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# Development of a TPACK Self-Efficacy Scale for Preservice Science Teachers

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# Development of a TPACK Self-efficacy Scale for Preservice Science Teachers

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## Abstract

Today, it is of great importance that teachers have pedagogical and technological knowledge in addition to content knowledge. For this reason, the present study aims to develop a TPACK self-efficacy scale for preservice science teachers by following the theoretical framework of technological pedagogical and content knowledge (TPACK), as suggested by Koehler and Mishra (2006). The scale consists of seven subscales, which are technology knowledge (TK), pedagogy knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPCK) with a total of 55 items. A total of 467 preservice science teachers from four different universities in Turkey participated in the study. The Cronbach's alpha reliability coefficient of the scale was calculated as 0.969. Following the modification suggestions, confirmatory factor analyses showed that the model fit the scale adequately. The study found significant differences between the bottom and top groups; this shows the sufficiency of the items' discriminatory powers. As the result of these analyses, it was found out that the scale had the necessary properties required for measuring the TPACK self-efficacy perceptions of preservice science teachers.

**Key words:** TPACK self-efficacy scale; Science education; Development of TPACK scale

## Introduction

Today, the qualifications expected from teachers are substantially higher compared to those expected in the past. Until two centuries ago, the teaching profession was seen as retelling the knowledge in one's content area, whereas in the minds of contemporary educators, it is a complicated concept that requires various special skills (Yiğit, 2014). Shulman (1986) provided the biggest contribution to this change in the teaching profession. With the studies conducted by Shulman (1986, 1987), teaching started to be regarded as a profession which requires pedagogical knowledge alongside content knowledge. As the education technologies immensely increased and became diversified, the perception started to prevail that teachers should have an adequate level of content knowledge, pedagogical knowledge, and technological knowledge. This idea resulted in the emergence of the concept of TPACK.

### Theoretical Framework

Almost all of the TPACK studies in the literature refer to the concept of PCK, which is also stated by Shulman (1986) in his study, as the starting point of TPACK. However, there is not a universal consensus on the scope of PCK and TPACK. Although detailed differently by different researchers, the only point on which a consensus has been formed is a theoretical model put forth by Mishra & Koehler (2006), which is formed from the intersection of three different sets and has seven subheadings (see Figure-1). In the studies conducted after the emergence of this model, researchers have deepened and widened these seven steps considering their branches and backgrounds.

*Technological Knowledge*

Technological knowledge is the knowledge of the technologies that contain a wide range from low technologies such as pencil and paper to digital technologies (Mishra & Koehler, 2006; Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). However, the technological knowledge referred to in TPACK studies is generally the

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knowledge related to digital technologies. For this reason, technological knowledge is mostly seen as the knowledge of computers, the internet/web and digital materials (Akaygun & Aslan-Tutak, 2016; Archambault & Crippen, 2009). When this perspective is widened, technological knowledge is stated as knowing and using computer software (operating system, basic office programs, and software peculiar to the area of instruction, etc.), using hardware (projection device, interactive whiteboard, etc.), using communication (internet, social networks, email, forums, chat tools, etc.) and research devices (Chuang, 2013; Handal, Campbell, Cavanagh, Petocz, & Kelly, 2013; Kaya & Dağ, 2013).

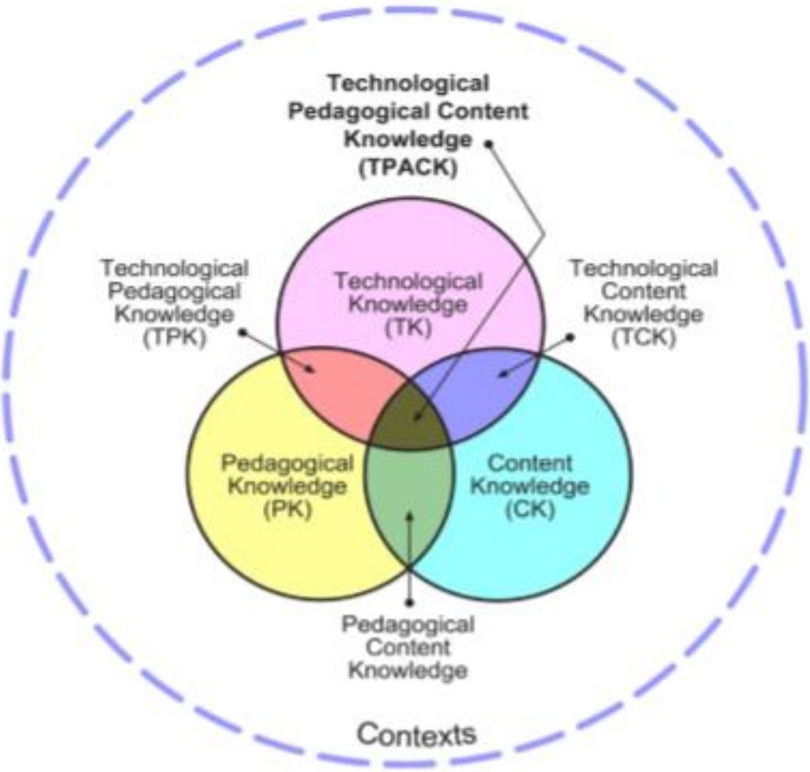


Figure 1. The TPACK framework and its knowledge components (Koehler & Mishra, 2009)

*Pedagogical Knowledge*

Pedagogical knowledge is the knowledge of teachers regarding to teaching-learning strategies, approaches, techniques and methods. The most important components of pedagogical knowledge are to understand how students learn, knowledge of general classroom management skills, lesson planning, and student assessment (Mishra & Koehler, 2006). In addition, taking the nature of the target group into consideration, helping gain a positive attitude towards learning, knowing teaching and learning theories and applying them in the classroom are within the scope of pedagogical knowledge (Abbitt, 2011; Bos, 2011; Chai, Koh, & Tsai, 2013; Kaya & Dağ, 2013; Koehler & Mishra, 2009; Schmidt et al., 2009).

*Content Knowledge*

Content knowledge is the knowledge of the subject matter to be taught or learned (Abbitt, 2011; Koehler, Mishra & Yahya, 2007). Shulman (1986) describes this subject matter knowledge as the knowledge of concepts, theories, ideas, organizational frameworks, knowledge of evidence and proof. When customized to science, in various countries content knowledge appears as certain learning areas. In science curriculums in Turkey and many other countries, these areas are listed as the knowledge of physics, chemistry, biology, astronomy, earth science, and science process skills/skills of scientific inquiry, science-technology-society and environment (MEB, 2006, 2013). Today, the teaching of the concepts of science by integrating with science processes, technology and society rather than teaching them in an isolated manner constitutes the most important focus of the standards of science education (Campbell & Smith, 2013, Lederman, Lederman, & Antink, 2013; MEB, 2006; Yager, 2013). In addition, another quality in terms of content knowledge is being aware of highly common misconceptions in science. Not providing the wrong information which results in misconceptions to students is important in terms of content knowledge (Koehler & Mishra, 2009; National Research Council, 2000; Tekkaya & Kılıç, 2012).

