

INVESTIGATION OF PRE-SERVICE BIOLOGY TEACHERS' SELF-CONFIDENCE CONCERNING TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE WITH RESPECT TO SOME VARIABLES

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The present study aims to determine pre-service biology teachers' self-confidence levels concerning their technological pedagogical content knowledge with respect to variables namely class level and computer knowledge. Designed as a survey, 91 pre-service teachers enrolled in the biology education programme participated in the study. Data were collected by using the Technological Pedagogical Content Knowledge Self-Confidence Scale developed by Graham, Burgoyne, Cantrell, Smith, Clair and Harris (2009) and adapted in Turkish by Timur and Tasar (2011). Findings of the study show that pre-service teachers have a high self-confidence concerning their technological pedagogical content knowledge. It was also found that there was no significant difference in pre-service teachers' self-confidence with respect to the class level. However, it was found that pre-service teachers who had enrolled in a computer course during their education had higher self-confidence.

KEYWORDS: Pre-Service Biology Teachers, Technological Pedagogical Content Knowledge, Self-Confidence

INTRODUCTION

Proficiency level of a teacher is significantly important on the learning processes of students (Gibson & Dembo, 1984). Thus, it is likewise important for teachers to be educated to have the necessary proficiencies. At this point,

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what the teachers' proficiencies are has become the subject of many studies. When literature is examined, it can be seen that teacher proficiencies are defined in various ways (Grossmann, 1990; Hill, Ball & Schilling, 2008; Shulman, 1987). Especially Shulman's study (1986; 1987) where he defined and classified teacher knowledge was widely accepted and has been the pioneer to various other studies. Shulman (1986) argues that teachers knowledge consists of three basic categories, namely, content knowledge, curriculum knowledge, and pedagogical content knowledge. Shulmans (1987) study on teacher knowledge divided it into seven categories as content knowledge, curriculum knowledge, general pedagogical knowledge, knowledge of learners and their characteristics, knowledge of educational context, and finally, knowledge of educational ends. Contributing to literature by coining the term "pedagogical content knowledge," he underlined the connection between pedagogy and content knowledge; and he argued that it is not enough for teachers to have knowledge on the topic but that they require to have a special knowledge domain concerning the teaching of the content knowledge. He called this knowledge domain pedagogical content knowledge and defined it as knowledge related to how content knowledge can be translated into a form that is easily comprehensible for students (Shulman, 1986; 1987). Teachers, thanks to their pedagogical content knowledge, can decide on how students can understand a topic better, which methods and strategies are more appropriate for the teaching of a topic, and which concepts students may face difficulties in understanding. Seen from this angle, the importance of pedagogical content knowledge is much better understood. With the increasing use of technology in teaching in recent years, researchers have added technological pedagogical content knowledge as a concept to teacher proficiencies in addition to pedagogical content knowledge (Cox, 2008; Koehler, Mishra & Yahya, 2007; Mishra & Koehler, 2006).

Technological knowledge is a significant sign of a society's development level. In developed societies, there is a certain generation of technological information along with people with the proper proficiency to use this technology. In this respect, technological literacy has become an important need in this age which we call the age of technology. Teachers who are technologically literate are expected to use their knowledge in creating more effective learning-teaching environments by relating this with their content knowledge and pedagogical knowledge (Koehler & Mishra, 2009; Mishra & Koehler, 2006). Various studies have put forth that using technology in learning-teaching processes significantly increases success (Aycan, Ari, Turkoguz, Sezer & Kaynar, 2002; Bozkurt & Sarikoc, 2008; Gonen, Kocakaya & Inan, 2006; Pektas, Turkmen & Solak, 2006; Serin, 2011; Tas, Kose & Cepni,

2006). In Turkey, digital proficiency is among the proficiencies in the revised curriculum of secondary school biology just as it is in the curricula of many other courses. Digital proficiency is defined as “basic skills such as using communication technologies in a sure and critical manner, using computers to access, evaluate, store, generate, present, and trade information, and participating and communicating in common networks through internet” (MofNE, 2018). In order for teachers to ensure their students gain such proficiency, they need to have themselves and to be able to use them in their classes. Indeed, in the Republic of Turkey Ministry of National Education's report for General Proficiency for Teaching (MofNE, 2017), the expression “they can use information and communication technologies effectively in learning-teaching processes” was counted among signs of proficiency. At this point, it can be concluded that teachers should have technological pedagogical content knowledge (TPACK) which includes using technological knowledge in teaching.

