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AI INTEGRATION IN MICROTEACHING: A TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE APPROACH TO IMPROVE THE QUALITY OF PROSPECTIVE MADRASAH IBTIDAIYAH TEACHERS

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Abstract

The advancement of Artificial Intelligence (AI) technology in education has created significant opportunities to enhance teaching quality, including in microteaching practices for prospective Madrasah Ibtidaiyah (MI) teachers. However, the implementation of AI in instructional practices still faces several challenges, such as limited technological literacy, gaps in curriculum integration, and difficulties in designing AI-based learning tools. This study aims to analyze the level of understanding of prospective MI teachers regarding AI technology in microteaching, examine AI integration through the Technological Pedagogical and Content Knowledge (TPACK) framework, identify implementation challenges, and evaluate the effectiveness of AI in improving teaching quality. This research employed a mixed-methods approach with a sequential explanatory design. Quantitative data were collected through surveys and pretest–posttest instruments, while qualitative data were obtained through interviews and observations of AI-based microteaching practices. Data analysis included descriptive and inferential statistics to measure the effectiveness of AI, as well as thematic analysis to map implementation challenges. The findings indicate that students began to integrate AI across the stages of lesson planning, implementation, and evaluation, reflecting the initial development of TPACK components, particularly Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK). Identified challenges include low levels of technological literacy, limited pedagogical readiness, technical constraints, anxiety toward AI usage, and concerns regarding academic ethics. The Wilcoxon test results show a significant improvement in microteaching scores from 2.46 to 4.46 ($p = 0.003$), confirming the effectiveness of AI integration in enhancing the teaching quality of prospective MI teachers.

Keywords: TPACK, Artificial Intelligence, Microteaching, Prospective MI School Teachers, Primary Education

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INTRODUCTION

The 21st century has been marked by rapid developments in digital technology, including artificial intelligence (AI) (Yau et al., 2023). Harry & Jati (2023) define AI as machine learning and natural language that can be used to analyze large amounts of data and generate patterns or predictions. AI technology has greater potential to transform the educational environment by improving students' problem-solving and adaptive learning abilities (Ng et al., 2023). AI makes learning no longer one size fits all but tailored to the needs of each individual (Yang et al., 2019). Examples include the use of AI for adaptive learning platforms, such as Smart Sparrow, DreamBox, and Knewton, which use AI to tailor the learning experience of students according to their individual abilities (Son et al., 2023). The use of AI tutors can support learning and enable students to understand the material anytime and anywhere using AI-based virtual assistants such as Chatbot (Chan & Lee, 2023). Learning gamification can be implemented to adjust challenges according to the level of understanding of the students, so that they will be motivated to learn (Rose, 2024).

The use of AI has great potential to improve the effectiveness of the teaching process, so ensuring the readiness of prospective Madrasah Ibtidaiyah (MI), equivalent to Islamic elementary school teachers, to integrate AI-based tools is essential, particularly in microteaching practices as a key component of pre-service teacher education and training (Karataş & Yüce, 2024). Microteaching is a learning method designed to train prospective teachers' teaching skills through small-scale teaching simulations. Microteaching is one of the courses in the Madrasah Ibtidaiyah Teacher Education (PGMI) study program in the Outcome-Based Education curriculum. In practice, prospective MI teachers are given the opportunity to design and implement learning with various strategies, including the use of technology.

The use of AI in microteaching practices for prospective Madrasah Ibtidaiyah (MI) teachers faces multidimensional challenges. First, limited understanding of technology is a major obstacle. A survey in Southeast Asia revealed that 72% of teachers feel less confident using AI tools due to a lack of technical training (UNESCO, 2021). Another survey conducted by UNESCO revealed that 11 of 51 countries in Southeast Asia have developed and implemented AI curricula (Wang, 2023). The impact of AI use on learning outcomes was also examined through a meta-analysis conducted by (Zawacki-Richter et al., 2019), which revealed that only 30% of AI implementations in primary education successfully improved learning outcomes, while 40% reduced student social interaction. Research by Hwang et al., (2020) in several Southeast Asian countries showed that 58% of prospective teachers failed to develop a Lesson Plan (RPP) that combined AI with the goal of developing higher-order thinking skills (HOTS). At the local level, preliminary findings from a study involving PGMI students (Observation, 2024) show that although 30% of the students have been able to use AI in designing authentic assessments, most still face challenges in integrating AI into the development of learning tools during microteaching practice. Since the campus is located in the center of the capital city, these

challenges are unlikely to be caused mainly by limited access to technology. Instead, they appear to be more closely related to students' readiness to use AI appropriately in instructional contexts, including technical, conceptual, and pedagogical aspects. This suggests that the potential of AI to support learning has not yet been fully matched by students' capacity to apply it effectively. Therefore, further analysis is needed to explore the challenges faced by PGMI students and to examine their readiness to integrate AI into learning tool development and microteaching practices, so that its implementation can be more effective and beneficial for the preparation of prospective MI teachers.

