JPIS JURNAL PENDIDIKAN ILMU SOSIAL

p-ISSN: 1412-3835
e-ISSN: 2541-4569
VOL 35, NO.2, DES 2025

ANALYSIS OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) AMONG PRE-SERVICE TEACHERS IN THE PPG PROGRAM AT THE INDONESIA UNIVERSITY OF EDUCATION

Rahimatul Annisa[1], Neti Budiwati[2], Susanti Kurniawati[3]
[1,2,3]Faculty of Economics and Business Education, Universitas Pendidikan Indonesia
email: rahimatulannisa@upi.edu

ABSTRACT

This study was motivated by the fact that the 2019 UKG results were still below standard. The changing times require teachers to be able to integrate technology into the learning process. If this situation continues, it will have an impact on the quality of human resources produced and hinder the ability to keep up with the rapid changes of the times. To produce professional teachers, the process must begin in college (for pre-service teachers), so the abilities of pre-service teachers must be taken into consideration. Studies related to the TPACK profile, especially for pre-service economics teachers, are still rare, so this research is necessary considering that economics is part of social sciences. The population in this study consisted of 58 pre-service economics students at UPI Bandung, using total sampling technique. The method used was quantitative descriptive, where the data obtained was categorized using data tabulation, namely the mean, while the instrument used was a standard instrument adapted from previous research. The results of the study show that the TPK level of pre-service economics teachers is in the good category. Meanwhile, the TCK, TPK, PCK, and TPACK levels of pre-service economics teachers are in the sufficient category. The findings in this study can be used as a basis for educational institutions to design a curriculum that can strengthen TPACK skills, especially for pre-service Pre-service teachers, and provide training that can improve their technological, pedagogical, and content skills.

Keywords: *Tpk, tck, pck, tpack, pre-service economics teachers*

Received: *17 November 2025*
Accepted: *25 Desember 2025*
Published: *30 Desember 2025*

p-ISSN: 1412-3835
e-ISSN: 2541-4569
VOL 35, NO.2, DES 2025

INTRODUCTION

Education in general can be defined as a process in human life to develop oneself and sustain life (Alpian et al., 2019). In order to fulfill the functions and objectives of national education as outlined in Law No. 20 of 2003, many parties are involved, both directly and indirectly, such as parents, teachers, the community, experts, and the government. In the learning process at school, teachers bear a significant responsibility. Therefore, in the planning, implementation, and evaluation of learning, teachers must possess the necessary competencies and quality understanding to ensure that the desired objectives are achieved. s emphasized by Konecna et al. (2023), an integral part of teacher candidate preparation is mastery of competencies in lesson planning, social competencies, a good work ethic, and the ability to adapt and develop oneself.

Based on Law No. 14 of 2005 concerning teachers and lecturers, there are four competencies that must be mastered, namely pedagogical competence, professional competence, personal competence, and social competence. In the Regulation of the Minister of National Education No. 16 of 2007, it is concluded that teachers must be able to plan, implement, and evaluate learning (Pedagogical Knowledge) and be proficient in ICT in learning (Technological Knowledge). In terms of professional competence, teachers must be able to master the foundations of education, methods, and other matters related to the subject they teach (Content Knowledge). In terms of personal competencies, teachers must demonstrate honesty, noble character, responsibility, a strong work ethic, and uphold the professional code of ethics for teachers (Pedagogical Knowledge). Social competencies are used to help teachers interact in their work environment.

The increasingly sophisticated developments of the times require teachers to master competencies that are in line with these developments. The competencies that teachers must possess in the 21st century include the ability to think critically, solve problems, communicate and collaborate, be creative and innovative, and possess information and communication technology (ICT) literacy (Dolezal et al., 2025; Gümüş & Kukul, 2023). According to Balayogi (2024), 21st-century professionalism requires teachers (and other professionals) to be open, ethical, collaborative, adaptive, active in policy change, and to continue learning and building knowledge. By mastering these competencies, teachers can equip their students with knowledge and skills that align with the evolving demands of the modern world.

