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Investigating TPACK Development among Pre-service Teachers in Micro Teaching in Indonesia

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ABSTRACT

This study explores the development of Technological Pedagogical Content Knowledge (TPACK) among pre-service teachers engaged in micro-teaching sessions in Indonesia. Using quantitative methods, data were collected from 150 pre-service teachers through a structured questionnaire and analyzed using SPSS version 26. The results showed that micro-teaching positively contributed to TPACK development, with significant technological, pedagogical, and content knowledge improvements. The findings confirm the effectiveness of micro-teaching in strengthening TPACK and emphasize the importance of integrating technology-based experiences in teacher education programs. This study provides valuable insights for educators and policymakers aiming to improve pre-service teacher training through practical, technology-supported teaching approaches.

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1. INTRODUCTION

Technology integration in teaching is becoming increasingly important in modern education, particularly through the development of Technological Pedagogical Content Knowledge (TPACK) which is essential for less experienced teachers. TPACK, which combines technology, pedagogy and content knowledge, helps teachers effectively implement technology in the teaching process and eases the transition from theory to practice. Various TPACK models, such as TPCK-W, ISD, ICT-TPCK, and SQD, have been tested in various fields with satisfactory results, showing improved learning outcomes [1]. The application of TPACK is proven to increase student engagement and achievement through the appropriate use of technology [2], especially in English Language Teaching after the COVID-19 pandemic [3]. Although TPACK offers many benefits, challenges in integrating it into curricula and teacher training still exist, so innovative efforts are needed to overcome these barriers and ensure the reliability of research [4].

Microteaching is an important technique in teacher education, providing a structured environment for pre-service

teachers to develop teaching skills, including the ability to integrate technology into pedagogy. It allows teachers to experiment with different teaching strategies and provides a platform to receive feedback and reflection, which supports the development of Technological Pedagogical Content Knowledge (TPACK). Micro teaching courses are designed to strengthen basic skills such as lesson planning, classroom management, and the use of educational media, which are essential in integrating technology into teaching practice [5]. In the context of Islamic Religious Education, micro teaching has been shown to improve mastery of basic teaching skills, preparing teachers for real-world challenges [6]. In addition, micro teaching also helps prospective teachers integrate technology into teaching methods, particularly in mathematics education, significantly enhancing their TPACK [7]. Micro-teaching has been shown to increase teacher efficacy and confidence, which are important for the application of technology in teaching [8]. The level of preparation prior to micro teaching greatly affects its effectiveness, and thorough preparation ensures that teachers can maximise the benefits of micro teaching [9]. However, successful micro teaching requires adequate resources, time, and supervisory support as well as the ability to transfer skills from a controlled environment to the actual classroom [7].

The development of Technological Pedagogical Content Knowledge (TPACK) among ECD teachers during microteaching sessions in Indonesia is crucial for integrating technology in early childhood education. Although empirical research is still limited, related studies highlight the importance of structured training and reflective practice to improve teachers' skills in integrating technology. TPACK is crucial for 21st century educators as it enables the effective use of technology in teaching, thus creating a more engaging learning environment [10]. The integration of TPACK in teacher training programmes can improve student engagement and learning outcomes through active participation [2]. Micro teaching provides opportunities for pre-service teachers to experiment with technology, which is effective in developing TPACK through reflection and adaptation of teaching strategies [11]. Research shows that engagement in micro teaching and collaborative planning significantly improves TPACK, especially in terms of technological knowledge [11]. Challenges such as inadequate technology infrastructure and teachers' limited knowledge of technology can be addressed through focused professional development [2]. In Indonesia, exploratory practice (EP) has supported teachers' professional development by emphasising technology integration and reflective practice to develop TPACK [12].

This study aims to address the gap by investigating the development of TPACK among pre-service teachers who attended micro teaching sessions in Indonesia. Using a quantitative analysis approach, this study explores how different aspects of micro teaching contribute to TPACK enhancement.

2. LITERATURE REVIEW

2.1 Technological Pedagogical Content Knowledge (TPACK)

The Technological Pedagogical Content Knowledge (TPACK) framework is a dynamic model that integrates technology, pedagogy, and content knowledge to improve teaching effectiveness. TPACK has evolved through various models such as TPCK-W, ISD, ICT-TPCK, and SQD, which have been shown to improve learning outcomes across multiple disciplines [1]. The adaptability of TPACK allows its application in different educational contexts, demonstrating its potential for further development and integration in teaching practice [1]. Research shows that teachers with higher levels of TPACK significantly improve students' scientific competence [13]. The integration of TPACK in instructional design is important to improve students' knowledge, skills and attributes [13]. TPK and TCK also play an important

role in TPACK development among prospective teachers, with TCK having a greater impact, emphasising the importance of strong content knowledge for effective TPACK development [10].