The Technological Pedagogical and Content Knowledge (TPACK) approach is a relevant framework for analyzing the readiness of prospective MI teachers to integrate AI. The TPACK model emphasizes that effective technology-based teaching must take into account the balance between three main elements: understanding of technology (Technological Knowledge/TK), pedagogical understanding (Pedagogical Knowledge/PK), and understanding of teaching content (Content Knowledge/CK) (Mishra & Koehler, 2006a). Using the TPACK approach, this study aims to evaluate the extent to which prospective MI teachers are able to effectively integrate AI-based tools into microteaching practices in accordance with the principles of quality learning (Mishra et al., 2011).

This study is expected to contribute to the development of the MI teacher education curriculum, particularly in optimizing the use of AI technology in learning. In addition, the results of this study can be used as a basis for improving the competence of prospective teachers in adapting technology pedagogically so that it can be applied more widely in MI classrooms. (Sun et al., 2023)

METHOD

This study employed a mixed-method approach (Creswell & Creswell, 2017), combining quantitative and qualitative methods to obtain a comprehensive understanding of prospective MI teachers' understanding of AI technology in microteaching, its integration through the TPACK approach, the challenges encountered, and its effect on teaching quality. This approach enabled data triangulation, thereby enhancing the validity and reliability of the findings. The study used an explanatory sequential design, conducted in two stages. In the first stage, quantitative data were collected through a survey to measure prospective MI teachers' understanding of AI in microteaching and the perceived effectiveness of its implementation. The intervention was carried out over four meetings, with each meeting lasting 70 minutes. It was implemented over one month, with sessions conducted once a week. In this stage, the Edcafe platform training was provided as part of the intervention before the post-test was administered, allowing students to gain direct experience in using AI to support microteaching activities. In the second stage, qualitative data were collected through in-depth interviews and

observations to explore participants' experiences and challenges in integrating AI into microteaching.

The research population consisted of prospective MI teachers, specifically sixth-semester students enrolled in the microteaching course in the PGMI Program at UIN Jakarta. The quantitative sample was selected using simple random sampling. In the qualitative phase, all nine students in the AI-based microteaching class were included as research participants. This was done to obtain a complete picture of students' experiences, understanding, and challenges in integrating AI into microteaching activities. The study was conducted in accordance with established research ethics principles. Prior to data collection, permission was obtained from the relevant institutional authorities. All participants were informed about the purpose and procedures of the study, as well as their right to participate voluntarily or withdraw at any stage without penalty. Informed consent was obtained from all participants before the study began. To ensure privacy and confidentiality, all personal data were protected and used solely for research purposes, and participants' identities were anonymized in the reporting of findings. The researchers also declared that there were no conflicts of interest associated with this study.

The research instruments were developed systematically based on the study objectives and relevant theoretical frameworks, particularly AI integration in education, microteaching, and the TPACK approach. The researcher first identified the main constructs and indicators to be measured, including understanding of AI technology, pedagogical integration, perceived effectiveness, and implementation challenges. Based on these indicators, questionnaire items, interview guidelines, and observation sheets were developed. The initial draft of the instruments was then reviewed to ensure alignment between the items and the research variables. To establish content validity, the instruments were evaluated by experts in educational technology, pedagogy, and research methodology. The validation process focused on the relevance, clarity, and representativeness of each item. Based on the experts' feedback, several items were revised in terms of wording, clarity, and contextual suitability. The results of the validity check indicated that the instruments were appropriate for data collection after minor revisions.

The data were analyzed using both quantitative and qualitative techniques in accordance with the mixed-method design. Quantitative data from the questionnaire were analyzed using descriptive and inferential statistics to identify the level of understanding, the extent of AI integration, and its perceived effectiveness in microteaching. Meanwhile, qualitative data from interviews and observations were analyzed through data reduction, data display, and conclusion drawing to identify recurring themes related to participants' experiences and challenges in integrating AI into microteaching. Finally, the quantitative and qualitative findings were integrated at the interpretation stage to provide a more comprehensive understanding of the research problem.