The facts on the ground show that teacher competence in Indonesia still needs to be improved. This can be seen from the results of the 2019 teacher competence test (UKG), which were still below average. According to the 2015-2019 Strategic Plan of the Ministry of Education and Culture, the target UKG score for 2019 was 80, with a minimum competency standard of 55. However, the average UKG score obtained was only 54.05, indicating that teachers have not been able to meet the target and minimum competency standards set. This serves as evidence that teacher competency in Indonesia remains low. If this situation is allowed to continue, it will

impact the quality of human resources produced and hinder the ability to keep pace with the rapidly evolving times. As found by Umbase (2023), teachers' knowledge and skills are still in the moderate to poor category, where teachers still have limitations in their knowledge and learning management skills.

According to Shulman (1986), a teacher's content knowledge must be combined with pedagogical knowledge to create new knowledge, namely Pedagogical Content Knowledge (PCK). Furthermore, Shulman (1986; 1987) revealed that PCK is specialized knowledge that a teacher must possess, related to how to teach specific content to students using strategies that can guide them toward understanding. In this context, Li & Copur-Gencturk (2024) state that pedagogical content knowledge (PCK) has been widely recognised as an important aspect of the expertise for teaching. Pedagogical Content Knowledge (PCK) consists of a synthesis of pedagogical knowledge (general knowledge of teaching methods) and content knowledge that allows teachers to organise their knowledge from a teaching perspective and use it as a foundation to help students understand specific concepts (Grigaliuniene et al., 2025).

In addition to mastering the content being taught and how to teach it, teachers must also master the use of technology in learning. Teachers must be able to integrate technology into learning, whether in terms of lesson planning, strategies, standards, or student interaction patterns (Muhaiminullah et al., 2018). This opinion is in line with (Lu et al., 2025), which states that technology integration involves coordinating curriculum objectives, pedagogical practices, and digital technology appropriately and even creatively to improve educational outcomes.

The ability to collaborate between pedagogy, content, and technology is known as Technological Pedagogical Content Knowledge (TPACK). TPACK is a conceptual framework that connects the three areas of knowledge that teachers must master: technological knowledge, pedagogical knowledge, and content knowledge (Mishra & Koehler, 2006). The TPACK concept was first introduced by Mishra and Koehler in 2006 and is an extension of the PCK model pioneered by Shulman. A teacher with TPACK skills can be identified by their ability to design teaching strategies that align content with approaches, models, and teaching methods (PCK), use technology in conjunction with instructional materials and deliver content utilizing technological facilities (TPK), and employ technology-based learning media (TPK) (Pulungtana & Dwikurnaningsih, 2020). The TPACK model contains indicators that reflect teachers' professional competencies and efforts to improve teacher quality as a major factor influencing the education system (Zhubi, 2025).

With TPACK skills, both teachers and Pre-service teachers will be able to produce quality learning outcomes and prepare students with the skills expected in the 21st century. The use of TPACK is not merely the use of digital tools, but rather influences the “flow of learning”: learning becomes more cohesive because teachers integrate knowledge, pedagogy, and technology simultaneously (Munir et al., 2024). This poses a challenge for teachers and Pre-service teachers to have the skills/competencies that are in line with developments. Pre-service teachers must

be equipped with various skills, such as TPACK. This is acquired while attending lectures. Pre-service teachers are considered part of the "digital natives" generation, meaning they have been accustomed to using technology in their daily lives for a long time (Kumar & Vigil, 2011). They are usually comfortable using various media, skilled in operating technology, and do not easily panic when faced with technical obstacles (Martin, 2015). Pre-service teachers must master TPACK in order to provide quality education in the digital age. Therefore, educational institutions responsible for preparing pre-service teachers must not neglect the importance of developing TPACK, and need to equip them with the necessary competencies to maximize educational effectiveness (Cojorn & Seesom, 2024).

