EEJ 13 (2) (2023) 246-257

English Education Journal

http://journal.unnes.ac.id/sju/index.php/eej

Unraveling EFL Pre-Service Teachers' TPACK through Self-Report Data

Yuni Dwi Susanti✉, **Sri Wahyuni, Zulfa Sakhiyya**

Universitas Negeri Semarang

Article Info

Article History:
Accepted 30 January 2023
Approved 8 March 2023
Published 20 June 2023

Keywords:
EFL pre-service teachers, self-report, teacher professional education, TPACK

Abstract

The technological revolution has changed the required knowledge and skills of teachers in facilitating the development of students' 21st-century skills. In light of this, Technological Pedagogical Content Knowledge (TPACK) has been defined as a useful conceptual framework to help define the knowledge base needed for effective technology integration into classroom practices. However, generally, teacher professional education programs do not help teacher candidates develop TPACK. From this standpoint, the purpose of the study was to better understand the nature of pre-service English teachers' TPACK over the professional development program named Pre-Service Teacher Professional Education (TPE) or *Pendidikan Profesi Guru (PPG) Prajabatan*. A survey was applied to examine 30 EFL pre-service teachers' TPACK using self-report as the data source. The self-report was adopted from Schmid et al. (2020), and it consists of 28 items of the seven TPACK components. The results demonstrated that EFL pre-service teachers see the value of technology for teaching English. They highly perceived their TPACK competencies, especially for the TK construct (*M=4.05*) and the TPACK construct (*M=4.08*). They need more guidance on how to effectively integrate technology though. Thus, teacher professional education programs should redesign various methods of courses to provide more opportunities for pre-service English teachers to teach with technology since experiences had the most effect on beliefs.

✉Correspondence Address:
Kelud Utara 3 Kampus Pascasarjana UNNES 34572
E-mail: yunidwisusanti1@students.unnes.ac.id

p-ISSN 2087-0108
e-ISSN 2502-4566

INTRODUCTION

21st-century teaching and learning are characterized by the heavily involved of technology in the classrooms. The development of technological tools has changed the styles of teaching and learning in classrooms. Technology provides opportunities for students to visualize and better engage with the teaching materials. Also, in technology-rich classrooms, students can be more motivated to explore, represent, and conceptualize the academic content.

The advancement of educational technology has changed the expectations placed on teachers to better facilitate the development of students' 21st-century skills. Teachers are expected to be able to integrate the curriculum across the learning areas to promote students' creativity, collaboration, and critical thinking. In light of this, pedagogical strategies and technological knowledge of teachers play a vital role in supporting students' learning although subject matter knowledge has been regarded as indispensable for teachers. In other words, teachers now should master not only content and pedagogical knowledge but also technological knowledge. Technological knowledge has been defined as the knowledge of various technologies for teaching and learning purposes (Tseng et al., 2019; Zambak & Tyminski, 2020; Lemon & Garvis, 2016). It is divided into three constituent categories, namely conceptual knowledge, procedural knowledge, and meta-cognitive knowledge (Cederqvist, 2022; Buckley et al., 2019). This knowledge requires teachers to be able to select, use, and evaluate technology integration into classroom practices.

Teachers are the key factors in the success of technological reform. Due to the rapid development of digital technologies, recent studies have shown that teachers are now expected to have the necessary knowledge and skills in using and integrating technology into their teaching practices. In light of this, the advancement of educational technology provides a great opportunity for teachers to use a variety of technology tools. From this standpoint, technology use in language teaching and learning has received significant attention. The use of technology in language classrooms contributes to better reading, listening, speaking, and writing skills (Xu et al., 2019; Zou et al., 2021; Shortt et al., 2021). Although English teachers hold an awareness of educational technology (Aryani et al., 2021; Putry et al., 2022), the use of technology in English classroom practices has yet to be effectively implemented on a large scale (Chuang et al., 2018). The majority of English teachers still rely on the traditional approach. They tend to use technology for lesson planning, data storage, and findings online teaching resources instead of using technology to assist their teaching activities. It suggests that the low levels of technology integration in EFL practices might adversely impact students' language skills development.

