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An Investigation of Technological Pedagogical and Content Knowledge (TPACK) Competencies of Pre-Service Visual Arts Teachers

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Abstract

This study aimed to examine TPACK (Technology, Pedagogy and Content Knowledge) competencies of pre-service visual arts teachers. Based on the descriptive and comparative survey model, TPACK competencies of pre-service visual arts teachers were compared on variables of gender, year of study and academic achievement. The participants of the study were 253 pre-service teachers studying in department of visual arts in Education Faculties of Atatürk, Karadeniz Teknik, Mersin and Necmettin Erbakan Universities. TPACK Competencies Scale was used to collect research data. The findings showed that TPACK competencies of pre-service visual arts teachers were low in terms of technology knowledge, but high in content knowledge. In addition, their TPACK competencies vary based on gender, year of study and academic achievement.

Introduction

Since contemporary visual arts education adopts child-centered education-training activities, it can be said that it enables more fruitful studies with the use of method-technique and equipment. The use of the material is extremely effective in terms of the meaning and purpose of the lesson. In art teaching, the desired result will be more effective and meaningful if the materials are enriched by classifying them according to the subjects (Koç, 2011). Visual arts education is an education based directly on tools and equipment. In art studies, amazing artworks can be created with pencil and paint, but paint and paper are not enough for the development of students. The variety of tools and equipment is important for students to exhibit different works and express their creativity in a different way:

- The effects of using technology in art teaching can be listed as follows:
- Arts teaching can be made more effective, lively, open and enjoyable.
- Details in the model can be more easily understood, and become interesting and attractive.
- It can create a desire to learn.
- It is effective in the development of aesthetic knowledge, manners and culture.
- It makes easy to explain a topic.
- Helps gain from time and speech.
- It provides the opportunity to create alternatives on designs (Artut, 2009; Kaleli, 2020).

For arts education, it is important for students and teachers to research innovative methods apart from classical methods and to develop competencies to use the opportunities offered by computers and Internet technologies in their educational activities appropriately in arts education. National Art Education Association (NAEA) addresses a comprehensive approach to teaching and learning in arts in visual arts teaching. According to NAEA, art teacher candidates should have competencies on curriculum development, evaluation of teaching and student learning outcomes, ability to transform teaching programs into practice, and general and field-specific teaching skills as well as art knowledge and skills (National Art Education Association, 1999).

For teachers to be successful in their career, they need to develop themselves in pedagogy, technology, and their content areas. By using information and communication technologies, teachers can follow developments in their areas, transfer the contemporary approaches and applications regarding teaching methods into their instruction, and keep themselves up-to-date. For these reasons, technology plays a critical role for teacher knowledge improvement (Bergeson & Beschorner, 2020; Hilton & Canciello, 2018; Kaur, 2020; Sahin, 2011; Sünbül, Gündüz, & Yılmaz, 2002; Yilmaz, 2017). The teaching has become a profession that requires more qualifications and competence today. The skills, attitudes and self-efficacy of teachers who will use computer and computer-assisted educational software are very important in the use of this technology (Baş, Kubiatko & Sünbül, 2016; Demirer, Çintaş & Sünbül, 2010; Demirer, Özdinç, & Şahin, 2009).

Examining teachers or teacher candidates' perceptions of their knowledge in technology, pedagogy, content, and their intersections is an essential need to determine the level of their knowledge in each domain (Aydoğmuş, 2019; Şahin, 2011). Technological pedagogical content knowledge is the knowledge of using technology, pedagogy, and content at the same time in the same context (Uygun, 2013). Cox (2008) describes TPACK as: the knowledge of the dynamic, transactional negotiation among technology, pedagogy, and content and how that negotiation impacts student learning in a classroom context. The essential features [of TPACK] are (a) the use of appropriate technology (b) in a particular content area (c) as part of a pedagogical strategy (d) within a given educational context (e) to develop students' knowledge of a particular topic or meet an educational objective or student need. This definition acknowledges the presence and interaction of all three components with particular emphasis on the use of content-dependent pedagogy. Technological pedagogical content knowledge (TPACK) development requires a long process and is basically a concept consisting of a combination of three types of knowledge, content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK).

