0.95 ≤ CFI < 0.97	.98
GFI	0.95 ≤ GFI ≤ 1	0.90 ≤ GFI < 0.95	.93
AGFI	0.90 ≤ AGFI ≤ 1	0.85 ≤ AGFI < 0.90	.89

12 items about for what purpose and how often PSTs use computers are added to TPACK-SAS to investigate whether their intention to use computers have or not an impact on their TPACK subdomains. Items' analyses are given in Table 7.

Table 7. Item Analyses About the İntention to Use Computer

	Item	Mean	Sd	t-test (27% of Higher and Lower Groups)	Item-total correlation
1	I use computer for social media.	4.762	1.451	11.791*	.568
2	I use computer to watch films or videos and listen to music.	5.025	1.277	12.318*	.592
3	I use computer to research about my content area.	5.167	1.134	9.301*	.511
4	I use computer to play game.	3.116	1.687	11.569*	.572
5	I use computer as an information storage tool.	5.236	1.293	12.896*	.603
6	I use computer to do my homework.	5.395	1.142	10.855*	.551
7	I use computer to follow current developments about daily life (e.g. news, games, programs…)	4.905	1.430	19.114*	.745
8	I use computer to follow developments related with my content area (e.g. up and coming books, articles, computer applications…)	4.237	1.466	22.122*	.799
9	I use computer to communicate (e.g send or receive e-mail, chat…)	4.567	1.479	22.043*	.791
10	I use computer for online shopping.	3.319	1.696	16.729*	.675
11	I use computer to improve my foreign language	2.574	1.464	15.670*	.662
12	I use computer for distance education.	2.821	1.703	15.296*	.622

*p< .01; N=754, $n_1=n_2=204$

"I use computer to research about my content area." item has the lowest item correlation (r=.511) while "I use computer to follow developments related with my content area (e.g. up and coming books, articles, computer applications…)" item has the highest (r=.799). All of the items seem as distinctive. According to Table 7, PSTs use computer least to learn foreign language (M-11; Mean=2.574; Sd=1.464) and the most to do homework (M-6; Mean=5.395; Sd=1.142). These results show that teacher preparation programs need to give more emphasis on foreign language teaching to prepare PSTs in a way that they catch up with time. Also, Cronbach's alpha was calculated .867 for intention to use computer.

Another aim of this study was to investigate the extent to which variables such as having own computer, amount of time PSTs spend using computer, proficiency of using computer, location of internet access and the intention to use computer predict PSTs levels of TPACK subdomain. For this purpose multiple regression analysis was performed. (Table 8).

Tablo 8. Beta and Adjusted R^2 Scores for Multiple Regression Analysis

	CK (Beta)	PK (Beta)	TK (Beta)	TCK (Beta)	TPK (Beta)	PCK (Beta)	TPACK (Beta)
Having own computer	.084*						
Amount of time PSTs spend using computer				.074*			
Proficiency of using computer	.262**	.103*	.460**	.209**	.252**	.174**	.173**
The intention to use computer	.226**		.206**	.150**	.150**	.093*	.154**
Location of internet access				-.074*			
Adjusted R^2	.147	.012	.318	.096	.111	.043	.065

*p< .05; **p< .001

Independent variables (the intention to use computer and proficiency of using computer) predict mostly TK (about 32%) and CK (about 15%) and least PK (about 1%), PCK (about 4%) and TPACK (about 7%). The intention to use computer and proficiency of using computer are important predictors of TPACK subdomains. Proficiency of using computer predicts mostly TK while the intention to use computer predicts mostly CK.

4. CONCLUSION and DISCUSSION

A valid and reliable TPACK survey (TPACK-SAS) was developed in this study. Eight steps suggested by DeVellis (2003) were followed completely in the survey developing process. Most of the previous surveys mention about only statistical analyses and there is a lack about validity and reliability (Koehler et al., 2011). The lack of details in generating item pool (e.g. the criteria used in selecting items to be included in item pool) attracts a great deal of attention. This study is particular because qualitative methods are employed and the item pool generating process was explained in detail. TPACK has been a new phenomenon in the last decade. Therefore, there is too much to measure and understand the levels of TPACK. In the literature about self-reported measures, there are some studies with in-service teachers (Lee & Tsai, 2010) and PSTs (Koh et al., 2010; Saengbanchong et al., 2014; Sahin, 2011; Schmidt et al., 2009; Yurdakul et al., 2012) which performed EFA. The factor numbers of these studies vary. The reason of having factors with different number and content may be the context in which survey was developed. Another reason may be researchers' opinions about content of items. Voogt et al. (2013) stated that problem in the self-assessment surveys could be a result of the ambiguity about the theoretical notions of TPACK (p.116). A wide range of literature was reviewed in this study to avoid the mentioned ambiguity.