Koehler and Mishra (2009) defined TPACK as a new form of knowledge that has come about due to the interaction between pedagogy and technology knowledge, which are its elements. According to the definition of Koehler and Mishra (2009), TPACK is the culmination of knowledge about how technology can be used in order to put new knowledge on top of students' previous knowledge and strengthen their previous knowledge, about what makes it easier or more difficult to learn concepts and how technology can help students during the teaching process, about teaching concepts effectively by using technology. Consequently, TPACK can be regarded as an expanded version of pedagogical content knowledge with the addition of technology as an element. In literature, various similar definitions are provided to enhance the content and comprehensibility of the concept. For instance, according to Niess (2005), TPACK is the integration of content knowledge with technology, teaching and learning knowledge. In other words, TPACK is a teacher's knowing how to employ technological tools and presentations in order for the student to understand a topic, using technology as pedagogical tool by relating pedagogical knowledge and technological knowledge while teaching content knowledge (Cavin, 2007; Graham, Burgoyne, Cantrell, Smith, Clair & Harris, 2009).

Koehler and Mishra (2009) explained the use of technology in teaching as three main knowledge domains (content knowledge, pedagogical knowledge, technological knowledge) and four knowledge domains that are formed by the intersection of the main knowledge domains. The intersection of content knowledge with pedagogical knowledge is called pedagogical content knowledge (PCK), the intersection of content knowledge with technological

knowledge is called technological content knowledge (TCK), and the intersection of pedagogical knowledge and technological knowledge is called technological pedagogical knowledge (TPK). The intersection of these three domains is called technological pedagogical content knowledge (TPACK) as shown in Figure 1.

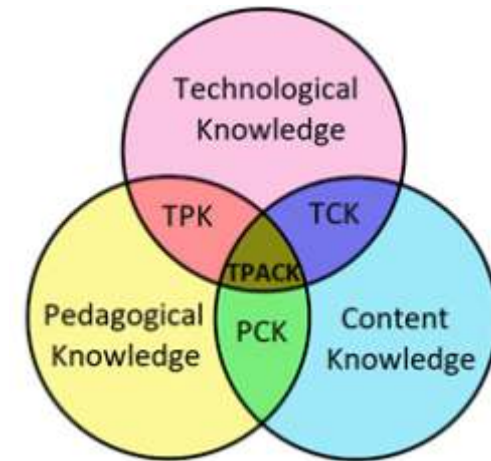


Figure 1. Structure of TPACK and its elements (Koehler & Mishra, 2009).

AIM OF THE STUDY

Determining pre-service teachers' self-confidence in their technological pedagogical content knowledge is an important step in their learning to use technology in an effective way in the teaching process. In this respect, several scales were developed to determine teachers' and pre-service teachers' self-confidence in TPACK (Archambault & Crippen, 2009; Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2008; Graham et al., 2009). In this study, pre-service biology teachers' self-confidence in TPACK was examined by using the “Technological Pedagogical Content Knowledge Self-Confidence Scale” developed by Graham et al. (2009). In the light of related studies, answers to following questions were sought:

1. What is the self-confidence level of pre-service biology teachers regarding technological pedagogical content knowledge?
2. Is there a meaningful difference in pre-service biology teachers' self-confidence perceptions regarding technological pedagogical content knowledge according to the “having taken a computer course” variable?
3. Is there a meaningful difference in pre-service biology teachers' self-confidence perceptions regarding technological pedagogical content

knowledge according to the class level variable?

RESEARCH METHODOLOGY

The research was designed based on the relational survey model. Relational survey model enables to examine the relationship of two or more variables with one another (Fraenkel, Wallen & Hyun, 2012). In this study, pre-service biology teachers' self-confidence in TPACK was examined in terms of the class and having taken computer course variables.

SAMPLE OF THE STUDY

The study group consists of 91 pre-service teachers enrolled in the biology education programme. Distribution of these pre-service teachers according to their class levels are as follows: Freshman: 16 (17.6%); Sophomore: 20 (22%); Junior: 21 (23%); Senior: 17 (18.7%); and 5th Year: 17 (18.7%). Moreover, 43 of these pre-service teachers (47.3%) expressed that they have taken a computer course while 48 of them (52.7%) said they have not.

