SCRIPT JOURNAL
Journal of Linguistic and English Teaching
http://jurnal.fkip-uwgm.ac.id/index.php/Script
P-ISSN: 2477-1880; E-ISSN: 2502-6623
April 2025, Vol. 10 No. 1

Insights on TPACK Implementation by Preservice English Teachers: Challenges and Solutions

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Abstract

Background:
A crucial issue in teacher education today is ensuring that PTs are well-prepared to integrate technology into their future classrooms. This study examines the implementation of Technological Pedagogical Content Knowledge (TPACK) among preservice English teachers in planning and implementing learning, as well as the barriers they face and their solutions.

Methodology:
This study used a case study research design to explore in depth how PTs apply the TPACK framework in real classroom situations. The participants in this study consisted of five PTs from teacher education programs at four universities in Indonesia.

Findings:
PTs generally show good alignment between technology use, pedagogical strategies, and content in their lesson plans, but are often not optimally integrated during implementation. The main barriers identified include limited access to technology resources, differences in technology skill levels between students and teachers, students' difficulties in adapting to technology-based learning, and time management issues. The solutions are to provide device assistance to students in need, provide basic technology training and plan carefully, and provide realistic time for students to adapt to technology and complete assignments.

Conclusion:
To enhance technology integration in education, universities must prioritize providing device assistance and basic tech training for PTs. By addressing these barriers, educators can better support effective technology use in the classroom, ultimately improving student learning outcomes.

Originality:
How pre-service teachers, who are the next generation of educators, develop and implement TPACK during their preparation and learning phases. In particular, there is very little research that specifically explores the implementation of TPACK in the classroom by PTs, as well as a lack of exploration of the challenges faced by them and the strategies used in the TPACK integration process.

Keywords	:	TPACK; Preservice Teachers; Challenges; Solutions.
DOI	:	10.24903/sj.v10i1.2000
Received	:	February 2025
Accepted	:	April 2025
Published	:	April 2025
How to cite this article (APA)	:	Darsih, E., Agustiana, V., Hanggara, A., & Palmer, R. (2025). Insights on TPACK Implementation by Preservice English Teachers: Challenges and Solution. *Script Journal: Journal of Linguistics and English Teaching*, *10*(1), 68-92. https://doi.org/ 10.24903/sj.v10i1.2000

INTRODUCTION

Developing teacher skills and knowledge in integrating technology into learning is a critical aspect of today's education. The Technological Pedagogical Content Knowledge (TPACK) framework has been recognized as an important framework that helps teachers integrate technology, pedagogy, and content effectively in their teaching practices (Abdul, 2024; Ariyanti et al., 2024; Esra & İsmail, 2024; Karaduman & Akman, 2024). The TPACK concept was first coined by Koehler et al. (2009) and Koehler et al. (2013) which is a new structure of the PCK or Pedagogical Content Knowledge Shulman concept (Shulman, 1987). In the context of teacher education, a deep understanding of TPACK and its application in classroom practice becomes very important. (Schmid et al., 2020). PTs as a new generation of educators, need to be equipped with TPACK skills to prepare them to face the challenges of education in the digital era. (Çebi, 2022). They face the dual challenge of mastering traditional teaching methodologies as well as the effective use of modern technology. (Öz, 2015; Günbaş & Gözüküçük, 2023). This challenge is embodied in the concept of TPACK, which emphasizes the importance of teachers effectively integrating technology with pedagogical and content knowledge. (Tseng et al., 2020).

A crucial issue in teacher education today is ensuring that PTs are well-prepared to integrate technology into their future classrooms. Despite the widespread availability of digital technology tools, many PTs feel unprepared to use these tools effectively. Lack of PTs' knowledge, skills, abilities, or competencies regarding the use of technology in their teaching has been identified as a major barrier to technology integration. (Darsih et al., 2024; Huang et al, 2024; Kabakci et al., 2012; Ye & Aziz, 2024). This lack of preparedness is often due to inadequate training in integrating technology into their teaching practices in ways that enhance learning outcomes. Addressing this issue is critical to developing competent, confident educators who can leverage technology to enhance student learning.

Recent advances in educational research highlight the importance of the TPACK framework in teacher education as the use of technology has become an undeniable part of the 21st century. (Barfi, 2023; Cojorn & Seesom, 2024; Darsih et al., 2024; Huang et al, 2024; Ye & Aziz, 2024). In recent years, research on the application of TPACK has shown the importance of integration between technology, pedagogy, and content in education for effective learning. (Barfi, 2023; Hero, 2020). Many studies have explored how teachers at different levels of education apply TPACK to improve their teaching effectiveness. First, at the university level, Mutanga & Nezandonyi examined the TPACK knowledge status of 20