At first TPACK notion was identified clearly as a framework with seven subdomains. Then an initial item pool was generated reviewing the literature (Archambault & Crippen, 2009; Archambault & Barnett, 2010; Chai et al., 2011; Koehler & Mishra, 2005; Koh et al., 2010; Lee & Tsai, 2010; Lux, 2010; Sahin, 2011; Schmidt et al., 2009; Yurdakul et al., 2012). A few of items about TPACK subdomains were added on by researches due to definitions of Koehler and Mishra (2005). In the beginning there were 140 items which some of are similar. Similarity between the items allows making careful selection and comparing items. Researchers examined items' relationships with the subdomains and clarity and shortness of the items individually and come together to share their ideas. Items on which all of the researchers agree to include in the survey were included and 21 items were omitted.

Likert type questions were preferred because of their ease of use and assumption that they give more reliable results (Edwards & Kenny, 1967). According to DeVellis (2003) even number response options make participants to choose one of the edges (positive or negative). So, odd number option was used in this study. While some researchers (Archambault & Barnet, 2010; Archambault & Crippen, 2009; Schmidt et al., 2009) use 5-point Likert type questions, TPACK-SAS have 7- point Likert type questions because six or seven point is available if the cognitive abilities of participants are about to college students (Weng, 2004). After the first evaluation of items, three experts were asked to review the items, state whether the item is related or not with the subdomain and add if any explanations. With the frame of feedbacks from experts, 96 items remained in the survey. Expert review is important for content validity. Another type of validity researchers should consider is construct validity. One way to provide construct validity is *think aloud* (Dillman, 2011). In the think aloud process, four PSTs from different grade levels were asked to read, examine, and answer items loudly. Ensuring the clearness and understandabilities of items was the main purpose in this stage. According to PSTs' answers, some structural and linguistic modifications were made on six items.

After the reviews of researchers, experts and plot study, item pool was administered to a sample of 754 PSTs that represents the population quantitatively and qualitatively. Item and factor analyses were performed to data obtained from participants. For item analyses item discrimination and item-total correlation was used; EFA and CFA for factor analyses. In the last form of the survey, it consisted 67 items [PK (15), TK (11), CK (8), TCK (5), TPK (10), PCK (11) and TPACK (7)]. Item with the lowest item-total correlation is "I think I do not have trouble in using technology. ($r=.583$; $p<.01$), the highest item-total correlation is "I think I know technologies which can be used in my content area (e.g lecturing video, materials and models, interactive softwares…) $r=.835$). As item-total correlation is high so it shows that item belongs to scale strongly.

According to item discrimination results, all of the items in the last form of the scale ($n=67$) is distinctive. This means that 67 items are in accordance with the whole scale and measure the construct well. Item which has the lowest mean score is "I think I can solve technical problems (e.g. network connection, windows system file error...) related with hardware." (Mean=4.669; Sd=1.679) in TK; the highest mean score is "I think I can develop and use different representations (e.g. visual, audial…) related with my content area" (Mean=5.936; Sd=1.133). Teacher education programs take four years in Turkey. In the first years courses related with content area are emphasized more, and then PSTs begin to take pedagogical courses. They take method courses and field experience in the last two years. Technology courses are separated into two groups: how to use technologies and how to use these in content area. PSTs' lowest score in TK implies that it should be given more emphasis on technology courses.

TK has the lowest correlation (r=.511) with TPACK and TCK (r=.777) has the highest. When the correlation coefficient is considered, it is seen that PSTs' TPACK levels have a strong relationship between their TK and TCK (Cohen, 1988, 1992, 1994; Field, 2009; Rosnow & Rosenthal, 1996). However, PSTs' TK is not efficient enough to predict their TPACK, in other words PSTs are not able to transform their TK into TPACK. PSTs feel themselves proficient maximum in PCK (Mean=5.725; Sd=.902) and minimum in CK (Mean=5.049; Sd=1.064) and TK (Mean=5.090; Sd=1.194).