DATA COLLECTION TOOLS

Data for the study was collected by using the “Technological Pedagogical Content Knowledge Self-Confidence Scale” developed by Graham et al (2009) and adapted to Turkish by Timur and Tasar (2011). Moreover, there was an introduction part where demographic information about participants were given before the actual scale begins. Consisting of a total of 31 items, the scale is evaluated with 5-likert type answer options (1= I don't trust at all, 2= I barely trust it, 3= I somewhat trust it, 4= I highly trust it, and 5= I completely trust it). Only in 5 items in the Technological Content Knowledge dimension is an option “0= I do not know such technologies.” When scoring options are taken into consideration, it can be seen that the highest score one can get on the scale is 155, while the lowest is 26. The scale was designed to determine the level of technology knowledge and the use of technology knowledge during the teaching process, and it consists of 4 dimensions, namely, Technological Pedagogical Content Knowledge (TPACK; 8 items), Technological Pedagogical Knowledge (TPK; 7 items), Technological Content Knowledge (TCK; 5 items), and Technological Knowledge (TK; 11 items).

DATA ANALYSIS

In the analysis of data, SPSS 23.0 was used. To test the consistency of participants' answers for the items in the scale, separate Cronbach alpha (α) reliability was calculated for both the scale in general and each of the

dimensions of the scale. The reliability coefficient of 0.70 and higher is taken as a criterion (Buyukozturk, 2006).

Confirmatory factor analysis was done to test the construct validity of the scale. Adequacy of the data for factor analysis was controlled by Kaiser-Meyer-Olkin (KMO) sampling adequacy and Bartlett's Sphericity Tests. It was taken into consideration that Kaiser-Meyer-Olkin (KMO) value was higher than 0.60 and Bartlett test was meaningful (Tabachnick & Fidell, 2007). In determining factor number, factors whose eigen value statistic is higher than 1 were considered to be meaningful. Moreover, when deciding on placing an item in the scale, it was made sure that its item factor load value and common variant value was 0.45 and higher.

Whether pre-service teachers' self-confidence of technological pedagogical content knowledge varies according to “having taken a computer course” variable was examined by t-test, and whether it varies according to “class level” variable was examined by single factor analysis of variance (ANOVA) for unrelated samples. Moreover, the effects of the fact that pre-service teachers have taken a computer course and the effects of their class level on different dimensions of the scale were analysed by multivariate analysis of variance (MANOVA) conducted separately for these two variants. Before moving onto the analyses, it was checked whether the data meet the assumptions of MANOVA such as normalcy, linearity, homogeneity of variance-covariance matrixes, or multicollinearity.

For MANOVA, although it is not a definite rule, Pallant (2007) argued that the required minimum sample size is met when there are more participants than the lowest number of dependent variables in each cell. In this part of the study, because there were two cells for the “having taken a computer course” variable and four for the class level variable, it can be argued that this assumption is met. Tabachnick and Fidell (2007), suggest Wilks' Lambda for general use in the comparison of average scores of groups in MANOVA, while they suggest using Pillai's Trace statistics in cases of small samples and a breach of assumptions. When the independent variable consists of two groups as was the case with the “having taken a computer course” variable, these statistics give the same result (Pallant, 2007). As such, in this study, Pillai's Trace statistics was taken into consideration in the evaluation of MANOVA analyses. In order to better interpret the meaningfulness values in the Inter-Group Interaction Test table which was calculated to determine between which dependent variables lies the difference, Bonferroni corrections were made by dividing the alpha meaningfulness value to the number of dependent variables (Pallant, 2007; Tabachnick & Fidell, 2007). Because there were four dependent

variables in the MANOVA tests in this study, alpha value was calculated to be .013 (.05/4) after the Bonferroni correction, and this value was used in comparisons. Moreover, for the control of the single-variant normalcy assumption of MANOVA, skewness and kurtosis values being between +2 and -2 was taken into consideration; for the multi-variant normalcy assumption Mahalanobis Distance Value was examined. The critical value is 18.47 for 4 dependent variables (Pallant, 2007). Because there was no value over the critical value in the analyses, multi-variable normalcy assumption was met. Equality of variance-covariance matrixes was examined by using Box' M and Levene's test statistics. In interpreting the explanation percent by the independent variable of the differences in the dependent variables as a result of the analyses, Cohen's (1988) eta square value (η^2) criteria were taken into consideration (0.01 small, 0.06 medium, 0.14 and over large).