### *Pedagogical Content Knowledge*

According to Shulman, PCK is the knowledge of how to teach specific content knowledge (Archambault & Barnett, 2010). In other words, PCK is the pedagogical knowledge that is required in order to teach a specific content (such as science). It is matching specific content knowledge with pedagogical knowledge (Shulman, 1986). However, there is no fixed recipe for this and teachers should continuously adapt their knowledge to new situations by considering certain features such as students' characteristics, school environment etc. This is because the most important indicator of a teacher's qualifications is his/her ability to transform his/her content knowledge to a form which students at different cultural, skill and knowledge levels can learn in the best way (Shulman, 1987). PCK, which was first defined by Shulman, consists of seven components as content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge regarding learners, knowledge of educational contexts and knowledge of the purposes of education and general viewpoints (Tekkaya & Kılıç, 2012). According to Koehler, Mishra, and Yahya (2007), PCK includes the representation and formulation of concepts, pedagogical techniques, and knowledge of what makes concepts difficult or easy to learn, knowledge of students prior knowledge and theories of epistemology. At the same time, being aware and getting rid of the misconceptions and learning disabilities students have is also within the scope of PCK (Archambault & Barnett, 2010; Tekkaya & Kılıç, 2012).

### *Technological Content Knowledge*

Technological content knowledge refers to how an effective form of presentation can be created by integrating specific content area with technology (Schmidt et al, 2009). Teachers need to know not only the subject matter they are supposed to teach, but also how the teaching of this subject matter may also change when integrated with technology (Mishra & Koehler, 2006; Schmidt et al, 2009). For this reason, TCK requires understanding how technology and subject matter reciprocally affect each other (Koehler, Mishra, & Yahya, 2007). In other words, TCK is the teachers' finding out the subject matters in their areas to which specific technologies are more appropriate. While teaching content knowledge by using technology, it is necessary to be careful about which technology will be used where and how. Some technologies may be effective in teaching certain content knowledge, whereas they may not show the same effect in teaching another content knowledge (Koehler & Mishra, 2009). Similarly, while some technologies are effective when they are used if needed and for a short time in a lesson, some other technologies may be more effective when used long-term.

### *Technological Pedagogical Knowledge*

Technological pedagogical knowledge (TPK) is to understand how technology use affects teaching and learning. When constructing TPK, first of all, it is necessary to know the constraints and affordances that the use of technology may cause in a teaching environment (Koehler & Mishra, 2009). Teachers who find themselves sufficient in terms of TPK should have the ability to decide which technological device fits for educational use. At the same time, they should be able to integrate the most convenient technology with the most appropriate teaching strategy, method, technique, model, or theory. In a similar way, these teachers should be able to integrate educational technologies with measurement and assessment methods and techniques, utilize technology according to individual differences of students, and have knowledge about classroom management in classroom environments. In summary, TPK is related to presentation of pedagogical strategies and technology integration (Mishra & Koehler, 2006).

### *Technological Pedagogical Content Knowledge*

TPACK is the presentation of content knowledge by being integrated with pedagogical knowledge through using various technologies (Chai, et al, 2013).

**Literature Review about TPACK Scales**

A literature review reveals that there are numerous scale development and adaptation studies related to TPACK. While some of these studies are compatible with the theoretical framework suggested by Mishra and Kohler (2009), some others may conflict with the theoretical framework of TPACK, are formed of subscales that are different in terms of number and sometimes fall outside the theoretical framework and the items of the scale show very big differences depending on the backgrounds of the authors. Schmidt et al. (2009) developed the most commonly used and most adapted scale.

Schmidt et al. (2009) developed a seven dimensional TPACK scale that preserves the theoretical framework and includes four main courses: mathematics, science, social studies and literacy. However, the original version of the scale may not be applied to anybody, but primary teachers, kindergarden teachers, or preservice primary/kindergarden teachers, if it measures these four main courses. Although, in theory, the scale is considered as ideal, in practice, the scale can yield the expected results when applied to science teachers and preservice science teachers. Since the scale measures each of four different subject matters with three items, it causes the difficulty that the same factors are obtained when the scale is applied to a single subject and relatively few items are included in content knowledge section compared to other categories, which constitutes the weakest side of the scale in terms of science teachers and preservice science teachers. At the same time, it is observed that the seven subscales within the theoretical framework could not be obtained in the factor analysis-based adaptation studies of the scale carried out by different researchers. Again, Koh, Chai, and Tsai (2010) conducted a validity and reliability study for the TPACK scale developed by Schmidt et al. (2009) with 1185 preservice teachers in Singapore and found out that the items of the scale shifted to factors other than the original scale.

Also, the number of the factors in the scale decreased to five in his/her study. Chai et al. (2011) adapted the scale developed by Schmidt et al. (2009) in a study on primary school teachers. In their study, the scale again included five factors. Similarly, Dikkartın-Övez and Akyüz (2013) applied the same scale to mathematics teachers and obtained four factors. Sahin (2011) developed a seven dimensional scale, and this scale can be adapted to any subject. Similarly, another seven-dimensional scale was created by Archambault and Crippen (2009). Even though such all-purpose TPACK scales preserve the theoretical frame, the scale items include highly general statements, and these statements do not reveal teachers' TPACK self-efficacy level (in science, social science, math or any other subject area) in relation to content knowledge (CK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). Along with including highly general statements that can be adapted to any subject, another weakness is that some subscales of the factors in the scale cannot be clearly distinguished from each other. Therefore, the recent focus is on the scales that are customized to one subject rather than the scales that cover all subjects.

A scale with seven subscales specific to one subject was developed by Akman and Güven (2015). The content knowledge section of the scale, developed by Akman and Güven (2015), was based on the social sciences curriculum. The scale individually addresses the learning areas of social sciences in the content knowledge section constitutes the strongest side of the scale. Besides this scale, there are other TPACK scales developed specifically for mathematics and science. The scale called TPCK-M, developed by Handal et al., (2013), includes three subscales customized for mathematics as technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPCK). As for science, there is a scale with four subscales developed by Graham et al. (2009). This scale was named as TPACK confidence scale, which is specific to only science education. The scale gives more prominence to the use of technology in science education in the form of technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) compared to pedagogical and content knowledge.

## Method

In the present study, the reliability and validity of a new TPACK scale was calculated for preservice science teachers.

**Participants**

The instrument developed for this study was applied to a total of 467 senior year students at the science education departments from four different universities in Turkey. The TPACK scale was applied to the participants of the study in the spring term of 2014. The application of the scale was performed at one university from each of the northern, southern, eastern, and western regions of Turkey. The students were given 40 minutes to fill in the questionnaire. Of the preservice teachers who took part in the study, 64% (299) were females and 36% (168) were males.