Some studies agreed that pre-service teachers' future instructional practices largely depend on what can be observed during a teacher preparation program (Sims & Fletcher-Wood, 2021; Finsterwald et al., 2013). However, teacher education institutions cannot be expected to produce qualified teachers who are ready to face all challenges throughout their teaching careers (Tatto, 2021). Therefore, pre-service teachers must be eager to elevate their teaching knowledge and skills. With this in mind, based on the Indonesian Government Regulation No. 74/2008 on Teacher, teacher candidates with a bachelor's degree are mandated to participate in a professional development program, named Pre-Service Teacher Professional Education (TPE) Program or known as *Pendidikan Profesi Guru (PPG) Prajabatan*. This program provides a high opportunity for pre-service teachers to hone their technological knowledge and skills.

Considering the importance of technology integration into classroom practices, it is highly important to examine pre-service teachers' knowledge of educational technology. As an extension of the teachers' knowledge base developed by Shulman (1986), Mishra and Koehler (2006) proposed a conceptual framework of technology integration in the classroom, named technological pedagogical content knowledge (TPACK).

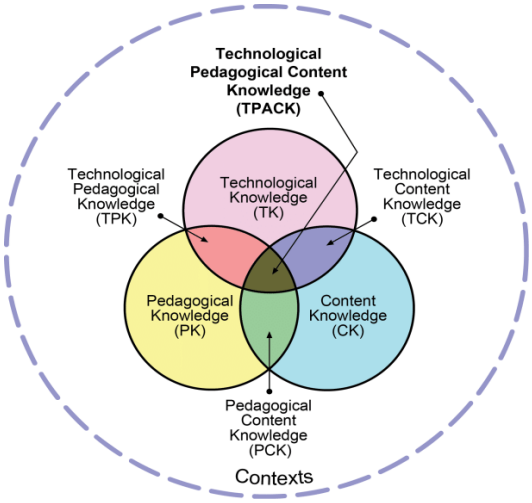

Figure 1. TPACK Framework (Mishra & Koehler, 2006)

This concept emphasizes that teachers must understand how technology works with pedagogy and content in order to successfully integrate technology in the classroom. TPACK covers the seven domains of teachers' knowledge, namely pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), technological knowledge (TK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). In this study, the first domain, PK, refers to the knowledge about teaching methods. The second domain, CK, refers to the knowledge of English as the subject matter. The third domain, PCK, refers to knowledge about English language teaching. The fourth domain, TK, refers to the knowledge about any kinds of technology. The fifth domain, TPK, refers to the knowledge about using technology to teach. The sixth domain, TCK, refers to the knowledge about technology used in English language teaching. The last domain, TPACK, refers to ICT integration knowledge. Basically, the TPACK framework can be used to fully understand teachers' knowledge of educational technology tools and the use of those tools in the classrooms. The TPACK framework has been increasingly used to measure the knowledge development of teachers (Ritzhaupt et al., 2016; Wen & Shinas, 2020; Voogt & McKenney, 2017). Specifically, it can be used to evaluate both in-service and pre-service teachers' ability in facilitating and enhancing students' 21st-century skills development, with technology.

Much research has been devoted to tracing pre-service teachers' knowledge and skills of technology through multiple TPACK assessment models. First, Technological Pedagogical Content Knowledge Scale has been used by Atar et al. (2019) and Yurdakul and Coklar (2014) to investigate pre-service English teachers' TPACK competencies. Additionally, Bilici et al. (2016) examined pre-service teachers' TPACK through lesson plan analysis and classroom observation. They used the Technological Pedagogical Content Knowledge-based lesson plan assessment instrument (TPACK-LpAI) to unpack the instructional goals, key indicators, and technology integration in the classroom and Technological Pedagogical Content Knowledge Observation Protocol (TPACK-OP) to assess pre-service teachers' knowledge of assessment, instructional strategies, and curriculum materials.

