Mandalika Mathematics and Education Journal
Volume 8 Nomor 1, Maret 2026
e-ISSN 2715-1190| |p-ISSN 2715-8292
DOI: http://dx.doi.org/10.29303/jm.v8i1.11268

A Profile of Technological Pedagogical and Content Knowledge Components of Prospective Mathematics Teachers in Microteaching Practice

Sudi Prayitno*, Sri Subarinah, Laila Hayati, Dwi Novitasari, Ketut Ary Sunjaya

Pendidikan Matematika, FKIP, Universitas Mataram, Mataram

s.prayitno@unram.ac.id

Abstract
This study aims to describe the profile of Technological Pedagogical and Content Knowledge (TPACK) components of prospective mathematics teachers in microteaching practice. A descriptive quantitative approach was employed using a survey method. Data were collected through a TPACK questionnaire measured on a five-point Likert scale. The participants consisted of 71 Mathematics Education students enrolled in a microteaching course at the Faculty of Teacher Training and Education, Universitas Mataram. The data were analyzed descriptively to determine the level of TPACK mastery. The results show that the average score across the seven TPACK components reached 81.44%, which falls into the high category, indicating that prospective mathematics teachers generally demonstrate a strong foundation in technology, pedagogy, and content knowledge. Among the components, Technological Pedagogical Knowledge (TPK) obtained the highest mean score, while Content Knowledge (CK) showed a relatively lower score. These findings suggest that although prospective mathematics teachers perform well in individual and paired TPACK components, the holistic integration of technological, pedagogical, and content knowledge in microteaching contexts still requires further strengthening through more authentic and sustained teaching experiences.

Keywords: TPACK; prospective mathematics teachers; microteaching; mathematics education

Abstrak
Penelitian ini bertujuan untuk mendeskripsikan profil komponen Technological Pedagogical and Content Knowledge (TPACK) calon guru matematika dalam pelaksanaan praktik microteaching. Penelitian ini menggunakan pendekatan kuantitatif deskriptif dengan metode survei. Data dikumpulkan menggunakan kuesioner TPACK yang diukur dengan skala Likert lima tingkat. Subjek penelitian terdiri atas 71 mahasiswa Program Studi Pendidikan Matematika yang mengikuti mata kuliah microteaching di Fakultas Keguruan dan Ilmu Pendidikan, Universitas Mataram. Analisis data dilakukan secara deskriptif untuk mengidentifikasi tingkat penguasaan TPACK calon guru matematika. Hasil penelitian menunjukkan bahwa rata-rata skor penguasaan tujuh komponen TPACK mencapai 81,44%, yang termasuk dalam kategori tinggi. Temuan ini mengindikasikan bahwa calon guru matematika secara umum telah memiliki dasar yang kuat dalam penguasaan pengetahuan teknologi, pedagogik, dan konten. Di antara ketujuh komponen TPACK, Technological Pedagogical Knowledge (TPK) memperoleh nilai rata-rata tertinggi, sedangkan Content Knowledge (CK) menunjukkan nilai yang relatif lebih rendah. Hasil ini menunjukkan bahwa meskipun calon guru matematika telah menunjukkan penguasaan yang baik pada komponen TPACK secara individual maupun dalam kombinasi dua komponen, integrasi

holistik antara pengetahuan teknologi, pedagogik, dan konten dalam konteks microteaching masih perlu ditingkatkan melalui pengalaman mengajar yang lebih autentik dan berkelanjutan

Kata Kunci: TPACK; mahasiswa calon guru matematik;, microteaching; pendidikan matematika

1. INTRODUCTION

Teaching is a complex professional practice that involves the integration of subject matter knowledge, pedagogical competence, professional judgment, and personal dispositions. Effective teaching extends beyond content mastery and requires teachers to design and manage meaningful learning experiences that respond to students' needs and contextual demands (Blömeke et al., 2020; Darling-Hammond et al., 2020; Shulman, 1987). As a profession, teaching also demands adherence to professional standards, ethical responsibility, and continuous professional development in order to remain responsive to rapid changes in educational systems and societal expectations (Darling-Hammond et al., 2017; OECD, 2019). Consequently, teacher education programs are expected to prepare prospective teachers who are reflective, adaptive, and professionally competent.

The rapid development of digital technology has further transformed the nature of teaching competencies. In addition to content knowledge and pedagogical knowledge, teachers are now required to integrate technology effectively into instructional practices. The Technological Pedagogical and Content Knowledge (TPACK) framework was proposed to conceptualize the dynamic interaction among technology, pedagogy, and content knowledge necessary for effective teaching in technology-enhanced learning environments (Mishra & Koehler, 2006). Within the context of 21st-century education, technology is no longer regarded merely as an instructional aid but as an integral component of instructional design, learning processes, and knowledge construction (Koehler et al., 2019; Partnership for 21st Century Learning, 2015).

TPACK has therefore been widely recognized as a core competency for teachers, particularly in ensuring relevant, engaging, and meaningful learning experiences. Teachers with well-developed TPACK are more capable of designing instruction that supports students' higher-order thinking, digital literacy, and problem-solving skills (Kereluik et al., 2013; Voogt et al., 2015). However, despite its acknowledged importance, empirical studies indicate that technology integration in classroom practice remains limited. Many teachers still rely on traditional instructional approaches, with minimal use of digital tools and multimedia resources, which may reduce instructional diversity and student engagement (Hasana & Maharany, 2017). Moreover, evidence from teacher competency evaluations suggests that pedagogical and professional competencies have not yet reached expected standards (Rosni, 2021). These findings underscore the need to strengthen TPACK development beginning at the pre-service teacher education stage (Chai et al., 2013).