However, it appears that several studies conducted on TPACK still show that some Pre-service teachers have not fully mastered the skills appropriate to their field of expertise. A study conducted by Ulfah & Erlina (2022) on Pre-service chemistry teachers found that 67% had good content knowledge, 71% of pedagogical knowledge was in the good category, 76% of technological knowledge was in the good category, 55% of technological content knowledge ability was in the good category and 40% in the sufficient category, 65% of technological pedagogical knowledge was in the good category, 49% of pedagogical content knowledge was in the good category and 43% in the sufficient category, and 69% of technological pedagogical content knowledge was in the good category. Another study (Agustini et al., 2019) also found that of the several TPACK components, the CK and PCK components had higher averages than the other components. Meanwhile, the application of technology among Pre-service teachers is still low. Soncio et al. (2024) also found that Pre-service teachers at Agusan del Sur State College of Agriculture and Technology had high TPACK and very high 21st-century teaching skills, with a strong positive relationship between the two. This means that the better the TPACK, the higher the 21st-century teaching skills. Using a different research method, Aulia et al. (2023) found that economics teachers with high TPACK levels can positively and significantly influence the integration of technology in learning.

Although various studies have examined Technological Pedagogical Content Knowledge (TPACK) in Pre-service teachers, most studies still focus on science and general education, while studies that specifically examine TPACK in Pre-service economics teachers are still limited. In addition, previous studies have generally emphasized the relationship between TPACK and other variables or learning effectiveness, so that they have not provided a comprehensive empirical picture of the profile of each TPACK component (TPK, TCK, PCK, and TPACK) in Pre-service economics teachers. This condition indicates a research gap that needs to be filled, especially in the context of economics teacher education in Indonesia. This study focuses on examining the comprehensive profile of Technological Pedagogical Content Knowledge (TPACK) in prospective economics teachers who are enrolled in the Teacher Professional Education Program (PPG) at the Indonesia University of Education. PPG students are students who are being prepared to become professional teachers, and TPACK is a skill that teachers must have today in order to

respond to the challenges of the 21st century. Therefore, it is important to examine the TPACK level of these prospective teachers in order to produce students with the expected skills and knowledge.

Based on the previous explanation, it can be seen that some studies conducted on TPACK still show that Pre-service teachers have not fully mastered the skills appropriate to their field of expertise, while in the theory proposed by Mishra & Koehler (2006), a teacher must have TPACK skills that combine technology, content, and pedagogy. Because effective implementation of TPACK can transform traditional classrooms into dynamic and engaging learning environments (Vijayatheepan, 2024). Therefore, this study focuses on examining: (1) the profile of Technological Knowledge (TK) among pre-service economics teachers; (2) the profile of Technological Content Knowledge (TCK) among pre-service economics teachers; (3) the profile of Pedagogical Content Knowledge (PCK) among pre-service economics teachers; and (4) the profile of Technological Pedagogical Content Knowledge (TPACK) among pre-service economics teachers.

RESEARCH METHOD

This research method used in this study is a descriptive method with a quantitative approach. According to Sudjana and Ibrahim (in Jayusman & Shavab, 2020), descriptive research is research that attempts to describe a phenomenon, event, or occurrence that is happening at the present time. In this study, the quantitative descriptive method aims to describe the Technological Pedagogical Content Knowledge of Pre-service economics teachers at the Indonesia University of Education.

The objects in this study are technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). Meanwhile, the subjects in this study are PPG Pre-service I and II Economics students at the Indonesia University of Education. The population in this study consists of all PPG Pre-service economics students at the Indonesia University of Education. The sample in this study consists of 58 pre-service teacher education students in the first and second semesters of the economics program at the University of Education Indonesia. The sampling technique used is total sampling. Total sampling was chosen because the number of pre-service teacher education students in the first and second semesters of the economics program at the University of Education Indonesia is less than 100, so the entire population was used as the sample.

Table 1.
Variables and Operational Definition

No.	Definition	Variable	Indicators
1.	Technological Pedagogical Knowledge is knowledge about the use of technology in the learning process so	Technological Pedagogical Knowledge (TPK)	1. The use of technology in learning. 2. Selecting technology that aligns with teaching