Next to the TPACK-assessment model, the measurement of pre-service teachers' TPACK has been conducted through a self-assessment survey, lesson plan analysis, teaching observation, and interview. For example, Baek and Sung (2020) examined pre-service teachers' perceptions of technology integration in the classrooms through focus group interviews and questionnaires. By conducting a lesson plan analysis, Wahyuni (2018) also investigated how pre-service English teachers integrated technology in the preparation stage of the teaching processes. In addition to that, Hsu (2016) and Kimm et al. (2020) asked pre-service teachers to self-evaluate and make judgments about their TPACK competencies. They mentioned that this approach provided a great opportunity for pre-service teachers to better understand their competencies in using and integrating educational technology into classroom practices. Moreover, Quintana et al. (2017) examined pre-service teachers' professional performance in using technology in the classroom, by using observation grids and personal log books.

Although a considerable amount of research has been conducted to understand pre-service teachers' teaching knowledge and skills, lack of studies that examine EFL pre-service teachers' technological beliefs over a professional development program. Basically, teachers' beliefs impact their teaching practices and students' learning as well (Farrell & Bennis, 2013). Thus, this study shed light on EFL pre-service teachers' beliefs in TPACK. By tracing EFL pre-service teachers' beliefs in TPACK, this study contributes to an understanding of the current state of how EFL pre-service teachers perceive their TPACK competencies. Also, the results of this study could inform teacher education institutions, especially the English department, whether the TPE program successfully shapes pre-service teachers' beliefs in technology-based classrooms.

METHOD

The present study aimed at investigating how EFL pre-service teachers perceived their TPACK competencies during the TPE program. The qualitative research approach was used in this study. Particularly, the case-study design was applied and the case was pre-service English teachers' beliefs in all seven constructs within the TPACK framework proposed by (Mishra & Koehler, 2006), consisting content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

Data for this study was collected from 30 EFL pre-service teachers, who were enrolled in the pre-service teacher professional education (TPE) program under English Department UNNES. For tracing EFL pre-service teachers' beliefs in TPACK, the researchers used a short self-report questionnaire which was adopted from Schmid et al. (2020). This instrument addressed the aspects of parsimony and practical usability of technology for teaching. The self-report has 28 items in total, which involved the seven knowledge components of TPACK with four items per subscale. All items are measured on a 5-point Likert-type scale rated with strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). The self-report is a valid and reliable instrument with Cronbach's alphas between .77 and .91 and McDonald's omegas between 0.79 and 0.92. The results from the self-report were analyzed using descriptive statistics by computing the mean scores from participants' responses to each item in the TPACK survey.

RESULTS AND DISCUSSIONS

The present study concerned with the EFL pre-service teachers' beliefs of TPACK. In regard to the research question, a five-Likert scale questionnaire was distributed to the EFL pre-service teachers. The following section presents the results of the TPACK scores delineated by EFL pre-service teachers expressed self-reported beliefs of their TPACK competencies in teaching using technology. It consists of the seven TPACK components proposed by Mishra and Koehler (2006), namely content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

Table 1. Mean scores of self-reported TPACK (N=30)

TPACK Sub-Scales	Mean	SD
CK	3.91	.16
PK	3.99	.17
PCK	3.85	.14
TK	4.05	.12
TPK	3.97	.06
TCK	3.85	.18
TPACK	4.08	.07

Table 1 gives a summary of the results of the TPACK scores. Overall, the self-report data indicates very high means for all seven TPACK sub-scales. Based on Table 2, the highest mean score was 4.08 for TPACK and the lowest 3.85

