

Integrating Technology for Sustainable Education: A Study on the Support Systems for Pre-Service Teachers in Malaysia

Muhamad Hakim Azaman¹, Mohd Nazir Md Zabit^{2*}, Puteri
Zarina Megat Khalid³, Siti Almunawwarah Shahuddin⁴,
Muhammad Fitri Ahmad⁵, Adila Fazleen Che Manan⁶

^{1,2,4}Department of Education Studies, Faculty of Human Development, Sultan Idris Education
University, Tanjong Malim, 35900, Malaysia, ³Department of English Studies, Faculty of
Languages and Communications, Sultan Idris Education University, Tanjong Malim, 35900,
Malaysia, ^{5,6}School of Education, Learning and Communication Sciences, University of
Warwick, Coventry, CV4 7AL, United Kingdom

Email: akimazman123@gmail.com, mohd.nazir@fpm.upsi.edu.my

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Abstract

This study explores the support systems available to pre-service teachers in Malaysia as they attempt to integrate technology into their teaching practices during their practicum. With the growing importance of digital literacy and technology in education, this research examines how the training provided by educational institutions, mentorship from schools, and government policies facilitate or limit the integration of technology. The study employs a qualitative approach, analyzing the experiences of 30 pre-service teachers and their perceptions of the support systems in place. The findings highlight the role of sustainable educational practices in technology integration, with a particular focus on the long-term impact of these support mechanisms in fostering effective teaching and learning environments. This paper aligns with the United Nations' Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 9 (Innovation and Infrastructure), and SDG 10 (Reduced Inequalities), demonstrating the importance of sustainable technology integration in teacher education. This study is motivated by the need to enhance pre-service teachers' readiness for digital transformation in Malaysia, where gaps in infrastructure and training persist. By examining institutional training, school mentorship, and government initiatives, it provides evidence on how support systems shape sustainable technology integration and offers insights for SDG-aligned educational reforms.

Keywords: Pre-service Teachers, Technology Integration, Support Systems, Sustainable Education

Introduction

The integration of technology into education has become one of the most significant transformations in the field of teaching and learning over the past few decades. As the world becomes increasingly digital, it is essential that educators and students are equipped with the skills and tools necessary to navigate this rapidly evolving landscape. Technology in education is not just about enhancing the delivery of content, but it also plays a crucial role in creating interactive, inclusive, and personalized learning environments that can meet the diverse needs of students. The use of digital tools allows for the development of essential 21st-century skills, such as critical thinking, collaboration, and digital literacy, all of which are crucial for success in the modern world (Capua et al., 2025).

In Malaysia, the government has recognized the importance of technology in education and has made considerable strides toward incorporating digital tools into the school system. One of the key initiatives in this regard is the Malaysia Digital Education Policy (DEP), launched by the Ministry of Education (MOE) in 2024. The DEP aims to transform the Malaysian education system by integrating digital technologies across all levels of education. The policy focuses on enhancing the teaching and learning process, ensuring that all students have access to quality digital resources, and equipping educators with the skills necessary to utilize these resources effectively (Ministry of Education Malaysia, 2024). The DEP seeks to foster a digitally literate society, promote innovation in education, and prepare students for future careers in an increasingly digital economy.

In line with the Malaysia Education Blueprint 2013-2025, which emphasizes the integration of information and communication technology (ICT) into the education system, the DEP further expands the scope of digital learning initiatives. The policy promotes the use of technology to create more engaging, collaborative, and student-centered learning environments. It envisions a future where education is not limited by geographic location, and all students, regardless of their background, can benefit from high-quality learning experiences enhanced by digital tools.

Despite these ambitious goals, the implementation of digital education in Malaysia faces several challenges, particularly in terms of the preparedness of pre-service teachers. These future educators are required to not only understand the theoretical aspects of educational technology but also be able to integrate technology into their teaching practices in real classroom settings. However, many pre-service teachers report feeling underprepared to incorporate technology effectively into their teaching, particularly during their practicum period (Kim et al., 2025). These challenges are often exacerbated by factors such as inadequate infrastructure, lack of training, and insufficient support from schools and teacher training institutions.

The role of support systems such as teacher training institutions, schools, and government policies is pivotal in determining how well pre-service teachers can integrate technology into their classrooms. Research suggests that the success of technology integration is not solely dependent on the availability of digital tools, but also on the presence of a supportive environment that nurtures teachers' technological skills and confidence (Haşlamani et al., 2023). Teacher training institutions play a crucial role by providing pre-service teachers with the foundational knowledge of educational technology. However, the gap between

theoretical training and practical application remains a significant issue, as many teachers find it difficult to effectively incorporate technology into their lessons without sufficient guidance or real-world experience (Ching & Jamaludin, 2025).