No.	Definition	Variable	Indicators
	that it can be used in different learning approaches (Mishra & Koehler, 2006; Schmidt et al., 2009).		approaches and strategies in the classroom. 3. Utilizing internet facilities to communicate with students.
2.	TCK is knowledge about how to understand and use a technology that can change the way of understanding certain concepts so that they are easier to understand (Malichatin, 2019; Schmidt et al., 2009).	Technological Content Knowledge (TCK)	1. Using specialized software for the subject being taught. 2. Knowing the technology that can be used to understand specific subject matter. 3. Using specialized software in the subject approach.
3.	Pedagogical Content Knowledge is knowledge about how teachers design, implement, and evaluate subject matter (Nofiani & Julianto, 2018).	Pedagogical Content Knowledge (PCK)	1. Helping students understand the lesson. 2. Addressing common learning difficulties experienced by students. 3. Involving students in managing their own learning of the taught material. 4. Supporting students in managing their own learning of the taught material.
4.	TPACK is a framework for designing new learning models by integrating three aspects: technology, pedagogy, and content/ subject knowledge (Ambaryati, 2019).	Technological Pedagogical Content Knowledge (TPACK)	1. Using strategies that combine content, technology, and teaching approaches. 2. Providing leadership in helping others to coordinate the use of content, technology, and teaching approaches in schools. 3. Using technology in the classroom to improve the learning process, teaching methods, and students' understanding of the material.

The data used in this study were sourced from primary and secondary data. Primary data in this study were obtained from respondents, while secondary data in this study were in the form of literature studies. The instrument used was a closed questionnaire, which provided only a few answer choices using a 5-point Likert scale. To test the instruments in this study, validity and reliability tests were used. The validity of the instruments in this study was calculated using the product

moment correlation formula, with a significance level of 0.05. Meanwhile, the reliability test used Cronbach's alpha coefficient with the help of the SPSS 26 for Windows application and was declared reliable if ≥ 0.70.

The data analysis technique used in this study was descriptive statistical analysis. Descriptive statistics are statistics used to analyze data by describing or depicting the collected data as they are, without intending to draw conclusions that apply to the general public or generalizations (Sugiyono, 2017). In this study, frequency distribution tables were used to classify criteria by finding ranges, highest and lowest scores, number of classes, and class intervals. This analysis is used to describe the variables of pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

RESULTS AND DISCUSSION

Technological Pedagogical Knowledge (TPK)

The results of the analysis of the Technological Pedagogical Knowledge (TPK) level of Pre-service economics teachers can be divided into five categories. If the calculated score based on the data tabulation falls between 42-45, the category is "good"; between 39-41, it is "adequate"; between 36- 38, it is 'poor'; between 33-35, it is "very poor"; and between 30- 32, it is "extremely poor." The results obtained are as follows.

Table 2.
TPK Level Category

Ability Level	Frequency	Percentage (%)
Very Good	17	29,3
Good	18	31
Adequate	17	29,3
Poor	4	6,9
Very Poor	2	3,4
Total	**58**	**100**

It can be concluded that nearly all PPG Pre-Service Economics Education students at UPI Bandung are able to connect technological and pedagogical competencies when teaching in the future. The Technological Pedagogical Knowledge (TPK) level consists of three indicators, with two indicators in the high category and one in the moderate category, as detailed below. The TPK level indicators are divided into three categories: the indicator for technology use in learning is in the high category, indicating that Pre-service economics teachers are highly capable of using technology in learning. This technology can be used from lesson planning, implementation, to evaluation. The indicator for selecting technology appropriate to the approach is in the moderate category, indicating that most pre-service economics education students sufficiently understand the characteristics of the technology to be used in teaching, considering the approach and strategies

employed. The indicator for classroom learning strategies and using internet facilities to communicate with students is in the high category, indicating that Pre-service economics teachers are highly capable of using the internet to communicate with students, as almost everyone is now able to use various communication facilities, and learning and using them is not difficult, making them accessible to all.

The driving factor behind the TPK level of PPG Pre-Service Economics students at UPI Bandung is that students have acquired pedagogical and technological knowledge during their undergraduate studies. During their undergraduate program (S1/D-IV), students are exposed to courses related to educational science, and during the PPG program, they are emphasized to develop ICT skills. However, there are also barriers for Pre-service teachers in applying TPK components, as explained by Uningal & Widiatningrum (2020), namely a lack of confidence in integrating technology. In line with previous research by Furqon, Arbianto et al. (2019), which stated that Pre-service teachers' readiness is in the good category. Pre-service teachers' understanding of TPK is in the good category in terms of knowledge related to the use of technology in each learning activity, can adapt the use of technology for different learning activities, and can use ICT to discuss with students. TPK also means the ability to choose tools that are appropriate for teaching strategies. In addition, TPK includes strategies for using technological features and skills in using specific technologies for learning purposes (Luu, 2024).