RESEARCH RESULTS

Level of Understanding of Prospective MI Teachers on the Use of AI in Learning Planning

The results of the study show that prospective MI teachers' level of understanding of the use of AI in lesson planning is still low, with an average score of 2.38 out of a total of 25 indicators measured from nine students. This means that prospective teachers are familiar with AI technology in general but do not yet understand its pedagogical and technical applications in microteaching. Based on the calculation of the 25 indicators, the data were then grouped into six main aspects of understanding AI in learning.

Table 1. Students' Initial Understanding Scores of AI Technology for Each Aspect

Understanding Aspects	Indicator	Average Score	Category
Knowledge of AI platforms and working principles	1–3	2,41	low
The use of AI in planning and teaching materials	4–7	2,56	low
Integration of AI in learning strategies and methods	8–13	2,33	low
Designing lesson plans and AI-based learning media	14–17	2,50	low
Attitudes, motivations, and ethics towards AI	18–21	2,63	low
Practical experience using AI (lesson plans, evaluation, assignments)	22–25	2,38	low

Based on the analysis of six aspects of understanding the use of Artificial Intelligence (AI) in learning, the findings indicate that respondents' overall level of understanding falls within the low category. The aspect of knowledge related to AI platforms and their working principles obtained an average score of 2.41, indicating that respondents have not yet adequately understood the basic concepts and types of AI platforms relevant to education. The utilization of AI in lesson planning and instructional material development also remains low, with an average score of 2.56, suggesting that the use of AI to support instructional planning has not yet become a common practice.

The integration of AI into learning strategies and methods recorded the lowest score, at 2.33, indicating that respondents' ability to incorporate AI into instructional models or approaches is still very limited. In the aspect of designing lesson plans (RPP) and AI-based instructional media, a score of 2.50 shows that the application of AI in instructional tools is still at an early stage. The aspect of attitudes, motivation, and ethics toward AI achieved a score of 2.63, the highest among the aspects, yet it remains within the low category, indicating that

positive attitudes toward AI are not sufficiently supported by adequate ethical understanding. The aspect of practical experience in using AI for learning activities also received a low score of 2.38, confirming that respondents' direct experience in applying AI in instructional contexts is still minimal. Overall, the low scores across all aspects emphasize the need for training, mentoring, and project-based practice to improve educators' literacy, technological skills, and ethical understanding of AI use in education.

AI Integration in Microteaching Based on the TPACK Approach (TK, PK, CK)

In microteaching practices, students began to integrate Artificial Intelligence (AI)-based technologies in a basic manner as part of the implementation of the TPACK (Technological, Pedagogical, and Content Knowledge) approach. This integration is evident across the stages of lesson planning, implementation, and evaluation.

Lesson Planning with an AI-Integrated TPACK Approach

Students conducted lesson planning by utilizing the Edcafe application as a digital platform for developing lesson plans (Rencana Pelaksanaan Pembelajaran/RPP). Edcafe is an AI-based learning platform designed to support educators in designing, developing, and organizing instructional tools efficiently. Through features such as the AI Slides Generator, Custom AI Chatbot, AI Flashcard Maker, Teaching Resources, and AI Quiz Maker, the platform automates the creation of instructional materials and learning media through a user-friendly interface that is accessible online.