Sample size of the study is assumed as enough for factor analyses (Field, 2009; Kline, 1994; Tabachnick & Fidell, 2013). KMO and BToS tests were utilized in investigating the appropriateness of data for factor analyses. KMO values which are equal or greater than .90 are accepted as *excellent*. The KMO (.972) and BToS (Chi-Square = 46057,977; df = 2211; p<.001) values imply that factor analyses can be performed (Field, 2009; Tabachnick & Fidell, 2013; Sharma, 1996).

Seven factors (TK, PK, CK, PCK, TCK, TPK, and TPACK) were obtained from EFA. Principal component analysis and Varimax with Kaiser Normalization were used in determining factor numbers (Field, 2009; Tabachnick & Fidell, 2013). Items with eigenvalues smaller than 1 (Tabachnick & Fidell, 2013), factor loadings smaller than .50 (Koh et al., 2010; Lee & Tsai, 2010) and cross loadings (Koh et al., 2010; Lee & Tsai, 2010; Lux, 2010) were omitted. TPACK factor has the lowest percentage of variance (5.867%) and PK has the highest (15.595%). Henson and Roberts (2006) suggested that total percentage of variance must be at least and greater than 52%. The obtained seven factors contributed to 67.094% of the total item variance in the TPACK-SAS.

All of the factors have quite higher Cronbach's alpha coefficient. Reliability coefficient which is equal or greater than .80 is assumed as *excellent* (DeVellis, 2003). CK (.924) has the lowest reliability coefficient while PK (.965) has the highest. Positive strong correlation between factors and the variety of factor numbers may lead to high values of reliability coefficient. CFA was performed to examine the construct validity and it is considered as supplementary of EFA (Lee, 2007). RMSEA, SRMR, RMR, NFI, NNFI, CFI, GFI, and AGFI (Table 6) were examined and these fit indexes show the confirmedness of the model (Brown, 2015; Chermelleh-Engel & Moosbrugger, 2003; Jöreskog & Sörbom, 1993; Kline, 2005).

Technology is getting rapidly in our daily lives. Computers are everywhere (e.g classrooms, home, student residents, shopping centers…) and easy to access. This brings a question in minds: For what purpose PSTs use computers? Intention to use computer scale (UCoS) with 12 items was developed to examine for what purpose and how often PSTs use computer. The extent to which PSTs' intentions to use computer predict their TPACK level is also investigated with UCoS. PSTs were also asked whether they have or not their own computers, where they access internet, amount of time they spend using computers and proficiency of using computers. The relationships between these independent variables and TPACK of PSTs were investigated via multiple regression analysis. Results show that PSTs' proficiency (β=.460) and intentions (β=.206) predict most TK (31.8%). If a PST has his/her own computer and spend lots of time using computer, this does not mean that he/she has a strong technological knowledge. An evaluation about his/her TK can be made through reviewing his/her proficiency and intention to use computer.

Archambault and Barnett (2010) stated that it is difficult to distinguish subdomains. But in this study seven subdomains consistent and simlir with the original framework were obtiained. This may be explained with these reasons;

(1) Voogt et al. (2013) mentioned an ambiguity in the content of subdomains. In this study the initial item pool was too large and there were too similar items in the pool. It might give researchers an opportunity to compare similar items and choose the most related item with the construct.
(2) Plot study of the items was performed with four PSTs. They were asked to think aloud. This revealed what PSTs might think when they read items. The difficulties or ambiguities they may encounter were prevented at the beginning. The clearness and meaningfulness of items were supplied before implementation.
(3) The participants are juniors and seniors in a teacher education program. In the teacher preparation programs in Turkey PSTs are equipped with more proficiency about teaching profession. It is more likely for juniors and seniors to distinguish the subdomains than freshmen and sophomores. Also in the last two years PSTs take technology courses related with both using different technologies and using them in their content areas.

We need to do more studies about TPACK. TPACK-SAS can be used in a teacher preparation program which gives more opportunities to PSTs to teach with technology or TPACK-SAS can be administered to in-service teachers. Using the survey in different context may reveal different results. These differences can inform researchers about the nature of TPACK.