One of the most powerful ways to integrate education with technology is the Technology Pedagogy Content Knowledge (TPACK) model. TPACK researchers argued that PCK should be enriched with TK due to the wide spread of technology in the world and the convenience and benefits it brings (Akturk & Saka Ozturk, 2019; Chai, Koh, & Tsai, 2011; Hill & Uribe-Florez, 2020; Kaleli, 2021; Mishra & Kohler, 2006; Mutlu, Polat, & Alan, 2019). TPACK is defined as the basic knowledge that teachers need to make teaching effective with technology and the theoretical framework of the application of the knowledge (Mishra & Kohler, 2006; Niess, 2005). TPACK includes three important teacher knowledge domains for the integration of technology and lessons; technology knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), and there is the integration of these knowledge domains, such as pedagogical content knowledge (PCK), technological content

knowledge (TCK), technological pedagogical knowledge (TPK), and finally, technological pedagogical content knowledge (TPACK) (Mishra & Kohler, 2006).

TPACK is suggested as effective teaching with technology. In the literature, TPACK is defined as a critical knowledge base needed to be developed by preservice teachers (Angeli & Valanides, 2005). Developing and implementing successful teaching requires an understanding of how technology is related to pedagogy and content (Koehler et al., 2007; Şahin, 2011). Technology knowledge (TK) refers to an understanding of the way that technologies are used in a specific content domain. For example, for physics teachers, it is an understanding of the range of technologies that physicists use in science and industry. Within the context of technology integration in schools, it appears to most often refer to digital technologies such as laptops, the Internet, and software applications. TK does however go beyond digital literacy to having knowledge of how to change the purpose of existing technologies (e.g. wikis) so that they can be used in a technology enhanced way (Harris & Hofer, 2011).

Content knowledge (CK) is "a thorough grounding in college-level subject matter" or "command of the subject" (American Council on Education, 1999). It may also include knowledge of concepts, theories, conceptual frameworks as well as knowledge about accepted ways of developing knowledge (American Council on Education, 1999). Pedagogical knowledge (PK) includes generic knowledge about how students learn, teaching approaches, methods of assessment and knowledge of different theories about learning.[7][8] This knowledge alone is necessary but insufficient for teaching purposes. In addition, a teacher requires content knowledge (Harris& Hofer, 2011). Koehler and Mishra (2005) added technological T to Shulman's pedagogical content knowledge PCK, getting technology, pedagogy, and content TPCK or TPACK.[1] Technological pedagogical content knowledge refers to the knowledge and understanding of the interplay between CK, PK and TK when using technology for teaching and learning. It includes an understanding of the complexity of relationships between students, teachers, content, practices and technologies.

There is also an integration of three components, technology, pedagogy and content. Of these, pedagogical content knowledge (PCK) is knowledge about how to combine pedagogy and content effectively. Technological content knowledge (TCK) refers to the knowledge about how technology can be used to provide new ways to teach content. Technological pedagogical knowledge (TPK) refers to the opportunities and constraints of technology as an enabler of different teaching approaches (Niess, 2005; Archambault & Crippen, 2009).

Successive technological innovations cause changes in traditional methods and educational tools. The rapid development of ICT provides significant opportunities for Visual Arts teachers to encourage students to learn global, interactive and dynamic. Art educators can improve students' learning by wisely integrating and infusing computer and learning technologies into student-centered or effective learning environments (Gregory, 2009). Although the factors affecting the educational technology integration process are multidimensional, teachers' inadequacy of competencies in knowledge, skills and abilities, especially regarding the use of technology in the teaching process is an important source of questions (Estes & Dailey-Hebert, 2018; Kabakçı Yurdakul, 2011). It

can be argued that in the process of integrating pedagogy, technology and content knowledge, teacher competencies and teacher candidates are important.

TPACK is the end result of these various combinations and interests, drawing from them – and from the three larger underlying areas of content, pedagogy, and technology – in order to create an effective basis for teaching using educational technology. In order for teachers to make effective use of the TPACK framework, they should be open to certain key ideas, including (Jamieson-Proctor, Finger& Albion, 2010):

- concepts from the content being taught can be represented using technology,
- pedagogical techniques can communicate content in different ways using technology,
- different content concepts require different skill levels from students, and edtech can help address some of these requirements,
- students come into the classroom with different backgrounds – including prior educational experience and exposure to technology – and lessons utilizing edtech should account for this possibility,
- educational technology can be used in tandem with students' existing knowledge, helping them either strengthen prior epistemologies or develop new ones.

