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Assessing Technological Pedagogical Content Knowledge Proficiency Among Prospective Mathematics Teachers in Micro-Learning Courses

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Abstrak

Calon guru wajib memiliki, menguasai, dan meningkatkan Pengetahuan Konten Pedagogis Teknologi (TPACK), yang diakui sebagai elemen penting dalam dekonstruksi pengetahuan guru. Penelitian ini berupaya menganalisis kemahiran TPACK siswa calon guru yang mengikuti mata kuliah Micro-Learning. Dengan menggunakan pendekatan penelitian deskriptif kualitatif, pengumpulan data dilakukan melalui lembar observasi dan wawancara. Analisis data meliputi reduksi, penyajian, dan penarikan kesimpulan. Temuan menunjukkan bahwa ketiga peserta menunjukkan kemampuan TPACK yang patut dipuji, meskipun masih terdapat ruang untuk mengoptimalkan Pengetahuan Teknologi dalam konteks pembelajaran.
Kata Kunci: Kemampuan; Calon Guru Matematika; Pembelajaran Mikro; TPACK.

Abstract

Prospective teachers are required to possess, master, and enhance their Technological Pedagogical Content Knowledge (TPACK), which is recognized as a pivotal element in the deconstruction of teacher knowledge. This study seeks to analyze the TPACK proficiency of prospective teacher students enrolled in a Micro-Learning course. Employing a descriptive qualitative research approach, data was collected through observation sheets and interviews. Data analysis encompassed reduction, presentation, and conclusion-drawing. The findings revealed that the three participants exhibited commendable TPACK abilities, although there is room for optimizing Technological Knowledge in the context of learning.
Keywords: Ability; Prospective Mathematics Teachers; Micro Learning; TPACK.

I. INTRODUCTION

Education holds a significant role in life, and teachers play a crucial part in realizing quality education. To achieve this, teachers must possess a set of competencies outlined in the Law on teachers and lecturers, encompassing pedagogical, professional, personality, and social competencies (Maryono & Sholihah, 2022).

Continuous improvement of teacher competency is imperative as it serves as a foundational element in attaining quality education. The combination of pedagogical and professional competencies gives rise to Pedagogical Content Knowledge (Shulman, 1986). These competencies are vital for teachers, as they need to master the subject matter and effectively convey it to students (Indriani, Hidayah, & Hidayah, 2021; Hadi & Kurniawati, 2022).

The pedagogical abilities of teachers involve effective learning management (Kurniawan & Astuti, 2017; Murtiyasa & Atikah, 2021). This proficiency is equally crucial for educators alongside subject matter expertise.

As time progresses, the undeniable role of technology in education becomes increasingly apparent. Technology serves not only as a subject of study but also as a facilitator of the learning process (Surani, 2019). To adapt to this landscape, teachers must cultivate technological skills alongside their teaching and subject matter expertise (Vu, 2018).

The amalgamation of material, pedagogical, and technological knowledge is encapsulated in Technological Pedagogical Content Knowledge, commonly abbreviated as TPACK. Originating from Shulman's Pedagogical Content Knowledge in 1986, TPACK has evolved by integrating technology (Koehler, et al., 2006; Chuang & Ho, 2011).

Technological Pedagogical Content Knowledge is a framework illustrating the integration of three fundamental knowledge components: content/material knowledge, pedagogical knowledge, and technological knowledge. According to Koehler et al. (2006) and Chuang & Ho (2011), TPACK encompasses Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

TPACK is a crucial possession for educators to establish conducive learning environments and achieve quality education. Attaining ideal educator skills is a challenging endeavor that necessitates continuous learning efforts dedicated to sustaining quality education.

Implementation of TPACK can commence early, particularly for student teachers. Early adoption during their college years allows prospective teacher students to acclimate to it before entering the professional field, fostering effective learning practices conducive to achieving quality outcomes.

As a versatile framework, TPACK empowers students to integrate content, pedagogical, and technological knowledge to enhance their learning presentations. By maximizing these dimensions, TPACK facilitates the improvement of teachers' proficiency in incorporating technology into learning and supports their overall competency development.

The hindrance to technology's effective utilization in learning often stems from teachers' inadequate understanding of technology (Restiana & Pujiastuti, 2019). Research by Waluyo & Nuraini (2021) reveals that awareness regarding technology's application in learning remains low among both teachers and students, with schools needing to provide supporting infrastructure for technology-enabled learning. Engaging students actively in learning allowing them to explore ideas using technology, is crucial for developing concepts and strategies in solving mathematical problems (Khaulah, 2018; Siswono, 2008), contributing significantly to the creation of quality learning environments.

The development of TPACK for prospective teacher students finds facilitation in lecture activities, such as the Capita Selekta Mathematics courses in Basic Education and Secondary Education. These courses enable students to refine their content/material knowledge in preparation for their future roles. Similarly, the Learning Design course refines pedagogical knowledge, preparing students to teach effectively. Micro-Learning courses play a pivotal role in honing students' abilities to integrate content/material, pedagogical, and technological knowledge in designing impactful learning experiences. These courses are a requisite component of the IPI Garut Mathematics Education Study Program for prospective teacher students.