### The Instrument Development Process

The scale development process started with a literature review related to TPACK. Nine trial items were written for each of all the subscales of TPACK. The initial form of the scale included 63 items. The items were evaluated by the experts who studied TPACK and science education. The necessary revisions were performed on the scale based on the experts' suggestions, and the scale was finalized. The items of the scale were transformed into Likert scale items to measure the TPACK self-efficacy perceptions of the preservice teachers. Each item of the scale had the following response categories: (1) I do not know at all, (2) I have a little knowledge, (3) I have a moderate knowledge, (4) I know well, and (5) I know very well. Afterwards, the scale was administered to the participants. Confirmatory factor analysis was performed for the construct validity of the scale. As the result of the factor analyses, the number of the items in the scale was determined as 55. To test the reliability of the scale, the internal reliability coefficient Cronbach's alpha was calculated by using SPSS 15.0 software. In addition, statistically significant difference was checked between the bottom and top group.

## Findings and Discussion

The data regarding the validity, reliability, and item analyses of the scale obtained in the scale development process are explained below.

### Validity of the Scale

The validity of the scale was maintained in two ways. The first of these was content validity and the second one was construct validity.

*Content Validity*

After the items of the scale were written, an email was sent to two faculty members from different departments who had studied TPACK and two faculty members who had studied science education and curriculum development to ask feedback about the scale. The items of the scale were revised based on the faculty members' comments. Then, the scale was administered to 4 science education graduates who are studying for their master's degree in science education and four randomly selected preservice science teachers. They provided feedback on readability, understandability, and duration. The words and sentences in the scale were corrected based on the feedback taken from these eight participants.

*Construct Validity*

Confirmatory factor analyses were performed to test the construct validity of the scale.

*Confirmatory Factor Analyses*

Confirmatory factor analyses were performed to see how appropriate the scale designed with seven subscales based on theoretical principle. The result of the confirmatory factor analyses is shown in Figure 2.

In confirmatory factor analyses, the criteria that are used to decide whether the theoretical framework support the data (Akman & Güven, 2015; Çelik, Şahin, & Aktürk, 2014; Celik, Sahin, & Aydin, 2014; Hu & Bentler, 1999; Kline, 2005). These criteria are given in Table 1.

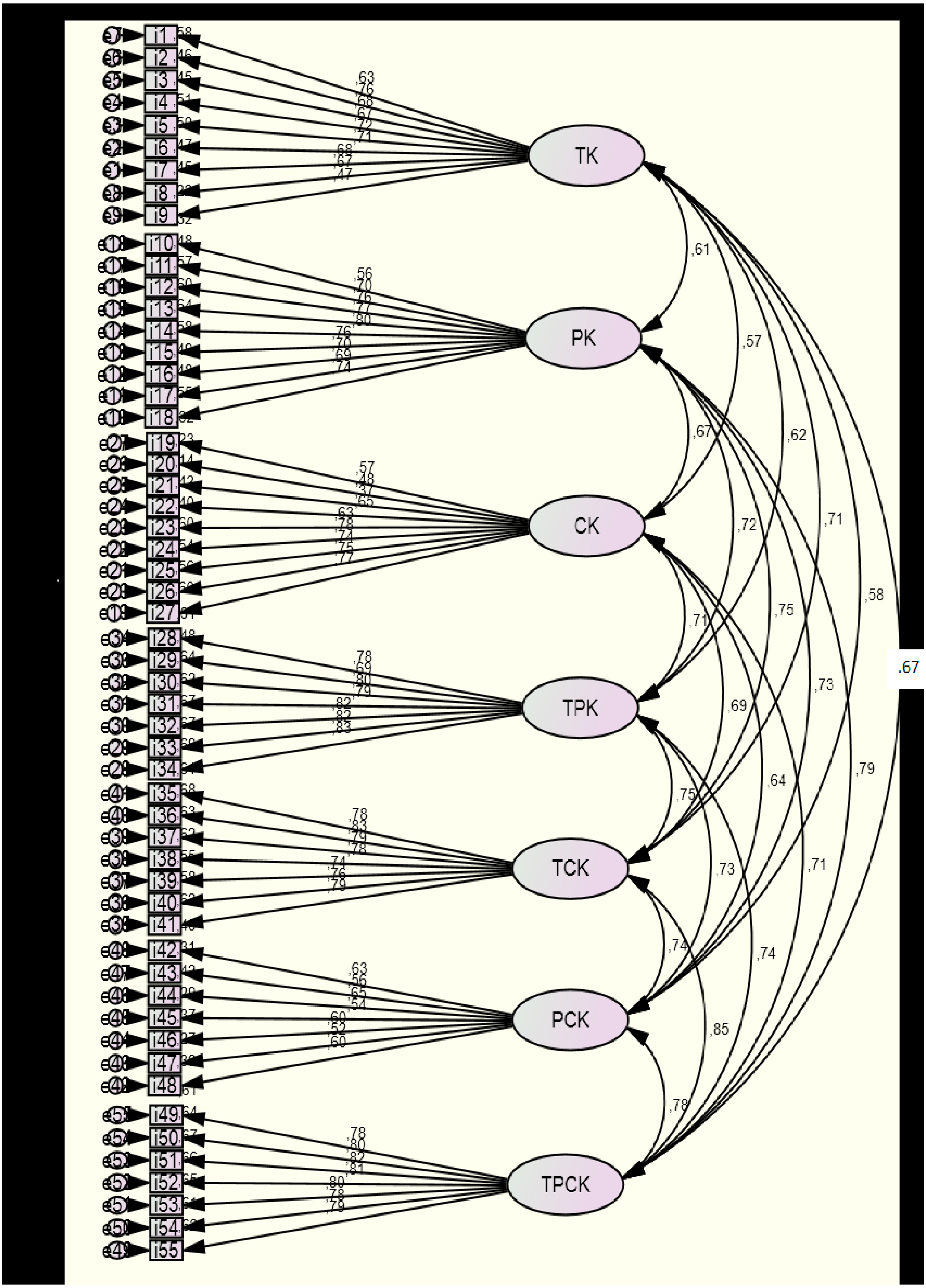


Figure2. CFA results of the seven-factor model ($\chi2$/sd=1,96, p<0.001)

Table 1. Confirmatory factor analysis fit index values

| Criterion references | Perfect fit indices | Acceptable fit indices | Indices of TPACK model |
|---|---|---|---|
| $\chi 2$ /df | ≤ 3 | ≤ 4-5 | 1.96 |
| RMSEA | ≤ 0.05 | 0.06-0.08 | 0.045 |
| NFI | ≥ 0.95 | 0.94-0.90 | 0.901 |
| CFI | ≥ 0.97 | ≥ 0.95 | 0.950 |
| GFI | ≥ 0.90 | 0.89-0.85 | 0.852 |
| AGFI | ≥ 0.90 | 0.89-0.85 | 0.855 |
| TL | ≤ 0.95 | 0.94-0.90 | 0.904 |
| RMR | ≤ 0.05 | ≤ 0,10 | 0.033 |

For the scale developed in this study, while $\chi 2$ / df=1.96, RMR=0.033, RMSEA=0.045 indicate a perfect fit, GFI= 0.852 CFI=0.950, NFI= 0.901, AGFI=0.855 and TL= 0.904 values were found to be within the acceptable fit range. These results show that the theoretical framework supports the data (Çelik, Şahin, & Aktürk, 2014; Tabachnick & Fidell, 2007).