lecturers and its positive impact on the quality of engineering and technical education. Mutanga et al. (2018) has a significant impact on students' scientific competence, with different levels of TPACK causing differences in student learning outcomes. (Sonsupap et al., 2024). Furthermore, a study on the analysis of TPACK literacy among lecturers at the Muhammadiyah University of Parepare, Indonesia in the Writing course. (Mahmud, 2020). As a form of breakthrough and the impact of the Covid 19 pandemic, online education replaces conventional classroom teaching, becoming the main teaching method. This has caused a significant change in the lecturer's approach to teaching translation courses. (Alkhawaja, 2022; Guerin, 2022). Exploration of TPACK integration in online learning at universities was also reviewed by Darsih, et al. (2023) and other studies reveal that Lesson Study is believed to have a positive impact on the development of TPACK (Darsih et al., 2021). Studies at the secondary school level, several findings indicate that teachers who have a strong understanding and skills of TPACK tend to be more successful in designing and implementing innovative and engaging learning. (Ali, 2023; Sabah et al., 2024), which in turn can improve student learning outcomes (Atun, 2023; Chaidam & Poonputta, 2022) such as improving writing skills (Kenan, 2024) and enrich students' vocabulary (Alamri, 2023). Other findings also showed that in-service secondary education teachers' TPACK levels varied by gender and teaching experience, with professional development courses showing improvements in technology integration. (Ricardo et al., 2024). This is different from what was revealed by Leong & Yunus that teaching experience and professional development did not have a significant impact on TPACK levels. (Leong & Yunus, 2024).

However, while the existing literature has provided important insights into the implementation of TPACK by practicing teachers and lecturers, there is still a gap in research on how pre-service teachers, who are the next generation of educators, develop and implement TPACK during their preparation and learning phases. In particular, there is very little research that specifically explores the implementation of TPACK in the classroom by PTs, as well as a lack of exploration of the challenges faced by them and the strategies used in the TPACK integration process.

This study focuses on the preparation of PTs to integrate technology in learning, an important skill in this digital era. Effective integration of technology, pedagogy, and content, as represented by the TPACK framework, can improve the quality of learning, making it more engaging and relevant to students. This study used a case study research design to explore in depth how PTs apply the TPACK framework in real-life classroom situations. Participants in

this study consisted of five preservice English teachers from teacher education programs at five universities in Indonesia. The five participants, who were all in their final year of the teacher education program (seventh semester), were in teaching practice at a secondary school designated as a partner school. Through classroom observations and in-depth interviews, this study aimed to (1) explore the application of TPACK by PTs in the context of lesson planning and implementation, and (2) identify barriers and solutions to the application of TPACK. Ultimately, this study aims to support the creation of a new generation of educators who are proficient in integrating technology with pedagogical and content knowledge to improve student learning outcomes.

METHODOLOGY

This research is important because it focuses on the preparation of PTs in integrating technology into learning, in accordance with the TPACK framework. This integration improves the quality of learning and equips teachers with relevant skills to face future educational challenges. The purpose of this study is to (1) explore the application of TPACK by PTs in the context of planning and implementing learning, and (2) identify challenges and solutions in implementing TPACK.

This study used a case study research design to explore in depth how PTs apply the TPACK framework in real classroom situations. Case studies were chosen as an approach because of their nature of allowing detailed analysis of complex phenomena in their original contexts. (Coombs, 2023; Creswell, 1994). Through a multiple case study approach, This study explores in detail three main aspects of PTs' teaching practice: planning, implementing, and evaluating learning, with a focus on how they integrate technology, pedagogy, and content (TPACK) in each of these stages. In the planning stage, this study examines how PTs design learning by integrating TPACK elements. This includes an analysis of their lesson plan (teaching module), which is expected to reflect their understanding of how to align technology with pedagogical objectives and learning materials. In the implementation stage, this study examines and directly observes how PTs implement the plans they have prepared in a real classroom context. The main focus of this observation is how technology is used to support the teaching and learning process and how they adapt to dynamic classroom situations. This study also looks at how they manage the interaction between technology, students, and learning materials to create effective learning experiences. The evaluation stage in this study highlights how PTs assess the effectiveness of the learning they have implemented, especially in terms of achieving learning objectives and the impact of technology use on student learning outcomes.

This study also explores in depth the various barriers faced by PTs in integrating technology into learning, as well as the solutions to overcome these barriers. These barriers, which can be technical or non-technical, are identified in this study.

Participants

The participants in this study consisted of five PTs from teacher education programs at four universities in Indonesia, namely the University of Muhammadiyah Mataram, Mahasaraswati University Denpasar, Panca Sakti University Tegal, Indonesia University of Education and Subang University. These five participants, who were all in their final year of the teacher education program (seventh semester of English Education study program), were selected based on their willingness to participate and their involvement in teaching practice at the secondary schools designated as partner schools. By involving participants from various universities, the researcher was able to collect more diverse data. This helped enrich the understanding of how TPACK is implemented in different contexts, as well as the challenges and strategies that may vary at each university.

The selection of participants was carried out using a purposive sampling technique. This technique is used to ensure that participants involved in the study have specific characteristics that are relevant to the objectives of the study. In this case, the participants selected were preservice English teachers who were in their final year of the teacher education program and were undergoing teaching practice at partner secondary schools.