2.2 *The Role of Micro Teaching in Teacher Training*

Micro teaching is a teacher training method that provides pre-service teachers with the opportunity to practice and hone their teaching skills in a controlled environment, usually with a small group of peers [14], [15]. Developed by Dwight Allen in the 1960s, the aim of micro teaching is to provide opportunities for teachers to experiment with specific teaching techniques and receive feedback. The method involves a cycle of planning, teaching, observation and reflection, which assists pre-service teachers in improving their teaching strategies and pedagogical approaches [16], [17]. Research shows that micro teaching is effective in developing various teaching competencies, such as classroom management, instructional strategies, and student engagement [5], [7], [8]. By focusing on specific teaching tasks and receiving targeted feedback, pre-service teachers can improve their teaching skills in a supportive environment [15]. The iterative nature of micro teaching also supports the development of critical reflection and self-assessment skills [17].

2.3 *Integrating Technology into Micro Teaching*

The integration of technology in micro teaching provides opportunities for pre-service teachers to explore and develop their TPACK. According to [18], [19], the use of technology in teacher training can accelerate TPACK development by providing practical experience using digital tools and resources. Technology-enhanced micro-teaching sessions allow pre-service teachers to experiment with various educational technologies, such as interactive whiteboards, digital simulations and online resources, in their teaching practice.

Research on the effectiveness of technology integration in micro teaching shows that technology can create a more engaging and interactive learning experience [2], [20], [21]. For example, the use of multimedia tools and educational applications during micro teaching can help pre-service teachers understand how to align technology with pedagogical strategies and content objectives. In addition, technology can also provide valuable data and feedback on teaching practices, which plays a role in TPACK enhancement.

2.4 *Empirical Studies on TPACK Development through Micro Teaching*

A number of studies have examined the impact of micro teaching on TPACK development among pre-service teachers. Micro teaching significantly influences the development of Technological Pedagogical Content Knowledge (TPACK) in teachers, especially those who are still in the training stage. Micro teaching creates a structured environment for pre-service teachers to improve their teaching abilities, including the integration of technology in learning. Micro teaching is essential in developing basic skills such as classroom management and media use, as well as improving teacher effectiveness, confidence and satisfaction, with a sustained positive impact [5], [8]. Digital micro-teaching during the COVID-19 pandemic has demonstrated its potential in training future teachers to adapt teaching strategies to the online environment [17]. In addition, micro-teaching has a significant impact on the academic

performance of teacher candidates, preparing them to become professional educators with the necessary teaching skills [16]. The design of micro teaching within the TPACK framework also enhances pre-service teachers' informatics teaching ability, addressing gaps in TPACK development and teaching effectiveness [22].

2.5 Research Gaps and Future Directions

Although research on TPACK and micro teaching continues to grow, there is still a need for research that specifically examines TPACK development among pre-service teachers in diverse educational contexts. Particularly, there is limited empirical evidence on the impact of micro teaching on TPACK development in Indonesia. This study aims to fill the gap by investigating the relationship between micro teaching and TPACK development among pre-service teachers in Indonesia.

3. RESEARCH METHODS

3.1 Research Design

This study uses a quantitative design to investigate the development of Technological Pedagogical Content Knowledge (TPACK) among pre-service teachers participating in micro teaching sessions in Indonesia. The aim is to quantitatively assess the influence of micro teaching on TPACK development as well as provide empirical evidence regarding the effectiveness of micro teaching in enhancing TPACK competencies. A cross-sectional survey design was used to collect data from a sample of pre-service teachers, which provides a snapshot of TPACK development at a specific point in time.

3.2 Sample and Sampling Technique

Pre-service teachers participating in teacher education programs at various Indonesian institutions were the study's target population. A stratified random sample technique was used to choose 150 pre-service teachers in total. This method improved the generalizability of the results by guaranteeing that the sample was representative of various educational settings and program years. Within each stratum, participants were chosen at random to guarantee a representative and varied sample.

3.3 Data Collection

A standardized questionnaire intended to gauge in-service teachers' progress in TPACK was used to gather data. The questionnaire was divided into multiple sections, each of which matched a distinct TPACK framework component: content knowledge, pedagogical knowledge, and technology knowledge. Furthermore, the survey comprised inquiries concerning the incorporation of these areas throughout the course of microteaching sessions. A Likert scale, with 1 denoting "strongly disagree" and 5 denoting "strongly agree," was employed in the questionnaire to gauge respondents' opinions on the advancement of TPACK and the efficacy of microteaching. To make sure the survey's items were reliable and understandable, a small sample of probationary teachers participated in a pre-test.