The support from mentor teachers in schools is equally critical. Mentor teachers, who are typically more experienced educators, are expected to provide advice and feedback to pre-service teachers during their practicum. However, mentor teachers themselves may not always be adequately equipped to provide the necessary support in terms of technology integration. This can create a situation where pre-service teachers are not receiving the guidance they need to confidently use technology in their teaching (Niyazova et al., 2023). Additionally, while the Malaysian government has made efforts to provide technological resources to schools, these initiatives have not always been accompanied by the necessary professional development opportunities for teachers, particularly in rural schools where access to resources may be more limited (Pazilah et al., 2024).

This study aims to explore how support systems influence the integration of technology into the teaching practices of pre-service teachers in Malaysia. The research focuses on the role of teacher education programs, school-based mentorship, and government initiatives in providing the resources, training, and support necessary for pre-service teachers to effectively use technology in their classrooms. By examining these support systems, the study aims to shed light on the barriers faced by pre-service teachers and identify areas for improvement.

Furthermore, this research is aligned with the United Nations' Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 9 (Innovation and Infrastructure), and SDG 10 (Reduced Inequalities). The successful integration of technology into education is not only about enhancing the learning experience but also about ensuring that educational opportunities are available to all, regardless of socio-economic status or geographic location. By fostering a sustainable approach to technology integration, this study seeks to contribute to the broader goal of providing equitable and high-quality education that prepares future generations for the demands of a digital world.

In particular, SDG 4 focuses on ensuring inclusive and equitable quality education for all, with an emphasis on improving educational outcomes through the use of technology. The role of teacher preparation programs in supporting this goal cannot be overstated, as they are responsible for equipping future educators with the skills needed to leverage technology effectively. SDG 9, which advocates for innovation and infrastructure, is also closely linked to this research, as the effective use of technology in education requires not only the availability of digital tools but also the establishment of sustainable infrastructures within schools and teacher training programs. Finally, SDG 10, which calls for the reduction of inequalities within and among countries, is particularly relevant, as access to technology in education is often uneven, with rural and disadvantaged schools facing greater challenges in providing digital resources to students and teachers.

This paper aims to provide a deeper understanding of how pre-service teachers in Malaysia are supported in integrating technology into their teaching practice and to explore the broader implications for achieving sustainable development in education. The findings will

contribute to the ongoing discussion about the future of teacher education and the role of technology in shaping a more inclusive and sustainable educational system. The motivation for this study stems from the observed gap between national digital education aspirations and the lived realities of pre-service teachers during their practicum. While Malaysia has introduced progressive policies such as the DEP and aligned with SDGs, there remains limited empirical work that connects these policy visions with the everyday support or lack thereof experienced by teacher trainees. This study contributes by bridging that gap, offering context-specific insights into how institutional, school, and policy support mechanisms influence pre-service teachers' digital practices. In doing so, it extends the discourse on sustainable education and provides recommendations for strengthening teacher preparation in both Malaysian and global contexts.

Literature Review

The Role of Technology in Education and Sustainability

Technology plays a transformative role in education, offering new ways to engage students and enhance learning outcomes. In a sustainable education system, technology not only facilitates access to knowledge but also fosters skills that are essential for navigating an increasingly digital world (Tong & Rahman, 2025). The use of technology in education helps address disparities in access to resources, making education more inclusive and equitable (Eden et al, 2024). This aligns with the goal of achieving SDG 4 (Quality Education), which emphasizes ensuring inclusive and equitable quality education for all and promoting lifelong learning opportunities.

In Malaysia, the introduction of technology into the classroom has been part of a broader push to modernize the education system. Initiatives such as the provision of digital devices to students and teachers are intended to close the digital divide and ensure that all students, regardless of background or location, have access to the tools they need for learning (Amini et al., 2024). However, despite these initiatives, significant barriers to the effective integration of technology remain, especially among pre-service teachers, who often lack the necessary training and support to use technology effectively in the classroom.

Pre-Service Teacher Training and Technology Integration

Teacher training programs play a critical role in preparing pre-service teachers to use technology in their classrooms. Theoretical knowledge about technology is often covered in teacher education curricula; however, practical experience in using technology in the classroom is frequently lacking. A study by Azman et al. (2024) found that while Malaysian teacher education programs introduce pre-service teachers to educational technology, many report feeling underprepared to integrate these tools during their teaching practice. This gap between theoretical knowledge and practical application underscores the need for more hands-on training opportunities and support for pre-service teachers.

