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UTILIZATION OF TECHNOLOGY IN THE LEARNING PROCESS OF PRE-SERVICE TEACHERS: A COMPARATIVE STUDY OF TEACHER EDUCATION INSTITUTIONS IN INDONESIA AND MALAYSIA

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Abstract

This study comparatively examines the use of technology in the learning process of pre-service teachers at Universitas PGRI Pontianak, Indonesia, and the Institute of Teacher Education, Batu Lintang Campus, Sarawak, Malaysia, following an inter-institutional academic visit between the two teacher education institutions. A qualitative comparative case study design was employed, analyzed through the Technological Pedagogical Content Knowledge (TPACK) framework and comparative education research strategies. Data were collected through observation of technology use in learning, interviews with lecturers, and documentation of digital learning tools at both institutions, then analyzed thematically. The findings show that both institutions direct the strengthening of pre-service teachers' technological competence through their respective national policy frameworks: TPACK strengthening within Indonesia's Teacher Professional Education (PPG) program and the New Pedagogy for Deep Learning (NPDL) digital modules under the Institute of Teacher Education Malaysia (IPGM). Differences were found in infrastructure readiness, continuous lecturer development, and technology use during field practice, with leadership, institutional support, and pre-service teachers' self-efficacy identified as key determinants of effective technology integration. These findings offer practical recommendations for strengthening technology integration in pre-service teacher learning at Universitas PGRI Pontianak.

Keywords: TPACK, pre-service teacher education, comparative studies, ICT integration.

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INTRODUCTION

Technology integration in learning has become an essential component of teacher education in various countries, along with the demands of 21st-century learning, which require pre-service teachers not only to master teaching materials but also to utilize technology pedagogically (Mishra & Koehler, 2020). The Technological Pedagogical Content Knowledge (TPACK) framework emphasizes that the effectiveness of technology-based learning is determined by the interaction of three domains of knowledge, namely technological, pedagogical, and content knowledge, which must

be mastered in an integrated manner by pre-service teachers (Schmidt et al., 2009). Various studies show that the TPACK competencies of pre-service teachers are correlated with the level of ICT integration achieved in their teaching practice (Khine et al., 2016; Valtonen et al., 2019).

In Indonesia, the Teacher Professional Education (PPG) policy explicitly encourages the strengthening of pre-service teachers' technological competence through courses on new technologies in teaching, as well as online and blended learning. Studies have shown a significant improvement in the TPACK competence of prospective PPG teacher participants compared to those who did not participate in the program (Zulfitri et al., 2019; Chang et al., 2024). However, several studies also show that ICT integration in the field practice experiences of pre-service teachers in Indonesia still faces challenges, such as gaps between theoretical preparation on campus and real conditions in schools (Habibi et al., 2020a, 2020b), limited infrastructure, and low institutional support (Habibi et al., 2020c; Lim & Pannen, 2012).

In Indonesia, professional teacher preparation is implemented through teacher education institutions (LPTKs), beginning with undergraduate teacher education and continuing with Teacher Professional Education (PPG). The Pre-Service PPG policy emphasizes the strengthening of pedagogical competence through TPACK-based learning, workshops, and field practice (Ministry of Education, Culture, Research and Technology, 2022; Zulfitri et al., 2019). A study by Chang et al. (2024) on science teachers in Indonesia showed that participation in the PPG program generally significantly increased the TPACK competence of pre-service teachers compared to those who did not participate in the program, although in-service teachers with more than two years of teaching experience still performed better in pedagogical and content knowledge. Therefore, Bhakti and Maryani's (2016) study highlight the importance of strengthening student-centered learning systems and educational internships as LPTK strategies to improve graduates' pedagogical competence.

In Malaysia, the preparation of pre-service teachers for technology-enhanced learning is guided by a policy framework centered on the Ministry of Education Malaysia and the Institute of Teacher Education Malaysia (IPGM). Since 2016, IPGM has implemented the New Pedagogy for Deep Learning (NPDL) approach, with digital modules developed nationally for all IPG campuses, including IPG Batu Lintang Campus. Studies in Malaysia show that the effectiveness of ICT integration depends on infrastructure readiness, school or institutional leadership, and educators' positive attitudes toward technology (Ghavifekr & Rosdy, 2015), while pre-service teachers' acceptance of certain technological devices, such as interactive whiteboards, is influenced by perceived usefulness and ease of use (Wong et al., 2013).

The academic visit of Universitas PGRI Pontianak to IPG Batu Lintang Campus provided an opportunity to directly and comparatively examine how these two teacher education institutions manage the use of technology in the learning process of pre-service teachers. Previous studies have generally examined technology integration within the separate contexts of each country (Irwanto, 2022; Kartimi et al., 2021; Castéra et al., 2020), while direct comparative studies based on field visits between Indonesian LPTKs and Malaysian IPGs are still rarely conducted. This gap forms the basis of the novelty of this study. This study aims to: (1) describe the forms of technology utilization in pre-service teacher learning at both institutions; (2) analyze the supporting and inhibiting factors of technology integration in each institution; and (3) formulate recommendations for strengthening technology integration in pre-service teacher learning at Universitas PGRI Pontianak based on the comparison results.