for PCK and TCK. It means that the EFL pre-service teachers are very knowledgeable about the technological pedagogical and content knowledge. Also, the results indicated that by the end of the TPE program, EFL pre-service teachers were able to acquire very high scores in their own thinking about content (CK=3.91), pedagogy (PK= 3.99), and pedagogical content (PCK= 3.85). The fact that the participants have experienced teaching practicum could explain these changes. This is in agreement with Voogt and McKenney (2017) that teaching experience could shape teachers' views on their competencies. Furthermore, the self-report data also indicated the development of EFL pre-service teachers' technology skills (TK= 4.05) and technology related dimensions of TPACK (TPK= 3.97, TCK= 3.85, and TPACK= 4.08). The data shows positive attitudes on pre-service teachers' views on educational technology integration into classroom practices. As stated by Baek and Sung (2020) and Kimm et al. (2020), teacher education program is expected to graduate teacher candidates who are confident and well-versed in technology competencies and literacy. Taken as a whole, the results indicate that every construct in TPACK framework was developed by EFL pre-service teachers during the TPE program. The results from each TPACK sub-scales are presented in the following section.

Content Knowledge

Content knowledge (CK) refers to EFL pre-service teachers' knowledge about English as the subject matter. The self-reported results on EFL pre-service teachers' CK is presented in Table 2.

No.	Statements	M	SD
5	I have sufficient knowledge of English as my teaching subject.	4.00	.87
6	I can use a subject-specific way of thinking in teaching English.	3.92	.64
7	I know the basic theories and concepts of English language teaching.	4.04	.54
8	I know the history and development of important theories in English language teaching.	3.68	.85

Basically, CK defines teachers' knowledge as the understanding of the subject they teach. CK requires teachers to know what they teach and teach what they know. It affects the way teachers' ability to explain clearly, ask good questions, make connections to students, and know the right moment to push each student when he or she is curious. CK includes the knowledge of theories and concept, knowledge of explanatory framework which connect ideas, and knowledge of the rules of evidence. Teachers who do not have those knowledge and understanding can misrepresent the subject to the students (Yang et al., 2018). In the context of English language teaching, teachers must understand the nature of English language.

Based on Table 2, it can be inferred that EFL pre-service teachers hold the body knowledge and information of English as a language and a system that students are expected to learn. Although the majority of EFL pre-service teachers still undecided whether they understand the development of theories in ELT, they agreed that they possess the knowledge of English and the theories of language teaching as well.

Table 2. Mean score responses for CK

Pedagogical Knowledge

Pedagogical knowledge (PK) refers to the EFL pre-service teachers' knowledge about teaching methods and teaching strategies to support students' learning. PK includes the knowledge of all issues of student learning, classroom management, instructional design and implementation, student assessment and evaluation. In light of this, teachers need to have not only the knowledge about teaching techniques and methods to be used in the classroom but also understanding the nature of students itself. In this case, teachers with deep pedagogical knowledge understand how students learn, contruct knowledge, develop skills and positive disposition towards learning. EFL pre-service teachers' self-reported of PK is shown in Table 3.

Table 3. Mean score responses for PK

No.	Statements	M	SD
9	I can adapt my teaching based on what students currently understand or do not understand.	4.12	.60
10	I can adapt my teaching style to different learners.	4.12	.67
11	I can use a wide range of teaching approaches in a classroom setting.	3.76	.78
12	I can assess student learning in multiple ways.	3.96	.79

As presented in Table 3, EFL pre-service teachers believed that they have the knowledge about teaching principles and strategies as well as classroom management. Although they did not highly perceive, they agreed that they can adjust their teaching approaches to different styles of students' learning, and assess them in multiple ways as well.

By understanding students' needs and difficulties in learning, teachers will be able to adjust their teaching strategies and/or approaches. It will result on students' learning achievement. This is in agreement with Wen and Shinas (2020), who stated that teachers' pedagogical knowledge affects their teaching practices. In other words, teachers' instructional practices in the classroom highly depends on their pedagogical knowledge and beliefs.

Pedagogical Content Knowledge

Pedagogical content knowledge (PCK) refers to the EFL pre-service teachers' knowledge about English language teaching. The results of EFL pre-service teachers' self-reported on PCK is presented in Table 4.