Figure 2 shows that the regression weights among the subscales of the scale and the items existing in these subscales vary between 0.37 and 0.83. All of these values are above the acceptable breakpoint of 0.30 (Klein, 2005). The variances of these coefficients depending on the subscales of the scale are as follows: .47 and .76 in technological knowledge (TK), .56 and .80 in pedagogical knowledge (PK), .37 and .78 in content knowledge (CK), .69 and .83 in technological pedagogical knowledge (TPK), .74 and .83 in technological content knowledge (TCK), .52 and .65 in pedagogical content knowledge (PCK), .78 and .82 in technological pedagogical content knowledge (TPCK).

The correlation values between the subscales are as follows: .61 between TK and PK, .57 between TK and CK, .62 between TK and TPK, .71 between TK and TCK, .58 between TK and PCK, .67 between TK and TPCK, .67 between PK and CK, .72 between PK and TPK, .75 between PK and TCK, .79 between PK and TPCK, .71 between CK and TPK, .69 between CK and TCK, .64 between CK and PCK, .71 between CK and TPCK, .75 between TPK and TCK, .73 between TPK and PCK, .74 between TPK and TPCK, .74 between TCK and PCK, .85 between TCK and TPCK, .78 between PCK and TPCK. These indicate that there are medium and higher correlations between the subscales of the scale, which reveals the correlation between the subscales.

## Reliability

The Cronbach's alpha reliability coefficient of the developed scale was calculated respectively for each subscale and the entire scale. These coefficients, which show the internal consistency reliability, are presented in the table below.

Table2. The Cronbach's alpha reliability coefficient of scale and subscales

| **Domain** | **Cronbach's alpha** |
|---|---|
| Technological Knowledge (TK) | .875 |
| Pedagogical Knowledge (PK) | .902 |
| Content Knowledge (CK) | .866 |
| Technological Pedagogical Knowledge (TPK) | .922 |
| Technological Content Knowledge (TCK) | .916 |
| Pedagogical Content Knowledge (PCK) | .792 |
| Technological Pedagogical Content Knowledge (TPCK) | .924 |
| Overall | .969 |

The Cronbach's alpha reliability coefficients of both the entire scale and individual subscales are higher than the value of 0.70. Measurement tools with a Cronbach's alpha reliability coefficient higher than this value are regarded as reliable tools (Tavsancil, 2002).

Table 3. 27 % Top-bottom groups comparison and item-total correlation for items of TPACK Scale

| Subscales | Items | Item-total correlation | Bottom Group 27 % | | Top Group 27 % | | Comparison of Top-Bottom Groups (t value) |
|---|---|---|---|---|---|---|---|
| | | r | X | S | X | S | |
| TK | 1 | .551 | 3.50 | 0.72 | 4.55 | 0.49 | -13.37** |
| | 2 | .586 | 3.52 | 0.75 | 4.43 | 0.49 | -15.10** |
| | 3 | .554 | 3.49 | 0.70 | 4.59 | 0.53 | -13.99** |
| | 4 | .510 | 3.11 | 0.92 | 4.36 | 0.82 | -11.27** |
| | 5 | .554 | 3.52 | 0.90 | 4.71 | 0.47 | -13.14** |
| | 6 | .573 | 3.24 | 0.91 | 4.53 | 0.64 | -12.97** |
| | 7 | .510 | 3.24 | 0.97 | 4.50 | 0.73 | -11.58** |
| | 8 | .510 | 3.17 | 0.93 | 4.35 | 0.78 | -10.85** |
| | 9 | .304 | 3.45 | 0.88 | 4.17 | 0.85 | -6.58** |
| PK | 10 | .531 | 3.16 | 1.04 | 4.44 | 0.63 | -11.73** |
| | 11 | .561 | 3.54 | 0.87 | 4.69 | 0.49 | -12.77** |
| | 12 | .651 | 3.48 | 0.84 | 4.82 | 0.40 | -16.07** |
| | 13 | .639 | 3.57 | 0.74 | 4.78 | 0.44 | -15.71** |
| | 14 | .679 | 3.41 | 0.71 | 4.79 | 0.44 | -18.35** |
| | 15 | .619 | 3.48 | 0.73 | 4.67 | 0.51 | -14.86** |
| | 16 | .620 | 3.29 | 0.91 | 4.65 | 0.49 | -14.67** |
| | 17 | .606 | 3.44 | 0.82 | 4.75 | 0.45 | -15.54** |
| | 18 | .676 | 3.31 | 0.83 | 4.67 | 0.50 | -15.61** |
| CK | 19 | .506 | 2.78 | 0.82 | 3.88 | 0.69 | -11.44** |
| | 20 | .351 | 3.25 | 0.95 | 4.03 | 0.83 | -6.96** |
| | 21 | .299 | 3.69 | 0.88 | 4.28 | 0.73 | -5.82** |
| | 22 | .541 | 2.70 | 0.93 | 4.11 | 0.79 | -12.90** |
| | 23 | .509 | 2.76 | 0.83 | 3.96 | 0.83 | -11.41** |
| | 24 | .630 | 3.21 | 0.73 | 4.57 | 0.54 | -16.69** |
| | 25 | .598 | 3.29 | 0.83 | 4.60 | 0.53 | -14.86** |
| | 26 | .619 | 3.20 | 0.80 | 4.48 | 0.61 | -14.16** |
| | 27 | .653 | 3.12 | 0.85 | 4.51 | 0.61 | -14.76** |
| TPK | 28 | .603 | 3.11 | 0.82 | 4.54 | 0.64 | -15.47** |
| | 29 | .597 | 3.25 | 0.86 | 4.53 | 0.61 | -13.49** |
| | 30 | .708 | 3.08 | 0.82 | 4.69 | 0.47 | -18.88** |
| | 31 | .705 | 2.90 | 0.82 | 4.68 | 0.50 | -20.70** |
| | 32 | .686 | 3.03 | 0.81 | 4.53 | 0.57 | -16.80** |
| | 33 | .696 | 3.10 | 0.80 | 4.69 | 0.49 | -18.90** |
| | 34 | .725 | 3.18 | 0.82 | 4.79 | 0.42 | -19.50** |
| TCK | 35 | .703 | 3.20 | 0.77 | 4.62 | 0.50 | -17.30** |
| | 36 | .719 | 3.32 | 0.74 | 4.67 | 0.47 | -17.16** |
| | 37 | .691 | 3.38 | 0.71 | 4.70 | 0.45 | -17.42** |
| | 38 | .699 | 3.38 | 0.75 | 4.71 | 0.50 | -16.45** |
| | 39 | .665 | 3.29 | 0.75 | 4.65 | 0.49 | -16.92** |
| | 40 | .689 | 3.30 | 0.72 | 4.55 | 0.52 | -15.63** |
| | 41 | .698 | 3.30 | 0.70 | 4.69 | 0.48 | -18.22** |
| PCK | 42 | .522 | 3.08 | 1.08 | 4.50 | 0.77 | -11.97** |
| | 43 | .403 | 3.19 | 1.11 | 4.34 | 0.75 | -9.53** |
| | 44 | .569 | 3.37 | 0.81 | 4.48 | 0.76 | -11.13** |
| | 45 | .434 | 3.61 | 0.77 | 4.51 | 0.72 | -9.54** |
| | 46 | .490 | 3.50 | 0.88 | 4.42 | 0.72 | -9.06** |
| | 47 | .405 | 3.52 | 0.80 | 4.25 | 0.73 | -7.49** |
| | 48 | .517 | 3.21 | 0.83 | 4.30 | 0.83 | -10.41** |
| TPACK | 49 | .737 | 3.19 | 0.75 | 4.63 | 0.53 | -17.40** |
| | 50 | .705 | 3.34 | 0.73 | 4.67 | 0.51 | -16.57** |
| | 51 | .750 | 3.08 | 0.76 | 4.65 | 0.47 | -19.36** |
| | 52 | .723 | 3.15 | 0.74 | 4.64 | 0.49 | -18.64** |
| | 53 | .690 | 3.23 | 0.73 | 4.60 | 0.50 | -17.19** |
| | 54 | .708 | 3.09 | 0.80 | 4.61 | 0.56 | -17.30** |
| | 55 | .700 | 3.15 | 0.88 | 4.69 | 0.51 | -16.74** |