Pre-service teachers with strong Technological Pedagogical Knowledge (TPK) are likely to have a heightened conviction about how technology can revolutionize their teaching practice (Hidayat et al., 2024). In addition, in the study Leung et al. (2024) they found that preservice teachers' online teaching performances during practicum reflected how their TPK supported the design and facilitation of digital activities, contributing to more interactive and learner-centred instruction.

Technological Content Knowledge (TCK)

The results of the analysis of the Technological Content Knowledge (TCK) level of Pre-service economics teachers can be divided into five categories. If the score calculated using data tabulation is between 43-45, the category is good; between 39-42, the category is sufficient; between 35-38, the category is poor; between 31-34, the category is very poor; and between 27-30, the category is extremely poor. The results obtained are as follows.

Table 3.
TCK Level Category

Ability Level	Frequency	Percentage (%)
Very Good	5	8,6
Good	12	20,7
Adequate	23	39,7
Poor	15	25,9
Very Poor	3	5,2
Total	**58**	**100**

It can be concluded that most students are already able to connect the learning material they are studying, namely economics, with the use of technology in learning. However, nearly a third of them still need special attention to improve their technological content skills. The Technological Content Knowledge (TCK) level consists of three indicators, with two indicators in the high category and one in the moderate category. The TCK indicators are divided into three categories: the indicator for using specialized software for the subject being taught is in the high category, indicating that Pre-service economics teachers are highly capable of utilizing specialized software effectively and efficiently in teaching. Such software is designed to deepen students' understanding, assist in data processing, and more. The indicator of knowing the technology that can be used to understand specific material is in the moderate category, indicating that Pre-service teachers are sufficiently capable of using technology appropriate to the material to be taught. Some materials have unique characteristics, so selecting the appropriate technology to present such material requires careful consideration. The indicator of using specialized software in subject-specific approaches is in the high category, indicating that most Pre-service economics teachers are highly capable of using specialized software in subject-specific approaches. Examples of specialized software in subject approaches include the use of e-learning, which can help teachers and Pre-service teachers coordinate the subjects they teach so that learning objectives can be achieved. This is reinforced by findings in a study conducted by Oyetade et al. (2023) that students are more motivated to use e-learning when they feel that the benefits are clear, there is social support, and supporting facilities (e.g., infrastructure, technical assistance) are available.

The technological content knowledge (TCK) component of Pre-service economics teachers is in the sufficient category. This indicates that Pre-service economics teachers are sufficiently capable of creating new ways to understand concepts in a subject with the help of technology. Students are quite capable of using software that can help in presenting subject matter content, such as the use of PowerPoint designed through Canva by inserting images or videos so that students can easily understand the material. The TCK factor of prospective teachers is in the adequate category, indicating that although prospective economics teachers already have basic skills in integrating technology with learning content, these skills are not yet fully optimized and are still general in nature. This shows the need for strengthening in the selection and utilization of more specific technologies in accordance with the characteristics of economics material, such as economic data analysis, concept modeling, and economic simulation. With this strengthening, it is hoped that prospective teachers will not only use technology as a tool to present material, but also as a means to build a deeper and more contextual conceptual understanding for students.

Another study conducted by Rahayu et al. (2022) found that the TCK abilities of pre-service teachers, especially PGSD teachers, were in the low category. Similarly, research conducted by Armiyati & Fachrurozi (2022) found that pre-service

teachers had the lowest scores in the TCK component. This is due to the limitations of students' ability to integrate learning content with more specific technologies. Another factor is the lack of direct practical experience in using technologies related to subjects and relevant technological devices and applications that are unfamiliar or have not been taught intensively.

Pedagogical Content Knowledge (PCK)

The results of the analysis of the level of Pedagogical Content Knowledge (PCK) of Pre-service economics teachers can be divided into five categories. If the score calculated using data tabulation is between 62-65, the category is good; between 57-61, the category is adequate; between 52-56, the category is poor; between 47-51, the category is very poor; and between 42-46, the category is extremely poor. The results obtained are as follows.