Through coordination with the faculty and the head of the English Education study program, the researcher obtained recommendations for selecting research participants. These recommendations help ensure that selected participants meet the necessary criteria, such as being in their final year of a teacher education program and undergoing teaching practice at a partner secondary school. Support from faculty and program heads also ensures that participants have relevant experience to provide in-depth insight into the application of TPACK in a real classroom setting. Information from each participant is presented in table 1:

Table 1. Participants Profile

Participants	Self-reported Gender	Age	TOEFL Prediction score	University
Participant 1	Man	21	560	University of Muhammadiyah Mataram
Participant 2	Woman	21	610	Mahasaraswati University Denpasar

Participant 3	Woman	20	550	Panca Sakti UniversityTegal
Participant 4	Woman	21	540	Indonesia University of Education
Participant 5	Woman	20	530	Subang University

Data Collection

Data were collected by using two methods to ensure a rich and comprehensive understanding of participant experiences:

1. Direct observation: Classroom observation was conducted with the aim of getting a direct picture of how participants apply the TPACK concept in their teaching. Each participant was observed during a teaching practice session at a partner high school, where the main focus of the observation was the integration of technology, pedagogy, and content in the learning process. There were 4 important aspects observed during the observation, namely the use of technology, learning strategies, teacher-student interactions, and classroom management. Regarding the aspect of technology use, the researcher observed how participants utilized digital tools or other technologies in teaching. This includes the type of technology used, how the technology was integrated into the lesson, and its effectiveness in improving student understanding. In terms of observing learning strategies, the researcher observed how participants implemented pedagogical strategies that supported technology-based learning. The interaction between participants (PTs) and students was also an important focus. This includes how participants facilitate discussions, provide feedback, and involve students in the learning process. The researchers also observed students' responses to the use of technology and how this affected classroom dynamics. Finally, the observation covered how participants managed the classroom in the context of technology use, including how they handled technical glitches, maintained student focus, and ensured that technology was used effectively to support learning objectives.
2. In-depth Interviews: After the observation session was completed, the researchers continued with interviews to dig deeper into the participants' experiences and thoughts regarding their teaching practice. The interviews used a semi-structured format, meaning that there was a prepared question guide, but the researchers also gave participants space to explore other topics that they considered relevant. The interviews were recorded to ensure that all important details were well documented and could be

analyzed comprehensively at a later stage. Each interview focused on three main aspects: the first was a reflection on teaching experience: participants were asked to reflect on their experiences during their teaching practice, including how they planned and implemented learning by integrating technology, pedagogy, and content (TPACK). The second was the challenges faced: the interviews also identified various challenges that participants faced during their teaching practice. These challenges could be related to the use of technology, classroom management, the implementation of pedagogical strategies, or even external factors such as school infrastructure and support from colleagues. By uncovering these challenges, the researchers were able to understand the common barriers faced by PTs in implementing TPACK. The third was solutions to overcome challenges: in addition to identifying challenges, participants were also asked to explain the strategies they used to overcome these problems. Each interview lasted approximately 45 minutes, allowing ample time for participants to share their experiences in detail.

Data Analysis

The data analysis in this study used a systematic approach to deeply understand how PTs implement TPACK in their teaching practice. This approach involved thematic analysis of data obtained from classroom observations and interviews, which allowed the researchers to identify patterns, themes, and meanings relevant to the implementation of TPACK in the classroom.

This data analysis process involves three phases, namely: *coding, categorization and interpretation* (Yin, 2009):

1. Coding: Data from interviews and observations were coded to identify important themes and patterns related to the integration of technology, pedagogy, and content knowledge. Coding aims to break down the data into smaller units of information that are relevant to the research.
2. Categorization: The identified codes were then categorized into broader themes and subthemes. This stage helps to organize the data in a more structured way, making it easier for researchers to see the relationships between the various themes and how each theme contributes to a greater understanding of TPACK implementation.
3. Interpretation: In the final phase, the categorized themes are interpreted to build a deeper understanding of how TPACK is applied in teaching practice by pre-service English teachers. This interpretation includes an analysis of the context, challenges,

and solutions or strategies used by participants in integrating TPACK into their teaching.

FINDINGS

Implementation of TPACK by Preservice English Teachers

This section presents the results of research on the implementation of TPACK by five PTs in teaching practice activities. This study aims to examine the extent to which PTs are able to integrate technology, pedagogy, and content knowledge in the context of planning and implementing teaching. Related to planning, the aspects analyzed are the relevance of the lesson plan with the use of technology and pedagogical strategies, as well as the relevance of the content delivered with the selected technology and pedagogy. Meanwhile, related to the implementation of teaching and learning, the analysis focuses on the use of technology, learning strategies, teacher and student interactions, and classroom management. The results of this study are expected to provide an overview of the readiness of PTs to face the challenges of education in the digital era, as well as provide input for the development of more effective teacher education programs.