Because it considers the different types of knowledge needed and how teachers themselves could cultivate this knowledge, the TPACK framework thus becomes a productive way to consider how teachers could integrate educational technology into the classroom. Then too, TPACK can also serve as a measurement of instructor knowledge, potentially impacting both training and professional development offerings for teachers at all levels of experience. Finally, the TPACK framework is useful for the ways in which it explicates the types of knowledge most needed in order to make technology integration successful in the classroom. Teachers need not even be familiar with the entire TPACK framework as such in order to benefit from it: they simply need to understand that instructional practices are best shaped by content-driven, pedagogically-sound, and technologically-forward thinking knowledge (Al-Abdullatif, 2019; Hsu et al.; Koyuncuoglu, 2021; Lee, Smith, & Bos, 2014).

There are limited data and research findings on how much pre-service visual arts teachers are sufficient in terms of effective and efficient use of technologies in their lessons, which are among the teacher competencies in recent years. Studies show that teachers and/or pre-service teachers have low levels of awareness, knowledge and practical skills about the models used for TPACK development. In addition, TPACK has become an important area to focus on due to the limitations of teachers and pre-service teachers' adaptation to new technologies, not including it in real classroom settings and not following a certain model in lesson design.

Individuals with high self-efficacy make high effort to fulfill a task. Therefore, graduating visual arts teacher candidates with high TPACK proficiency levels will be helpful for the success of training qualified teachers and integration of technology into education and training system. Thus, TPACK competencies of pre-service visual arts teachers were investigated in a multifaceted way. In order to achieve this aim, answers to the following questions were sought:

- What are the participants' level of the technological pedagogical and content knowledge (TPACK) competencies?
- Do the participants' technological pedagogical and content knowledge (TPACK) competencies differ by gender?
- Do the participants' technological pedagogical and content knowledge (TPACK) competencies differ by their year of study?
- Do the participants' technological pedagogical and content knowledge (TPACK) competencies differ by their academic achievement?

Method

This research used a descriptive, comparative correlational survey design. In the comparative correlational survey model, the causes and consequences of the differences observed in the relationship between research variables are emphasized. In this model, research is carried out without any intervention on the conditions that may affect the results. In descriptive research designs, any problem, event or phenomenon is identified in an uncontrolled process (Büyüköztürk et al., 2008). In this study, in accordance with the comparative correlational survey model, TPACK scores of the participants were investigated by considering the variables of gender, year of study and academic achievement.

Students studying visual arts at Atatürk, Karadeniz Teknik, Mersin and Necmettin Erbakan Universities constitute the participants of this research. Reaching all of the participants require serious time and labour. Considering this, convenience sampling method was preferred (Büyüköztürk, et al., 2008). Thus, 253 pre-service visual arts teachers who study visual arts at these universities participated in the study and they were randomly selected. The pre-service teachers included in the study consist of students who continue to study or graduate from Visual Arts education programs in the 2019-2020 academic year. Participation in the study was on voluntary basis. Students were informed about the purpose of the study.

Data Collection Tools

In accordance with the scope of the study, TPACK scale developed by Şahin (2011) was used to determine pre-service visual arts teachers' Technology, Pedagogy and Content Knowledge competencies. This instrument is a seven-point Likert scale consisting of 47 items.

Findings

In this section, in accordance with the general purpose of the research, the findings obtained by comparing the scores obtained from the measurement tool based on gender, year of study and academic achievement are presented (see Table 1).