Table 4. Mean score responses for PCK

No.	Statements	M	SD
13	I know how to select effective teaching approaches to guide student thinking and learning in teaching English.	3.92	.57
14	I know how to develop appropriate tasks to promote students' complex thinking of English language.	3.64	.76
15	I know how to develop exercises in which students can consolidate their knowledge of English language.	3.88	.67
16	I know how to evaluate students' performance in English language teaching.	3.96	.61

A teacher is considered to have a deep PCK if he/she understands what teaching approaches or strategies that fit the content of the subject matter. By possessing this knowledge, a teacher may address student' difficulties and misconceptions towards the etaching content. In other words, PCK concerns with the representation of pedagogical techniques, which make difficult concept to learn into easy.

Table 4 shows that EFL pre-service teachers hold the knowledge about teaching and

the knowledge of English as the subject matter. It indicates that they understand how to teach English as a language to students with appropriate approach which fit to students' learning style. Although some of the EFL pre-servuce teachers still undecided whether they can develop such a task or assignment which can promote students' critical thinking of English language, they perceived that they can appropriately assess and evaluate students' learning.

Technolgical Knowledge

Technological knowledge (TK) refers to EFL pre-service teachers' knowledge about technology. Basically, TK is the knowledge of standard technologies and more advances technologies or digital technologies. In this 21st-century teaching learning, it seems that a teacher must understand how to operate digital technology. It includes the technical skills needed to use technology, such as installing and removing peripheral devices and software programs. Also, a teacher must be aware with technology advancements. The results from EFL pre-service teachers' self-reported of TK is presented in Table 5.

Table 5. Mean score responses for TK

No.	Statements	M	SD
1	I keep up with important new technologies.	4.16	.62
2	I frequently play around with the technology.	4.12	.73
3	I know about a lot of different technologies.	3.88	.83
4	I have the technical skills I need to use technology.	4.04	.54

As presented in Table 5, EFL pre-service teachers perceived that they stay updated with the latest technology trends. Also, they have the relevant skills needed to use different types of technological tools. It indicates that through the TPE program, EFL pre-service teachers could be more aware with technology advancements and understand how to use them appropriately.

The finding of EFL pre-service teachers' TK relates to what have been stated by Buckley et al. (2019) in their study, that education program results on student teachers' technological knowledge. With technological knowledge, pre-service teachers could better apply digital tools in the classrooms. In relation to that, by holding this technology literacy, pre-service teachers could create their technology-based classrooms in the future instructional practices. It is due to the fact that teachers are more likely to use technology in the classroom if they can use it.

Technological Pedagogical Knowledge

Technological pedagogical knowledge (TPK) refers to EFL pre-service teachers' knowledge about integrating and using technology for assisting their teaching activities. TPK requires teachers to be more aware on how particular technology might change the teaching and learning processes. It includes teacher's ability to select and choose technological tool based on its fitness to the teaching strategies. Table 6 presents the results from EFL pre-service teachers' self-reported on TPK.

Table 6. Mean score responses for TPK

No.	Statements	M	SD
17	I can choose technologies that enhance the teaching approaches for English lesson.	4.00	.65
18	I can choose technologies that enhance students' learning for English lesson.	3.88	.78
19	I can adapt the use of the technologies that I am learning about to different teaching activities.	4.00	.65
20	I am thinking critically about how to use	4.00	.65

No.	Statements	M	SD
	technology in my English classroom.		

As presented in Table 6, EFL pre-service teachers perceived that they have sufficient knowledge on how to integrate the interplay of technology and teaching approaches to support students' learning. They agreed that they can choose suitable technology which fit to the learning approaches to enhance students' learning.

By holding the knowledge on how to appropriately choose certain technology to support teaching and learning activities, EFL pre-service teachers show their readiness to teach with technology. It is supported by Chuang et al. (2018), who stated that teachers' beliefs impact on their readiness to use technology in the classrooms. In line with that, Aryani et al. (2021) also stated that teachers' practices in using educational technology, largely depends on the views of technological knowledge. Furthermore, teachers with student-centered pedagogical beliefs will be able to successfully integrate technology in the classroom. On the contrary, teachers with traditional beliefs requires much greater changes in their teaching practices with technology.