Participant 1

Based on the results of observations of the teaching module of participant 1, it was found that the relevance between the lesson plan and the use of technology and pedagogical strategies has been optimally appropriate. Here are some points that support these findings:

a) Relevance of Lesson Plans to the Use of Technology

In the lesson plan, participant 1 clearly integrates the use of technology in accordance with learning objectives. The technology used supports teaching and learning activities, such as the use of digital presentations and interactive devices, which are in line with the material being delivered. Each selected technology tool is used to enhance students' understanding of the content, thus providing a positive impact on the learning process.

b) Relevance of Lesson Plans to Pedagogical Strategies

Participant 1 also successfully combined pedagogical strategies that were appropriate to the use of technology. For example, he used a student-centered approach through collaborative application-based group discussion activities, which allowed students to actively participate and use technology as a tool to explore and solve problems. This pedagogical strategy is very relevant to the characteristics of 21st century learning, where students are encouraged to think critically and creatively using technology.

c) Relevance of Content to Selected Technology and Pedagogy

The content delivered by participant 1 is a conversation text that uses Expression of Asking for Attention, Expression of Giving Attention, Expression of Checking for Understanding, Expression of Showing Understanding, and Expression of Showing Lack of Understanding according to the chosen technology and pedagogical strategy. In delivering the material, he uses several images to clarify abstract concepts, which are difficult to understand through conventional methods. The use of this media is not only relevant to the content but also supports pedagogical strategies that prioritize visualization and interactivity to improve student understanding.

Overall, observations showed that participant 1 was able to plan TPACK-based learning well. The alignment between technology, pedagogy, and content was achieved optimally, which showed participant 1's readiness to apply the TPACK approach in the classroom.

Participant 2

Based on the results of observations of the teaching modules prepared by participant 2, it was found that the relevance between the lesson plan and the use of technology and pedagogical strategies was appropriate and well-integrated. Several main points that support these findings are as follows:

a) Relevance of Using Technology in Lesson Plans

Participant 2 has designed the use of technology that supports the achievement of learning objectives. In her lesson plan, technology not only functions as a presentation tool, but also as a means of interaction and evaluation. The participant plans the use of interactive software, such as online learning applications and interactive quiz tools to measure student understanding in real time. The technology chosen supports student activities actively and collaboratively, reflecting good integration between learning content and the technology used.

b) Relevance of Pedagogical Strategies to the Use of Technology

The pedagogical strategy implemented in participant 2's learning plan is in accordance with the use of the chosen technology. The participant uses a blended learning approach, where students not only get material through direct explanations in class but also through an online platform to carry out independent tasks and collaborate in groups online. This strategy provides greater flexibility and opportunities for students to learn at their own pace, as well as utilizing technology as an effective learning support tool.

c) Relevance of Learning Content to Technology and Pedagogical Strategies

The content delivered by participant 2 was relevant to the technology used and the pedagogical strategies applied. Participants selected appropriate content to be presented with visual technologies such as animated videos and interactive graphics, which helped students understand abstract concepts more easily. In addition, the selection of project-based teaching methods and group discussions, supported by online technology, helped students to apply their knowledge practically and more deeply.

Overall, the observation results show that the lesson plan prepared by participant 2 has good relevance between technology, pedagogical strategies, and learning content. This reflects the participant's ability to effectively combine important components of TPACK in modern and interactive learning planning.

Participant 3

Based on the results of observations of the teaching modules prepared by participant 3, it was found that the relevance between the lesson plan and the use of technology and pedagogical strategies was less appropriate and had not been well integrated. Several points that support these findings are as follows:

a) Relevance of Using Technology in Lesson Plans

Although participant 3 has included the use of technology in his lesson plan, the choice of technology does not fully support the learning objectives effectively. The technology used is limited to PowerPoint for delivering material, without any variation in the use of other aids such as interactive videos, simulations, or collaborative applications. This makes technology function more as a passive presentation tool, rather than as a means that can increase student interaction and understanding of the content being taught.

b) Relevance of Pedagogical Strategies to the Use of Technology

The pedagogical strategies chosen by participant 3 were not fully integrated with the use of available technology. The lesson plans tended to use lecture methods supported by PowerPoint, so that student interaction with the material and with the teacher was limited. There was no student-centered approach that utilized technology to increase active student engagement. In fact, more interactive technologies such as online quizzes, online group discussions, or the use of collaborative software could help students become more involved in the learning process.

c) Relevance of Learning Content to Technology and Pedagogical Strategies

The content presented in the lesson plan is not fully relevant to the technology and

pedagogical strategies chosen. Learning content that requires more interactive visualization, such as videos or simulations, is only presented through PowerPoint slides, which makes students less able to get a clear picture of the more abstract material. This causes a lack of integration between the content and the technology used, so that the pedagogical strategies applied do not support students' deep understanding.

Overall, the observation results show that the learning plan prepared by participant 3 still has weaknesses in terms of relevance and integration between technology, pedagogical strategies, and learning content. The limited use of technology and pedagogical approaches that do not support active student interaction cause the learning process to be less than optimal. Participant 3 is advised to further vary the use of technology that is relevant to the material and apply more interactive pedagogical strategies to increase student engagement and learning effectiveness.