Teacher education institutions play a central role in developing prospective teachers' professional competencies by providing learning experiences that connect theory and practice. One essential component of teacher education curricula is microteaching, which allows prospective teachers to practice instructional skills, apply pedagogical theories, and reflect on teaching performance in a structured and controlled environment (Aminah & Wahyuni, 2018). Microteaching serves as a critical transitional space between coursework and real classroom practice, enabling prospective teachers to experiment with instructional strategies and technology use with reduced complexity and risk.

Nevertheless, evidence suggests that many prospective teachers still experience difficulties during microteaching, particularly in integrating technology with appropriate pedagogical strategies and subject matter. This condition indicates that theoretical understanding of pedagogy and technology does not automatically translate into effective instructional practice. Accordingly, examining prospective teachers' ability to integrate content, pedagogy, and technology within microteaching contexts is crucial for understanding their readiness to implement technology-enhanced instruction.

Previous studies have extensively explored TPACK among in-service teachers and pre-service teachers in various subject areas, including mathematics (Cuhadar, 2018; Jang & Tsai, 2012; Listiawan & Baskoro, 2015). However, several limitations can be identified in the existing literature. First, many studies rely heavily on self-reported measures of TPACK and provide limited insight into how TPACK components are enacted in specific instructional contexts. Second, research on pre-service teachers tends to focus on teaching practicum or school-based internships, while microteaching as an early and formative instructional setting has received comparatively little attention. Third, studies that specifically examine the detailed profile of TPACK components among prospective mathematics teachers within microteaching practice remain scarce.

This gap is noteworthy because microteaching plays a pivotal role in shaping prospective teachers' instructional competencies before they enter real classroom environments. Understanding how prospective mathematics teachers integrate technological, pedagogical, and content knowledge during microteaching can provide valuable evidence for improving teacher education curricula and instructional design. Therefore, this study aims to describe the profile of Technological Pedagogical and Content Knowledge components of prospective mathematics teachers in microteaching practice. The findings are expected to inform teacher education institutions in designing more effective programs to prepare future mathematics teachers who are professionally competent and technologically adaptive.

2. METHOD

This study employed a descriptive quantitative research design, which aims to describe and interpret research variables based on numerical data as they naturally occur within the population. Descriptive quantitative research is commonly used to present systematic, factual, and accurate descriptions of phenomena through statistical summaries such as scores, percentages, and categories (Creswell, 2014; Fraenkel, Wallen, & Hyun, 2019). In this study, the descriptive approach was utilized to analyze the level of TPACK for prospective mathematics teachers based on survey and performance data (Alamsyah et al., 2018).

The participants of this study were students of the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Mataram, who were enrolled in a microteaching course. A purposive sampling technique was employed, in which participants were selected based on specific criteria relevant to the research objectives, namely students who had completed core pedagogical and content courses and were actively engaged in microteaching activities (Etikan, Musa, & Alkassim, 2016). The total number of participants involved in this study was 71 prospective mathematics teachers.

The data collected in this study consisted of two main sources: (1) a TPACK questionnaire and (2) students' final scores in the microteaching course. Analysis of TPACK can be conducted using several methods, including self-report measures, open-ended questionnaires, performance assessments, interviews, and observations (Abbitt, 2011; Koehler et al., 2012). In this study, two methods were selected: self-report measures in the form of a survey and performance assessment in the form of microteaching evaluation scores. The self-report method was chosen because it is widely used and considered appropriate for measuring teachers' perceptions of their TPACK (Chai et al., 2016; Mouza, 2016; Schmidt-Crawford et al., 2020). Meanwhile, performance assessment was employed to provide complementary information regarding students' instructional performance and to generate practical insights for program improvement.

The TPACK questionnaire used in this study was adapted from instruments developed by Schmidt et al. (2009) and Sahin (2011). The questionnaire measured seven TPACK subdomains: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). Responses were measured using a five-point Likert scale, ranging from 1 (Very Poor) to 5 (Very Good). Likert scales are widely used in educational research to measure individuals' attitudes, perceptions, and self-assessed competencies due to their flexibility, reliability, and ease of application (Joshi et al., 2015; Boone & Boone, 2012).

The instrument adaptation process involved translation into Indonesian, contextual adjustment to the microteaching setting, and expert review to ensure linguistic clarity and content relevance. Content validity was established through expert judgment, while instrument reliability was examined using Cronbach's alpha coefficient. The reliability coefficient exceeded the acceptable threshold of 0.70, indicating satisfactory internal consistency (Fraenkel et al., 2019).

The questionnaire data were analyzed descriptively by calculating mean scores and percentages for each TPACK component. Based on the mean scores obtained, students' TPACK levels were categorized into three groups: high, moderate, and low, following the classification criteria adapted from Widoyoko (2014), as presented in Table 1.

Table 1. Categories of TPACK ability level

Mean scores	Percentage (%)	Category
4,00 – 5,00	> 80	High
3,00 – 3,99	60 – 80	Moderate
1,00 – 2,99	< 60	Low

This study was conducted in accordance with ethical research principles. All participants provided informed consent, participation was voluntary, and participants' identities were kept confidential. The microteaching performance scores were accessed with institutional permission and analyzed in aggregated form.