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GENİŞ ÖZET

Giriş

Öğretmen adaylarını teknolojiyi etkili, esnek ve verimli bir şekilde kullanacak şekilde yetiştirmek için, öğretmen eğitimcileri öğretmen adaylarının kendi alanlarını teknoloji ile kullanmalarını sağlamalı ve öğretmeyi öğrenmeyi olayları var olan bilgi, inanç ve meyillerine dayanarak yorumladıkları yapıcı ve yinelemeli bir süreç olarak ele almalıdırlar. Teknoloji ile öğretme tamamlanmamış, çelişkili ve değişen gereksinimleri olan zorlu bir problem olarak tanımlanmaktadır. Bu problemleri normal bir problem gibi ele almanın büyük bir hata olduğunu ve bu problemleri geleneksel yollarla çözmenin çok zor olduğunu ileri sürmektedirler. Bu nedenle, teknoloji ile öğretim problemini çözmek için yeni yollar geliştirmek gereklidir. Teknoloji ile öğretim yapmada problem öğrenciler için en kullanışlı ve en uygun konuya özgü teknolojinin hangisi olduğuna karar vermek, seçmek ve kullanmaktır.

Mishra ve Koehler (2006) öğretmenlerin öğretim uygulamalarına teknolojiyi etkili bir biçimde entegre etmek için ihtiyaç duydukları bilgiye değinen Teknolojik Pedagojik Alan Bilgisi (TPAB) isimli bir yapısal çerçeve geliştirmişlerdir. TPAB'ın sadece yeni teknolojiler için olmadığını, tüm teknolojiler için kullanılabileceğini hatırlamakta fayda vardır. Konu öğretimi için etkili teknoloji entegrasyonu sadece alan, pedagoji ve teknolojiyi gerektirmez, fakat aynı zamanda bunların arasındaki ilişki de oldukça önemlidir. Teknoloji, pedagoji ve alan arasındaki etkileşim ve kesişim ve bu bileşenlerin birbirleri ile olan dinamik ilişkilerin başarılı bir teknoloji entegrasyonun önemi büyüktür. Bu çalışmada öğretmen adaylarının teknoloji kullanımına ilişkin algılarını ölçecek geçerli ve güvenilir bir TPAB ölçeği geliştirmeyi amaçlamaktadır.

Yöntem

Öğretmen adaylarının teknolojik pedagojik alan bilgisi öz yeterliklerinin belirlenmesi amacıyla 'Teknolojik Pedagojik Alan Bilgisi Öz-Değerlendirme Ölçeği (TPAB-ÖDÖ)' ölçeği geliştirilmiştir. Ölçeğin geliştirilme süreci DeVellis (2003) tarafından tanımlanan sekiz adımda gerçekleştirilmiştir. Bu adımlar; *(i) neyi ölçmek istediğinizi açık bir şekilde belirleme, (ii) madde havuzunu oluşturma, (iii) ölçüm formatını belirleme, (iv) madde havuzu için uzman görüşü alma, (v) maddelerin geçerliğini gözden geçirme, (vi) maddeleri bir örneklemde uygulama, (vii)maddeleri değerlendirme* ve *(viii) ölçek uzunluğunu en uygun hale getirme.*

Öğretmen adayları için geliştirilen TPAB-ÖDÖ, eğitim fakültesinin 3. sınıf (f=256) ve 4. sınıflarında (f=498) öğrenim görmekte olan 754 öğretmen adayına (f_{Erkek}=259; f_{Bayan}=495) uygulanmıştır. Ölçeği oluşturan maddelere ilişkin madde-toplam puan sıralamasına göre, alt % 27'lik (n_1=204) ve üst % 27'lik (n_2=204) gruplar oluşturularak, her bir madde için alt ve üst gruplara ait farkların anlamlılığı t-testi ile test edilmiştir. Madde-toplam korelasyon değerleri hesaplanmıştır. Ölçeğin yapı geçerliğini test etmek için çok değişkenli istatistik tekniklerinden açımlayıcı (AFA) ve doğrulayıcı faktör (DFA) analizleri yapılmıştır. Ölçek faktörlerinin cronbach α güvenirlik değerleri hesaplanmıştır.