RESULTS OF THE STUDY

Factor analysis of Technological Pedagogical Content Self-Confidence Scale resulted in the same way as the analyses in the Turkish adaptation studies by Timur and Tasar (2011). The analysis suggested the 4-dimension structure of the scale for the sampling of the study as well. However, seven items which took factor load values within different dimensions were left out of the scale in this process. The remaining 24 items were gathered in four dimensions just like it was in the original version of the scale: Technological Pedagogical Content Knowledge (TPACK; 6 items), Technological Pedagogical Knowledge (TPK; 5 items), Technological Content Knowledge (TCK; 5 items), and Technological Knowledge (TK; 8 items). In this case, because items in the Technological Content Knowledge dimension were scaled in 0-5 and others were scaled in 1-5, minimum score one can get from this version of the 24-item scale is 19 and maximum is 120. KMO value calculated for this scale in the factor analysis was 0.82; Bartlett's sphericity test's meaningfulness level was found to be 0.000 ($p < 0.05$). For the whole scale in general, factor load values of items varied between 0.45 and 0.85; and their common variant values varied between 0.45 and 0.81. When the results of the reliability test were examined, it was determined that Cronbach alpha reliability coefficient for the whole scale was 0.90. Reliability coefficients calculated for the dimensions of the scale were 0.91, 0.90, 0.86, and 0.88, respectively, for Technological Pedagogical Content Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, and Technological Knowledge.

Average total score of pre-service teachers got in the scale was calculated to be 87.31. Their average scores for the dimensions of the scale were 3.80 for Technological Pedagogical Content Knowledge, 3.88 for Technological

Pedagogical Knowledge, 3.09 for Technological Content Knowledge, and 3.71 for Technological Knowledge. Since the maximum score to be received was 120 for the scale, and maximum average score to be received for the subdimensions was 5, it can be argued that pre-service teachers' scores are above average.

Pre-service teachers' self-confidence of technological pedagogical content knowledge was examined according to the "having taken a computer course" variable with independent sampling t-test. Findings of the analysis are given in Table 1.

Table 1

T-Test Results for TPACK Self-Confidence According to the Variable Having Taken a Computer Course.

Computer Course	N	Mean	SD	df	t	p
Yes	43	97.82	9.80	89	8.90	0.000
No	48	77.90	11.37			

When results in Table 1 are examined, it can be seen that pre-service teachers who have taken a computer course have a meaningfully higher self-confidence of technological pedagogical content knowledge compared to those who have not taken a computer course ($t_{89} = -8.90$; $p < 0.001$).

Pre-service teachers' average scores in each subdimension was examined according to the "having taken a computer course" variable with MANOVA analyses (Table 2). It was concluded that there is a meaningful difference between the scores of those pre-service teachers who have taken a computer course and who have not (Box's M=0.186, Pillai's Trace=0.507, $F_{(4,86)} = 22.152$, $\eta^2 = 0.507$, $p < 0.001$).

Table 2

MANOVA Result of TPACK, TPK, TCK, and TK Scores According to the Variable Having Taken a Computer Course.

	Effect	Value	F	Hypothesis df	Error df	p	η^2
Groups	Pillai's Trace	0.507	22.152	4	86	0.000	0.507

According to analysis of results, meaningfulness value for all 4 subdimensions was lower than 0.013 which was the calculated alpha value after the Bonferroni correction. In other words, there is a meaningful difference in pre-service teachers' TPACK, TPK, TCK, and TK scores according to whether they have taken a computer course or not. Table 3 presents

information regarding the source of these differences.

Table 3

Findings Regarding the Interaction between TPACK, TPK, TCK, and TK Scores.