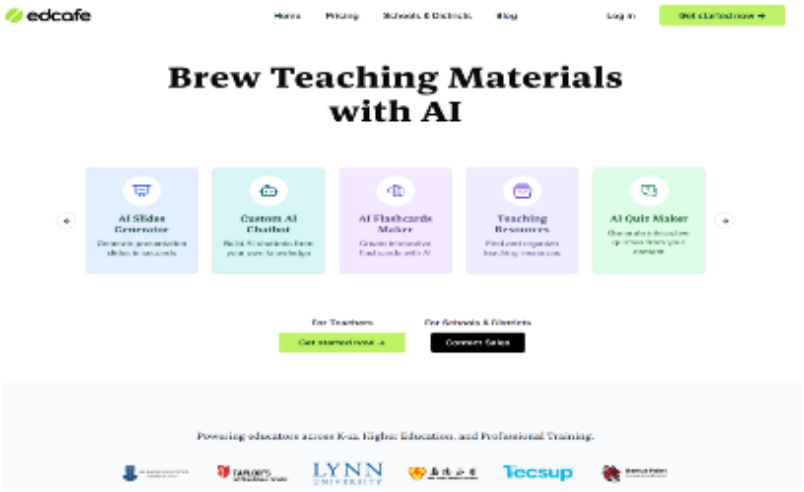

Figure 2. Edcafe Display *: Brew Teaching Materials*

Students prepare lesson plans by utilizing the Edcafe application as a digital platform to develop Learning Implementation Plans (RPP). Edcafe is an AI-based learning platform designed to help educators design, develop, and organize learning tools more efficiently. Through various features such as AI Slides Generator, Custom AI Chatbot, AI Flashcard

Maker, Teaching Resources, and AI Quiz Maker, this platform enables automation of the preparation of teaching materials and learning media through an easy-to-use interface that can be accessed online.

Through Edcafe, students can digitally integrate all the main components of the lesson plan, ranging from learning identity, learning outcomes, learning objectives, learning activity steps, to assessment. One example of its application can be seen in the lesson plan entitled "Getting to Know Simple Language Skills: Listening, Speaking, Reading, and Writing" for grade I elementary school students. The lesson plan is prepared by utilizing the form generator feature that provides automatic guidance in filling out each component of the lesson plan, so that the preparation process becomes faster, systematic, and has fewer format errors.

In the learning planning stage, students also show the ability to take advantage of the interactive features available in Edcafe, such as clone, share, and like. The clone feature is used to copy existing lesson plan templates as the basis for developing new designs, while the share feature is used to share lesson plan designs with supervisors and peers to get input. These findings suggest that the learning planning process is not only oriented towards document preparation, but also reflects the practice of digital collaboration in the development of teaching tools. In addition, students take advantage of the support of the AI-based system in Edcafe to help align learning outcomes with relevant learning activities. All products produced through Edcafe include three main forms of technology integration, namely the preparation of learning planning through the Lesson Plan Creator, the development of teaching materials through the AI Slides Generator and AI Flashcard Maker, and the preparation of evaluations through the AI Quiz Maker. The use of these features shows students' ability to apply Technological Knowledge (TK) at the AI-based microteaching planning stage.

In TPACK's perspective, the use of Edcafe not only reflects the mastery of technology functionally, but also shows how technology can strengthen Pedagogical Knowledge (PK) and Content Knowledge (CK). Thus, the use of Edcafe marks a shift from manual lesson plan preparation to more efficient, creative, and collaborative AI-based digital learning planning practices. The use of Edcafe at the learning planning stage also has a positive impact on the efficiency and accuracy of the preparation of teaching tools. Students are able to produce learning designs that are more structured, easy to share, and can be updated dynamically according to the needs of microteaching activities. Therefore, Edcafe not only improves students' technology skills, but also strengthens their understanding of the integration of technology in 21st century learning planning.

Learning Implementation with an AI-Integrated TPACK Approach

The implementation of learning with the Technological Pedagogical and Content Knowledge (TPACK) approach integrated with Artificial Intelligence (AI) showed positive results in increasing students' motivation, engagement, and conceptual understanding. This

approach is applied by combining the three main components of TPACK, namely Content Knowledge, Pedagogical Knowledge, and Technological Knowledge in an innovative, adaptive, and fun learning process. The implementation of learning began with the use of the Edcafe platform, which was used to display a slide deck entitled Environmental Materials. This medium is designed to provide a brief overview of the natural environment, explain its components, as well as emphasize the importance of environmental conservation.

Figure 3. Teaching Materials through AI

The Edcafe platform facilitates teachers and students in accessing learning materials visually and in a structured manner. Attractive displays and image media support (such as waterfalls and tropical forests) create a contextual and inspiring learning experience. This strengthens the aspect of Content Knowledge (CK) because students not only understand theories about the environment, but are also able to relate it to real phenomena in their surroundings. The implementation of learning begins with the use of the Educaplay platform, as seen in Figure 1. The platform provides various types of AI-based activities such as Line Up, Yes or No, Froggy Jumps, and Video Quiz. Teachers use these features to design educational games that combine text, images, audio, and video in a single learning activity.