3. RESULTS AND DISCUSSION

Technological Knowledge (TK)

TK refers to an individual's knowledge of using, operating, and adapting to various digital technologies, such as computers, the internet, multimedia devices, and software applications that support the learning process. This knowledge includes the ability to learn new technologies and to utilize existing technologies effectively within educational contexts (Mishra & Koehler, 2006; Koehler et al., 2013; Malichatin, 2019). Within the TPACK framework, TK serves as a fundamental component that supports the meaningful integration of technology into teaching and learning activities (Voogt et al., 2015).

Table 2. Self-Assessment of Technological Knowledge

No	Description of Competency	Mean score	Percentage (%)	Category
1	Knowledge of basic laptop components used in instructional activities	4.14	82.82	High
2	Ability to operate technologies for connecting laptops to display devices (e.g., projectors, smart TVs)	4.01	80.28	High
3	Engagement with recent technological developments relevant to teaching and learning	4.13	82.54	High
4	Knowledge of technologies for electronic and web-based instructional materials (e.g., videos, e-modules, e-worksheets)	4.32	86.48	High
5	Knowledge of instructional software and applications (e.g., presentation tools, interactive quizzes, timers)	4.31	86.20	High
	Overall mean	4.18	83.66	High

Based on the analysis of questionnaire data collected from 71 prospective mathematics teachers, the results of TK are presented in Table 2. Overall, the findings indicate that the students' TK is classified as high, with an average score of 4.18, corresponding to a percentage of 83.66%. As shown in Table 2, the students demonstrate a good level of knowledge regarding the basic components of technological devices used in learning, such as laptops and supporting hardware, with a percentage score of 82.82%. Their understanding of operating technology related to device connectivity, such as connecting laptops to projectors or smart displays, is also categorized as high, with a percentage of 80.28%. Furthermore, students show strong competence in utilizing electronic and web-based learning resources, including instructional videos, e-modules, and electronic worksheets, achieving a percentage of 86.48%. Similarly, their mastery of various instructional software and applications, such as presentation tools and digital quiz platforms, reaches a high level, with a percentage of 86.20%. These results suggest that prospective mathematics teachers have developed a strong foundational readiness in technological knowledge, particularly in technologies commonly employed in microteaching practices. This finding aligns with the demands of 21st-century education, which emphasize the importance of technological literacy for prospective teachers as a prerequisite for effective technology integration in instructional practices (Chai et al., 2016; Redecker, 2017).

Pedagogical Knowledge (PK)

PK relates to teachers' ability to design, implement, and evaluate instructional processes in ways that support meaningful learning. This form of knowledge encompasses an understanding of instructional approaches, teaching strategies and techniques, classroom management, and assessment practices that foster student engagement and learning development. In teacher education, PK plays a central role in shaping how instructional content is delivered and how classroom interactions are organized (Shulman, 1986; Koehler et al., 2013; Malichatin, 2019).

Table 3. Self-Assessment of Pedagogical Knowledge

No	Description of Competency	Mean score	Percentage (%)	Category
1	Knowledge of planning student-centered learning activities	4.06	81.13	High
2	Knowledge of applying varied instructional strategies and techniques to support dynamic learning	3.87	77.46	Moderate
3	Knowledge of guiding students individually and in groups to create enjoyable learning experiences	3.97	79.44	Moderate
4	Knowledge of diverse assessment types and techniques to ensure students feel safe and comfortable during evaluation	3.86	77.18	Moderate
5	Knowledge of classroom management to maintain a conducive learning environment	4.04	80.85	High
	Overall mean	3.96	79.21	Moderate

The analysis of questionnaire data collected from 71 prospective mathematics teachers reveals differing levels of achievement across the indicators of PK. Overall, the students' PK falls within the moderate category, with a mean score of 3.96, corresponding to 79.21%. The highest level of achievement is observed in the ability to design learning activities that emphasize student engagement, reaching a percentage of 81.13% and classified as high. Similarly, students demonstrate relatively strong knowledge in managing classroom environments to ensure conducive learning conditions, with a percentage score of 80.85%. In contrast, other pedagogical aspects remain at a moderate level, particularly those related to the use of varied instructional strategies, the provision of individual and group student guidance, and the implementation of diverse assessment methods.

These findings suggest that prospective mathematics teachers have developed a foundational level of pedagogical competence, especially in planning and classroom management. However, pedagogical skills that require adaptability and practical implementation—such as applying diverse teaching strategies and assessment techniques—still need further development. This pattern aligns with prior research indicating that prospective teachers often demonstrate stronger competencies in instructional planning than in instructional execution and assessment practices (Darling-Hammond et al., 2017; Chai et al., 2016). Consequently, microteaching experiences offer an important opportunity to strengthen pedagogical knowledge through guided practice and reflective learning.

Content Knowledge (CK)

CK refers to teachers' understanding of the subject matter they teach, encompassing knowledge of facts, concepts, principles, and procedures, as well as the structural relationships within a discipline (Shulman, 1986; Ball, Thames, & Phelps, 2008). In mathematics education, CK extends beyond procedural proficiency to include a deep conceptual understanding of why mathematical ideas work, how concepts are interconnected, and how they can be represented and justified (Hill, Rowan, & Ball, 2005).

As shown in Table 4, the CK of prospective mathematics teachers is classified at a moderate level, with an overall mean score of 3.94 (78.70%). This result indicates that participants possess an adequate foundation of mathematical content knowledge, although their mastery has not yet reached a deep or comprehensive level. The highest mean score was found for the use of diverse references to support instruction (mean = 4.34; high category), suggesting that students are relatively proficient in accessing various learning resources. In contrast, indicators related to engaging with recent mathematical developments and conducting mathematical experimentation remained in the moderate category, reflecting limited involvement in inquiry-based and exploratory mathematical practices.