Table 1. Descriptive Values of Scores

Items of TPACK Survey	Mean	Std. Deviation
Solving a technical problem with the computer	2.32	0.79
Knowing about basic computer hardware (ex., CD-Rom, mother-board, RAM) and their functions	2.37	0.8
Knowing about basic computer software (ex., Windows, Media Player) and their functions	2.76	0.54
Following recent computer technologies	2.6	0.73
Using a word-processor program (ex., MS Word)	2.83	0.39
Using an electronic spreadsheet program (ex., MS Excel)	2.68	0.5
Communicating through Internet tools (ex., e-mail, MSN Messenger)	2.99	0.69
Using a picture editing program (ex., Paint)	3.11	0.72
Using a presentation program (ex., MS Powerpoint)	2.67	0.51
Saving data into a digital medium (ex., Flash Card, CD, DVD)	2.83	0.41
Using area-specific software	2.78	0.43
Using printer	2.48	0.52
Using projector	2.74	0.53
Using scanner	3.01	0.75
Using digital camera	2.98	0.42
TK Technology Knowledge	**2.77**	**0.24**
Assessing student performance	3.17	1.16
Eliminating individual differences	2.84	1.13
Using different evaluation methods and techniques	2.91	1.11
Applying different learning theories and approaches (ex, Constructivist Learning, Multiple Intelligence Theory, Project-based Teaching)	3.98	0.83
Being aware of possible student learning difficulties and misconceptions	3.96	1
Managing class	3.32	1.16
Pedagogy Knowledge (PK)	**3.36**	**0.66**
Knowing about key subjects in my area	4.51	0.79
Developing class activities and projects	4.1	0.92
Following recent developments and applications in my content area	3.79	1.15
Recognizing leaders in my content area	4.08	0.97
Following up-to-date resources (ex, books, journals) in my content area	3.94	1.13
Following conferences and activities in my content area	4.02	0.7
Content Knowledge (CK)	**4.07**	**1.2**
Choosing technologies appropriate for my teaching/learning approaches and strategies	2.65	0.51
Using computer applications supporting student learning	2.51	0.51
Being able to select technologies useful for my teaching career	2.56	0.52
Evaluating appropriateness of a new technology for teaching and learning	2.64	0.55
Technological Pedagogical Knowledge (TPK)	**2.59**	**0.35**

Selecting appropriate and effective teaching strategies for my content area	3.11	0.97
Developing evaluation tests and surveys in my content area	2.77	1.07
Preparing a lesson plan including class/school-wide activities	2.86	1.1
Meeting objectives described in my lesson plan	3.06	0.97
Making connections among related subjects in my content area	2.84	1.06
Making connections between my content area and other related courses	3.13	0.93
Supporting subjects in my content area with outside (out-of-school) activities	3.24	0.91
Pedagogical Content Knowledge (PCK)	**3.01**	**0.69**
Using area-specific computer applications	2.95	0.61
Using technologies helping to reach course objectives easily in my lesson plan	2.75	0.69
Preparing a lesson plan requiring use of instructional technologies	2.92	0.65
Developing class activities and projects involving use of instructional technologies	3.07	0.89
Technological Content Knowledge (TCK)	**2.92**	**0.55**
Integrating appropriate instructional methods and technologies into my content area	2.47	1.43
Selecting contemporary strategies and technologies helping to teach my content effective	2.72	1.32
Teaching successfully by combining my content, pedagogy, and technology knowledge	2.7	1.41
Taking a leadership role among my colleagues in the integration of content, pedagogy,and technology knowledge	2.65	1.41
Teaching a subject with different instructional strategies and computer applications	2.74	1.39
Technological Pedagogical and Content Knowledge (TPACK)	**2.66**	**1.07**

When Table 1 is analyzed, the mean scores are as follows: TC (Technology Knowledge) 2.77; PK (Pedagogical Knowledge) 3.36; CK (Content Information) 4.02; TPK (Technology Pedagogy Knowledge) 2.59; TCK (Technology Content Information) 2.92; PCK (Pedagogy Content Knowledge) 3.01 and finally TPACK (Technology Pedagogy Content Knowledge) 2.66. According to the mean values obtained, pre-service visual arts teachers' TK (Technology Knowledge), TPK (Technology Pedagogy Knowledge) and TPACK (Technology Pedagogy and Content Knowledge) competencies are low. Participants' PK (Pedagogy Knowledge), TCK (Technology Content Knowledge) and PCK (Pedagogy Content Knowledge) competencies are medium. Finally, the CK (Content Information) competencies of the participants are high.

Another question of the study is "Do the TPACK competencies of pre-service visual arts teacher differ by gender? The scores of the participants from the TPACK scale were compared by gender. The results are shown in Table 2.