Figure 4. Eduplay Platform Overview

Through the use of Educaplay, teachers can develop materials that are interactive and in accordance with the characteristics of students. AI-based systems allow for automatic adjustment of difficulty levels based on students' abilities, so that each student can learn at their own pace (adaptive learning). In the implementation stage, teachers use the Gimkit platform to implement gamification learning strategies that combine elements of competition and collaboration between students. As seen in Figure 2, students actively participate in games that require students to answer questions to level up and obtain the highest scores.

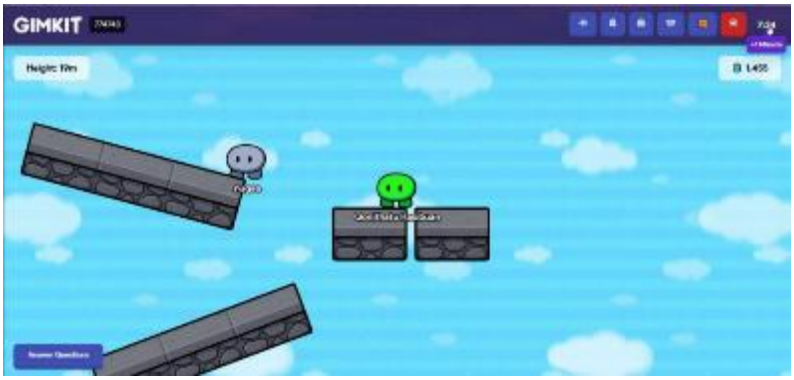

Figure 5. Gimkit Platform Display

The use of Gimkit has been proven to be able to create an active, competitive, but still collaborative learning atmosphere. Students show increased enthusiasm and emotional involvement during the learning process. This supports the Pedagogical Knowledge (PK) dimension in TPACK, where teachers play the role of facilitators who create meaningful learning experiences through game-based digital activities. Furthermore, the application of multimedia interactive quizzes is a concrete example of the application of Content Knowledge (CK) in the context of science learning.

Figure 6. Interactive Quiz

As shown in Figure 6, the "Solar System" themed quiz is designed with attractive visual displays, space animations, and astronaut characters to reinforce students' fascination and

understanding of the concept of planets. Media kuis interaktif ini tidak hanya berfungsi sebagai alat evaluasi, tetapi juga sebagai sarana eksplorasi konsep yang mengembangkan kemampuan berpikir kritis dan analitis siswa. Integrasi elemen audio-visual membantu siswa memahami perbandingan ukuran planet dan posisi orbit secara lebih konkret.

Learning Evaluation with an AI-Integrated TPACK Approach

Evaluation was conducted through AI-based digital assessments designed to measure the achievement of learning objectives, conceptual understanding, and the effectiveness of technology integration. One of the evaluation tools used was the Edcafe Quiz, which contained multiple-choice questions related to flora and fauna topics. Each question was equipped with automated explanations (AI explanations) that provided immediate feedback to students for both correct and incorrect answers. This feature demonstrates the implementation of AI-driven feedback that supports reflective and adaptive learning. From a pedagogical perspective, the quiz was structured with gradually increasing levels of difficulty in accordance with Bloom's taxonomy, while from a content perspective, all items were aligned with the thematic curriculum for lower elementary grades. Thus, the evaluation reflects a balanced integration of technology, pedagogy, and content within the TPACK framework.

Challenges Faced by Prospective MI Teachers in Integrating AI into Microteaching

Technological Literacy and AI Competence

Interview results indicate that prospective MI teachers are familiar with AI; however, their understanding remains limited to basic functions, such as using AI as a tool for creating instructional media, assessment items, or lesson plans. Many students acquire AI knowledge independently, which limits their ability to pedagogically adapt AI outputs, particularly in adjusting language and content to suit MI students. They also experience difficulties in evaluating the relevance and accuracy of AI-generated outputs. The main challenge lies not only in technical skills but also in the ability to modify and filter content to align with the characteristics of elementary school learners. Although students' motivation to learn AI is relatively high, the absence of formal training results in AI usage that remains experimental and individual. Overall, students' technological literacy is still partial and not yet integrative; however, they possess strong potential and intrinsic motivation for further development.