These findings suggest that prospective teachers' CK tends to be predominantly procedural and declarative rather than conceptually rich and investigative, a pattern consistent with previous studies indicating that pre-service teachers often apply procedures without fully articulating underlying mathematical reasoning (Stylianides & Ball, 2008). Additionally, the moderate level of competence in organizing topics logically for knowledge construction may constrain the design of coherent learning trajectories and responsive instructional decisions (Charalambous et al., 2011).

Table 4. Self-Assessment of Content Knowledge in Mathematics

No	Description of Competency	Mean score	Percentage (%)	Category
1	Knowledge of mathematical facts, concepts, principles, and procedures supporting instructional content	3.99	79.72	Moderate
2	Ability to identify appropriate topics and sequence them logically to support students' knowledge construction	3.94	78.87	Moderate
3	Engagement in updating mathematical content knowledge through recent and credible sources and academic activities	3.82	76.34	Moderate
4	Use of diverse references (e.g., books, e-books, and web-based sources) to develop effective instruction aligned with learning objectives	4.34	86.76	High
5	Knowledge of mathematical experiment to design engaging and challenging learning activities	3.59	71.83	Moderate
	Overall mean	3.94	78.70	Moderate

Overall, while prospective mathematics teachers demonstrate sufficient CK to support instructional practice, further development is needed to strengthen conceptual understanding, mathematical reasoning, and engagement in mathematical inquiry. Enhancing CK is essential, as it forms a critical foundation for the development of other TPACK domains, particularly Pedagogical Content Knowledge (PCK) and Technological Content Knowledge (TCK) (Ball et al., 2008; Kleickmann et al., 2013).

Technological Pedagogical Knowledge (TPK)

TPK refers to an understanding of how technology can be effectively employed to support pedagogical strategies, instructional methods, and learning approaches. Rather than focusing solely on technological proficiency, TPK emphasizes the alignment between technological tools and pedagogical intentions within specific learning contexts.

Based on the results presented in Table 5, the TPK of prospective mathematics teachers is classified in the high category, with a mean score of 4.28 (85.69%). This finding indicates that the students demonstrate strong competence in integrating technology into pedagogical practices during microteaching activities. High scores were observed in the use of computers and projectors or smart TVs, as well as in the development and utilization of instructional software such as presentation tools and learning videos. These results suggest that students are generally confident in using technology to facilitate lesson delivery and classroom management. Furthermore, the effective use of information and communication technologies, including messaging platforms and email, reflects students' ability to support pedagogical communication and learning continuity beyond face-to-face instruction. According to Koehler and Mishra (2009), such pedagogical uses of technology are central to TPK, as technology functions as a mediator that enhances interaction and supports meaningful learning experiences. Nevertheless, indicators related to flexible technology use and the development of interactive digital applications received comparatively lower scores, although they remained within the moderate category. This pattern suggests that students' integration of technology tends to emphasize presentation and efficiency rather than learner-centered interactivity and engagement. This finding aligns with Tondeur et al. (2017), who argue that prospective teachers often integrate technology at a basic level before progressing toward more transformative pedagogical uses.

Table 5. Self-Assessment of Technological Skills in Teaching

No	Description of Competency	Mean score	Percentage (%)	Category
1	Use of computers and projectors (or smart TVs) to optimize instructional activities	4.58	91.55	High
2	Skills in creating and using instructional software and applications (e.g., presentations, videos)	4.48	89.58	High
3	Use of information and communication technologies to support instructional continuity (e.g., email, messaging platforms)	4.45	89.01	High
4	Flexible use of technology through visual displays and hands-on manipulatives in mathematics instruction	3.94	78.87	Moderate
5	Skills in developing and using interactive software and applications for student engagement (e.g., online quizzes, interactive worksheets)	3.97	79.44	Moderate
		4.28	85.69	High

Overall, the findings indicate that prospective mathematics teachers possess a solid foundation of Technological Pedagogical Knowledge, particularly in supporting instructional delivery and communication. However, further development is required to encourage more innovative and pedagogically driven uses of technology that actively engage students and promote higher-order thinking skills.

Technological Content Knowledge (TCK)

TCK refers to an understanding of how technology can be used to represent, visualize, and transform subject-specific content. In mathematics education, TCK plays a crucial role in supporting the representation of abstract concepts through visual, symbolic, and dynamic forms, enabling learners to develop deeper conceptual understanding.

Table 6. Self-Assessment of Technological Content Knowledge in Mathematics

No	Description of Competency	Mean score	Percentage (%)	Category
1	Ability to use technology to present mathematical content clearly and engagingly (e.g., visual representations, formulas, and data)	4.30	85.92	High
2	Skills in using software and applications related to mathematical content (e.g., dynamic mathematics and computational tools)	3.96	79.15	Moderate
3	Skills in locating instructional content through web-based technologies (e.g., digital libraries and online modules)	3.96	79.15	Moderate
4	Skills in evaluating learning content using application-based technologies (e.g., online quizzes and assessment tools)	4.01	80.28	High
5	Skills in presenting instructional content through video formats, both self-produced and curated sources	4.04	80.85	High
	Overall mean	4.05	81.07	High

Based on the data presented in Table 6, the TCK of prospective mathematics teachers is categorized as high, with a mean score of 4.05 (81.07%). This finding suggests that students demonstrate a strong ability to use technology to support the presentation and management of mathematical content during microteaching activities. High scores on indicators related to the use of visually rich presentation media indicate that students are capable of leveraging technology to clarify mathematical ideas through graphs, tables, and symbolic representations. Furthermore, students also show strong competence in using technology-based applications for content evaluation and in presenting learning materials through instructional videos. These results suggest that technology is employed not only as a delivery tool but also as a means to enrich and assess mathematical content. According to Niess (2011), the effective use of technology to represent and assess subject matter is a key feature of well-developed TCK. However, competencies related to the use of specialized mathematical software, such as GeoGebra, Maple, or MATLAB, remain in the moderate category. This indicates that students' engagement with content-specific technologies requiring deeper mathematical reasoning is still limited. This finding is consistent with Hegedus and Moreno-Armella (2009), who argue that the effective use of dynamic mathematical technologies requires a strong integration of conceptual mathematical understanding and technological skills.