Table 4.
PCK Level Category

Ability Level	Frequency	Percentage (%)
Very Good	4	6,9
Good	10	17,2
Adequate	22	37,9
Poor	13	22,4
Very Poor	9	15,5
Total	**58**	**100**

It can be concluded that most students are already able to connect the learning material they are studying, namely economics, with the use of technology in learning. However, there are still quite a number of students in the poor to very good categories, so there is still room for improvement. The following figure shows the percentage of PCK proficiency levels of pre-service PPG students majoring in economics at UPI Bandung.

The Pedagogical Content Knowledge (PCK) level consists of 4 indicators, with 2 indicators in the high category and 2 indicators in the moderate category. The indicators for the PCK level of Pre-service economics teachers are as follows: The indicator for helping students understand the material is in the moderate category. This indicates that Pre-service economics teachers are sufficiently capable of helping students understand the teaching material. The indicator for addressing common learning difficulties experienced by students is in the moderate category. This indicates that Pre-service economics teachers are sufficiently capable of addressing common learning difficulties experienced by students. Assisting students in overcoming learning difficulties can involve guiding students to actively participate in learning, adopting an out-of-classroom approach, creating a pleasant learning environment, and providing rewards for what students do. The indicator of involving students in managing their own learning of the material taught is in the high category. This shows that Pre-service economics teachers are very capable of

involving students in managing their own learning of the material taught, such as by using the Cooperative Learning model, implementing student-centered learning, and providing opportunities for students to express their opinions, ideas, and thoughts. The indicator supporting students to manage their own learning on the material taught is in the high category because Pre-service teachers understand that it is important to improve students' independent learning abilities to help them understand a lesson in their own way.

The Pedagogical Content Knowledge (PCK) component of Pre-service economics teachers is in the sufficient category. This proves that students are sufficiently capable of connecting pedagogical knowledge and the material taught. There is a need for a deeper understanding of the use of learning strategies that must be adapted to the characteristics of the subject matter being taught. This aligns with the statement by Armiyati & Fachrurozi (2022), who noted that PCK will assist teachers in developing teaching practices that align with the characteristics of the subject matter. The experiences gained by Pre-service economics teachers during their undergraduate studies can serve as a foundation for designing enjoyable learning experiences. To improve the pedagogical and content knowledge (PCK) of Pre-service teachers, we can start by improving two important components, namely CK and PK. If these components are in the low category, it means that Pre-service teachers have not mastered them. This will have an impact on other components. This statement is in line with the results of research conducted by Kim (2018), which found that Pre-service mathematics teachers were unable to provide appropriate questions or assignments for students due to a lack of CK, which then led to low PCK.

Pre-service teachers' PCK factors are in the adequate category, indicating that pre-service economics teachers' ability to integrate pedagogical strategies with the characteristics of economics material still needs to be improved. This condition indicates that their mastery of content and pedagogy has not been fully implemented optimally in designing and implementing learning that is able to accommodate differences in student characteristics. Therefore, it is necessary to strengthen pedagogical practice experience oriented towards the characteristics of economic material, such as designing learning scenarios, compiling high-level questions, and selecting appropriate learning models, so that the PCK abilities of pre-service teachers can develop more comprehensively. Research conducted by Arbianto et al. (2019) found that pre-service technical teachers' PCK was in the good category because pre-service technical teachers generally have a strong understanding of technical material (content knowledge) and the right strategies to teach the material, enabling them to effectively combine content and learning methods. The next factor is that prospective engineering teachers usually have gained practical experience or learning simulations during their studies, such as microteaching or project/technique-based teaching practices, so they are more familiar with how to develop appropriate teaching strategies for specific content.

Technological Pedagogical Content Knowledge (TPACK)

The results of the analysis of the level of Technological Pedagogical Content Knowledge (TPACK) of Pre-service economics teachers can be divided into five categories. If the score calculated using the data tabulation is between 41-43, the category is good; between 38-40, the category is sufficient; between 35-37, the category is poor; between 32-34, the category is very poor; and between 29-31, the category is extremely poor. The results obtained are as follows.

Table 5.
TPACK Level Category

Ability Level	Frequency	Percentage (%)
Very Good	5	8,6
Good	14	24,1
Adequate	27	46,6
Poor	7	12,1
Very Poor	5	8,6
Total	**58**	**100**

Source: Research Results (data processed)

It can be concluded that most students are already capable of integrating technology, pedagogy, and content. The following figure shows the percentage of TPACK proficiency levels among pre-service PPG students majoring in economics at UPI Bandung.