Pedagogical Readiness in Integrating AI

Prospective MI teachers continue to face challenges in linking AI with active learning strategies. AI is more frequently used as a visual aid rather than as an integral component of the pedagogical process. Students tend to focus on media appearance rather than on achieving students' conceptual understanding. Other challenges include integrating AI with discussion or exploration activities, determining the appropriate timing of AI use within specific learning models, and improvising when technical issues arise. There are variations in readiness between students with prior digital experience and those who are newly exposed to AI. The findings

indicate that pedagogical readiness needs to be strengthened in terms of integrative understanding, adaptive skills, and reflective awareness that AI serves as a facilitator rather than the center of learning.

Technical Constraints and Digital Infrastructure

The implementation of AI in microteaching is also constrained by unstable internet connectivity, limited access to devices, and uneven availability of practice facilities. Students frequently encounter obstacles when running interactive media, forcing them to abruptly switch to manual methods. Not all students possess devices with adequate specifications, leading to disparities in technological readiness. These conditions highlight the need for improved digital infrastructure and institutional support to ensure that AI integration can be implemented optimally and equitably.

Psychological Factors and Self-Confidence

Psychological factors significantly influence the success of AI integration. Many students experience anxiety, lack confidence, and worry about technical errors when using AI in front of the class. Limited understanding of how AI systems operate also makes them hesitant to explain unexpected outputs. Nevertheless, microteaching practice and lecturer support gradually help build students' confidence. Psychopedagogical assistance is therefore necessary to better prepare students mentally for digital learning environments.

Ethics and Academic Responsibility in the Use of AI

Prospective teachers' understanding of AI ethics varies considerably. Some students recognize AI as a support tool that must be used wisely, while others remain unaware of issues such as plagiarism, content inaccuracies, and the importance of verifying AI-generated outputs. Confusion regarding the boundaries of AI-generated materials in academic contexts indicates the need for clear digital ethics guidelines. Strengthening academic literacy and integrity is essential to ensure that prospective teachers are not only technologically proficient but also responsible in their use of AI.

Effectiveness of AI Use in Microteaching on Improving the Teaching Quality of Prospective MI Teachers

In assessing the effectiveness of the use of AI in microteaching activities on improving the teaching quality of prospective MI teachers, this study uses the Wilcoxon Signed Rank Test as an analysis method. The Wilcoxon test was chosen because the pretest and posttest data showed a consistent pattern of increase in all participants, so it did not meet the assumption for parametric tests such as the Paired Sample T-Test. In addition, the Wilcoxon test is ideally used to measure changes in ability in two paired conditions, especially when the distribution of data is irregular or the difference in scores between participants does not vary significantly. Thus, the

Wilcoxon test provides a more accurate and reliable picture of the effectiveness of AI use interventions in improving the microteaching skills of prospective MI teachers.

Table 2. Output SPSS Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest,	2,46332[a]	9	,16746	,05582
	PostTest	2,46332 [a]	9	,16746	,05582

a. The correlation and t cannot be computed because the standar error of the difference is 0.

Based on the results of statistical analysis, it is known that there is a clear difference between the participants' PreTest and PostTest scores. The average PreTest score of 2.4622 indicates a relatively low level of initial comprehension. After treatment or learning intervention, the average PostTest score increased to 4.4622. This increase of 2 points indicates a very significant change in understanding in all participants. The same standard deviation in both measurements indicated that the data spread was relatively consistent, so the increase was even across all respondents.

Table 3. Output SPSS Wilcoxon Signed Ranks Tests

Test Statistics[a]

	PostTest-PreTest
Z	-3,000[b]
Asympt. Sig. (2-tiled)	,003

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

The analysis was continued using the nonparametric Wilcoxon Signed Rank Test which was more suitable for data with these characteristics. The results of the Wilcoxon test showed a value of Z = –3,000 with a significance of p = 0.003. A p-value that is well below the significance limit of 0.05 indicates that the increase in score after learning is not caused by mere coincidence, but is a real effect of the treatment given. Thus, the results of this analysis show that the learning interventions used have proven to be effective in significantly improving the understanding of prospective MI teachers. Consistent improvement across respondents reinforces the conclusion that the learning model or approach applied is able to have a positive impact on improving learning outcomes.

DISCUSSION

This discussion explains how prospective Madrasah Ibtidaiyah (MI) teachers understand and integrate Artificial Intelligence (AI) in microteaching based on the TPACK framework. This framework is used to examine the interaction between technological

knowledge, pedagogical knowledge, and content knowledge in modern instructional practices. The findings indicate that students' initial understanding of AI remains low. Although they are familiar with several platforms such as ChatGPT and Edcafe, their understanding is limited to basic functions, resulting in underdeveloped Technological Knowledge (TK). This condition affects their ability to develop Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), which is consistent with the findings of Zawacki-Richter et al., (2019) regarding the limited ability of prospective teachers to connect technology with learning contexts.