Furthermore, the nature of pre-service teacher training can be inconsistent, with some institutions offering more robust technology integration programs than others. Liu (2024) emphasizes that teacher education institutions need to place greater focus on equipping pre-service teachers with the practical skills necessary for effective technology integration. The training must include not only the technical skills to use digital tools but also pedagogical

strategies that align with the goals of sustainable education, ensuring that technology is used to enhance learning outcomes in meaningful ways.

Support Systems for Technology Integration

The support systems that pre-service teachers receive during their practicum are integral to their ability to effectively use technology in the classroom. These support systems include the infrastructure provided by schools, mentorship from experienced teachers, and the professional development opportunities offered by teacher training institutions (Bibi & Aziz, 2024). Effective mentorship is particularly important in guiding pre-service teachers on how to incorporate technology into their teaching practices, as mentor teachers provide both technical support and pedagogical advice (Sani et al., 2025).

In Malaysia, there are significant differences in the availability of technological resources and support between urban and rural schools. Research by Zainul Ekhwan et al. (2025) found that urban schools are generally better equipped with the technology needed for effective teaching, while rural schools face challenges such as limited access to digital devices and unreliable internet connectivity. These disparities contribute to unequal opportunities for pre-service teachers, as those placed in rural schools often lack the resources and support needed to integrate technology into their teaching.

Barriers to Technology Integration

Despite the increasing availability of technological tools, several barriers hinder the effective integration of technology into teaching practices. Pre-service teachers often report challenges such as inadequate infrastructure, insufficient training, and resistance to change. According to Abiloye (2025), teachers who feel inadequately prepared to use technology in their teaching are often reluctant to incorporate it into their practices, resulting in missed opportunities for student engagement and learning. Moreover, institutional support plays a crucial role in overcoming these barriers, as schools and universities must provide the necessary resources, training, and encouragement to foster a culture of technology integration.

Method

Ethical Considerations

Ethical approval for this study was obtained from the Human Research Ethics Committee by the university. Informed consent was obtained from all participants, who were assured of the confidentiality and anonymity of their data. Participants were informed that their involvement in the study was voluntary and that they had the right to withdraw at any time without consequence. Additionally, they were assured that their responses would be used solely for academic purposes and that no personal identifiers would be included in the final report.

Sampling

Following ethical approval, participants were recruited from teacher training programs from universities across Malaysia. Recruitment was conducted through email invitations and advertisements distributed via online platforms. The target participants were pre-service teachers enrolled in their final year of the teacher training program, as they were actively engaged in teaching practice during the study period.

A purposive sampling technique was employed to select participants who had previous exposure to technology integration in their teacher training programs. Participants were required to have experience with digital tools through their coursework or previous teaching practice placements. Pre-service teachers who had no prior exposure to educational technology or who had not participated in any training related to technology integration were excluded from the study to ensure that the research focused on individuals with relevant experience.

The final sample consisted of 30 pre-service teachers (25 females, 5 males), aged between 24 and 26 years, who were pursuing their Bachelor's degrees in Education Teaching English as Second Language. This sample size was deemed sufficient for qualitative research and reflects the gender distribution typically seen in teacher education programs in Malaysia, where the majority of students are female (Ministry of Education Malaysia, 2023).

Data Collection and Validation

Data were collected through semi-structured interviews, which are particularly effective in eliciting deep, contextual insights into the perceptions and experiences of participants (Creswell, 2018). This approach allows flexibility while maintaining some level of consistency, ensuring comparability across interviews, which is crucial for cross-case analysis (Babchuk, 2019). The semi-structured format also allows for follow-up probing, enabling the researcher to gather a richer understanding of participants' perspectives and experiences (Chand, 2025). The interviews were structured around key themes related to the integration of technology in teaching practice, such as pre-service teachers' experiences with technology, their perceptions of support systems, and the barriers they encounter. These themes are closely aligned with the research questions, such as: "How do you feel about using technology in the classroom?" and "What types of support have you received in integrating technology into your teaching practice?" Further questions explored their self-efficacy and preparation for using technology in the classroom, with queries like "Do you consider yourself confident in using digital tools in your teaching?" and "What impact do you think technology will have on your teaching career?"