Overall, these findings indicate that prospective mathematics teachers possess a solid foundation of TCK, particularly in presenting and evaluating mathematical content using general-purpose technologies. Nevertheless, further development is needed to enhance their ability to use advanced, content-specific technologies that support exploration, visualization, and conceptual learning in mathematics.

Pedagogical Content Knowledge (PCK)

PCK refers to an understanding of how subject matter can be represented, organized, and taught in ways that make it comprehensible to learners. PCK integrates knowledge of content with pedagogical strategies, including the selection of instructional approaches, the design of learning activities, and the development of assessments that meaningfully capture students' understanding.

Table 7. Self-Assessment of Pedagogical Content Knowledge (PCK) in Mathematics

No	Description of Competency	Mean score	Percentage (%)	Category
1	Ability to select instructional approaches and strategies that are appropriate for teaching specific mathematical concepts to achieve learning objectives optimally	3.99	79.72	Moderate
2	Ability to design mathematics lesson plans aligned with targeted competencies and characteristics of the mathematical content being taught	4.17	83.38	High
3	Ability to sequence mathematical learning objectives from simple to complex concepts to support students' conceptual understanding	4.10	81.97	High
4	Ability to develop mathematics student worksheets with in-depth content that promotes discipline, collaboration, and responsibility	4.30	85.92	High
5	Ability to design assessment tools that effectively measure students' understanding of specific mathematical content	4.13	82.54	High
	Overall mean	4.14	82.70	High

Based on the data presented in Table 7, the PCK of prospective mathematics teachers is categorized as high, with a mean score of 4.14 (82.70%). This result indicates that the students demonstrate strong competence in connecting mathematical content knowledge with pedagogical practices during microteaching sessions. Most PCK indicators fall within the high category, particularly those related to lesson planning, sequencing learning objectives from simple to complex, and developing student worksheets and assessment tools. The ability to design coherent learning progressions reflects students' awareness of the structural nature of mathematical content and its role in supporting conceptual understanding. In mathematics education, organizing content progressively is essential for facilitating meaningful learning experiences. This finding is consistent with Depaepe, Verschaffel, and Kelchtermans (2013), who emphasize that mathematics teachers' PCK is reflected in their capacity to structure content and select representations that align with students' cognitive development. High scores in developing worksheets and assessment instruments further suggest that students attend not only to content delivery but also to students' learning processes and outcomes. Such competence indicates a growing awareness of assessment as an integral component of instruction. According to Park and Oliver (2008), the alignment between instructional strategies, learning activities, and assessment is a key characteristic of well-developed PCK.

However, the indicator related to selecting appropriate instructional approaches and strategies remains in the moderate category. This suggests that although students are able to design instructional materials effectively, their pedagogical decision-making may still lack flexibility when adapting strategies to diverse learning contexts. Therefore, continued development of PCK among prospective teachers should emphasize reflective practice and varied teaching experiences to support adaptive and responsive instruction.

Technological Pedagogical and Content Knowledge (TPACK)

TPACK represents an integrated form of knowledge that reflects teachers' ability to simultaneously combine technology, pedagogy, and content to achieve effective learning outcomes. Rather than emphasizing the separate mastery of each domain, TPACK highlights teachers' capacity to make instructional decisions that are responsive to content characteristics, learners' needs, and the affordances of technology.

Table 8. Self-Assessment of TPACK in Mathematics

No	Description of Competency	Mean score	Percentage (%)	Category
1	Ability to select appropriate learning strategies and technologies aligned with the mathematical content being taught	4.18	83.66	High
2	Ability to integrate mathematical content knowledge, pedagogical knowledge, and technological knowledge to support effective instruction	3.94	78.87	Moderate
3	Ability to apply appropriate instructional strategies to guide students' understanding of mathematical content through the use of available technologies	3.94	78.87	Moderate
4	Ability to use a variety of software and applications to present mathematical content in engaging, enjoyable, and effective learning environments	3.94	78.87	Moderate
5	Ability to evaluate learning content using assessments with varied cognitive levels supported by interactive digital applications	3.75	74.93	Moderate
	Overall mean	3.95	79.04	Moderate

As presented in Table 8, the overall TPACK level of prospective mathematics teachers is categorized as moderate, with a mean score of 3.95 (79.04%). The highest score was found in the ability to select appropriate learning strategies and technologies aligned with mathematical content, indicating students' emerging awareness of contextualized technology use. However, competencies requiring deeper integration of content knowledge, pedagogical strategies, and technology—such as designing coherent technology-enhanced instruction and conducting technology-based assessments—remain at a moderate level.