3.4 Data analysis

Using SPSS version 26, a number of primary steps were involved in the data analysis process. In order to give a general picture of the sample's characteristics and answers to the questionnaire, descriptive statistics including mean, standard deviation, and frequency distribution were first computed. The internal consistency of the questionnaire items was then

evaluated using Cronbach's alpha reliability analysis. Values of 0.70 or higher were deemed acceptable, showing that the items accurately measure the relevant construct. Then, in order to confirm that the questionnaire's factor structure was legitimate and that the questions appropriately reflected the TPACK components, exploratory factor analysis (EFA) was used to determine the dimensions underpinning the TPACK construct. Additionally, in order to investigate the interaction between various TPACK components and microteaching experiences, Pearson correlation coefficients were computed, which aided in the identification of important relationships between the variables. The impact of microteaching on TPACK development was finally examined by multiple regression analyses, which evaluated the degree to which microteaching influences each TPACK component while accounting for possible confounding variables.

4. RESULTS AND DISCUSSION

4.1 Results

a. Sample Demographics

The following is a summary of the sample's demographic characteristics: The majority of the sample's teachers were female, and there were more probationary teachers overall than there were male teachers (female: 60 or 60%, male: 60 or 40%). A younger group of teachers is evident from the age distribution of the majority of respondents, which falls between 20 and 25 years old (20–25 years: 85 or 56.7%, 26–30 years: 50 or 33.3%, 31–35 years: 10 or 6.7%, and 36 years and above: 5 or 3.3%). Pre-service teachers from various educational stages were included in the sample based on years of study, with the largest groups being in the first and second years (Year One: 40 or 26.7%, Second Year: 45 or 30%, Third Year: 35 or 23.3%, Fourth Year: 30 or 20%). The bulk of pre-service teachers had bachelor's degrees in education (120 or 80%), with the remaining pre-service teachers having bachelor's degrees in non-education subjects (30 or 20%). The respondents' range of experience in utilizing technology was pretty even, with the majority having moderate to high experience (20 or 13.3% for little experience, 75 or 50% for medium experience, and 55 or 36.7% for high experience). Regularity of brief instruction sessions The majority of pre-service teachers attended three to five sessions, which gave them ample opportunity for practice and feedback (50 or 33.3% attended 1-2 sessions, 70 or 46.7% attended 3-5 sessions, and 30 or 20% attended six or more sessions).

b. Descriptive Statistics

Descriptive statistics from the 150 pre-service teachers who took part in microteaching sessions in this study's data collection show the following: The average technological knowledge (TK) score was 3.85 (SD = 0.72), indicating that individuals felt generally competent in terms of technology. A mean score of 4.02 (SD = 0.68) was achieved for pedagogical knowledge (PK), showing a strong comprehension of instructional strategies. With a mean score of 4.10 (SD = 0.65) for content knowledge (CK), the subject matter was clearly understood. TPACK received a mean score of 3.98 (SD = 0.70) overall, demonstrating a favorable self-assessment of combining technology, pedagogy, and subject matter expertise. According to these findings, pre-service teachers believe they have a solid foundation in TPACK overall, with ratings for pedagogy and content knowledge being somewhat higher than those for technological knowledge.

c. Reliability Analysis

The internal consistency of the questionnaire was evaluated using Cronbach's alpha, and the reliability coefficients for the TPACK components are as follows: TPACK as a whole has an α value of 0.831, content knowledge is 0.808, pedagogical knowledge is 0.813, and technological knowledge is 0.785. The fact that each of these coefficients was higher than the permissible cutoff point of 0.70 suggests that the questionnaire items accurately assessed the corresponding constructs.

d. Factor Analysis

To verify the factor structure of the TPACK components, an exploratory factor analysis (EFA) was carried out. The items for each construct (TK, PK, and CK) fit into their corresponding factors, according to the results, supporting the validity of the three-dimensional TPACK framework. Additionally, the factor analysis demonstrated that the micro teaching experience-related components clustered together, indicating their significance for TPACK development.

e. Correlation Analysis

The following results were obtained via the calculation of Pearson correlation coefficients to investigate the relationship between TPACK components and microteaching experience: A correlation of r = 0.624 (sig 0.000) was found between technological knowledge and pedagogical knowledge, r = 0.583 (sig 0.000) between technological knowledge and content knowledge, r = 0.653 (sig 0.000) between pedagogical knowledge and content knowledge, and r = 0.726 (sig 0.002) between micro teaching experience and overall TPACK. pleasant and statistically significant relationships were found for all variables, suggesting that higher levels of TPACK development are linked to pleasant microteaching experiences. The micro teaching experience and total TPACK showed the highest association, indicating that micro teaching has a significant influence on TPACK growth.