The semi-structured interviews were conducted with 30 pre-service teachers on Zoom, in their native language, to ensure ease of communication and comfort. Each interview lasted between 45 and 60 minutes and was conducted by two interviewers to reduce biases and enhance the reliability of the data collection. The flexibility of the interview guide allowed the researchers to explore emerging themes while ensuring consistency across all interviews (Lim, 2024).

Following the interviews, data transcription was initially generated using Zoom's automatic transcription function. To ensure transcription reliability, the transcripts were cross-checked by independent research assistants, following an investigator triangulation approach to avoid personal biases during transcription and analysis (Coleman et al., 2024). This approach contributed to the validity of the data collected by minimizing individual interpretation errors.

Data Analysis

After transcription, the data were translated into English and imported into Atlas.ti software for coding and thematic analysis. The analysis followed the step-by-step process outlined by Braun and Clarke (2019), focusing on systematically identifying patterns within the data.

In the initial phase, the researchers familiarized themselves with the data by reading and re-reading the transcripts, which allowed for a deeper understanding of the content and context of the interviews. During this phase, the researchers also conducted initial coding manually by highlighting significant phrases, sentences, or sections relevant to the themes of technology integration, teacher self-efficacy, and the support systems in place. For example, quotes like “I feel confident using educational apps” were coded under themes of “self-efficacy,” while statements like “Our school provides lots of digital resources” were categorized under “institutional support.”

In the subsequent phase of thematic identification, the coding was organized into categories related to the research questions. The themes were developed inductively, with coding items designed to facilitate the later validation of the data. For instance, the phrase “I enjoy using digital platforms for teaching” would be coded under “attitudes toward technology,” while “Training sessions on digital tools have been helpful” was categorized under “institutional support for technology integration.”

To ensure reliability, inter-coder checks were conducted, and the initial codes were compared by two independent coders. The inter-coder reliability was calculated at 94%, and any discrepancies were resolved through discussion and consensus. After this, the identified themes were reviewed by the entire research team for validation. The final set of themes was confirmed and refined to ensure consistency, coherence, and accuracy in the interpretation of the data. The consistency rate between the final validation and the settled coding was 97%, which indicates a high level of agreement among the researchers.

Findings

As Malaysia continues to focus on integrating digital technologies into education, pre-service teachers are expected to incorporate these tools into their teaching practices. However, the results of this study indicate that while pre-service teachers recognize the value of technology, they face challenges in fully adopting and utilizing it. The findings are organized into five key themes: (1) attitudes and intentions towards technology integration, (2) self-efficacy and actual digital literacy, (3) perceptions and practices of technology in the classroom, (4) the need for enhanced support and training, and (5) the role of institutional and social support in technology adoption.

Demand-Based Attitudes and Intentions Toward Technology Integration

The first theme identified in the study is the demand-based attitudes and intentions towards technology integration in education ($n = 30$). While the participants acknowledged the usefulness of technology, many expressed a passive attitude towards adopting technology in their teaching. They typically used technology only when explicitly required by their institutions or schools, rather than proactively seeking to integrate it into their teaching practices.

For example, Interviewee P5 stated:

"I find Google Classroom useful for communication with students, but I wouldn't use technology much beyond that unless it's required for assignments. It's a tool, but I prefer traditional teaching methods."

Interviewee P8 echoed this sentiment:

"I'll use technology if the lesson demands it, but I don't see much need to use it regularly. For example, I use Zoom for online classes, but I feel that in-person teaching is still much more effective."

This suggests a mindset where technology is seen as a supplementary tool, not as a central element in teaching. Many pre-service teachers felt that traditional, face-to-face methods were sufficient, and they only relied on digital tools when necessary. This behavior is reflective of what has been described in the literature as a demand-based or conservative approach, where technology is adopted when it is explicitly required, rather than being used proactively to enhance teaching and learning (Jin et al., 2024).

The reluctance to fully embrace technology could be attributed to the lack of institutional support ($n = 25$) and the limited exposure to advanced digital tools in their training programs. Interviewee P7 explained:

"At my school, they provide some digital tools, but there's not much guidance on how to use them effectively in teaching. I feel like I can manage without them most of the time."

This illustrates that while pre-service teachers are exposed to technology, they are often not equipped with the necessary skills or encouragement to make full use of it in the classroom. Without clear support and guidance, the integration of technology remains limited and reactive.