This research also shows that Edcafe not only functions as a technical tool to produce lesson plans, slides, and quizzes, but also as a pedagogical scaffold that helps students organize learning tools more systematically and efficiently. These findings are important because they show that AI can help reduce procedural burden, giving students more room to think about alignment of learning objectives, activities, and assessments. In this case, the integration of AI in microteaching can be understood in line with the development of ethnomathematics-based e-modules that emphasize the importance of digital media designed according to the needs and characteristics of learners (Suryaningsih & Putriyani, 2022). Although the contexts are different, they show that technology will have educational value when it not only delivers efficiency, but also supports more purposeful, contextual, and relevant learning designs for learners.

The development of TPACK in this study seems to take place gradually through three phases of microteaching, namely planning, implementation, and evaluation. In the planning stage, students use Edcafe to compile lesson plans, make presentations, and design AI-based quizzes. At the implementation stage, TPACK integration is increasingly visible through the use of platforms such as Educaplay and Gimkit that encourage student engagement. Meanwhile, at the evaluation stage, AI Quiz Maker helps students prepare formative assessments with automated feedback. This pattern shows that AI does not stop at its role as a technical tool, but begins to enter pedagogical and evaluative territory. This finding can be strengthened by an inquiry-based learning study that emphasizes that the quality of learning increases when prospective teachers and students are actively involved in the learning process, rather than just passively receiving material (Suryaningsih & Ruslih, 2020). In other words, AI in microteaching becomes more meaningful when used to build participatory, reflective, and learner-centered learning..

These findings suggest that Edcafe did not merely function as a technical tool for producing lesson plans, slides, and quizzes, but also as a pedagogical scaffold that helped students organize instructional components more systematically and efficiently. In this sense, the platform reduced procedural burdens and provided more space for students to focus on aligning learning objectives, activities, and assessment. This interpretation is consistent with international evidence in higher education showing that AI can enhance teaching and learning through resource generation, assessment redesign, and instructional efficiency, while its real

educational value depends on whether technology is integrated with sound pedagogical decision-making rather than used only for automation. Lee et al., (2024) found that generative AI was already being used by higher education staff for teaching and assessment, yet many still required clearer institutional support and guidance for best practice. Similarly, Schmidt et al., (2025) reported that although students and lecturers recognized AI's potential to improve teaching and learning, major concerns remained regarding reliability, ethical use, curriculum integration, and over-reliance. In the present study, this helps explain why Edcafe was effective in strengthening students' technological engagement during lesson planning, but did not automatically ensure deep pedagogical integration. From a TPACK perspective, Edcafe appears to strengthen Technological Knowledge (TK) first; however, its deeper contribution depends on the extent to which that technological competence is transformed into Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), so that AI is used not only to make teaching materials visually attractive and efficient, but also to support conceptually meaningful, pedagogically appropriate, and learner-centered instruction.

Nevertheless, microteaching activities encourage the gradual development of TPACK. During the planning stage, students used Edcafe to design lesson plans, create automated presentation slides, and generate AI-based quizzes. These activities demonstrate improvements in TK and TCK, as described by (Mishra & Koehler, 2006). Students began to connect instructional content with technology and adjust learning media to the characteristics of MI students. During the implementation stage, TPACK integration became more evident through the use of platforms such as Educaplay and Gimkit. Gamification features increased student engagement and reflected students' ability to apply TPK by selecting appropriate pedagogical strategies integrated with technology, in line with (Angeli & Valanides, 2009). In the evaluation stage, students utilized AI Quiz Maker to develop adaptive formative assessments with automated feedback. This practice strengthened the development of TCK, as students were able to align assessment content with learners' needs and leverage AI to enrich the assessment process.