Participant 4

Based on the results of the analysis of the teaching modules prepared by participant 4, it was found that the relevance between technology, pedagogical strategies, and the content prepared has been well integrated. Here are some key points that support these findings:

a) Relevance of Using Technology in Lesson Plans

Participant 4 demonstrated a good understanding in selecting technology that is relevant to the learning objectives. In her teaching module, technology is not only used to deliver material, but also as a means to increase student engagement. Examples of technology use include interactive applications for quizzes and formative assessments, as well as learning videos that support the visualization of abstract concepts. The use of this technology supports more dynamic learning and provides opportunities for students to actively participate.

b) Relevance of Pedagogical Strategies to the Use of Technology

The pedagogical strategies implemented in participant 4's lesson plan are highly relevant to the use of technology chosen. The participant combines blended learning methods, where students engage in both face-to-face and online learning activities. Technology is used to facilitate student collaboration through an online learning platform, allowing them to interact in online group discussions. This strategy supports student-centered learning, providing flexibility for students to learn in a way that suits their needs, while still utilizing technology as a tool to deepen the material.

c) Relevance of Content to Technology and Pedagogical Strategies

The learning content designed by participant 4 is also very much in line with the technology and pedagogical strategies chosen. Content that requires visualization and experimentation is explained through technology-based simulations, which allow students to see and understand concepts practically. In addition, the material presented in the form of interactive videos and project-based assignments allows students to apply their knowledge directly. Thus, the content delivered becomes more relevant and meaningful to students because they can learn through various forms of interactive media.

Overall, the results of the analysis show that the teaching module prepared by participant 4 has a strong relevance between the use of technology, pedagogical strategies, and learning content. This integration reflects participant 4's understanding of the importance of TPACK in planning and implementing effective teaching in the digital era. The combination of technology, pedagogy, and content in the teaching module supports the creation of interactive, collaborative, and student-centered learning.

Participant 5

Based on the results of the analysis of the teaching modules prepared by participant 5, it was found that the relevance between technology, pedagogical strategies, and the content prepared was quite good. Here are some key points that support these findings.:

a) Relevance of Using Technology in Lesson Plans

Participant 5 has chosen appropriate technology to support learning objectives. Although the use of technology is limited, such as PowerPoint and learning videos, the technology is effective in visualizing the material. In addition, there is a plan to use an online quiz application for evaluation, although it has not been fully implemented in the implementation. This choice of technology shows an understanding of the importance of aids in the learning process, although there is still room for the addition of more interactive technology variations.

b) Relevance of Pedagogical Strategies to the Use of Technology

The pedagogical strategies implemented in participant 5's learning plan were quite relevant to the use of the technology chosen. The participant used a lecture method supported by visual technology, followed by group discussions to encourage student participation. Although not entirely student-centered, the collaborative elements in the learning strategy indicate an attempt to actively engage students. However, it should be noted that a more varied and student-focused approach would have increased the

effectiveness of learning.

c) Relevance of Learning Content to Technology and Pedagogical Strategies

The content delivered by participant 5 was quite appropriate to the technology and pedagogical strategies used. The theoretical material was presented in an interesting way through the use of videos and presentation slides. However, there were some parts of the content that could be improved by adding practical examples or real applications of the concepts taught. Better integration of the content with the technology used would make the learning experience more relevant and engaging for students.

Overall, the results of the analysis show that the teaching module prepared by participant 5 has quite good relevance between the use of technology, pedagogical strategies, and learning content. Although some aspects can still be improved, such as variations in the use of technology and the application of methods that are more focused on students, participant 5 has shown a good understanding of the integration of TPACK in learning planning. With further adjustments and development, this teaching module has the potential to improve the effectiveness of the learning process in the classroom.

Challenges and Solutions in Technology Integration by Preservice English Teachers

Based on interview data conducted with 5 participants, there were several significant findings regarding the challenges faced in TPACK integration during the learning process and their solutions. These obstacles include:

1. Limited Access and Technology Resources
2. Technology Skills Gap
3. Students Adaptation
4. Time Management

To address these challenges, it is essential to provide targeted solutions such as device assistance for students in need, basic technology training, and realistic timeframes for adaptation and assignment completion.

DISCUSSION

The results of observations showed that participant 1 was able to plan TPACK-based learning well. The alignment between technology, pedagogy, and content was achieved optimally, which showed participant 1's readiness to apply the TPACK approach in the classroom. However, in the implementation of learning by participant 1, several aspects that were observed included the use of technology, learning strategies, teacher and student interactions, and class management. There were several notes regarding the use of technology

and student interactions that still needed to be improved.