Table 2. Comparison of the Scores by Gender

	Gender	N	Mean	Std. Deviation	T	P
TK	Male	103	2.86	0.26	2.07	.03
	Female	149	2.67	0.23		
	Male	103	3.39	0.7	.47	.64

PK	Female	149	3.35	0.7		
	Male	103	4.00	0.7	-.51	.61
CK	Female	149	4.04	0.7		
	Male	103	2.62	0.4	1.23	.22
TPK	Female	149	2.57	0.4		
	Male	103	2.86	0.4	-1.53	.13
TCK	Female	149	2.96	0.6		
	Male	103	2.90	0.7	-2.06	.04
PCK	Female	149	3.08	0.7		
	Male	103	2.52	1.05	-1.72	.09
TPACK	Female	149	2.76	1.07		

When Table 2 is examined, there is a significant difference in TC and PCK dimensions of the scale based on the variable of gender ($p<0.05$). Male pre-service teachers' technology knowledge and female pre-service teachers' pedagogy content knowledge scores were significantly higher.

The next question of the study is "Do the TPACK competencies of the Visual Arts teacher candidates differ according to the grade level? In order to find an answer to this question, the scores of the participants from the TPACK scale were compared based on year of study variable with the ANOVA. The results are shown in Table 3.

Table 3. Comparison of Scores by Year of Study

	Year of Study	N	Mean	Std. Deviation	F	p	PostHoc
TK	1	49	2.66	0.20	8.138	.000	4>1
	2	46	2.74	0.22			3>1
	3	106	2.77	0.23			
	4	52	2.89	0.28			
PK	1	49	3.37	0.58	1.208	.307	
	2	46	3.28	0.72			
	3	106	3.41	0.71			
	4	52	3.49	0.56			
CK	1	49	3.91	0.76	2.219	.086	
	2	46	4.00	0.67			
	3	106	4.16	0.79			
	4	52	4.16	0.47			
TPK	1	49	2.55	0.39	0.746	.526	
	2	46	2.56	0.32			
	3	106	2.60	0.36			
	4	52	2.65	0.33			

	1	49	2.76	0.26	5.285	.002	4>1
	2	46	2.83	0.31			3>1
TCK	3	106	2.91	0.53			
	4	52	3.16	0.84			
	1	49	2.61	0.59	14.21	.000	4>1;4>2
	2	46	2.86	0.62			3>1;3>2
PCK	3	106	3.04	0.66			4>3
	4	52	3.43	0.66	10.43	1.71	4>1;4>2
	1	49	2.09	1.00			3>1;3>2
	2	46	2.51	1.03			4>3
TPACK	3	106	2.71	1.00			
	4	52	3.21	1.04			

When Table 3 is examined, there is a significant difference in the TC, TCK, PCK, TPACK dimensions of the scale according to year of study variable ($p<0.05$). According to the Tukey test analysis, the TC, TCK, PCK, TPACK mean scores of the third and fourth year teacher candidates were significantly higher than the first and second year teacher candidates.

The final question is "Do the TPACK competencies of pre-service visual arts teachers differ according to their academic achievement? For this purpose, the scores of the participants from the TPACK scale were compared based on academic success variable with ANOVA. The results are below.

Table 4. Comparison of Scores by Academic Achievement

	Academic Achievement	N	Mean	Std. Deviation	F	p	PostHoc
	1. High	81	2.86	0.30	7.66	0.00	1>3
TK	2. Medium	94	2.78	0.22			
	3. Low	78	2.71	0.21			
	1. High	81	3.41	0.61	0.62	0.54	
PK	2. Medium	94	3.40	0.71			
	3. Low	78	3.31	0.66			
	1. High	81	4.19	0.60	2.01	0.14	
CK	2. Medium	94	4.00	0.74			
	3. Low	78	3.96	0.70			
	1. High	81	2.60	0.34	0.14	0.87	
TPK	2. Medium	94	2.58	0.34			
	3. Low	78	2.57	0.42			
	1. High	81	3.35	0.30	23.46	0.00	1>2
TCK	2. Medium	94	2.83	0.43			1>3
	3. Low	78	2.78	0.87			

PCK	1. High	81	3.55	0.65	23.82	0.00	1>2
	2. Medium	94	2.89	0.62			1>3
	3. Low	78	2.85	0.62			
TPACK	1. High	81	3.37	1.03	15.54	0.00	1>2
	2. Medium	94	2.49	0.99			1>3
	3. Low	78	2.48	1.01			

When Table 4 is examined, there is a significant difference in the TC, TCK, PCK, TPACK dimensions of the scale based on academic success variable ($p<0.05$). According to Tukey test analysis, it was found that pre-service teachers with high levels of academic achievement had significantly higher TC, TCK, PCK, TPACK scores.