Technological Content Knowledge

Technological content knowledge (TCK) refers to EFL pre-service teachers' knowledge about integrating appropriate technology for teaching English language. Table 7 presents the mean score of EFL pre-service teachers' self-reported on TCK.

Table 7. Mean score responses for TCK

No.	Statements	M	SD
21	I know how technological developments have changed the field of English language teaching.	4.04	.68
22	I can explain which technologies have been used in research in English language teaching.	3.96	.74
23	I know which new technologies are currently being developed for teaching English.	3.64	.76
24	I know how to use technologies to participate in scientific discourse in English language teaching.	3.76	.66

Table 7 shows that EFL pre-service teachers perceived the important role of technology for English language teaching. Although they still undecided if they know the current technology which are developed for teaching English (M=3.64), they realized that there are technologies to be used for teaching English.

Kurt et al (2014) mentioned that TCK requires teachers to know not just the subject matter but also the manner in which technology can change the teaching of the subject matter itself. For example, Kahoot is a digital application which allows students to easily learn grammar. In this regard, teachers might take into consideration on how to implement Kahoot into grammar teaching and learning. In this study, it was found that EFL pre-service teachers understand the role of technologies for ELT purposes. It means that they can select appropriate technology for teaching English language. Also, by possessing this knowledge, they will be able to choose technology which can help them to tangibly and clearly explain difficult concepts to students.

Technological Pedagogical Content Knowledge

Technological pedagogical and content knowledge covers all domains in TPACK. It refers to EFL pre-service teachers' knowledge about ICT integration in ELT practices. Table 8 presents the results of EFL pre-service teachers' self-reported on TPACK.

Table 8. Mean score responses for TPACK

No.	Statements	M	SD
25	I can use strategies that combine content, technologies, and teaching approaches that I learned about in ELT classroom.	4.04	.61
26	I can choose technologies that enhance the content of English lesson.	4.16	.55
27	I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.	4.12	.44
28	I can teach English lessons that appropriately combine my teaching subject, technologies, and teaching approaches.	4.00	.58

As showed in Table 8, EFL pre-service teachers perceived that theu hold the knowledge on how various technologies can be used to assist their ELT practices. It indicates that they understand the work of three types of knowledge (TK, PK, and CK) for sucessful educational technology integration in ELT practices.

Basically, TPACK is the emergent form of three basic component of teachers' knowledge (content knowledge, pedagogy knowledge, and technology knowledge). As mentioned by Kereluik et al. (2013), TPACK is the basis framework of good teaching with the involvement of appropriate educational technology. It requires the knowledge on how to use technology, knowledge of students' needs, knowledge of pedagogical techniques that can reduce students' learning problems, knowledge of how technology can make a certain concept difficult or easy, and also knowledge on how technology can bu used to strengthen students' learning.

By posessing this knowledge, EFL pre-service teachers will be able to sucessfully intergate technology into content materials for pedaogical purposes. It is due to the fact that technology integration into classroom practices is affected by teacher competencies. In light of this, Yurdakul and Coklar (2014) stated that the level of ICT usage and technology knowledge influence all seven domains of TPACK competencies. Therefore, by holding the knowledge of content, pedagogy, and technology, EFL pre-service teachers could show better performance in their future teaching career.

Considering the EFL pre-service teachers' views on their TPACK competencies, it can be concluded that they highly perceived the role of technology for assissting and facilitating the English language teaching and learning. This view could influence their future instructional practices since teachers' beliefs could shape the reasons of why teachers act the way they do. It is due to the fact that teachers' decision-making highly relies on their assumption or what they belive. As stated by Farrell and Bennis (2013), teachers' beliefs play a vital role in shaping teachers' behavior that impacts students' learning development. Subsequently, by perceiving technology integration into classroom practices, it is expected that EFL pre-service teachers could better integrate technology into academic content and for pedagogy purposes.