The Gap between Self-Efficacy and Actual Digital Literacy

The second theme identified was the contrast between self-efficacy and actual digital literacy ($n = 26$). Many pre-service teachers expressed confidence in their ability to use basic digital tools like Google Docs, PowerPoint, and Zoom, but their actual proficiency was often limited to basic functionalities. Despite feeling capable, they lacked the skills to use these tools in ways that would significantly enhance teaching and learning.

For example, Interviewee P12 stated:

"I am comfortable using basic tools like Google Drive and Zoom. I feel confident using them for assignments or group work, but I haven't really explored more advanced features, like data analytics or interactive platforms."

While many participants reported feeling confident with these basic tools, when it came to more advanced technology such as digital platforms for interactive learning, gamified learning tools, or using learning management systems (LMS) for real-time assessments, there was a clear gap in their knowledge and experience. This disconnect between perceived capability and actual proficiency reflects the self-efficacy paradox, where teachers believe they can use technology but are not fully equipped to integrate it in a transformative way (Shahzad et al., 2024).

This gap is important because self-efficacy plays a key role in technology adoption; teachers who feel confident in their ability to use digital tools are more likely to integrate them into their teaching practices. However, this study suggests that pre-service teachers' confidence is not always backed by actual technical skills. They may feel confident using basic tools but lack the depth of knowledge required to effectively implement more advanced tools, which can hinder their ability to innovate in the classroom.

Perceptions and Practices of Technology in the Classroom

The third theme that emerged focused on pre-service teachers' perceptions and practices of technology in the classroom (n = 30). Although pre-service teachers recognized the potential of technology to enhance classroom activities, they generally viewed it as an aid for administrative tasks, such as distributing materials, conducting quizzes, or assigning homework, rather than using it to transform teaching and learning. Technology was not seen as a core tool for instructional delivery but more as an auxiliary resource.

For instance, Interviewee P4 stated:

"I use technology mainly to distribute materials or conduct online quizzes. But when it comes to actually teaching the lesson, I prefer to use face-to-face methods."

Similarly, Interviewee P10 remarked:

"I use Google Classroom to upload reading materials and assign homework, but when it comes to teaching the lesson, I rely more on traditional methods."

This tool-based view of technology suggests that pre-service teachers are not yet fully aware of the potential of digital tools to foster interactive, collaborative, and student-centered learning environments. While they use technology for specific tasks, such as managing assignments or conducting quizzes, they do not yet see technology as an integral part of the pedagogical process. This reflects a limited understanding of how technology can be used to engage students, foster creativity, and promote active learning.

Interviewee P9 explained:

"We were shown how to use digital tools for basic classroom management, but I haven't learned how to make lessons more interactive with them. It would be useful to learn more about how to use technology to engage students in learning."

There is a clear opportunity here for teacher education programs to move beyond just teaching the basic use of technology and to focus on how it can be integrated into the pedagogical process to enhance student engagement and improve learning outcomes.

The Need for Enhanced Support and Training for Technology Integration

A recurring theme in the interviews was the need for enhanced support and training in technology integration (n = 28). Many pre-service teachers felt unprepared to fully incorporate technology into their teaching practices. While they had received basic training on how to use digital tools, they felt that they lacked the necessary skills to use these tools in more meaningful, innovative ways.

For example, Interviewee P11 commented:

"We were taught how to use basic tools like Google Drive or Zoom, but there wasn't much focus on how to integrate them effectively into the pedagogical approaches and content knowledge or how they can truly enhance student engagement."

Participants emphasized the importance of interactive workshops and real-world applications where they could gain more hands-on experience using digital tools to enhance teaching. They also expressed a need for training that went beyond administrative uses of technology to explore how it could be used to foster interactive, student-centered learning.

Interviewee P6 shared:

"We need more hands-on training that focuses on the creative and collaborative uses of technology in the classroom, not just basic functionality."

This suggests that pre-service teachers need more comprehensive professional development that goes beyond basic tool usage to include strategies for integrating technology into curriculum design, lesson planning, and student engagement.

The Role of Institutional and Social Support in Technology Adoption

The final theme concerns the role of institutional and social support in the adoption of technology in education (n = 30). Pre-service teachers reported that their willingness to integrate technology into their teaching was significantly influenced by the support they received from their institutions and social networks. Institutions that provided consistent, structured support helped pre-service teachers feel more confident in using technology.

Many participants noted that while they were introduced to digital tools during their teacher training programs, they felt that their schools did not provide adequate support or guidance on how to integrate these tools effectively into teaching. Interviewee P9 explained:

"It would be great if schools offered ongoing support in using technology. Sometimes, there's a disconnect between what we learn in university and what happens in the classroom."