Dependent Variable	Computer Course	Mean	SD	Sum of Squares	df	Mean Square	F	p	η^2
TPACK	Yes	4.27	0.59	18.013	1	18.013	45.87	.000*	0.340
	No	3.38	0.66						
TPK	Yes	4.27	0.55	12.294	1	12.294	31.88	.000*	0.264
	No	3.53	0.68						
TCK	Yes	3.42	1.14	8.919	1	8.919	6.86	.010*	0.072
	No	2.79	1.14						
TK	Yes	4.22	0.56	21.332	1	21.332	48.95	.000*	0.355
	No	3.25	0.74						

*The new meaningfulness level is 0.013 according to the Bonferroni correction for MANOVA.

When Table 3 is examined, it can be seen that scores of pre-service teachers who have taken a computer course is higher in all dimensions of the scale compared to those who have not. These differences were explained by the “having taken a computer course” variable by 34%, 26.4%, 7.2%, and 35.5%, respectively.

ANOVA was conducted to see whether pre-service teachers' self-confidence of technological pedagogical content knowledge vary according to their class levels. Findings of the analysis are given in Table 4.

Table 4

ANOVA Results of TPACK Self-Confidence According to Class Level Variable.

	Source of Variance	Sum of Squares	df	Mean Square	F	p
TPACK Self-Confidence	Between Groups	529.87	4	132.47	0.613	0.654
	Within Groups	18581.94	86	216.07		
	Total	19111.81	90			

As can be seen in Table 4, no meaningful difference was found in pre-service teachers' total scores in the Technological Pedagogical Content Knowledge Self-Confidence Scale as a result of the variance analysis ($F_{(4-86)} = .613, p > 0.05$).

Pre-service teachers' average scores were examined by MANOVA analyses in terms of class variable (Table 5).

Table 5

MANOVA Result for TPACK, TPK, TCK, TK Scores According to Class Variable.

	Effect	Value	F	Hypothesis df	Error df	p
Groups	Pillai's Trace	0.150	0.839	16	344	0.641

When the findings in Table 5 are examined, it was concluded that pre-service teachers' scores in the subdimensions of the scale do not show a meaningful difference in terms of class level, just as they did not show a meaningful difference in the total scores of the scale (Box's $M = 0.399$, Pillai's $\text{Trace} = 0.150, F_{(16,344)} = 0.839, p > 0.05$).

DISCUSSION AND CONCLUSION

The rapidly advancing technology has become an indispensable part of our lives. Social networks, in particular, have enabled many people from different walks of life to use technology in some way or the other. Technology has also affected the education and training processes and caused education technologies to change. Thus, teacher proficiencies have also changed to necessitate using these technologies. However, a teacher's knowledge of technology on its own does not mean much; technology needs to integrate in a proper and effective way with teaching processes. Nevertheless, it is evident that the use of technology in education activities is still not at a desirable level. Studies have shown that few teachers/pre-service teachers have this proficiency (Judson, 2006; Saglam Kaya & Acarli, 2016).

Although there are still problems in the integration of technology with education processes, the benefits of using technology is evident. In his study, which was realized with students enrolled at the primary school teaching programme, Yavuz and Coskun (2010), concluded that pre-service teachers have a positive opinion of using technology in teaching. In their study, Usta and Korkmaz (2010) concluded that pre-service teachers' attitude towards using technology in education increases as their technology literacy increases. Moreover, they indicated that pre-service teachers have a positive perception of using technology in education, and this positive perception positively affects their attitude towards teaching profession. Indeed, the level of using teaching technologies is seen as a variable that affects pre-service teachers'

attitude towards teaching profession (TED, 2009).