First, the use of technology by participant 1 is still limited to delivering material through Power Point only. Although PowerPoint helps in visualizing important points of the material, the lack of variation in the use of technology makes learning feel monotonous. There is no use of interactive technology, such as videos, simulations, or collaborative applications that can improve student understanding and facilitate more active interaction. In today's digital era, it is important to utilize various technologies that support active and creative learning, not just as a presentation tool. Second, pedagogical strategies implemented by participant 1 are still focused on the lecture method supported by PowerPoint. Although the material is delivered systematically, the approach used does not sufficiently support student-centered learning. Students play a more passive role as listeners, and there is little opportunity to be actively involved in the learning process. This can have an impact on low student involvement and interest in the material being taught. Third, the interaction between participants and students seemed less dynamic. Participants rarely asked open questions or engaged in discussion activities that could trigger active student participation. Most students just listened without giving feedback, and when there were questions, only a few students responded. This limited interaction showed a lack of effort by participants to facilitate an interactive classroom atmosphere, which could have been supported by other technologies, such as online quiz applications or technology-based discussion forums. The last, classroom management by participant 1 was quite good in terms of maintaining an orderly and conducive classroom atmosphere. However, student involvement in learning seemed minimal, due to the lack of varied strategies and use of technology. This caused students' attention to decline quickly, especially because there was no variation in methods or tools used to arouse their interest. Classroom management would be more effective if participant 1 used technology to make classroom activities more interactive and interesting.

Overall, the observation results show that although the results of the teaching module analysis are good, learning runs smoothly, there are some shortcomings, especially in the use of technology and learning strategies. Learning that only focuses on lectures with PowerPoint and the lack of active interaction between teachers and students can limit the effectiveness of learning. To improve the quality of learning, participant 1 is advised to further vary the use of technology that supports interactivity and develop pedagogical strategies that encourage more active student involvement.

Participant 2

Based on the results of observations on the implementation of learning carried out by participant 2, it was found that several important aspects such as the use of technology, learning strategies, teacher and student interactions, and classroom management have been running well and in accordance with the learning plan. The following is a further analysis related to the results of the observation:

First, Participant 2 was able to utilize technology well during the learning process. In addition to using PowerPoint to visualize the material, participants also utilized interactive devices such as online learning applications and technology-based quizzes. The use of educational videos and online simulations helped students understand difficult concepts in an easier and more interesting way. Technology was used effectively to not only deliver the material, but also as an evaluation tool through online quizzes that were accessed by students during learning. Second, the teaching strategy implemented by participant 2 is very student-centered and interactive. Participants implement a blended learning strategy that combines face-to-face learning with digital platforms. Students are given the freedom to learn independently through materials that have been uploaded online and engage in group discussions facilitated by collaborative applications. This approach allows students to be more actively involved in the learning process, developing critical thinking and problem-solving skills through project-based tasks. Third, the interaction between participant 2 and students went well and dynamically. Participants actively asked questions, facilitated discussions, and provided constructive feedback to students. Students also felt comfortable interacting with participant 2, as seen from the large number of students involved in the Q&A sessions and group discussions. Participants used technology such as online discussion applications to monitor and respond to student questions directly, thus strengthening the two-way relationship between teachers and students. The last, classroom management by participant 2 also ran effectively. Participants were able to create a conducive, structured, and interactive classroom atmosphere. By using technology as an integral part of the teaching and learning process, participants managed to maintain students' attention and ensure that each student was involved in learning. In addition, participants were able to manage transitions between learning activities smoothly, so that there was no confusion or disruption during the learning process.

Overall, the implementation of learning by participant 2 went well. The use of relevant technology, interactive learning strategies, active teacher-student interaction, and effective classroom management all contributed to achieving an optimal learning process. Participant 2 demonstrated solid ability in applying TPACK components in learning, reflecting readiness to

face the challenges of teaching in the digital era.

Participant 3

Based on the results of observations of the implementation of teaching by participant 3, it was found that several aspects observed, including the use of technology, learning strategies, teacher and student interactions, and classroom management, were still not optimal and needed improvement. The following is an analysis of each aspect observed:

First, the use of technology in the implementation of teaching and learning by participant 3 was less than optimal. Participants only used PowerPoint to deliver material, and technology was not used to increase student interactivity or engagement. There was no variation in technology such as videos, simulations, or other interactive tools that could help clarify abstract concepts or stimulate student interest. As a result, students tended to be passive and only received information without the opportunity to participate actively through more dynamic technology. Second, the teaching strategy implemented by participant 3 is still too focused on the lecture method supported by slide presentations. There are no student-centered learning activities or those that encourage deeper interactions, such as group discussions, collaborative tasks, or the use of interactive technology that can actively involve students. This causes the learning process to be one-way, where students only receive information from the teacher without being actively involved in the material exploration process. Third, the interaction between participant 3 and students also seemed lacking. During the learning process, participants rarely provided open questions or activities that encouraged students to participate in discussions. Most of the interactions that occurred were the teacher talking, while students tended to be silent and passive. Participants also did not utilize technology to build more intense interactions, such as the use of online quiz applications or online discussion forums, which could facilitate more participation from students. The last, classroom management by participant 3 was also not optimal. Due to the lack of variation in the use of technology and learning strategies, students' attention was easily diverted, and the classroom atmosphere became less dynamic. Participants seemed to have difficulty keeping students focused on the material, especially because the learning methods applied were monotonous and did not provide opportunities for students to move or interact. The management of transitions between activities was also less smooth, leaving some students confused about what to do next.

Overall, observations show that the implementation of teaching and learning by participant 3 still has many shortcomings. Limited use of technology, less varied learning strategies, minimal teacher and student interaction, and less effective classroom management

cause learning to take place passively and less interesting for students. To improve the quality of learning, participant 3 is advised to enrich the use of interactive technology, implement more student-centered learning strategies, and improve classroom management so that the learning atmosphere becomes more dynamic and productive.