Sonuç ve Tartışma

Yapılan birçok ölçek geliştirme ve uyarlama çalışmalarında geçerlik ve güvenirlik çalışmalarında nitel boyutun geri planda bırakıldığı görülmektedir. Çalışmalarda, daha çok öğretmen adaylarına uygulanan ölçek formu sonrasında yapılan istatistiki analizler ön plana çıkarılmaktadır. Özellikle ölçme aracının geliştirilmesine ilişkin oluşturulan madde havuzu içeriği hakkında daha güçlü değerlendirmelerin eksikliği dikkat çekmektedir. Çalışmada ölçmek istenen TPAB yapısı açık bir şekilde tanımlanarak geniş bir madde havuzu oluşturulmuştur. Madde havuzu bu alanda yapılmış olan ölçekler incelenerek oluşturulmuştur. Ayıraca, araştırmacılar tarafından TPAB ve bileşenlerine yönelik maddeler yazılmıştır. Oluşturulan madde havuzunda yer alan her bir madde bir özelliği ölçmesi açısından önemlidir. Maddeler arasında benzer yapılar bulunması araştırmacılara maddeleri karşılaştırabilme ve tercihte bulunabilmelerine olanak sağlamıştır.

Ölçme aracında yer alması planlanan maddelere ilişkin uzman görüşlerine başvurulmuştur. Alan uzmanlarının maddelere ilişkin görüşleri incelenerek maddeler üzerinde gerekli değerlendirmeler yapılarak maddelerin son hali (n=96) verilmiştir. Her madde üzerinde her üç uzman görüşünün de açıklama ve önerileri çerçevesinde 100% uyum sağlanıncaya kadar çalışılmıştır. Uzman görüşleri maddelerin kapsam geçerliğini arttırmaktadır. Bu çalışmada benzer çalışmalardan farklı olarak yapı geçerliğine katkı sağlamak amacıyla öğretmen adayları ile sesli düşünme stratejisi kullanılarak pilot yapılmıştır.

Ölçme aracı, diğer yöntemlere göre kullanım kolaylığı ve güvenilir sonuçlar verdiği düşünülerek yedili likert formda hazırlanmıştır. TPACK-ÖDÖ'nin geliştirilmesinde madde havuzuna ilişkin son hali verildikten sonra geniş bir örneklemde pilot uygulaması yapılmıştır. Ölçek, yapılan analizler sonrasında 67 maddeden [PK(15), TK(11), AB(8), TAB(5), TPB(10), PAB(11) ve TPAB(7)] oluşmaktadır. Öğretmen adaylarının teknolojiyi kullanmada zorluk yaşamayacağını düşünmesi (TB-19; r=.583) en düşük madde korelasyonu gösterirken, kendi alanlarında kullanabilecekleri teknolojileri bildiğini düşünmeleri (Örn: konu anlatımlı videolar, materyal ve modeller, interaktif/etkileşimli yazılımlar) ise en yüksek madde-toplam korelasyonuna (TAB-35; r=.835) sahiptir. Madde-toplam korelasyonu ne kadar yüksek ise o maddenin ölçeğe o kadar güçlü ait olduğunu göstermektedir.

Ölçeği oluşturan faktörler arasındaki korelasyon değerleri incelendiğinde TPAB faktörü ile en düşük korelasyona sahip olan faktörün TB faktörüdür (r=.511). En büyük korelasyona sahip olan faktörün ise TAB faktörü (r=.777) olduğu görülmektedir. Öğretmen adaylarının TPAB düzeyleri ile TB ve TAB düzeyleri arasında güçlü bir korelasyonun olduğu sonucuna ulaşılabilir. TPAB faktöründe, en düşük korelasyonun TB arasında olması öğretmen adaylarının sahip oldukları teknolojik bilgilerin TPAB düzeylerini yordamada eksik olduğu görülmektedir. Bu durumun sebebi olarak öğretmen yetiştirme programında zayıf ve yetersiz teknoloji derslerinin verilmesi ya da almış oldukları teknoloji ders içeriklerini TPAB'a nasıl dönüştüreceklerini bilmemesi olarak gösterebilir.