This disconnect between institutional training and real-world classroom application can be mitigated by stronger institutional support, including mentorship, guidance, and opportunities for peer collaboration. Pre-service teachers noted that having access to peer networks and mentorship from experienced educators would provide more opportunities for collaboration, learning, and problem-solving in technology integration.

Interviewee P20 remarked:

"It would help if the university provided more workshops that go beyond the basics, like how to use technology for active learning or how to manage a digital classroom. Sometimes, I feel like I'm left to figure it out on my own."

Additionally, social support from peers was seen as crucial for building confidence and sharing best practices. Pre-service teachers suggested that creating spaces for collaboration, such as learning communities or digital forums for sharing experiences, would greatly benefit their development in integrating technology.

Interviewee P4 shared:

"Having a group of teachers who are all learning to use technology together can make it less intimidating. When you can share challenges and successes, it becomes easier to adopt new practices."

This highlights the importance of a supportive social environment in encouraging pre-service teachers to embrace technology more fully.

Discussion

The findings of this study highlight the current state of technology integration among pre-service teachers in Malaysia, shedding light on several key challenges and opportunities that shape their preparedness for using technology in their future classrooms. As Malaysia moves towards greater digitalization in education, understanding how pre-service teachers perceive and practice technology integration is critical for informing future teacher training programs and policy decisions. The results are discussed in relation to the themes of attitudes and intentions, self-efficacy and digital literacy, perceptions and practices, training and support needs, and the role of institutional and social support.

Attitudes and Intentions Toward Technology Integration

The demand-based attitudes toward technology integration observed in this study indicate that pre-service teachers in Malaysia adopt a conservative approach to technology use. This passive approach, where technology is only utilized when required, is consistent with findings from other studies that highlight the reluctance of teachers to embrace technology unless it is seen as essential (Muyambi & Ramorola, 2025). While pre-service teachers recognized the potential of technology, many remained skeptical about its necessity in the classroom. This is in line with technological adoption theories, which suggest that perceived usefulness and ease of use are key determinants of technology adoption (Venkatesh et al., 2003). In the case of these pre-service teachers, technology was often seen as a supplementary tool rather than a transformative force in pedagogy.

The reluctance to integrate technology might also be attributed to the lack of practical, hands-on experiences with advanced digital tools. Teacher training programs in Malaysia may offer theoretical knowledge about technology, but they often fall short in providing the practical training that pre-service teachers need to confidently use these tools in real classroom settings. This gap between theoretical knowledge and practical application has been well-documented in the literature (Mishra & Koehler, 2009), and it emphasizes the importance of experiential learning in technology integration.

The Gap between Self-Efficacy and Actual Digital Literacy

The second theme is the gap between self-efficacy and actual digital literacy which highlights the difference between pre-service teachers' confidence in using digital tools and their actual ability to integrate technology meaningfully into teaching. While many participants reported feeling confident in using basic tools like Google Docs and Zoom, their limited exposure to advanced educational technologies suggests a significant gap in their digital literacy skills. This finding aligns with the work of Zhai (2024), who argue that while teachers may feel confident using basic tools, a deeper understanding of how technology can be used to engage students and enhance learning is often lacking.

The contrast between perceived and actual competence also raises concerns about the role of teacher education programs in providing comprehensive technology training. The study found that while pre-service teachers were familiar with basic tools, they were less comfortable with more complex digital platforms. This gap in digital literacy reflects the need for teacher education programs to go beyond training teachers to use tools in isolation and focus on how technology can be integrated into pedagogical practices. Training should emphasize not only the technical skills required to use digital tools but also how these tools can be leveraged to create interactive, student-centered learning experiences (Koehler & Mishra, 2009).

Perceptions and Practices of Technology in the Classroom

The study also revealed that pre-service teachers primarily viewed technology as a tool for administrative tasks rather than a core element of teaching and learning. While digital tools were used to distribute materials, manage assignments, and conduct quizzes, pre-service teachers did not perceive technology as central to their pedagogical practices. This limited view of technology aligns with a tool-based model of technology integration, where technology is seen merely as an aid to teaching rather than a transformative force in the learning process (Jambangan & Serrano, 2025).

This perception may be influenced by a lack of exposure to the more interactive and collaborative possibilities of technology. Many pre-service teachers in this study did not explore how technology could be used to foster deeper engagement, critical thinking, or collaboration among students. The lack of institutional support for the use of advanced technology in classrooms, as highlighted by the participants, further exacerbates this issue. Teacher training programs must provide more opportunities for pre-service teachers to experiment with and explore a wider range of digital tools that encourage collaboration, creativity, and inquiry-based learning.