Above all, in this study, the self-report data could provide important information regarding EFL teachers' TPACK awareness. It informs teacher educators about how pre-service teachers' views on technology integration into classroom practices. The results also confirm the impact of TPE program in shaping EFL pre-service teachers' views on ICT integration into classroom practices.

CONCLUSION

This study has aimed to investigate the EFL pre-service teachers' beliefs about their TPACK competencies in this 21st-century teaching and learning. It is in regards to content, pedagogy, and technology knowledge that EFL

pre-service teachers reflect technology integration and teaching strategy which can support the teaching and learning process. By distributing a self-report questionnaire to 30 EFL pre-service teachers, the results of this study confirm that EFL pre-service teachers hold their beliefs in TPACK, and they see the value of educational technology to support the teaching and learning of English in the classrooms. Take into consideration, the results have provided the current state of EFL pre-service teachers' beliefs about the interplay of content, pedagogy, and technology knowledge for English language teaching. Indeed, EFL pre-service teachers need more guidance on how to effectively use technology in the ELT classrooms. It is expected to contribute to pre-service teacher professional education program and the successful integration of technology into classrom practices. As for the limitations, this study was based on a survey scale in which the partcipants individually assessed the items in accordance with their views and believes. Thus, further study is needed to investigate their actual performance in implementing all domains of TPACK competencies in the classrooms. Also, it will be valuable to better understand and compare what they believe in TPACK to what they do in the classrooms.

REFERENCES

Aryani, O. D., Linggar Bharati, D. A., & Astuti, P. (2021). Teachers' practices in using educational mobile applications to teach english. *English Education Journal*, *11*(1), 37–55.

Atar, C., Aydın, S., & Bagcı, H. (2019). An investigation of pre-service English teachers' level of technopedagogical content knowledge. *Journal of Language and Linguistic Studies*, *15*(3), 794–805.

Badilla Quintana, M. G., Vera Sagredo, A., & Lytras, M. D. (2017). Pre-service teachers' skills and perceptions about the use of virtual learning environments to improve teaching and learning. *Behaviour and Information Technology*, *36*(6), 575–588.

Baek, E. O., & Sung, Y. H. (2020). Pre-service teachers' perception of technology competencies based on the new ISTE technology standards. *Journal of Digital Learning in Teacher Education*, *37*(1), 48–64.

Bilici, S. C., Guzey, S. S., & Yamak, H. (2016). Assessing pre-service science teachers' technological pedagogical content knowledge (TPACK) through observations and lesson plans. *Research in Science and Technological Education*, *34*(2), 237–251.

Buckley, J., Seery, N., Power, J., & Phelan, J. (2019). The importance of supporting technological knowledge in post-primary education: a cohort study. *Research in Science and Technological Education*, *37*(1), 36–53.

Cederqvist, A. M. (2022). An exploratory study of technological knowledge when pupils are designing a programmed technological solution using BBC Micro:bit. *International Journal of Technology and Design Education*, *32*(1), 355–381.

Chuang, H. H., Ho, C. J., Weng, C. Y., & Liu, H. C. (2018). High school students' perceptions of English teachers' knowledge in technology-supported class environments. *Asia-Pacific Education Researcher*, *27*(3), 197–206.

Farrell, T. S. C., & Bennis, K. (2013). Reflecting on ESL teacher beliefs and classroom practices: A case study. *RELC Journal*, *44*(2), 163–176.

Finsterwald, M., Wagner, P., Schober, B., Lüftenegger, M., & Spiel, C. (2013). Fostering lifelong learning - Evaluation of a teacher education program for professional teachers. *Teaching and Teacher Education*, *29*(1), 144–155.

Hsu, L. (2016). Examining EFL teachers' technological pedagogical content knowledge and the adoption of mobile-assisted language learning: a partial least square approach. *Computer Assisted Language Learning*, *29*(8), 1287–1297.

Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth:

Teacher knowledge for 21st century learning. *Journal of Digital Learning in Teacher Education*, *29*(4), 127–140.