Micro-Learning courses, specifically, refine eight fundamental teaching skills, encompassing the opening and closing of lessons, material explanation, questioning techniques, reinforcement provision, class management, discussion facilitation, group teaching proficiency, and the introduction of learning variations (Turney in Rombot, 2020). These courses also aid students in developing the three foundational knowledge components: content/material knowledge, pedagogical knowledge, and technological knowledge.

In light of the preceding explanation, this research aims to analyze the TPACK abilities of prospective teacher students in the Micro-Learning course. Distinguishing itself from previous studies, this research examines the TPACK abilities of prospective Mathematics teacher students in the Micro-Learning course, focusing on level 3 students in the IPI Garut Mathematics Education program.

II. METHOD

This study investigates students' technological pedagogical content knowledge (TPACK) abilities of prospective

teachers enrolled in the microlearning course. Employing a descriptive qualitative research approach, this methodology was used for an in-depth exploration of social or human issues (Creswell, 2013). The research utilized observation sheets and interview sheets as instruments. The observation sheet assessed the TPACK abilities of prospective teacher students, while interviews provided a comprehensive understanding of their TPACK abilities within the Micro-Learning course. The interviews were conducted in-depth with the participating students.

The participants in this study were students enrolled in the Micro Learning Course, specifically third-year academic students in the Mathematics Education Study Program at Institut Pendidikan Indonesia Garut. The research was conducted in April 2023. The data analysis followed the process of data reduction, data presentation, and drawing conclusions, as outlined by Miles and Huberman (1992).

III. RESULT AND DISCUSSION

The participants in this study were third-year students enrolled in the Mathematics Education program who were undertaking the Micro-Learning course. Three students, CHY, ELS, and DYN, were randomly selected as participants and referred to as S1, S2, and S3. Subsequently, both observations and interviews were conducted to assess their Technological Pedagogical Content Knowledge (TPACK) capabilities.

The evaluation of TPACK involves an assessment of three key components: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). It is important to note that TPACK represents an integration of these three fundamental components — CK, PK, and TK — as illustrated in the diagram below:

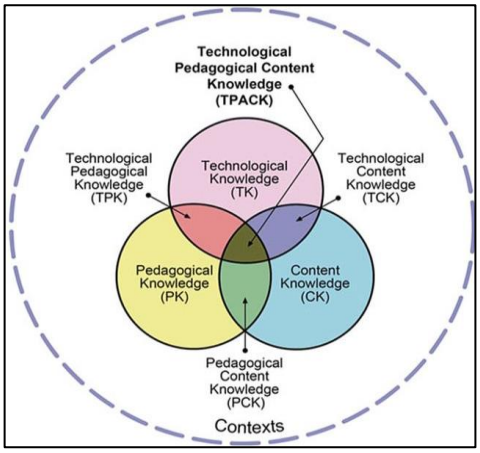

Figure 1. TPACK Framework, according to Schmidt et al. (2009)

Prior to engaging in teaching practice, S1 developed a lesson plan and identified the material to be presented in the class. According to the observation results, S1 received an assessment score of 3.85.

In the Content Knowledge (CK) component, S1 successfully fulfilled the CK indicators by demonstrating a mastery of the taught material and possessing a solid understanding of it. During this teaching practice, undergraduate students focused on the topic of "Building Curved Side Spaces."

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The following excerpt is from an interview with S1 regarding Content Knowledge:

R: To what extent do you understand the material taught?

S1: I thank God; I have a deep understanding. I possess explanatory skills, which the lecturer previously assessed. That's why I selected material that I truly mastered, and I also prepared answers in case of unexpected questions from peers who played the role of students in the previous session.

In the Pedagogical Knowledge (PK) component, undergraduate students fulfilled the PK indicators. The following footage captures undergraduate students during their teaching practice:

Figure 2. S1 Snapshot in Teaching Practice

Based on Figure 2, S1 is capable of delivering effective lessons in accordance with the developed Lesson Plans (RPP), utilizing appropriate methods and adjusting the material to the suitable learning approach.

The following is an excerpt from an interview with S1 regarding Pedagogical Knowledge:

R: How do you manage and organize classroom conditions during learning practices?

S1: I motivate with the phrase "Man Jadda Wa Jadda = Whoever is serious, he will succeed," hoping that students will remember their educational goals and be reminded of the purpose of learning. This encourages students to participate in the learning process actively. Also, since the middle school students of class IX were in an active position when their energy levels were too high, I responded in a friendly manner while emphasizing the importance of paying attention when the teacher was speaking. I would say, "Shh, let's listen first," while making a gesture with my index finger in front of my lips. I am always attuned to the students' conditions, encouraging them to engage in the entire learning process rather than being absorbed in explaining things themselves.

In the Technological Knowledge (TK) component, S1 meets the TK indicators sufficiently. S1 utilizes the internet to find learning material sources, and they are adept at using laptops/computers for various learning preparations, such as creating lesson plans, developing teaching materials, and preparing learning tools. However, technology like PowerPoint (PPT) wasn't used in this teaching practice due to limited time constraints imposed by the course lecturer.