Discussion

In the study, it was found that pre-service visual arts teachers' technology knowledge and TPACK competencies were low. The number of participants who think that they do not have enough skills is also considerably high. This result is striking in terms of success in the profession when considering the importance of the education on basic technology skills and pedagogical competencies provided to pre-service teachers (Çavuş, Gökdaş 2006; Usta & Korkmaz, 2010). Therefore, it could be suggested to include applied courses that will enable pre-service visual arts teachers to integrate technology, technology-pedagogy and content knowledge into the curriculum. Hiçyılmaz and Inam Karahan (2016) state that pre-service visual arts teachers do not consider themselves competent enough in using instructional technologies. For this reason, it is important for teacher candidates to be part of an education program that train themselves appropriately and efficiently on the use of developing technologies in our current education system (Keane, 2015).

Another finding of this study is related to the comparison of pre-service teachers' TPACK competencies by gender and year of study. According to the results of the analysis, male pre-service visual arts teachers' competencies in technology knowledge is higher than their female peers. In most of the studies, it is stated that men display higher technology competencies (Asimaki & Vergidis, 2013; Doğru, 2020). However, female teacher candidates also showed higher competencies in pedagogical content knowledge. These findings are similar to the research findings of Mahmutoğlu (2019) and Karamaz (2013). In Mahmutoğlu's (2019) study, it has been found that female pre-service visual arts teachers have stronger pedagogical competencies and more comfortable and effective interactions with their students. Tuncer and Bahadır (2016) state that pre-service teachers' attitudes towards teaching profession differ in favor of female pre-service teachers. It could be argued this is due to the suggestion that females find themselves more suitable for the teaching profession.

Another finding obtained in the study is that TPACK competencies of the third and fourth year pre-service visual arts teachers are higher than the first and second year ones. These findings are similar to the findings of the studies conducted by Doğru (2020), Işıksal and Paykaç, (2011), Margrett and Marsiske (2002), and Sieverding and Koch (2009). According to Goffe and Scase (1992), there are differences in male and female

technology competencies depending on cultural and occupational factors. It has been observed that technology competencies of men are higher in many male-dominated sectors. However, the literature on the relationship between gender and technology competence reveal many differences. In general, technology competencies, content and pedagogical knowledge are based on planned learning processes (McGee et al., 2009). Therefore, pre-service visual arts teachers, who have systematic and planned teaching experiences in their departments, gain competence in technology use and TPACK skills over the years.

The other finding in the study is related to the relationship between academic achievement and competencies in TPACK skills. The analysis revealed a significant relationship between these variables. The literature shows that pre-service visual arts teachers who have high academic achievement have higher levels of competencies in technology, pedagogical and general self-efficacy (Galleguillos & Olmedo, 2017; Kara, 2020). Therefore, Kara (2020), Stankov et al. (2012) state that general teaching self-efficacy, including technological and pedagogical competencies, is in a close and positive correlation with a high level of academic participation and academic achievement.

Conclusions and Recommendations

In the study, it was found that the technology knowledge and TPACK competencies of pre-service visual arts teachers were low. The study also showed that female pre-service teachers' technology knowledge and TPACK competencies were low, whereas male peers' content knowledge competencies of teacher were low. In addition, it was found that the level of achievement was low and the TPACK efficacy of the pre-service teachers in the lower classes was significantly low. In addition, TPACK competencies of pre-service teachers with low academic achievement and earlier years of study were significantly low.

According to the findings of the research, giving pre-service visual arts teachers the opportunity to teach a limited number of lessons in practical training conducted within the scope of school practice does not contribute to the development of TPACK skills. For this reason, TPACK planning and activities should be included in teacher candidates' practical training and practice. In order to better understand visual arts teacher candidates' TPACK development process, it is important to follow the candidates for a long time and to provide the necessary conditions for the candidates to complete their TPACK development in a shorter time in the following years. Studies on TPACK competencies of pre-service visual arts teachers are limited in the literature. In order to contribute to the literature, further studies can be carried out with visual arts teachers across different school levels. In addition, pre-service visual arts teachers' TPACK competencies can be investigated with qualitative studies supported by observation forms.

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