*Test-Re-Test Reliability Analysis*

Six weeks after the first administration, the test was administered again to one of the groups. The correlation between the results of this re-test conducted on 63 students, and their previous results was examined. The correlation coefficient was calculated as 0.82 ($p<0.001$). This value shows the consistency of the test over time (Büyüköztürk et al., 2011; Büyüköztürk, 2012).

*Item Analysis*

An independent samples *t* test was used to check whether there was a statistically significant difference between the top and bottom groups to determine the item discrimination of the scale items. At the same time, the correlation of each item with the total score was computed. Table 3 presents these results which reveal the item discrimination of the scale items.

When Table 3 is examined, the t values varied between -20.70 and -5.82, and there was a statistically significant relationship between the bottom and top groups. At the same time, a positive significant correlation was found between each item and the total items. These findings show that the discriminatory power of the test was substantially high. The high discriminatory power of the test is an indicator of its reliability (Büyüköztürk et al., 2011; Büyüköztürk, 2012).

## Conclusion

This study aims to develop a scale that assesses the TPACK self-efficacy of preservice science teachers. In accordance with the theoretical framework suggested by Mishra and Kohler (2006), the scale developed in the study includes a total of 7 subscales as Technology Knowledge (TK), Pedagogy Knowledge (PK), Content Knowledge (CK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPCK). The subscales of this 55-item scale were determined and confirmed by using confirmatory factor analyses. One of the strong sides of the scale is that it includes subscales that are consistent with the theoretical framework suggested by Kohler and Mishra (2006).

The most distinctive feature of the scale is the Content Knowledge subscale. While current TPACK scales measure content knowledge in general terms, the scale developed in this study was customized to science learning areas. In particular, the broad-fields curriculum design approach combines large program areas into a single course, like science and social science; therefore, measuring each subject area is given importance. The scale represents physical science, chemistry, biology, earth science, and astronomy, as individual items, constitutes one of its strongest sides. Besides, another strong side of the scale is that items related to science process skills/skills of scientific inquiry and science-technology-society-environment, which have become an indispensable part of science education, are included as a subscale in our scale. Another remarkable feature of the scale is that common misconceptions in science are included in content knowledge.

Although not as impressive as content knowledge, another important feature of the scale is that the items of the scale were written by grouping a wide range of technologies from traditional technologies to digital technologies and the internet under certain themes (e.g. digital software, social networks, science lab materials, basic software, mobile learning tools, etc.). In the scales presented in the literature, the names of these technologies are listed individually. In the present study, however, names related to technology are given in parenthesis as examples to these main titles. This feature of the scale contributes to the prolongation of the lifetime of technology, which is the fastest changing subscale of TPACK scales.

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The scale developed in this study can be used by other researchers with an appropriate citation. There is no requirement to get permission from the author.

## References


Abbitt, J.T. (2011). An Investigation of the Relationship between Self-Efficacy Beliefs about Technology Integration and Technological Pedagogical Content Knowledge (TPACK) among Preservice Teachers. *Journal of Digital Learning in Teacher Education, 27*(4), 134-143.

Akaygun, S. & Aslan-Tutak, F. (2016). STEM images revealing stem conceptions of pre-service chemistry and mathematics teachers. *International Journal of Education in Mathematics, Science and Technology, 4*(1), 56-71. DOI:10.18404/ijemst.44833.

Akman, O., & Guven, C. (2015). TPACK survey development study for social sciences teachers and teacher candidates. *International Journal of Research in Education and Science (IJRES), 1*(1), 1-10.

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education, 9*(1), 71-88.

Archambault, L.M., & Barnett, J.H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education, 55* (4), 1656-1662.

Bos, B. (2011). Professional development for elementary teachers using TPACK. *Contemporary Issues in Technology and Teacher Education, 11*(2), 167-183.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş., & Demirel, F. (2011). *Bilimsel araştırma yöntemleri (12. baskı)*. Ankara: PegemA Yayıncılık.

Büyüköztürk, Ş. (2012). *Veri Analizi El Kitabı (Onaltıncı baskı).* Ankara: PegemA Yayıncılık.

Campbell, T., & Smith, E. (2013). Envisioning the changes in teaching framed by the National Science Education Standards-Teaching Standards. *International Journal of Education in Mathematics, Science and Technology, 1*(3), 162-183.

Chai, C.S., Koh, J. H.L., Tsai, C.C., & Tan, L.L.W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education, 57* (1), 1184–1193.

Chai, C.S., Koh, J. H.L., & Tsai, C.C. (2013). A Review of technological pedagogical content knowledge. *Educational Technology & Society, 16* (2), 31–51.

Chuang, H. (2013). A case study of e-tutors' teaching practice: Does technology drive pedagogy? *International Journal of Education in Mathematics, Science and Technology, 1*(2), 75- 82.

Celik, I., Sahin, I., & Aktürk, A.O. (2014). Analysis of the relations among the components of technological pedagogical and content knowledge (TPACK): A structural equation model. *Journal of Educational Computing Research, 51*(1), 1-22.

Celik, I., Sahin, I., & Aydin, M. (2014). Reliability and validity study of the Mobile Learning Adoption Scale developed based on the Diffusion of Innovations Theory. *International Journal of Education in Mathematics, Science and Technology, 2*(4), 300-316.

Dikkartın-Övez, F.T., & Akyüz, G. (2013). İlköğretim Matematik Öğretmeni Adaylarının Teknolojik Pedagojik Alan Bilgisi Yapılarının Modellenmesi. *Eğitim ve Bilim, 38*, 170.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., St. Clair, L., & Harris, R. (2009). TPACK Development in Science Teaching: Measuring the TPACK Confidence of Inservice Science Teachers. *TechTrends, Special Issue on TPACK, 53*(5), 70-79.