Participant 4

Based on the results of observations on the implementation of learning carried out by participant 4, it was found that several important aspects, including the use of technology, learning strategies, student interaction, and classroom management, had been running well. The following is an analysis of each aspect observed:

First, Participant 4 successfully integrated technology effectively into the learning process. Technology was used not only to deliver material, but also as an interactive tool that increased student engagement. The use of online learning applications, interactive quizzes, and educational videos allowed students to better understand concepts. In addition, participants utilized collaborative platforms that allowed students to work together in groups, share ideas, and discuss material in real-time, creating a dynamic learning environment. Second, the learning strategies implemented by participant 4 are very varied and student-centered. Participants used blended learning methods, which combine face-to-face learning with online activities. In learning sessions, participants facilitated group discussions and collaborative projects, which encourage students to actively contribute and collaborate. This strategy not only improves students' understanding but also helps them develop important social and communication skills. Third, the interaction between students and between students and teacher went very well. Participant 4 encouraged students to ask questions, discuss, and share opinions during learning. By using technology, participants created opportunities for students to actively participate in learning, both through discussions in class and on online platforms. All students appeared involved and enthusiastic, as seen from the many questions asked and ideas shared during the discussion sessions. The last, classroom management by participant 4 was effective. The participant was able to maintain a conducive and structured classroom atmosphere. By using technology to facilitate activities, the participants managed to maintain student attention and ensure that all students were involved in the learning process. Transitions between activities were also carried out smoothly, so there was no confusion among students. The participant demonstrated the ability to manage time well, ensuring that each part of the learning plan was carried out effectively. Overall, the results of the observation showed that the implementation of learning by participant 4 was very successful in integrating technology,

implementing interactive learning strategies, encouraging student interaction, and carrying out effective classroom management. This combination created a positive and productive learning environment and supported the achievement of predetermined learning objectives. Participant 4 demonstrated a solid ability to apply the principles of TPACK in implementing modern and student-oriented learning.

Participant 5

Based on the results of observations of the implementation of learning conducted by participant 5, it was found that several important aspects, including the use of technology, learning strategies, student interaction, and classroom management, were running quite well. However, there were several discrepancies with the plans that had been prepared in the teaching module. The following is an analysis of each aspect observed:

First, Participant 5 successfully used technology in the learning process, although it was not entirely in accordance with the plan in the teaching module. The use of PowerPoint and videos to deliver the material was done well, but the planned online quiz application was not implemented. However, the technology used still helped in visualizing information and maintaining student attention. The addition of a variety of interactive technology tools, such as online polling or discussion applications, would further increase student engagement. Second, the learning strategies implemented by participant 5 show an effort to implement effective methods. Although the lecture method is still dominant, participants involved students in group discussions after the delivery of the material. However, there are several activities planned in the teaching module, such as project-based learning, which are not fully implemented. This results in a lack of opportunities for students to apply knowledge practically. The implementation of more diverse strategies will increase student interaction and learning experience. Third, the interaction between students and between students and teachers seemed quite good. Participant 5 provided opportunities for students to ask questions and discuss, which helped create a more active learning atmosphere. However, some students seemed less engaged, perhaps due to the lack of variety in the teaching methods applied. Increasing the use of technology to facilitate interaction, such as using online forums or collaborative applications, would help increase participation of all students. Last, participant 5's classroom management went quite well. An orderly and conducive classroom atmosphere was created, although there were a few moments where transitions between activities were less than smooth, causing confusion among students. The participant demonstrated the ability to maintain student focus, but time management could be improved to ensure that all parts of the lesson plan were

implemented effectively.

Overall, the observation results showed that the implementation of learning by participant 5 was quite good, although there were some discrepancies with the plan in the teaching module. Good use of technology, quite varied learning strategies, adequate student interaction, and effective classroom management showed positive potential. With further adjustments and more consistent implementation of the teaching module plan, participant 5 has the opportunity to improve the quality of learning better in the future.

Challenges and Solutions in Technology Integration by Preservice English Teachers

One of the main barriers identified was limited access to and resources for technology. Many students lacked access to technology devices, such as laptops or tablets, and a stable internet connection. This hindered students' ability to actively participate in technology-based learning. Some pre-service teachers also reported difficulties in providing the resources needed to support the use of technology in learning, resulting in less effective learning.

> "We do want to use more technology in learning, but not all students have laptops. Some of them only rely on mobile phones, and even then they often don't have enough quota. This makes it difficult to do tasks that require access to the internet or learning platforms." (Participant 2)
>
> "In schools, we have tried to provide some tablets for students, but the number is very limited. We need more resources to support technology-based learning. Without it, it is very difficult to integrate technology effectively into the curriculum." (Participant 4)

The limited access and technology resources expressed by participants indicate that there is inequality in the use of technology in the classroom. Some students who do not have adequate devices or stable internet access have difficulty participating in learning that should be interactive and technology based. This situation creates a gap in students' learning experiences and can lead to low learning outcomes. This is in line with research results showing that one significant barrier is the gap in access to technology between students and educators, which affects the entire integration process. Celeste & Nimfa (2024), Gyau & Gyan (2022), Hossain, (2023) & Iyamu et al. (2022) Many schools lack reliable technology devices, equipment and internet connectivity, which are critical for effective integration (Hossain, 2023).