However, interview results reveal that students continue to face several challenges, including low technological literacy, limited pedagogical readiness, technical constraints such as device availability and internet connectivity, and psychological factors such as anxiety and lack of confidence in using technology. These challenges hinder the optimal development of TPACK as a whole. This finding is reinforced by recent evidence from the Indonesian higher education context showing that although AI is widely used as an academic assistance tool, a means of skill development, and a support for learning effectiveness, it also raises concerns related to excessive dependence, reduced critical engagement, and academic integrity. In contexts where AI adoption develops more rapidly than formal guidance and AI literacy initiatives, students often rely on informal practices and peer support rather than structured pedagogical direction. As a result, AI may improve efficiency, but it does not automatically

strengthen deep learning unless its use is accompanied by self-regulated learning, ethical awareness, verification, reflection, and authorship. This perspective helps explain why, in the present study, the development of TPACK was beneficial yet not fully optimal across all participants (Rahiem, 2026). Nevertheless, the effectiveness analysis showed that the use of AI had a significant impact on improving teaching competence. The Wilcoxon test results ($p = 0.003$) confirmed a significant improvement from pretest to posttest, indicating not only the strengthening of TK but also improvements in PK and CK. These findings support the theory proposed by Holmes & Porayska-Pomsta (2023), which suggests that AI can enrich pedagogical competence through adaptive learning resources and automated feedback.

From a practical perspective, these findings imply that AI integration in microteaching should not be limited to introducing digital tools, but should be systematically embedded in teacher education programs through structured training, guided practice, and reflective supervision. Lecturers in microteaching courses can use AI-based platforms to help prospective teachers design lesson plans, create interactive media, and develop formative assessments more efficiently. At the institutional level, teacher education programs should provide adequate infrastructure, stable internet access, and pedagogical mentoring to ensure that AI is used meaningfully rather than merely technically. In addition, workshops on AI literacy and ethics are needed so that prospective teachers can use AI critically, responsibly, and contextually in elementary Islamic school settings.

Despite its contributions, this study has several limitations. First, the study was conducted in one institutional context only, namely the PGMI Program at UIN Jakarta, which may limit the generalizability of the findings to other teacher education contexts. Second, the qualitative phase involved a relatively small number of participants, which may not fully represent the diversity of experiences among prospective MI teachers. Third, the study focused primarily on microteaching practices and did not examine the long-term impact of AI integration on actual classroom teaching performance. In addition, some of the data relied on self-reported responses, which may have been influenced by participants' subjective perceptions.

Therefore, future research should involve a larger and more diverse sample drawn from multiple institutions to provide broader evidence regarding AI integration in teacher education. Further studies are also recommended to examine the long-term effects of AI-assisted microteaching on real teaching practice, pedagogical decision-making, and student learning outcomes. Experimental or longitudinal designs may provide deeper insight into how TPACK develops over time through AI-supported training. Future research may also explore specific models of AI-based pedagogical intervention, including ethical guidance frameworks, to better support prospective teachers in responding to the demands of 21st-century education.

Overall, the integration of AI in TPACK-based microteaching has substantial potential to improve the teaching quality of prospective MI teachers. Although technical, pedagogical,

and psychological barriers remain, AI contributes positively to the development of professional competence. With stronger technological literacy, adequate infrastructure support, and sustained pedagogical guidance, prospective teachers are more likely to develop TPACK more deeply and to be better prepared for the demands of 21st-century education.

CONCLUSION

This study indicates that the initial understanding of prospective Madrasah Ibtidaiyah (MI) teachers regarding the use of Artificial Intelligence (AI) technology in lesson planning remains at a low level. Although the prospective teachers are familiar with AI technology, they have not yet fully understood its pedagogical and technical applications within the context of microteaching. The analysis results show that the majority of respondents are still at an early stage of understanding the principles of AI, its application in instructional material planning, and the ability to integrate AI into learning strategies. Despite challenges related to technological literacy, pedagogical readiness, technical constraints, and psychological factors, this study demonstrates that the implementation of the TPACK approach integrating AI into learning has a positive impact on the stages of lesson planning, implementation, and evaluation. The use of platforms such as Edcafe and Educaplay enables students to utilize AI technology to design and develop instructional materials, as well as to provide more interactive assessments. Furthermore, the findings also reveal the effectiveness of AI utilization in microteaching activities. The results of the Wilcoxon test indicate a significant increase between pretest and posttest scores, suggesting that the use of AI in microteaching contributes positively to the improvement of students' understanding and teaching skills. This improvement occurs consistently across all participants, indicating that AI-based interventions not only enhance technological knowledge (TK) but also enrich pedagogical knowledge (PK) and content knowledge (CK). Overall, the findings of this study confirm that although challenges in AI integration still exist, the use of AI in microteaching has proven to be an effective strategy for developing students' TPACK competencies and improving the overall quality of teaching.

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