The Technological Pedagogical Content Knowledge (TPACK) level of students consists of three indicators, with one indicator in the high category and two indicators in the moderate category. The TPACK indicators are divided into three categories: the indicator for using strategies that combine content, technology, and teaching approaches is in the moderate category. This indicates that Pre-service economics teachers are sufficiently capable of using strategies that integrate content, technology, and teaching approaches. The indicator for providing leadership in helping others coordinate the use of content, technology, and teaching approaches at school is in the moderate category. This indicates that Pre-service economics teachers are sufficiently capable of assisting their peers in guiding the use of technology, content, and pedagogy in schools. When compared to other indicators, the percentage of the second TPACK indicator is relatively low because Pre-service teachers have not yet fully mastered the ability to teach their peers in utilizing technology, content, and materials. The indicator of using technology in the classroom to enhance the learning process, teaching methods, and students' understanding of the material falls into the high category. This indicates that Pre-service economics teachers are highly capable of using technology in teaching, thereby improving the quality of learning, teaching methods, and students' understanding of the material being taught. This is in line with research conducted by Zulyusri et al. (2022),which found that the application of the TPACK model in

learning can improve learning outcomes, learning effectiveness, and the 21st-century competencies of both students and teachers.

Pre-service teachers' TPACK factors are in the adequate category, indicating that the integration of technology, pedagogy, and economic learning content has not yet been fully developed optimally. Although pre-service teachers have been able to utilize technology in the learning process, this ability still tends to focus on the use of technology as a tool, not yet fully integrated into the design of learning strategies that are in line with the characteristics of economic material and the needs of students. Therefore, it is necessary to strengthen TPACK-based teaching practice experiences that emphasize integrated learning design, pedagogical reflection, and professional collaboration so that prospective teachers' TPACK abilities can improve more comprehensively. Armiyati & Fachrurozi (2022) found the same thing, where the TPACK ability components of pre-service teacher students were in the fairly good category. This is because learning in higher education does not explicitly emphasize the integration of all three components, but still tends to separate content mastery, pedagogy, and technology. In addition, the use of technology is more dominant as a learning aid, such as presentation media or e-learning, rather than as a means to transform the way of understanding and presenting content conceptually. This results in suboptimal TPACK integration.

CONCLUSION

The TPACK abilities of prospective economics teachers in the pre-service PPG program at UPI Bandung, which were assessed based on their TPK abilities, were categorized as good, while their TCK, PCK, and TPACK abilities were categorized as sufficient. These findings are expected to provide input for the implementation of a curriculum that can improve prospective teachers' abilities in pedagogy, content, and technology, as well as through training and the provision of the latest information related to TPACK, thereby producing high-quality prospective teachers. Theoretically, this study contributes to enriching TPACK studies in the context of economics education, which has been limited, especially for prospective teachers in the professional education track. The findings regarding the differences in the level of mastery between TPACK components provide empirical evidence that TPACK development is non-linear and is greatly influenced by the specificity of the discipline of economics. This reinforces the view that TPACK needs to be understood as a contextual and subject-specific construct, so that its development cannot be standardized across subjects. For prospective teachers, this study is expected to provide input for improving their pedagogical, content, and technological competencies by participating in training, independent learning, and seeking information to improve their quality and prepare them to become 21st-century teachers. For teacher education institutions, especially PPG program organizers, this research is expected to provide input for designing more focused curricula and learning strategies to strengthen the integration of pedagogy, economic content, and technology. PPG programs need to provide a more systematic portion of practice-

based learning, such as the design of technology-assisted economic learning tools, TPACK-based microteaching, and training in the use of technology relevant to the characteristics of economic material. Thus, the development of prospective teachers' TPACK is not only conceptual but also applicable and contextual. For further research, this study is expected to serve as a reference for subsequent studies by examining all TPACK components to understand the relationships between components in greater depth. In addition, future researchers can use SEM as a better data analysis technique to see the structural relationships between TPACK components and the direct and indirect effects between variables more comprehensively.

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