Therefore, it is important to identify solutions that can address these issues, such as improving technology infrastructure in schools, providing device assistance to students in need, and seeking support from the government or related institutions to provide better internet access. With these steps, TPACK integration can be more effective and equitable across all

students.

The gap in technology skills between students and teachers is another barrier. Interviews revealed that students have varying levels of technology skills. Some students are very familiar and proficient in using technology, while others have difficulty understanding and using the technological tools needed for learning. This leads to inequities in the learning process, with less experienced students feeling left behind and having difficulty following the lessons.

> "In class, I often find that there are students who adapt very quickly to technology. They can easily use the applications that we implement. However, there are also other students who have a very hard time just opening the learning platform. This is clearly a challenge for me in teaching the material" (Participant 1)

The technology skills gaps revealed in the interviews suggest that not all students are ready to participate in technology-enabled learning. This is reinforced by research findings that students may lack motivation and readiness to engage with technology, which can be exacerbated by a lack of support and resources, leading to resistance in participating in online learning and difficulty using technology effectively (Bejasa, 2023; Herdina et al., 2023; Hossain, 2023; Kaminskienė et al., 2022; Limbong et al., 2024; Tuzahra, 2021).

On the other hand, PTs also feel the impact of this skills gap. They have to adjust their teaching methods to meet the needs of students who have different technological skills. This can make learning inefficient and less focused on learning objectives.

To address the technology skills gap that is affecting student participation, institutions can implement several strategic steps. First, conducting basic technology training regularly, either through orientation sessions at the beginning of the semester or short workshops outside of class hours, will help students become more familiar with the technology tools used in learning. In addition, student mentoring programs can be initiated, where students who are more technologically proficient mentor their less proficient peers. This approach will not only improve technology skills but also build students' self-confidence which will positively impact their active participation in class (Arnado & Aviles, 2023).

Students' adaptation to the use of technology in learning is also a significant challenge. Some students have difficulty adapting to technology-based learning methods, especially if they are not used to this approach before. Interviews indicated that changes in learning methods that integrate technology take time for students to adjust. Lack of understanding of how to use technology to learn can disrupt the overall learning process.

> "I often see students struggling when we switch to online learning. Even though I explain

how to use the platform, not all students can follow it right away. Some of them need more time to understand and adapt." (Participant 2)

The findings on student adaptation indicate that changes in learning methods that integrate technology require time for students to adjust. Some students feel confused and stressed when faced with new tools or platforms that they have not mastered, which can ultimately disrupt their concentration and motivation to learn. Barriers related to students' lack of understanding and discomfort with new tools are also revealed by the study results. (Celeste & Nimfa, 2024; Herdina et al., 2023; Hossain, 2023; Rintaningrum, 2023).

Students' lack of understanding and discomfort in adapting to the technology used can hinder the learning process. The solution to overcome this is to provide basic technology training at the beginning of learning, accompanied by easy-to-access online tutorial support. In addition, mentoring programs between students can help those who are less familiar adapt more quickly with the guidance of more advanced peers.

Time management was also identified as a significant barrier to TPACK integration.. (Bhardwaj, 2013; Rintaningrum, 2023; Shane & Wojnowski, 2005). PTs reported that the time available for instruction was often insufficient to integrate technology effectively. In some cases, the preparation required for technology use in the classroom could be time-consuming, and teachers felt burdened with having to prepare appropriate materials and tools. In addition, the time required to help students adapt to technology and complete technology-based learning activities often resulted in delays in achieving established learning objectives.

"Time management is a big challenge. When we do online learning, I have to make sure that all students get the materials and are able to participate. However, sometimes students who are not used to technology need more time, and that makes the class session longer than planned. This can interfere with other class schedules." (Participant 3, 5)

Inability to manage time well can interfere with the effectiveness of learning and reduce the quality of learning outcomes. Therefore, it is important to plan carefully and provide realistic time for students to adapt to technology and complete assignments. In addition, by providing training on the efficiency of using technological tools to teachers and students, so that they are more quickly familiar and proficient in using them. The curriculum must also be adapted to a realistic schedule, providing space for the use of technology without reducing time for core materials.

CONCLUSION

The findings indicate that while preservice teachers (PTs) understand the importance of technology integration through the TPACK framework, practical implementation often encounters barriers such as limited access to technology, varying skill levels, student adaptation challenges, and time management issues. To bridge the gap between theory and practice, additional support, including technology training and adequate resources, is essential. Future research should explore the long-term effects of targeted technology training on PTs, compare their experiences with those of in-service teachers, and investigate the impact of TPACK on student learning outcomes. Effective implementation of TPACK can enhance student engagement and learning, making it crucial to address these barriers to maximize its potential in educational settings.

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