These findings suggest that prospective teachers possess foundational TPACK but have not yet achieved full integration of its components in instructional practice. This pattern supports previous research indicating that TPACK represents an advanced form of teacher knowledge that does not develop automatically from separate domains, but requires reflective practice and structured learning experiences (Angeli & Valanides, 2009). In particular, the relatively lower performance in technology-supported assessment reflects challenges in aligning learning objectives, instructional strategies, and digital tools within a pedagogically meaningful framework (Voogt et al., 2015).

Overall, the results indicate that prospective mathematics teachers are still in a developmental stage of TPACK acquisition. Accordingly, teacher education programs should emphasize integrative teaching experiences and reflective use of technology to strengthen coherent instructional design and higher-order mathematical learning.

Comparative Analysis of TPACK Components

Figures 1 and 2 present a comprehensive overview of prospective mathematics teachers' TPACK during microteaching practice, viewed from two complementary perspectives: mean scores across TPACK components and the distribution of students' self-assessment categories.

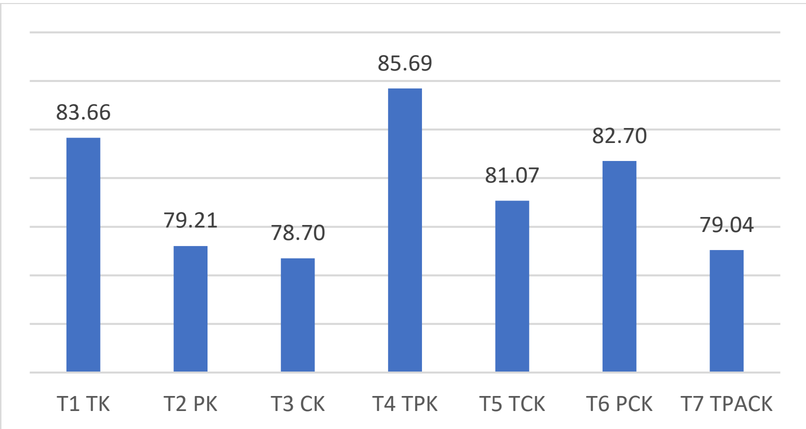

Figure 1. Mean Scores (in Percentage) of TPACK Components of Prospective Mathematics Teachers during Microteaching Practice

Figure 1 shows that all TPACK components fall within the moderate to high range, with percentage scores between 78.70% and 85.69%, indicating a foundational readiness to integrate technology, pedagogy, and content. Technological Pedagogical Knowledge (TPK) achieved the highest score (85.69%, high), suggesting that prospective teachers are relatively proficient in using technology to support pedagogical strategies. This finding is consistent with prior studies indicating that pre-service teachers tend to develop technology–pedagogy integration earlier than deeper content-related integration (Chai et al., 2016; Koehler et al., 2013).

Technological Knowledge (TK) and Pedagogical Content Knowledge (PCK) also reached high categories, reflecting students' familiarity with instructional technologies and their growing ability to connect mathematical content with appropriate teaching strategies. Technological Content Knowledge (TCK), although categorized as high, showed a slightly lower score, indicating that integrating technology with specific mathematical content remains more challenging than using technology for general pedagogical purposes (Jang & Tsai, 2012). In contrast, Pedagogical Knowledge (PK) and Content Knowledge (CK) obtained the lowest mean scores and remained in the moderate category, suggesting that deeper pedagogical understanding and conceptual mastery of mathematics are areas requiring further development (Hill et al., 2008). Overall TPACK was also categorized as moderate (79.04%), highlighting that the simultaneous integration of technology, pedagogy, and content represents a higher-level competence that has not yet been fully achieved (Mishra & Koehler, 2006; Voogt et al., 2015).

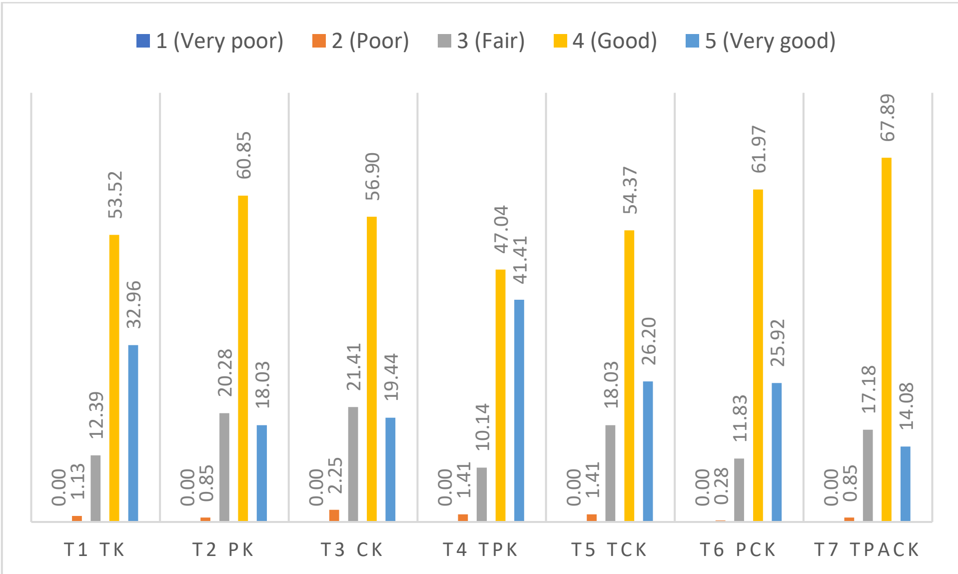

Figure 2. Distribution of Students' Self-Assessment Categories across TPACK Components during Microteaching Practice

Complementing these results, Figure 2 shows that the **"Good"** category dominates students' self-assessments across all TPACK components, reinforcing the overall moderate performance indicated by the mean scores. TPK displays a relatively higher proportion of "Very Good" responses, reflecting strong confidence in pedagogical uses of technology, whereas CK shows a notable proportion of "Fair" responses, indicating ongoing difficulties in achieving deeper conceptual understanding. For overall TPACK, the dominance of the "Good" category alongside fewer "Very Good" responses further confirms that full integration of technology, pedagogy, and content is more demanding than mastery of individual or paired domains.