Kimm, C. H., Kim, J., Baek, E. O., & Chen, P. (2020). Pre-service teachers' confidence in their ISTE technology-competency. *Journal of Digital Learning in Teacher Education*, *36*(2), 96–110.

Kurt, G., Akyel, A., Kocoglu, Z., & Mishra, P. (2014). TPACK in practice: A qualitative study on technology integrated lesson planning and implementation of Turkish pre-service teachers of English. *ELT Research Journal*, *3*(3), 153–166.

Lemon, N., & Garvis, S. (2016). Pre-service teacher self-efficacy in digital technology. *Teachers and Teaching: Theory and Practice*, *22*(3), 387–408.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record: The Voice of Scholarship in Education*, *108*(6), 1017–1054.

Putry, A. R. A., Astuti, P., & Sakhiyya, Z. (2022). The manifestation of EFL teachers' self-efficacy and TPACK with their teaching performance. *English Education Journal*, *12*(2), 151–161.

Ritzhaupt, A. D., Huggins-Manley, A. C., Ruggles, K., & Wilson, M. (2016). Validation of the Survey of Pre-service Teachers' Knowledge of Teaching and Technology: A Multi-Institutional Sample. *Journal of Digital Learning in Teacher Education*, *32*(1), 26–37.

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK . xs) and comparing the factor structure of an integrative and a transformative model. *Computers & Education*, *157*(November 2019), 103967.

Shortt, M., Tilak, S., Kuznetcova, I., Martens, B., & Akinkuolie, B. (2021). Gamification in mobile-assisted language learning: a systematic review of Duolingo literature from public release of 2012 to early 2020. *Computer Assisted Language Learning*, *36*(3), 517–554.

Shulman, L. S. (1986). Those who understand: Kowledge growth in teaching. *Educational Researcher*, *15*(2), 1.

Sims, S., & Fletcher-Wood, H. (2021). Identifying the characteristics of effective teacher professional development: a critical review. *School Effectiveness and School Improvement*, *32*(1), 47–63.

Tatto, M. T. (2021). Professionalism in teaching and the role of teacher education. *European Journal of Teacher Education*, *44*(1), 20–44.

Tseng, J. J., Cheng, Y. S., & Yeh, H. N. (2019). How pre-service English teachers enact TPACK in the context of web-conferencing teaching: A design thinking approach. *Computers and Education*, *128*, 171–182.

Voogt, J., & McKenney, S. (2017). TPACK in teacher education: are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education*, *26*(1), 69–83.

Wahyuni, S. (2018). Evaluation of pre-service English teachers' integration of educational technology into their lesson plans. *Language Circle: Journal of Language and Literature*, *12*(2), 227–235.

Wen, H., & Shinas, V. H. (2020). Using a multidimensional approach to examine TPACK among teacher candidates. *Journal of Digital Learning in Teacher Education*, *37*(1), 30–47.

Xu, Z., Banerjee, M., Ramirez, G., Zhu, G., & Wijekumar, K. (Kay). (2019). The effectiveness of educational technology applications on adult English language learners' writing quality: a meta-analysis. *Computer Assisted Language Learning*, *32*(1–2), 132–162.

Yang, Y., Liu, X., & Gardella, J. A. (2018). Effects of professional development on teacher pedagogical content knowledge, inquiry teaching practices, and student understanding of interdisciplinary science. *Journal of Science Teacher Education*, *29*(4), 263–282.

Yurdakul, I. K., & Coklar, A. N. (2014). Modeling preservice teachers' TPACK competencies based on ICT usage. *Journal of Computer Assisted Learning*, *30*(4), 363–376.

Zambak, V. S., & Tyminski, A. M. (2020). Examining mathematical technological knowledge of pre-service middle grades teachers with Geometer's Sketchpad in a geometry course. *International Journal of Mathematical Education in Science and Technology*, *51*(2), 183–207.

Zou, D., Huang, Y., & Xie, H. (2021). Digital game-based vocabulary learning: where are we and where are we going? *Computer Assisted Language Learning*, *34*(5–6), 751–777.