Handal, B., Campbell, C., Cavanagh, M., Petocz, P., & Kelly, N. (2013). Technological pedagogical content knowledge of secondary mathematics teachers. *Contemporary Issues in Technology and Teacher Education, 13*(1), 22-40.

Hu, L., & Bentler, P. M. (1999). Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.

Kaya, S., & Dağ, F. (2013). Sınıf öğretmenlerine yönelik teknolojik pedagojik içerik bilgisi ölçeğinin Türkçe'ye uyarlanması. *Kuram ve Uygulamada Eğitim Bilimleri, 13*(1), 291-306.

Kaya, Z., Kaya, O.N., & Emre, İ. (2013). Teknolojik Pedagojik Alan Bilgisi (TPAB) Ölçeği'nin Türkçeye Uyarlanması, *Kuram ve Uygulamada Eğitim Bilimleri, 13*(4), 2355-2377.

Kline, R. B. (2005). *Principles and practice of structural equation modeling (2nd ed.).* New York: Guilford Press.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

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

Koh, J.H.L., Chai, C.S., & C.C. Tsai. (2010). Examining the technological pedagogical content knowledge of Singapore preservice teachers with a large-scale survey. *Journal of Computer Assisted Learning, 26,* 563-573.

Lederman, N.G., Lederman, J.S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. *International Journal of Education in Mathematics, Science and Technology, 1*(3), 138-147.

MEB (2006). *Fen ve teknoloji dersi öğretim programı*. Retrieved January 6, 2015, from http://ttkb.meb.gov.tr/program2.aspx?islem=1&kno=25.

MEB (2013). *Fen bilimleri dersi öğretim programı.* Retrieved January 6, 2015, http://ttkb.meb.gov.tr/program2.aspx?islem=1&kno=213.

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

National Research Council. (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

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

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123-149.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review, 57*(1), 1-22.

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental designs using ANOVA*. Thomson/Brooks/Cole.

Tavşancıl, E. (2002). *Tutumların ölçülmesi ve SPSS ile veri analizi, 1. Baskı,* Ankara: Nobel Yayınevi.

Tekkaya, C., & Kılıç, D.S. (2012). Biyoloji öğretmen adaylarının evrim öğretimine ilişkin pedagojik alan bilgileri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 42*, 406-417.

Yager, R.E. (2013). Successes and continuing challenges: Implementing the changes in Professional development for teachers in the U.S. *International Journal of Education in Mathematics, Science and Technology, 1*(3), 184 – 189.

Yigit, M. (2014). A review of the literature: How preservice mathematics teachers develop their technological, pedagogical, and content knowledge. *International Journal of Education in Mathematics, Science and Technology, 2*(1), 26-35.

## Appendix A – TPACK-Science Self Efficacy Scale (English Version)

**Dear Colleague;**

This questionnaire is designed to investigate the relationship between *preservice science teachers'* technological, pedagogical, and content knowledge. Your answers will be used for the research purposes. Your identity and answers will be kept confidential. Your sincere responses to the questionnaire are highly important to determine the validity and reliability of the study. The numbers presented on the right side of the page refer to your level of perception regarding the statements: (1) I do not know at all, (2) I have a little knowledge, (3) I have a moderate knowledge, (4) I know well, and (5) I know very well. Please, cross or circle the number of the statement from 1 to 5 that corresponds to your perception level. Thank you for your contribution and time.