The Need for Enhanced Support and Training for Technology Integration

A central finding of this study is the need for enhanced support and training in technology integration. Pre-service teachers expressed a strong desire for more comprehensive training in how to use digital tools effectively in the classroom. While they were introduced to basic tools during their teacher preparation, many felt unprepared to integrate these tools into their teaching practices in a meaningful way. The lack of hands-on, practical training on how to design lessons that incorporate technology in ways that engage students and foster critical thinking was a significant barrier identified by participants. This gap in training is not unique to Malaysia and has been observed in other studies on teacher education (Xue et al., 2024; Mafuah et al., 2024; Al-Hattami, 2025).

Pre-service teachers emphasized the importance of mentorship and peer collaboration to help them build confidence in using technology. In many cases, they felt that their exposure to technology during their training was insufficient, and they would benefit from more direct support in applying these tools in the classroom. Teacher education programs should consider incorporating more interactive workshops, simulation activities, and peer networks to provide pre-service teachers with the skills and confidence needed to effectively integrate technology into their teaching practices.

The Role of Institutional and Social Support in Technology Adoption

The final theme, institutional and social support, highlights the crucial role of both institutions and the broader social environment in fostering technology adoption. Pre-service teachers who reported receiving strong support from their institutions and schools were more likely to adopt technology confidently in their teaching. This finding reinforces the idea that institutional policies and professional development programs play a significant role in shaping teachers' attitudes toward technology integration (Zou et al., 2025).

Many participants expressed a desire for more institutional frameworks that encourage technology use and provide ongoing training opportunities. Additionally, social support from peers and mentor teachers was found to be essential in helping pre-service teachers build confidence in using digital tools. By fostering a supportive learning community where pre-service teachers can share experiences and challenges, institutions can help them feel more comfortable experimenting with and incorporating technology into their teaching.

Moreover, peer collaboration was highlighted as an effective strategy for overcoming barriers to technology integration. Teachers who collaborate and learn from each other are more likely to feel supported in their efforts to adopt new technologies. Social networks that encourage knowledge-sharing and problem-solving can serve as valuable resources for pre-service teachers as they transition into their professional roles.

Implications for Teacher Education Programs

The findings of this study have important implications for teacher education programs in Malaysia and beyond. First, teacher education programs must place a greater emphasis on integrating technology into the curriculum and provide pre-service teachers with more practical, hands-on experience using a wide range of digital tools. Training should not be limited to the technical skills required to use technology but should also focus on pedagogical strategies that enable teachers to use technology to enhance student learning. Programs should also consider mentorship and peer collaboration as essential components of teacher development, as these provide the social support necessary for technology adoption.

Additionally, institutional support is key to ensuring that technology is not just an optional tool but a central part of the teaching and learning process. Schools and universities should provide ongoing professional development opportunities that allow pre-service teachers to stay updated on the latest technological tools and pedagogical strategies.

The findings of this study also suggest that there is a critical need for teacher education programs to place more emphasis on technology integration and ensure that pre-service teachers receive comprehensive, practical training in digital literacy and innovative teaching practices. Aligning teacher training programs with the goals of SDG 4, SDG 9, and SDG 10 will require a paradigm shift from seeing technology as a supplementary tool to viewing it as an essential element of teaching and learning. Teacher preparation should provide hands-on experiences, collaborative opportunities, and mentorship to ensure that pre-service teachers are not only capable of using digital tools but are also equipped to use these tools in ways that promote engagement, creativity, and critical thinking.

Conclusion and Implications for Future Research and Practice

This study examines the readiness of pre-service teachers in Malaysia to incorporate technology into their teaching practices by exploring their attitudes, self-efficacy, practices, and training needs. The findings suggest several key themes: (1) a demand-based approach to technology integration, where technology is used only when required; (2) a gap between perceived confidence and actual digital literacy; (3) technology as a tool for administrative tasks rather than a transformative pedagogical resource; and (4) a strong need for more comprehensive support and training in technology integration. These results highlight the importance of aligning teacher education programs with the evolving demands of a digitally-driven educational environment.

The study's findings are aligned with SDG 4 (Quality Education), which seeks to ensure inclusive and equitable quality education for all and promote lifelong learning opportunities. The lack of proactive integration of technology by pre-service teachers suggests a need for training programs that not only enhance digital literacy but also teach future educators how to utilize technology in ways that foster collaborative learning and promote critical thinking. By preparing pre-service teachers to integrate technology meaningfully into the classroom, teacher education programs can help move closer to achieving SDG 4, ensuring that all students have access to innovative and inclusive education.