METHOD

Research Design

This study used a qualitative approach with a comparative case study design (Priya, 2021), which aimed to gain an in-depth understanding of how technology is utilized in the learning process of pre-service teachers at two institutions with different policy contexts. Considering that the main data were derived from a single academic visit of limited duration, this research is positioned as an

initial exploratory study with a descriptive-interpretive nature. This study employed the comparative education analysis framework developed by Bereday (1964), which consists of four stages of analysis: description, interpretation, juxtaposition, and comparison. The description stage focuses on presenting learning facts in each institution separately; the interpretation stage examines these facts by considering the social, cultural, and educational policy contexts that underlie them; the juxtaposition stage places data from the two institutions side by side to identify patterns of similarities and differences; and the comparison stage draws analytical conclusions from the paired findings (Phillips & Schweisfurth, 2014). This framework was chosen because it is appropriate for the characteristics of research data obtained from a cross-country field visit and allows systematic analysis without making excessive generalization claims based on one short visit.

Place, Time, and Research Subjects

The study was conducted at Universitas PGRI Pontianak, West Kalimantan, Indonesia, and the Institute of Teacher Education, Batu Lintang Campus, Kuching, Sarawak, Malaysia, during an academic visit held on 25–26 October 2026. The observed program was the Bachelor of Education Degree Program (PISMP), an undergraduate teacher education program designed to prepare prospective primary school teachers and preceded by the Foundation Program for Bachelor of Teaching (PPISMP). The research subjects consisted of two lecturers and 15 students. The subjects were selected using purposive sampling based on their direct involvement in the observed technology-based learning activities.

Data Collection Techniques

Data were collected through three techniques. First, observations were conducted to examine the use of technology in the learning process, including the types of devices or applications used, the ways lecturers integrated technology into teaching strategies, and students' responses. Second, semi-structured interviews were conducted with lecturers to gather information about policies, training, and barriers related to technology integration. Third, documentation studies were carried out on digital learning tools, online platforms, and ICT policies implemented in both institutions.

Data Analysis Techniques

The data were analyzed using thematic analysis by following the stages of data familiarization, initial coding, theme searching, theme reviewing, theme naming, and report writing (Nowell et al., 2017; Vaismoradi et al., 2013). The comparative analysis further followed the comparative education research strategy proposed by Rust et al. (1999), namely contextual description of each institution, interpretation based on teacher education technology policies in Indonesia and Malaysia, and juxtaposition of findings to formulate patterns of similarities and differences.

Data Validity

Data validity was ensured through source triangulation involving lecturers, students, and documents, as well as technique triangulation involving observation, interviews, and documentation. In addition, the study fulfilled trustworthiness criteria, including credibility, dependability, and confirmability (Nowell et al., 2017).

RESULTS AND DISCUSSION

Types and Forms of Technology Utilization in Learning

Referring to the TPACK framework (Mishra & Koehler, 2006; Schmidt et al., 2009), the utilization of technology in pre-service teacher learning in Indonesia is generally directed toward mastering online and blended learning platforms as part of the PPG curriculum (Zulfitri et al., 2019). The study by Kartimi et al. (2021) also shows the implementation of online learning in science

education during the distance-learning period. At IPGKBL, technology utilization is directed through standardized digital modules within the NPDL framework, which was centrally developed by IPGM. Technology-based student projects are carried out using applications such as Canva, the myIPG learning management system, the Examination Management System (iTEMS), student portals, digital learning tools, interactive presentation applications, and digital writing boards. Meanwhile, Universitas PGRI Pontianak uses an LMS in the form of SIAKAD and an integrated academic management system.

Competence and Readiness of Lecturers

Lecturers' TPACK competence is a key determinant of the quality of technology integration in learning (Castéra et al., 2020; Khine et al., 2016). This readiness is influenced by the availability of continuous training and institutional support (Habibi et al., 2020c). Lecturers at Universitas PGRI Pontianak assessed their readiness to integrate technology as good, particularly in the aspects of Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK). They felt sufficiently confident in utilizing various digital platforms for delivering materials, communicating with students, and organizing technology-based assessments. However, some informants stated that the development of more complex learning media, such as virtual simulations, digital laboratories, and Internet of Things (IoT)-based technology integration, still requires advanced training and more intensive assistance. In addition, limited infrastructure and internet access in several locations also become obstacles to optimizing TPACK implementation.