**TPACK-Science Self Efficacy Scale**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | How to use the materials used in the teaching-learning process in a science laboratory (activity/experiment materials like microscope, radiometer, dynamometer, thermometer) | 1 | 2 | 3 | 4 | 5 |
| 2. | How to use the electronics-based teaching technologies (computer, projection, television, camera, video, etc.) | 1 | 2 | 3 | 4 | 5 |
| 3. | How to use the essential software programs (Word, Excel, and PowerPoint etc.) | 1 | 2 | 3 | 4 | 5 |
| 4. | How to use interactive technological learning tools (interactive whiteboard/LCD panel, tablet, digital course book, etc.) | 1 | 2 | 3 | 4 | 5 |
| 5. | How to use mobile learning tools (tablet, mobile phone etc.) with internet support | 1 | 2 | 3 | 4 | 5 |
| 6. | How to use multimedia (video clips, animation, simulation, virtual lab, etc.) | 1 | 2 | 3 | 4 | 5 |
| 7. | How to create distance learning environments through social networks that provide audio and visual communication (skype, messenger etc.) | 1 | 2 | 3 | 4 | 5 |
| 8. | How to use digital software (java simulation, inspiration, graphic calculator etc.) | 1 | 2 | 3 | 4 | 5 |
| 9. | How to create a social environment on the internet (discussion boards, wikis, web blogs, electronic document sharing) | 1 | 2 | 3 | 4 | 5 |
| 10 | How to develop daily, yearly and unit plans | 1 | 2 | 3 | 4 | 5 |
| 11 | How to use classical (multiple choice, fill-in the blanks, etc.) and alternative/complementary (Portfolio, rubric etc.) measurement and assessment tools for evaluating student performance | 1 | 2 | 3 | 4 | 5 |
| 12 | How to use different teaching strategies (verbal learning, discovery learning, inquiry-based learning, etc.) | 1 | 2 | 3 | 4 | 5 |
| 13 | How to use different teaching methods (Problem-based learning, Project based learning etc.) | 1 | 2 | 3 | 4 | 5 |
| 14 | How to use different teaching techniques (Brainstorming, Six thinking hats, Analogy, Metaphor, Station, drama, snowball, exhibition, panel, forum, etc.) | 1 | 2 | 3 | 4 | 5 |
| 15 | How to use different teaching-learning approaches, and theories (behaviorist, constructivist, multiple intelligence, etc.) | 1 | 2 | 3 | 4 | 5 |
| 16 | How to teach based on different teaching-learning models (5E, 7E learning models etc.) | 1 | 2 | 3 | 4 | 5 |
| 17 | How to plan lessons by taking the individual differences of the students into consideration | 1 | 2 | 3 | 4 | 5 |
| 18 | Classroom management according to different teaching-learning approaches | 1 | 2 | 3 | 4 | 5 |
| 19 | Adequate content knowledge of physics for my profession | 1 | 2 | 3 | 4 | 5 |
| 20 | Adequate content knowledge of chemistry for my profession | 1 | 2 | 3 | 4 | 5 |
| 21 | Adequate content knowledge of biology for my profession | 1 | 2 | 3 | 4 | 5 |
| 22 | Adequate content knowledge of astronomy for my profession | 1 | 2 | 3 | 4 | 5 |
| 23 | Adequate content knowledge of earth science for my profession | 1 | 2 | 3 | 4 | 5 |
| 24 | Content knowledge regarding the interaction of science-technology-society-environment | 1 | 2 | 3 | 4 | 5 |
| 25 | Content knowledge regarding scientific process skills and the nature of science | 1 | 2 | 3 | 4 | 5 |
| 26 | The common scientific misconceptions | 1 | 2 | 3 | 4 | 5 |
| 27 | Content knowledge regarding the concepts, principles, generalizations, theories and laws of Science | 1 | 2 | 3 | 4 | 5 |
| 28 | How to use the technologies that are suitable to different teaching theories, approaches and models | 1 | 2 | 3 | 4 | 5 |
| 29 | How to use the technologies that are suitable to different teaching strategies, methods and techniques | 1 | 2 | 3 | 4 | 5 |
| 30 | How to utilize technology according to students' individual differences | 1 | 2 | 3 | 4 | 5 |
| 31 | How to utilize technology while carrying out measurement and assessment (electronic portfolio, online test, online rubric etc.) | 1 | 2 | 3 | 4 | 5 |
| 32 | How to decide whether a new technology is suitable for teaching | 1 | 2 | 3 | 4 | 5 |
| 33 | Classroom management while using different teaching technologies | 1 | 2 | 3 | 4 | 5 |
| 34 | How to use technology in a way that affects learning positively | 1 | 2 | 3 | 4 | 5 |
| 35 | How to decide on the appropriate teaching technologies for different learning areas of Science (physics, chemistry, biology, astronomy …) | 1 | 2 | 3 | 4 | 5 |
| 36 | How to utilize technology in a way that enables to learn the concepts of science better | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 37 | How to choose the technologies that will enable to learn Science content knowledge more easily | 1 | 2 | 3 | 4 | 5 |
| 38 | How to decide on the technologies that will enable to learn Science content knowledge in a meaningful way | 1 | 2 | 3 | 4 | 5 |
| 39 | How to decide on the appropriate technologies depending on the characteristics of Science content knowledge (simulation for teaching electrics, using models for teaching DNA, etc.) | 1 | 2 | 3 | 4 | 5 |
| 40 | How to integrate my knowledge about the learning areas of science with appropriate teaching technologies | 1 | 2 | 3 | 4 | 5 |
| 41 | How to utilize technology at the correct place and inadequate time while teaching science content | 1 | 2 | 3 | 4 | 5 |
| 42 | How to prepare lesson plans in accordance with the outcomes stated in science curriculum | 1 | 2 | 3 | 4 | 5 |
| 43 | How to choose the theories, approaches, models, strategies, methods and techniques that are appropriate to the outcomes stated in science curriculum | 1 | 2 | 3 | 4 | 5 |
| 44 | How to evaluate by using the assessment tools that are appropriate to the outcomes stated in science curriculum | 1 | 2 | 3 | 4 | 5 |
| 45 | How to design in-class and out-of-class activities that are appropriate to the outcomes stated in science curriculum | 1 | 2 | 3 | 4 | 5 |
| 46 | How to prepare science content by taking the students' individual differences into consideration | 1 | 2 | 3 | 4 | 5 |
| 47 | How I can teach the concepts of science in a more comprehensible and thorough way | 1 | 2 | 3 | 4 | 5 |
| 48 | How to resolve common misconceptions in science | 1 | 2 | 3 | 4 | 5 |
| 49 | How to integrate the outcomes of science with appropriate strategies, methods, techniques, and technologies | 1 | 2 | 3 | 4 | 5 |
| 50 | How to choose the appropriate strategies, methods, techniques and technologies that will enable to learn Science content better | 1 | 2 | 3 | 4 | 5 |
| 51 | How to decide on the appropriate pedagogical and technological applications for the learning areas of science (physics, chemistry, biology, astronomy, earth science, etc.) | 1 | 2 | 3 | 4 | 5 |
| 52 | How to integrate my content knowledge with my pedagogical and technological knowledge in a way that will increase the value of students' learning | 1 | 2 | 3 | 4 | 5 |
| 53 | How to adapt the emerging strategies, methods, techniques, models, and technologies to the outcomes of science | 1 | 2 | 3 | 4 | 5 |
| 54 | How to guide my colleagues in integrating the outcomes of science with appropriate technologies and pedagogies | 1 | 2 | 3 | 4 | 5 |
| 55 | How to restructure my content knowledge by using my technological and pedagogical knowledge in a way different from the presentation style of knowledge in the course book | 1 | 2 | 3 | 4 | 5 |

## Appendix B – TPACK-Science Self Efficacy Scale (Turkish Version)

**Sevgili meslektaşım;**

Bu anket *fen bilgisi öğretmen adaylarının* teknoloji, pedagoji ve alan bilgisi arasındaki ilişkiyi araştırmak için düzenlenmiştir. Ankette vereceğiniz cevaplar araştırma amaçlı kullanılacak olup kimliğiniz ve cevaplarınız kesinlikle gizli tutulacaktır. İçtenlikle vereceğiniz cevaplar araştırmanın geçerliği ve güvenirliği açısından büyük önem arz etmektedir. Sayfanın sağ tarafındaki rakamlar önermelere ilişkin algı düzeyinizi ifade etmektedir: ***(1) Hiç Bilmem, (2) Az Düzeyde Bilirim, (3) Orta Düzeyde Bilirim, (4) İyi Düzeyde Bilirim, (5) Çok İyi Düzeyde Bilirim.*** Sizlerden istenen aşağıda verilen önermelere karşılık gelen algı düzeyinizi 1 den 5 e kadar olan ifadelerden uygun olanı çarpı işareti ya da yuvarlak içine alarak işaretlemenizdir. Değerli katkılarınız için teşekkür ederiz.