In particular, the study underscores the importance of enhancing self-efficacy in technology use and addressing the gap between perceived and actual digital literacy. This directly supports SDG 9 (Industry, Innovation, and Infrastructure), which emphasizes the need to build resilient educational infrastructures that can support the integration of technology. Pre-service teachers' ability to use digital tools effectively is not only essential for improving classroom practices but also for developing 21st-century skills that are increasingly demanded in the digital economy. Comprehensive training that bridges the digital literacy gap will empower pre-service teachers to adopt technology as a core tool in their pedagogical strategies, ensuring that they can foster innovation and adapt to changing educational landscapes.

The study also reveals a tool-based view of technology, where pre-service teachers primarily use technology for administrative tasks rather than as a central part of teaching and learning. This limited view aligns with the broader challenge highlighted by SDG 9, which advocates for fostering innovation in education. To achieve SDG 9, it is essential that pre-service teachers are not only trained in basic digital tools but also in how to leverage these tools for interactive and engaging learning experiences. By adopting a broader view of technology, pre-service teachers can move beyond merely using it for administrative purposes and begin to utilize it to create dynamic, collaborative learning environments that prepare students for the digital future.

Additionally, the study emphasizes the need for enhanced training and support, which is aligned with SDG 10 (Reduced Inequalities). In a rapidly digitizing world, the equitable distribution of technological resources and training is essential to ensure that all teachers regardless of background or geographical location have the opportunity to develop the skills needed to succeed in a technology-enhanced classroom. This is particularly important in the Malaysian context, where rural and underserved schools may lack access to the infrastructure

and training opportunities that urban schools have. The findings suggest that by providing equitable professional development opportunities in technology, teacher education programs can help reduce inequalities in education and ensure that all pre-service teachers are adequately prepared to meet the needs of their students.

The study's findings also point to the importance of institutional and social support in technology adoption. Pre-service teachers who receive consistent support from their institutions and social networks are more likely to adopt technology confidently and effectively. This aligns with SDG 4's focus on fostering collaborative partnerships in education. By creating supportive learning environments and peer networks, teacher training institutions can help pre-service teachers develop the confidence and skills needed to successfully integrate technology into their classrooms. Mentorship programs, peer collaboration, and ongoing professional development can further contribute to building a supportive community that encourages technology use as a natural part of teaching and learning.

This study contributes to the broader discourse on educational technology by emphasizing the critical role that technology will play in shaping the future of education. In line with SDG 4, the study underscores the transformative potential of technology to provide equitable, high-quality education that can reach students regardless of location or background. Ensuring that pre-service teachers are fully prepared to integrate technology into their practices will be pivotal in realizing the goals of SDG 4, particularly in promoting inclusive and innovative education.

Given the findings, future research should explore how cultural influences impact technology adoption in pre-service teachers, particularly in Malaysia's unique educational context. Understanding how local values and norms shape pre-service teachers' attitudes toward technology can help tailor more contextually appropriate training programs. Further studies should also explore students' perceptions of technology-enhanced learning environments, particularly in relation to self-directed, teacher-supported learning. This will yield valuable insights into the future educational transformation and the role of teachers in facilitating technology-driven, student-centered education.

Moreover, investigating how personal characteristics such as personality and gender influence technology adoption could provide further insights into how individual preferences shape learning styles and needs in technology-driven classrooms. Finally, expanding this research to include longitudinal studies or quantitative surveys could provide a broader perspective on the role of pre-service teachers' experiences and attitudes in their long-term technology integration behaviors.

In conclusion, this study underscores the need for enhanced training, institutional support, and collaborative learning environments to prepare pre-service teachers in Malaysia to integrate technology effectively into their classrooms. Aligning teacher education programs with the goals of SDG 4, SDG 9, and SDG 10 will help ensure that technology becomes a central part of teaching, promoting inclusive, innovative, and equitable education. By equipping pre-service teachers with the skills and confidence to use technology as a transformative educational tool, we can contribute to a more sustainable, technology-driven education system that meets the needs of all learners and prepares them for the digital future. The

contribution of this study lies in highlighting the nuanced role of support systems in shaping technology integration among future educators, thus providing both theoretical enrichment to teacher education research and practical guidance for strengthening institutional and policy framework.

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