The next participant, identified as S2, initiated teaching practice by creating a lesson plan and deciding on the material to

be presented in class. Based on observation results, the S2 received an assessment of 3.50.

In the Content Knowledge (CK) component, S2 has fulfilled the CK indicators as they can master and understand the material well. In this teaching practice, S2 covered Building Flat Side Spaces material.

The following is an excerpt from an interview with S2 regarding Content Knowledge:

R: To what extent do you understand the material taught?

S2: I comprehensively understand the content before teaching specific material to students. Therefore, after selecting the teaching material, I make sure to grasp it thoroughly, minimizing the chance of encountering any unforeseen issues.

In the Pedagogical Knowledge (PK) component, S2 has fulfilled the PK indicators. The following depicts S2 student during their teaching practice:

Figure 3. S2 Snapshot in Teaching Practice

Based on Figure 3, she demonstrated effective teaching practices according to the created Lesson Plans (RPP), utilizing appropriate methods and aligning the material with the correct learning approach.

The following is an excerpt from an interview with S2 regarding Pedagogical Knowledge:

Q: How do you select and apply the appropriate learning model that suits the learning material?

S2: When choosing and implementing the suitable learning model, I initially consider the available facilities and infrastructure in the school, including materials and tools that will support learning. Additionally, before deciding on a learning model, I think about the material's characteristics, indicators, and learning objectives and understand the specific traits of the students. This is essential for creating active, creative, and enjoyable student learning experiences.

She has fulfilled the TK indicators in the Technological Knowledge (TK) component. They have utilized the internet to find material sources for learning, expanded reference sources related to the learning material, and demonstrated the ability to use laptops/computers for tasks such as preparing lesson plans, creating teaching materials, developing learning tools, and employing PowerPoint presentations and learning videos during instruction.

The following is an excerpt from an interview with S2 regarding Technological Knowledge:

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Q: How do you select technology that aligns with your learning approaches and strategies in classroom practice?
S2: When choosing suitable technology for learning, I tailor it to the requirements of the learning process. I integrate learning strategies that can be enhanced with technological aids, such as utilizing laptop-based learning media, PowerPoint presentations (PPT), and instructional videos to prevent monotony in the learning process.

The following student, identified as S3, created a lesson plan and determined the material to be presented in class before undertaking teaching practice. Based on observation results, S3 received an assessment of 3.70.

In the Content Knowledge (CK) component, S3 has fulfilled the CK indicators. S1 is proficient in the material taught and comprehensively understands it. In this teaching practice, S3 students cover material related to Quadratic Functions.

The following is an excerpt from an interview with S3 regarding Content Knowledge:

Q: How do you analyze the material taught?
S3: Before presenting the material to students, I thoroughly study it. I then create simple examples of questions to enhance students' comprehension. Additionally, I prepare several examples of questions at a more advanced level to further deepen students' understanding.

In the Pedagogical Knowledge (PK) component, S3 has met the PK indicators. The following is footage of S3 during teaching practice:

Figure 4. Snapshot of S3 in Teaching Practice

Based on Figure 4, S3 is proficient in delivering effective learning according to the developed RPP, utilizing appropriate methods and adapting the material to the suitable learning approach.

The following is an excerpt from an interview with S3 regarding Pedagogical Knowledge:

Q: How do you develop learning tools (RPP)?
S3: I usually refer to textbooks and examine examples of lesson plans. I chose a method that is suitable for use in the classroom.

In the Technological Knowledge (TK) component, S3 has fulfilled the TK indicators. He has utilized the internet to find material sources, increased reference sources related to learning material, and can use laptops/computers to prepare lessons, including creating lesson plans, teaching materials, learning tools, and presentation tools like PPTs, learning videos, and mathematical applications.

The following is an excerpt from an interview with S3 regarding Technological Knowledge:

Q: How do you use technology (laptop, LCD projector, printer, scanner, etc.)?

S3: Typically, I use a laptop for creating essential documents, processing data, compiling teaching materials, and employing various learning support applications such as Geogebra and Excel. LCD projectors are used to display learning material or media.

Based on the analysis of the research results presented, the three participants in the research, namely student-teacher candidates in the Micro-Learning course, have met the TPACK indicators. However, there is room for improvement in the Technological Knowledge component, as some students have not fully optimized technology in their learning practices.

Teachers/educators, including student-teacher candidates, should possess the TPACK components. This can support optimal learning, and learning objectives will be successfully attained. As a prospective teacher, one must develop TPACK skills (Valtonen et al., 2020); therefore, TPACK skills must be acquired and mastered (Yigit, 2014). TPACK is crucial in deconstructing teacher knowledge (Chai et al., 2018; Harris et al., 2017).

IV. CONCLUSION

Based on the research results, it can be concluded that the three prospective teacher-student participants in the Micro-Learning course have met the TPACK requirements. However, there is a need for improvement and further development in the Technological Knowledge aspect, as some students are not yet fully optimized in utilizing technology for learning.

A suggestion for future researchers is to explore other courses, particularly those emphasizing technology integration in learning. This exploration can facilitate the optimization of technology in the context of Mathematics education.

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