Taken together, these findings suggest that microteaching practice effectively supports the development of foundational TPACK competencies. However, advancing toward more mature and balanced TPACK requires greater emphasis on strengthening mathematical content knowledge and providing sustained, authentic opportunities for integrated technology-enhanced instruction.

4. CONCLUSION

This study aimed to examine the profile of Technological Pedagogical Content Knowledge (TPACK) among prospective mathematics teachers during microteaching practice. The findings indicate that, overall, students' TPACK competencies fall within the moderate to high categories, suggesting that they have developed a basic level of readiness to integrate technology, pedagogy, and mathematical content in instructional contexts. Technology-related components, particularly Technological Pedagogical Knowledge (TPK) and Technological Knowledge (TK), achieved the highest scores. This result indicates that prospective teachers are relatively confident and skilled in using technology to support pedagogical strategies. In contrast, Content Knowledge (CK) and Pedagogical Knowledge (PK) obtained comparatively lower scores, although they remain within the moderate category, highlighting the need for further strengthening of conceptual and pedagogical understanding of mathematics.

Overall TPACK was found to be at a moderate level, emphasizing that the simultaneous integration of technology, pedagogy, and content represents an advanced competency that has not yet been fully developed. The distribution of self-assessment categories further reveals that most students perceive their competencies as "good," while the proportion of "very good" ratings remains limited, particularly for overall TPACK. In conclusion, microteaching practice plays a crucial role in establishing foundational TPACK competencies among prospective mathematics teachers. Nevertheless, to promote more comprehensive and sustainable TPACK development, greater emphasis should be placed on strengthening mathematical content knowledge and providing more authentic, reflective teaching experiences that support the integrated use of technology, pedagogy, and content.

5. ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the University of Mataram for funding this research under research contract number 2054/UN18.L1/PP/2024.

6. REFERENCES

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education*, *43*(4), 281–300. https://doi.org/10.1080/15391523.2011.1 0782573

Alamsyah, T. P., Syachruroji., & Jamaludin, U. (2018). Analisis Pedagogical Content Knowledge (PCK) Mahasiswa PGSD Peserta Program Pengalaman Lapangan Kependidikan (PPLK) Universitas Sultan Ageng Tirtayasa. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *III*(1), 1–11.

Aminah, N., & Wahyuni, I. (2018). Kemampuan Pedagogic Content Knowledge (PCK) Calon Guru Matematika Pada Program Pengalaman Lapangan di SMP/SMA Negeri Kota Cirebon. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 2(2), 259. https://doi.org/10.33603/jnpm.v2i2.1291

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, 52(1), 154–168.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Blömeke, S., Kaiser, G., & Weiss, M. (2020). Profiles of mathematics teachers' competence and their relation to instructional quality. *ZDM – Mathematics Education, 52*, 329–342. https://doi.org/10.1007/s11858-020-01128-y

Boone, H. N., & Boone, D. A. (2012). Analyzing Likert data. *Journal of Extension, 50*(2), 1–5.

Celik, B. (2017). Teaching profession and passion. *International Journal of Social Sciences and Educational Studies*, 4(2 (Special Issue)), 85–92. https://doi.org/10.23918/ijsses.v4i2sip85

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2013). A review of technological pedagogical content knowledge. *Educational Technology & Society, 16*(2), 31–51.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2016). *A review of the quantitative measures of Technological Pedagogical Content Knowledge (TPACK).* In M. C. Herring, M. J. Koehler, & P. Mishra (Eds.), *Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators* (2nd ed., pp. 87–106). Routledge.

Charalambous, C. Y., Hill, H. C., & Ball, D. L. (2011). Prospective teachers' learning to provide instructional explanations: How does it look and what might it take? *Journal of Mathematics Teacher Education*, 14(6), 441–463.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Cuhadar, C. (2018). Investigation of pre-service teachers' levels of readiness to technology integration in education. *Contemporary Educational Technology,* 9(1), 61–75.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Palo Alto, CA: Learning Policy Institute.

Day, C. (2004). *A passion for teaching*. London: RoutledgeFalmer.

Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagogical content knowledge: A systematic review of the way in which the concept has pervaded mathematics educational research. *Teaching and Teacher Education*, 34, 12–25.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). *How to design and evaluate research in education* (10th ed.). New York, NY: McGraw-Hill.

Haider, A., & Jalal, S. (2018). Good teacher and teaching through the lens of students. *International Journal of Research*, 5(7), 1395–1409.

Hasana, S. N., & Maharany, E. R. (2017). Pengembangan Multimedia Menggunakan Visual Basic for Application (Vba) Untuk Meningkatkan Profesionalisme Guru Matematika. JPM: *Jurnal Pendidikan Matematika*, 3(2), 30. https://doi.org/10.33474/jpm.v3i2.648

Hegedus, S. J., & Moreno-Armella, L. (2009). Intersecting representation and communication infrastructures. *Educational Studies in Mathematics*, 70(1), 49–65.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education, 39*(4), 372–400.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2), 371–406.

Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education, 67*, 37–45. https://doi.org/10.1016/j.tate.2017.05.016

Jang, S. J., & Tsai, M. F. (2013). Exploring the TPACK of Taiwanese secondary school science teachers using a new contextualized TPACK model. *Australasian Journal of Educational Technology, 29*(4), 566–580. https://doi.org/10.14742/ajet.282

Jang, S. J., & Tsai, M. F. (2012). Exploring the TPACK of Taiwanese elementary mathematics and science teachers with respect to use of interactive whiteboards. *Computers & Education, 59*(2), 327–338. https://doi.org/10.1016/j.compedu.2012.02.003

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology, 7*(4), 396–403.

Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What Knowledge Is of Most Worth: Teacher Knowledge for 21 st Century Learning. *Journal of Digital Learning in Teacher Education*, 29(4), 127–140. https://doi.org/10.1080/21532974.2013.10784716

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013). Teachers' content knowledge and pedagogical content knowledge: The role of structural differences in teacher education. *Journal of Teacher Education*, 64(1), 90–106.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education, 193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2013). The technological pedagogical content knowledge framework. In M. J. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (pp. 101–111). New York, NY: Springer.

Koehler, M. J., Shin, T. S., & Mishra, P. (2012). *How do we measure TPACK? let me count the ways*. In Ro. N. Ronau, C.R. Rakes, & M. L. Niess (Ed.), Educational technology, teacher knowledge, and classroom impact: a research handbook on frameworks and approaches. Hershey PA: IGI Global.

Koh, J. H. L., & Chai, C. S. (2016). Seven design frames that teachers use when considering technological pedagogical content knowledge (TPACK). *Computers & Education, 102*, 244–257. https://doi.org/10.1016/j.compedu.2016.09.003

Listiawan, T., & Baskoro, W. W. (2015). *Analisis Technologi Content Knowledge (TCK) calon guru matematika dalam menggunakan perangkat lunak geometri dinamis*. In

SeminarNasional Matematika dan Pendidikan Matematika (hal. 827–834). Yogyakarta. https://doi.org/10.13140/RG.2.1.4443.3522

Malichatin, H. (2019). *Pengembangan kompetensi guru dalam pembelajaran berbasis teknologi*. Yogyakarta: Deepublish.

Meijer, P. C., Korthagen, F. A. J., & Vasalos, A. (2009). Supporting presence in teacher education: The connection between the personal and professional aspects of teaching. *Teaching and Teacher Education*, 25(2), 297–308. https://doi.org/10.1016/j.tate.2008.09.013

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mouza, C. (2016). *Developing and assessing TPACK among pre-service teachers. In Handbook of technological pedagogical content knowledge (TPACK) for educators* (Vol. 169). Routledge New York, NY

Niess, M. L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educational Computing Research*, 44(3), 299–317.

OECD. (2019). *Teaching and learning international survey (TALIS) 2018 results: Teachers and school leaders as lifelong learners*. Paris: OECD Publishing.

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education*, 38(3), 261–284.

Partnership for 21st Century Learning. (2015). *P21 partnership for 21st century learning. Partnership for 21st Century Learning*. http://www.p21.org/documents/P21_Framework_Definitions.pdf

Redecker, C. (2017). *European framework for the digital competence of educators: DigCompEdu*. Luxembourg: Publications Office of the European Union.

Rosni. (2021). Kompetensi guru dalam meningkatkan mutu pembelajaran di sekolah dasar. *Jurnal EDUCATIO: Jurnal Pendidikan Indonesia*, 7(2), 113–124. https://doi.org/10.29210/1202121176

Sahin, I. (2011). Development of survey of technological pedagogical and content knowledge (TPACK). Turkish Online *Journal of Educational Technology*, 10(1), 97–105.

Sakuma, A. (2018). The origin of teaching as a profession in Japan: A transnational analysis of the relationship between professionalism and nationalism in the 19th century. *Espacio, Tiempoy Educacion*, 5(2), 35–54. https://doi.org/10.14516/ete.232

Schmidt, D. A., Thompson, A. D., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, 42(2), 123–149.

Schmidt-Crawford, D., Thompson, A. D., & Mishra, P. (2020). Considering TPACK as a knowledge framework for teachers. *Journal of Research on Technology in Education, 52*(3), 241–255. https://doi.org/10.1080/15391523.2020.1767525

Shulman, L. S. (1986). Thoe who understan: knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Srinivasan, M., Li, S. T. T., Meyers, F. J., Pratt, D. D., Collins, J. B., Braddock, C., Hilty, D. M. (2011). Teaching as a competency: Competencies for medical educators. *Academic Medicine*, 86(10), 1211–1220. https://doi.org/10.1097/ACM.0b013e31822c5b9a

Stylianides, A. J., & Ball, D. L. (2008). Understanding and describing mathematical knowledge for teaching: Knowledge about proof for engaging students in the activity of proving. *Journal of Mathematics Teacher Education*, 11(4), 307–332.

Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap. *Australasian Journal of Educational Technology*, 33(3), 1–16.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2015). Technological pedagogical content knowledge: A review of the literature. *Journal of Computer Assisted Learning, 31*(3), 186–199.

Walsh, A., Koppula, S., Antao, V., Bethune, C., Cameron, S., Cavett, T., Dove, M. (2018). Preparing teachers for competency-based medical education: Fundamental teaching activities. *Medical Teacher*, 40(1), 80–85. https://doi.org/10.1080/0142159X.2017.1394998

Widoyoko, E. P. (2014). *Teknik penyusunan instrumen penelitian* (Cet. III). Yogyakarta: Pustaka Pelajar.