Meanwhile, interviews with lecturers at the Institute of Teacher Education, Batu Lintang Campus (IPGKBL), Sarawak, indicated that almost all lecturers regularly participate in Continuous Professional Development (CPD) programs required by the Malaysian Ministry of Education. The training attended includes Google for Education Certified Educator, Microsoft Innovative Educator (MIE), the use of DELIMa (Digital Educational Learning Initiative Malaysia), Microsoft Teams- and Google Workspace for Education-based learning development, digital learning design using Canva Education, learning management system integration, flipped classroom learning, blended learning, synchronous and asynchronous learning, the use of artificial intelligence in education, and the development of interactive multimedia-based learning media. Some lecturers also participate in national training related to Education 4.0, Digital Pedagogy, and Higher Order Thinking Skills (HOTS), which are integrated with the use of digital technology.

Based on self-perception, IPGKBL lecturers assessed their readiness as very good. Overall, the interview results show that both institutions pay attention to the development of TPACK competence through various technology-based learning training programs. However, IPGKBL demonstrates a more structured and sustainable professional development system through CPD programs integrated with national policy, while Universitas PGRI Pontianak still depends on a combination of internal university training and external workshops.

Supporting and Inhibiting Factors of Technology Integration

The study by Ghavifekr and Rosdy (2015) identified infrastructure readiness, technical competence, and institutional leadership as determining factors in the effectiveness of ICT integration, while Habibi et al. (2020c) found that support from leaders and fellow lecturers serves as a major supporting factor in the Indonesian context, whereas limited infrastructure and workload become inhibiting factors. Technology acceptance among pre-service teachers is also influenced by perceived usefulness and ease of use (Wong et al., 2013).

Based on interviews and discussion sessions during the academic visit, lecturers from the Biology Education Study Program at Universitas PGRI Pontianak and lecturers from the Institute of Teacher Education, Batu Lintang Campus (IPGKBL), Sarawak, identified several supporting and inhibiting factors in the implementation of technology-based learning. From the perspective of Universitas PGRI Pontianak, lecturers identified university and faculty leadership support for digital

transformation as a major supporting factor. This support is realized through the organization of various digital learning training programs, the provision of a Learning Management System (LMS), access to online conference platforms, and encouragement to utilize various interactive learning applications in the lecture process. Collaboration among lecturers is also considered fairly strong, particularly in sharing experiences related to the use of digital media, the preparation of electronic teaching materials, and the utilization of Artificial Intelligence (AI)-based applications to support learning and research. In addition, students are considered to have adequate basic technological skills, making it relatively easy for them to adapt to digital-based learning.

However, the lecturers also expressed several obstacles that are still encountered. The main obstacles include limited internet network quality at certain times, variations in students' device specifications, limited licensed learning software, and the high administrative workload of lecturers, which reduces the time available to develop innovative digital learning media. Some lecturers also stated that not all courses, especially those requiring laboratory practice, can be fully integrated with digital technology; therefore, a combination of face-to-face learning and direct practice is still needed.

Meanwhile, lecturers at the Institute of Teacher Education, Batu Lintang Campus (IPGKBL), Sarawak, stated that the greatest supporting factors come from institutional policies and the Malaysian Ministry of Education, which consistently encourage digital transformation through Continuous Professional Development (CPD) programs. The institution provides adequate technological infrastructure, such as high-speed internet networks, smart classroom learning spaces, access to Microsoft 365 Education, Google Workspace for Education, DELIMa, and various licensed educational software. In addition, the existence of communities of practice among lecturers enables the regular exchange of experiences and learning innovations. Technical support from the campus information technology unit is also considered to accelerate the resolution of various technical constraints that arise during the learning process.

Nevertheless, IPGKBL lecturers also identified several challenges. Rapid technological development requires lecturers to continuously update their digital competence through ongoing training. In addition, the increasing demands for digital learning documentation, the preparation of multimedia teaching materials, and the development of technology-based assessments require a greater allocation of time. Some lecturers also stated that variations still exist in students' levels of digital literacy, especially in the use of more complex applications, so assistance is needed at the initial stage of implementation.

The discussion results show similarities between the two institutions, namely the importance of leadership support, a culture of collaboration among lecturers, and sustainable professional training as the main factors supporting the successful integration of technology in learning. On the other hand, differences are evident in infrastructure readiness and supporting systems. IPGKBL is considered to have a more integrated digital ecosystem through national policy and systematic institutional support, while Universitas PGRI Pontianak still faces challenges related to infrastructure, variations in students' devices, and limited lecturer time to develop digital learning innovations.