Computers are no doubt the first tools that come to mind when one thinks of technology. Computer courses are not enough on their own to ensure using technology in education, but they are nevertheless an important prerequisite. It has been noted in literature that a teacher's computer skills are a significant variable that affect the effect and efficiency of the education process (Altun, 2003; Seferoglu, 2004). Today, there are many studies on computer knowledge and using computers in education. In their study, Akkoyunlu and Kurbanoglu (2003) concluded that pre-service teachers' self-efficacy perceptions concerning computers increase as their class levels go up, and they explained the difference between classes with the increase in knowledge and experience as students go up in class levels. In a study conducted with pre-service teachers, Altun (2003) contended that pre-service teachers' attitude towards computers is indecisive but that having taken a computer course affect pre-service teachers' attitude in a positive manner. Cagiltay, Cakiroglu, Cagiltay and Cakiroglu's study (2001) where they examined teachers' opinion on using computers in education, it was seen that teachers have a positive opinion on this and that they believe that using technology in schools would increase the quality of education. Moreover, it was determined that although teachers were willing to use computers in education, they were worried because of not having enough computers at schools, the inappropriateness of the curriculum and their own lack of knowledge in using computers properly. Considering these findings, they suggested that teachers should be given training on computer use, schools should be supported with related software, technical support personnel, hardware, and education experts. Seeing these suggestions, we can say that schools have come a long way in the past 17-18 years. Various developments such as providing in-service training for teachers, technical support for schools, web sites that enable using education technologies more easily and effectively have paved the way for using technology in an integrated way within the curriculum. Teacher proficiencies were redefined and a new teacher profile in teacher training was aimed, who can use content, pedagogical, and technological knowledge in an interactive manner (Koehler & Mishra, 2009; TED, 2009). Considering that the new generation, who are called "digital-born" or "Internet generation," has a different style of learning (Ng, 2012), teachers of this generation are expected to use technology effectively in education processes, to be equipped to answer to the needs of this generation, and to be able to integrate their technological knowledge with content and pedagogical knowledge. Thus, studies aiming to determine teachers' and pre-service teachers' technological pedagogical content

knowledge levels after the coinage of the term Technological Pedagogical Content Knowledge (Koehler & Mishra, 2009; Akyildiz & Altun, 2018; Archambault & Crippen, 2009; Bozkurt, 2016; Chuang & Ho, 2011; Dogru & Aydin, 2017; Koh, Chai & Tsai, 2010; Sancar Tokmak, Yavuz Konokman & Yanpar Yelken, 2013; Sad, Acikgul & Delican, 2015). However, just as it is the case in other proficiency domains, this proficiency can manifest differently in each teaching field in different levels and forms. Present study, because it has examined pre-service biology teachers' TPACK levels, contributes to literature by making an evaluation of this proficiency from the biology education perspective. At the end of the study, it was concluded that pre-service biology teachers' TPACK self-confidence perceptions are high. Different studies in literature, which were conducted within different teaching programmes, also point at the high levels of self-confidence perceptions in pre-service teachers (Akyildiz & Altun, 2018; Sancar Tokmak, Yavuz Konokman & Yanpar Yelken, 2013). That pre-service biology teachers' TPACK self-confidence does not differ according to class level is another finding that is supported by other studies in literature conducted within different teaching programmes (Gunduz, 2018; Sancar Tokmak, Yavuk Konokman & Yanpar Yelken, 2013). That pre-service teachers who have taken a computer course have higher TPACK levels is an important finding to take notice.

When findings are examined, it can be seen that students who have taken a computer course received significantly higher scores in all dimensions of the TPACK Self-Confidence Scale compared to those who have not taken a computer course. In her study conducted with the participation of teachers, Guder (2018) noted that the more computer and internet experience teachers have the more their TPACK self-confidence increases. In other words, in order to use technology in education processes, it is necessary to increase computer usage skills, which can be considered as a basic skill for the use of technology. When findings are examined, the high scores of students who have taken a computer course in all dimensions of TPACK Self-Confidence Scale also increase significantly their intention to use technology in education (Yungul, 2018). In this respect, during their teacher training, teachers should be encouraged to gain self-confidence in using computers. As such, they would not have any anxiety in using education technologies and they would be more willing. To this end, necessary adjustments should be made in teacher training programmes after reviewing these programmes in order to increase students' experience with technology. At this point, there should be courses in the teaching programme to improve their computer and other technological skills. Indeed, in Turkey, after the update by the Council of

Higher Education, there is a 3-credit compulsory general culture course called "Information Technologies" in all Teacher Training Undergraduate Programmes beginning with 2018-2019 academic year (CoHE, 2018). However, it is not enough to merely increase pre-service teachers' technological knowledge, pre-service teachers should also be trained in how to integrate their technological knowledge into the teaching process. Course contents should have example as to how technology can be used in teaching, micro teaching applications should be done on this. In addition, it can be useful to add a course to curricula in which students get information and examples on teaching with technology. As such, we get one step closer to creating a teacher profile that meets the requirements of the age. It should not be forgotten that the technology and the method to be used in education would vary in every field. At this point, examining in detail pre-service teachers' technological pedagogical content knowledge for each field would be a good start to determine and eliminate problems.

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