AFA sonuçlarına göre, ölçme aracı yedi faktör (PB, TB, AB, TAB, TPB, PAB ve TPAB) ve 67 maddeden oluşmuştur. Ölçeği oluşturan faktörler kendi içerisinde en az varyans yüzdesinin TPAB (5.867%) faktörüne, en fazla varyans yüzdesine ise PB (15.595%) faktörüdür. Toplan varyansın %5'in altına düşen faktörler ise çıkarılmıştır.

Faktörlerin güvenirlikleri incelendiğinde; en küçük güvenirlik değerine AB (.924), en yüksek güvenirlik faktörüne ise PB (.965) faktörü sahiptir. Faktörlerin sahip olmuş olduğu güvenirlik değerlerinin oldukça yüksek olmasının sebebi olarak faktörler arasındaki pozitif yüksek korelasyonu ve faktör sayısına ilişkin çeşitliliğin fazla olması gösterilebilir. Ayrıca, ölçeğin yapı geçerliğini test etmek için DFA yapılmıştır. DFA, AFA'nın tamamlayıcısı olarak görülmektedir. DFA analizi sonucunda model-veri uyumuna ilişkin elde edilen bulgulara göre, χ^2 değerinin (χ^2=9,459.68; p=.01) kabul edilebilir düzeyde anlamlı farklılık oluşturduğu görülmektedir. χ^2 değerinin anlamlı çıkmaması beklenir. Bu çalışmada elde edilen χ^2 (χ^2=9,459.68; p=.01) değerinin anlamlılık sınırında olduğu görülmektedir. Bu durumun sebebi olarak χ^2 istatistiğinin, örneklem büyüklüğüne duyarlı olması gösterilmektedir. Bu nedenle χ^2 değerinin tek başına kullanılmaması gerektiği, bunun yerine örneklem dağılımının beklenen değeri (e.g., df value) ile χ^2 değeri karşılaştırılmıştır. Bu çalışmada, χ^2/df değeri 9,459.68/3,428=2.759 olarak hesaplanmıştır. Bu değerin *iyi uyum değerinde* olduğu söylenebilir. Ayrıca, alternatif uygunluk ölçütlerine de bakılmıştır. Bu ölçütlere ilişkin; RMSEA değeri .067; SRMR değeri .057; RMR değeri .094; NFI değeri .97; NNFI değeri .98; CFI değeri .98; GFI değeri .93; AGFI değeri ise .89 olarak bulunmuştur. DFA'dan elde edilen bu değerlerin AFA modelini doğruladığı söylenebilir.

APPENDIX

	Please indicate why and the extent to which you use your computer	Never	Hardly ever	Rarely	Sometimes	Often	Usually	Always
1	I use computer for social media.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2	I use computer to watch films or videos and listen to music.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
3	I use computer to research about my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
4	I use computer to play game.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
5	I use computer as an information storage tool.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
6	I use computer to do my homework.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
7	I use computer to follow current developments about daily life (e.g. news, games, programs…)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
8	I use computer to follow developments related with my content area (e.g. up and coming books, articles, computer applications…)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
9	I use computer to communicate (e.g send or receive e-mail, chat…)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
10	I use computer for online shopping.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
11	I use computer to improve my foreign language	(1)	(2)	(3)	(4)	(5)	(6)	(7)
12	I use computer for distance education.	(1)	(2)	(3)	(4)	(5)	(6)	(7)

			Strongly Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Strongly Agree
PK	1	I think I can use various instructional strategies that will help students associating different conception.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	2	I think I can determine teaching methods according to students' level.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	3	I think I can assess student learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	4	I think I can make change(s) in my teaching due to students' different learning styles.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	5	I think I can teach using a great variety of effective teaching approaches (e.g. constructivist, multiple intelligence) to guide student learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	6	I think I can use teaching practices, strategies and methods effectively.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	7	I think I can motivate students.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	8	I think I can communicate with students in an effective way.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	9	I think I can make classroom suitable for learning and teaching activities.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	10	I think I can use the time well.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	11	I think I can plan my teaching due to student outcomes.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	12	I think I can teach based on students' individual differences.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	13	I think I can call students' attention to lesson.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	14	I think I can remind students' prior knowledge.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	15	I think I can meet the requests, expectations and needs of students.	(1)	(2)	(3)	(4)	(5)	(6)	(7)