f. Regression Analysis

To evaluate the effect of micro teaching experiences on TPACK development, multiple regression analyses were performed. The results of the regression model indicated that micro teaching experiences substantially predicted an increase in TPACK (β = 0.457, sig 0.002). In particular, β = 0.387 (sig 0.002) was the impact on technological knowledge, β = 0.422 (sig 0.000) was on pedagogical knowledge, and β = 0.408 (sig 0.000) was on content knowledge. These findings imply that practical experience in a micro teaching environment improves pre-service teachers' capacity to successfully incorporate technology into their teaching practice and that the micro teaching experience plays a substantial role in the development of technological, pedagogical, and content knowledge.

4.2 Discussion

The study's findings shed important light on how pre-service teachers' development of TPACK is influenced by microteaching. Pre-service teachers feel confident in their abilities to combine technology, pedagogy, and content knowledge, as indicated by their usually favorable TPACK self-assessment. Although pre-service teachers have a solid grasp of pedagogical techniques and subject matter, their scores in pedagogy and content knowledge are slightly higher than their scores in technology knowledge, indicating that they could use more assistance in integrating technology into their lessons.

The strong positive association that has been shown between the micro teaching experience and the components of TPACK highlights the efficacy of micro teaching in augmenting TPACK. Participating in real-world, technologically-rich teaching experiences aids pre-service teachers in comprehending and implementing TPACK principles, as evidenced by the robust correlation found between microteaching and overall TPACK growth.

The primary predictor of TPACK development was microteaching experience, as demonstrated by regression analysis. This result is consistent with earlier studies that demonstrate the substantial improvement of teaching competency that may be achieved in microteaching environments through organized practice and feedback [23], [24]. The study's findings emphasize how crucial it is for teacher education programs to include technology-rich microteaching strategies in order to assist pre-service teachers in creating thorough TPACK.

To improve pre-service teachers' teaching competency and willingness to incorporate technology into pedagogical practice, as well as to enhance their Technological Pedagogical Content Knowledge (TPACK), it is imperative that technology-based microteaching be incorporated into teacher education. Feedback in microteaching is crucial for teacher reflection, but how well it is delivered and structured matters a lot. Research has shown that providing dialogic and visionary feedback enhances teaching effectiveness [25], [26]. Microteaching has been shown to improve digital abilities, critical thinking, and innovative teaching, particularly during COVID-19 lockdowns [27], [28]. The ability of instructors to use technology inclusively and reflectively is much enhanced by TPACK-based courses [28], [29].

4.3 Implications

The study's conclusions have a number of ramifications for programs that prepare teachers. First off, pre-service teachers' development of TPACK can be improved by include technology-rich microteaching experiences in the teacher education curriculum. Pre-service teachers should have the chance to try out different technologies and get helpful feedback from these programs. In order to guarantee a well-rounded approach to teaching using technology, teacher educators should also stress the significance of striking a balance between pedagogy, content understanding, and technology.

4.4 Limitations and Future Research

There are various constraints associated with this study. The use of a cross-sectional design restricts the ability to make causal conclusions, and the reliance on self-reported data may add potential bias. Future research could employ a longitudinal approach to monitor the progression of TPACK over a period of time and employ various data sources to authenticate the results. Furthermore, further investigation might be conducted to examine the effects of various micro teaching experiences on specific components of Technological Pedagogical Content Knowledge (TPACK), as well as to assess the efficacy of different technologies in boosting TPACK.

5. CONCLUSION

This study demonstrates that micro teaching is an invaluable instrument for fostering the growth of Technological Pedagogical Content Knowledge (TPACK) in pre-service teachers. The strong link between micro teaching experience and different dimensions of Technological Pedagogical

Content Knowledge (TPACK) underscores its efficacy in improving the capacity of pre-service teachers to effectively integrate technology with pedagogy and content knowledge. The notable advancements witnessed in technology, pedagogy, and topic understanding highlight the necessity of integrating technology-intensive micro teaching experiences into teacher preparation programs. Teacher training courses can enhance the preparation of future educators by offering practical and hands-on experiences that allow pre-service teachers to implement TPACK principles. This approach enables them to successfully utilize technology in their teaching practice. Subsequent studies should investigate the enduring consequences and various micro-teaching models in order to enhance teacher training methods and enhance the incorporation of technology in education.

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