Synthesis Comparison

In general, both institutions demonstrate a strong policy commitment to strengthening pre-service teachers' technological competence, each through different frameworks: the PPG-TPACK framework in Indonesia (Zulfitri et al., 2019; Chang et al., 2024) and the centralized NPDL module in Malaysia (Anwar, 2025). The main difference lies in the level of national standardization in the development of technology-based learning modules and the consistency of sustainable professional development for lecturers. In Malaysia, this system is relatively more centralized, whereas in Indonesia, technology integration still varies across study programs and institutions (Habibi et al., 2020c; Lim & Pannen, 2012). Another important similarity is that, in both contexts, institutional

leadership and pre-service teachers' self-efficacy are consistently identified as determinants of successful technology integration (Ghavifekr & Rosdy, 2015; Wong et al., 2013).

Discussion

AI as a Core Component in Learning Design

The findings in Table 1 show that AI is no longer positioned as a supplementary technology but as a core component of learning design. This pattern is in line with findings that AI-based tools can play a direct role in presenting and managing learning materials in higher education (Luo et al., 2025). The use of six platforms in one learning session also shows that participants were trained to select tools that were appropriate to the intended purpose of the media being produced. This readiness aligns with findings showing that pre-service teachers' acceptance of AI increases when supported by adequate training and a clear AI-TPACK framework (Runge et al., 2025).

The products produced were multimodal in nature, encompassing visual, audio, and video outputs. This kind of production practice is consistent with studies showing that the use of generative AI contributes to improving innovation skills and digital literacy among education participants (Wu & Zhang, 2025). In the context of teacher education, the ability to design diverse media is part of the 21st-century digital competencies that pre-service teachers need to develop (Ng et al., 2023). At the same time, it reflects the dual perspective of pre-service teachers, who view generative AI as both an opportunity for productivity and a pedagogical challenge that needs to be managed reflectively in teaching practice (Bae et al., 2024).

The Meaning of AI-Based Learning Innovation and the Strengthening of Pre-Service Teacher Competence

The use of AI allows the media production process to be carried out more quickly and flexibly. Participants were encouraged to produce digital products directly connected to the curriculum, so that each output had a clear pedagogical context. Creating learning media with generative AI in this way is known to strengthen AI literacy and pre-service teachers' confidence in utilizing technology creatively and responsibly (MacDowell et al., 2024).

Learning practices at IPG Batu Lintang, which position AI as a core component, encourage multimodal media production, and emphasize product-based learning connected to content standards, show that AI functions as a tool for expanding the creative capacity of pre-service teachers rather than merely replacing technical tasks. This pattern is in line with experimental evidence showing that AI integration in design-based learning can improve design thinking mindsets as well as students' creative and reflective thinking skills (Saritepeci & Yildiz Durak, 2024). Nevertheless, participants' experiences need to be interpreted critically, considering that pre-service teachers generally still express concerns about the reliability and ethical dimensions of AI in learning (Gamlem et al., 2025).

Academic Mobility as Cross-Cultural Knowledge Transfer

The academic mobility program provided participants with an opportunity to directly observe educational practices that differed from those in their country of origin. Through interaction with the academic environment of IPG Batu Lintang, participants gained an understanding of how AI technology is integrated into teacher education. This experience shows that student mobility functions not only as an academic exchange activity but also as a mechanism for knowledge transfer and educational innovation across countries, as shown in studies on the development of intercultural competence through short-term mobility programs (Przytuła et al., 2024). This finding is also in line with a study on short-term mobility programs for pre-service teachers in Taiwan, which showed that cross-country teaching experiences strengthened participants' exploratory, practical, and caring competencies in relation to educational contexts different from those in their country of origin (Lin et al., 2025).

Implications for the Development of Teacher Education in Indonesia

Based on reflections on the observed practices, several potential aspects can be adapted in teacher education in Indonesia. First, the integration of AI in the development of learning media can strengthen pre-service teachers' digital competence, in line with the framework of teacher competence in the 21st century (Ng et al., 2023). Second, project-based learning approaches that produce tangible products can enhance creativity and 21st-century skills. Third, the integrated use of various AI platforms can broaden students' multimodal learning experiences.

This adaptation needs to consider conditions in Indonesia, where AI integration is still at an early stage and requires continuous strengthening of teacher capacity (Damanik et al., 2025; Mukhlis et al., 2025; Zalisman, 2025). Therefore, the development of teacher education in Indonesia should position AI technology integration not merely as a technical skill, but as part of a pedagogical transformation that supports innovative, creative, and student-centered learning.

CONCLUSION

Study This conclude that utilization technology in learning prospective teachers at PGRI Pontianak University and the Batu Lintang Campus Teacher Education Institute are both directed by the framework policy national which emphasizes strengthening TPACK, but different at different levels standardization digital modules, coaching sustainable lecturer/lecturer, and its application in practice experience field. It is recommended that Pontianak PGRI University strengthen training technology learning sustainable for lecturer, developing more digital modules standardized interprogram studies, as well as strengthen integration technology in practice experience field student prospective teachers. Research advanced recommended use multi- visit design or survey scale more wide for strengthen generalization findings.

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