			Strongly Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Strongly Agree
TK	16	I think I can solve technical problems (e.g. network connection, Windows system file error…) related with hardware.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	17	I think I can solve problem related with software (e.g. downloading proper adds-on, program loading…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	18	I can help people around me solve their technical problems about computers.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	19	I think I do not have trouble in using technology.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	20	I think I have knowledge and skills required for using technology in daily life.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	21	I think I have enough knowledge about different technologies (e.g. computers, interactive whiteboard, tablet…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	22	I think I have enough knowledge about main computer hardwares (e.g CD-Rom, mainboard, RAM) and their functions.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	23	I think I have enough knowledge about main computer softwares (e.g Windows Media Player, Abode Reader, Foxit,…) and their features.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	24	I can use word processor program(s) (e.g Microsoft Word, LibreOffice, Apache OpenOffice, Calligra…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	25	I can use spreadsheets (e.g Microsoft Excel…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	26	I can communicate via internet tools such as e-mail, Skype, Hangouts etc.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CK	27	I think I have enough knowledge in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	28	I think I am expert in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	29	I think I know topic I will teach extensively.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	30	I think I follow the current developments in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	31	I think I know famous people in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	32	I think I follow contemporary resources (e.g books, journals…) and activities in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	33	I think I have enough knowledge about outcomes in the curriculum.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	34	I think I know conceptions, rules, and generalizations in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TCK	35	I think I know technologies which can be used in my content area (e.g lecturing video, materials and models, interactive softwares…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	36	I think I can use technology to help abstract concepts to be learned.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	37	I think I can decide which topics in my content area technology support.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	38	I think I can decide which topics in my content area technology constrain.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	39	I can reach online resources related with subject matter.	(1)	(2)	(3)	(4)	(5)	(6)	(7)

			Strongly Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Strongly Agree
TPK	40	I think I can design an online environment (e.g. blogs, Google groups, Facebook groups…) to develop students' knowledge and skills, using different teaching methods.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	41	I think I can guide students to interact with each other in an online environment.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	42	I think I know how technology affects teaching and learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	43	I think I know how to integrate technology to teaching and learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	44	I think I can use technology effectively to meet students' learning needs.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	45	I think I can decide which technology can be used to enhance learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	46	I think o know how to use specified technologies to enhance learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	47	I think I know how to use technology in different teaching activities.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	48	I think I can use computer applications that support learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	49	I think I can decide whether a new technology is appropriate or not for teaching and learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PCK	50	I think I can use teaching methods (e.g. collaborative learning, problem solving, demonstration, inquiry-based learning, discussion, lecturing, case study…) specific to my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	51	I think I can develop and use different representations (e.g. visual, audial…) related with my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	52	I think I am familiar with students' misconceptions about a specific topic.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	53	I think I can adopt a material due to students learning (e.g. students' abilities, prior knowledge, misconceptions, bias…).	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	54	I think I am aware of difficulties particular to a topic that students may encounter.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	55	I think I can use essential and effective approaches (e.g. constructivism, multiple intelligence…) to guide students' thinking and learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	56	I think I can develop traditional measurement tools (e.g. multiple choice, true-false question, open-ended questions) related with my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	57	I think I can develop alternative measurement tools (e.g. portfolio, performance, project…) related with my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	58	I think I can prepare a comprehensive lesson plan that includes attractive activities, different materials.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	59	I think I can reach gains identified in the lesson plan.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	60	I think I can link interrelated topics in my content area.	(1)	(2)	(3)	(4)	(5)	(6)	(7)

			Strongly Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Strongly Agree
TPACK	61	I think I can use technology in determining the reasons of student difficulties when learning specific conceptions.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	62	I think I can use technology in removing students' difficulties when teaching specific conceptions.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	63	I think I can use technology to help students build new knowledge on the existing ones.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	64	I think I can decide which technologies affect positively teaching and learning.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	65	I think I can make leadership for my colleagues to help them use their content, pedagogy (e.g. teaching methods, misconceptions, classroom management…) and technology knowledge together.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	66	I think I am aware of the relationships between knowledge of content, pedagogy (e.g. teaching methods, misconceptions, classroom management…) and technology.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	67	I think I can use technology effectively to meet the pedagogical needs (teaching methods, instructional materials, classroom management, student learning…) when teaching a particular topic.	(1)	(2)	(3)	(4)	(5)	(6)	(7)