**TPAB-Fen Öz Yeterlik Ölçeği**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Fen laboratuvarlarında bulunan öğretme-öğrenme sürecine yönelik materyalleri (mikroskop, radyometre, dinamometre, termometre gibi etkinlik/deney malzemeleri) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 2 | Elektronik temelli öğretim teknolojilerini (bilgisayar, projeksiyon, televizyon, kamera, video vb) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 3 | Temel yazılım programlarını (Word, excell, powerpoint v.b) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 4 | Etkileşimli teknolojik öğrenme araçlarını (akıllı tahta/LCD panel, tablet, dijital ders kitabı v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 5 | Mobil öğrenme araçlarını (tablet, mobil telefon v.b) internet destekli kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 6 | Çoklu medya ortamlarını (video klibi, animasyon, simülasyon, sanal lab v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 7 | Sesli ve görüntülü iletişim sağlayan sosyal iletişim ağları (skype, messanger v.b.) ile uzaktan öğrenme ortamları oluşturmayı | 1 | 2 | 3 | 4 | 5 |
| 8 | Dijital yazılım programlarını (java simulasyon, inspiration, grafik hesap makinesi v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 9 | Internet üzerinden sosyal ortam (discussion boards, wikis, web blogs, elektronik doküman paylaşma) oluşturmayı | 1 | 2 | 3 | 4 | 5 |
| 10 | Günlük, yıllık ve ünitelendirilmiş plan geliştirmeyi | 1 | 2 | 3 | 4 | 5 |
| 11 | Öğrenci performansını değerlendirirken klasik(çoktan seçmeli test, boşluk doldurma v.b.) ve alternatif/tamamlayıcı (portfolio, rubrik v.b.) ölçme değerlendirme araçlarını kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 12 | Farklı öğretim stratejilerini (Sunuş, Buluş, Araştırma-inceleme v.b. ) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 13 | Farklı öğretim yöntemlerini (Probleme Dayalı öğrenme, Proje tabanlı öğrenme v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 14 | Farklı öğretim tekniklerini (Beyin fırtınası, Altı Şapkalı Düşünme, Analoji, Metafor, İstasyon, drama, kartopu, sergi, panel, forum v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 15 | Farklı öğretme-öğrenme yaklaşım ve kuramlarını (davranışçı, yapılandırmacı, çoklu zeka v.b.) kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 16 | Farklı öğretme-öğrenme modellerine (5E,7E öğrenme modelleri v.b.) göre öğretim yapmayı | 1 | 2 | 3 | 4 | 5 |
| 17 | Öğrencilerin bireysel farklılıklarını dikkate alarak ders planlamayı | 1 | 2 | 3 | 4 | 5 |
| 18 | Farklı öğretme-öğrenme anlayışlarına göre sınıf yönetimini | 1 | 2 | 3 | 4 | 5 |
| 19 | Fizik ile ilgili mesleğim için yeterli alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 20 | Kimya ile ilgili mesleğim için yeterli alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 21 | Biyoloji ile ilgili mesleğim için yeterli alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 22 | Astronomi ile ilgili mesleğim için yeterli alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 23 | Yerbilimleri ile ilgili mesleğim için yeterli alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 24 | Fen-teknoloji- toplum- çevre etkileşimiyle ilgili alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 25 | Bilimsel süreç becerileri ve bilimin doğası ile ilgili alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 26 | Fen dersindeki yaygın kavram yanılgılarının neler olduğunu | 1 | 2 | 3 | 4 | 5 |
| 27 | Fen dersine ait kavramlar, ilkeler, genellemeler, teoriler ve yasalar ile ilgili alan bilgisini | 1 | 2 | 3 | 4 | 5 |
| 28 | Farklı öğretim teorilerine, yaklaşımlarına ve modellerine uygun teknolojileri kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 29 | Farklı öğretim stratejilerine, yöntemlerine ve tekniklerine uygun teknolojileri kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 30 | Öğrencilerin bireysel farklılıklarına göre teknolojiden faydalanmayı | 1 | 2 | 3 | 4 | 5 |
| 31 | Ölçme ve değerlendirme yaparken teknolojiden (elektronik portfolyo, online test, online rubrik v.b) faydalanmayı | 1 | 2 | 3 | 4 | 5 |
| 32 | Yeni bir teknolojinin öğretime uygunluğuna karar vermeyi | 1 | 2 | 3 | 4 | 5 |
| 33 | Farklı öğretim teknolojilerini kullanırken sınıf yönetimini | 1 | 2 | 3 | 4 | 5 |
| 34 | Teknolojiyi öğrenmeyi olumlu etkileyecek şekilde kullanmayı | 1 | 2 | 3 | 4 | 5 |
| 35 | Fen dersinin farklı öğrenme alanları (fizik, kimya, biyoloji, astronomi …) için uygun öğretim teknolojilerine karar vermeyi | 1 | 2 | 3 | 4 | 5 |
| 36 | Fen kavramlarını daha iyi öğrenmeyi sağlayacak şekilde teknolojiden faydalanmayı | 1 | 2 | 3 | 4 | 5 |
| 37 | Fen dersine ait içerik bilgisini daha kolay öğrenmeyi sağlayacak teknolojileri seçmeyi | 1 | 2 | 3 | 4 | 5 |
| 38 | Fen dersi içerik bilgisinin anlamlı öğrenilmesini sağlayacak teknolojilere karar vermeyi | 1 | 2 | 3 | 4 | 5 |
| 39 | Fen dersindeki içerik bilgisinin özelliğine göre uygun teknolojilere (elektriğin öğretiminde | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | simülasyon, DNA'nın öğretiminde model kullanma v.b. ) karar vermeyi | | | | | |
| 40 | Fen dersi öğrenme alanlarına ait bilgilerimi uygun öğretim teknolojileri ile bütünleştirmeyi | 1 | 2 | 3 | 4 | 5 |
| 41 | Fen dersine ait içeriği öğretirken doğru yerde ve yeterli sürede teknolojiden faydalanmayı | 1 | 2 | 3 | 4 | 5 |
| 42 | Fen programında yer alan kazanımlara uygun ders planı hazırlamayı | 1 | 2 | 3 | 4 | 5 |
| 43 | Fen programında yer alan kazanımlara uygun öğretme teori, yaklaşım, model, strateji, yöntem ve teknikleri seçmeyi | 1 | 2 | 3 | 4 | 5 |
| 44 | Fen programında yer alan kazanımlara uygun ölçme araçları ile değerlendirme yapmayı | 1 | 2 | 3 | 4 | 5 |
| 45 | Fen programında yer alan kazanımlara uygun sınıf içi ve sınıf dışı etkinlik tasarlamayı | 1 | 2 | 3 | 4 | 5 |
| | Öğrencilerin bireysel farklılıklarını dikkate alarak fen dersi içeriği hazırlamayı | 1 | 2 | 3 | 4 | 5 |
| 47 | Fen kavramlarını nasıl daha kolay anlaşılır ve derinlemesine öğreteceğimi | 1 | 2 | 3 | 4 | 5 |
| 48 | Fen dersindeki yaygın kavram yanılgılarını nasıl gidereceğimi | 1 | 2 | 3 | 4 | 5 |
| 49 | Fen dersi kazanımlarını uygun stratejiler,yöntemler,teknikler ve teknolojiler ile bütünleştirmeyi | 1 | 2 | 3 | 4 | 5 |
| 50 | Fen dersi içeriğinin daha iyi öğrenilmesini sağlayacak uygun stratejileri, yöntemleri, teknikleri ve teknolojileri seçmeyi | 1 | 2 | 3 | 4 | 5 |
| 51 | Fenin öğrenme alanlarına (fizik, kimya, biyoloji, astronomi, yer bilimi v.b.) göre uygun pedagojik ve teknolojik uygulamalara karar vermeyi | 1 | 2 | 3 | 4 | 5 |
| 52 | Öğrencilerin öğrenmesinin değerini artıracak şekilde alan bilgimi, pedagoji ve teknoloji bilgim ile bütünleştirmeyi | 1 | 2 | 3 | 4 | 5 |
| 53 | Yeni çıkan strateji, yöntem, teknik, model ve teknolojileri fen kazanımlarına uyarlamayı | 1 | 2 | 3 | 4 | 5 |
| 54 | Meslektaşlarıma fen kazanımlarının uygun teknolojiler ve pedagojiler ile bütünleştirilmesi konusunda öncülük etmeyi | 1 | 2 | 3 | 4 | 5 |
| 55 | Ders kitabındaki bilginin sunuluş şeklinden farklı şekilde teknoloji ve pedagoji bilgimi kullanarak alan bilgisini yeniden yapılandırabilmeyi | 1 | 2 | 3 | 4 | 5 |