

# Pedagogical Readiness of Teachers in Teaching Digital Technology: A Systematic Review

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## ABSTRACT

The rapid expansion of digital technology education has intensified expectations for teachers to demonstrate strong pedagogical readiness in designing and implementing meaningful technology-enhanced learning. However, existing empirical evidence remains fragmented across contexts, conceptually inconsistent, and heavily focused on technological competence rather than pedagogical enactment, creating a significant gap in understanding teachers' readiness for digital technology teaching. This study therefore conducted a systematic literature review guided by the PRISMA framework to synthesise empirical findings on teachers' pedagogical readiness and the contextual challenges shaping digital pedagogy implementation. A comprehensive search of Scopus and Web of Science databases identified studies published between 2022 and 2026, yielding 38 eligible journal articles following screening and eligibility procedures. An integrative analysis approach was employed to synthesise findings across diverse methodological designs. The review revealed two overarching themes: (1) Teachers' Pedagogical Readiness for Digital Technology Integration and (2) Contextual and Instructional Challenges in Implementing Digital Pedagogy. Findings indicate that pedagogical readiness is a multidimensional construct shaped by technological pedagogical knowledge, professional development experiences, beliefs, self-efficacy, and contextual support. Although teachers generally demonstrate positive perceptions and basic digital competence, persistent challenges remain in translating technological familiarity into pedagogically meaningful and student-centred practices. Moreover, digital pedagogy implementation is constrained by infrastructure limitations, institutional support gaps, assessment complexities, and subject-specific pedagogical demands, resulting in uneven and context-dependent classroom practices. Overall, the synthesis highlights that effective digital technology teaching depends on the dynamic interaction between teacher competence and systemic conditions. Strengthening pedagogical readiness therefore requires sustained pedagogy-centred professional learning, coherent policy alignment, and supportive institutional ecosystems. This review contributes theoretical clarity to the conceptualisation of pedagogical readiness while offering evidence-based implications for policymakers, curriculum developers, and teacher educators seeking to advance sustainable and equitable digital technology integration in schools.

**Keywords:** pedagogical readiness, digital technology education, digital pedagogy, TPACK, systematic review

## INTRODUCTION

The rapid advancement of digital technology has profoundly transformed educational systems worldwide, reshaping not only what students are expected to learn but also how teaching and learning are enacted in classrooms. In response to the demands of the Fourth Industrial Revolution and the digital economy, many countries have introduced digital technology-related subjects into formal curricula, encompassing areas such as computational thinking, coding, digital literacy, data analysis, and the ethical use of technology. While curriculum reforms and policy initiatives are essential, their success ultimately depends on teachers as the primary agents of implementation. Consequently, teachers' pedagogical readiness has emerged as a critical determinant in the effective teaching of digital technology.

Pedagogical readiness extends beyond basic technological competence. It refers to teachers' preparedness to design, implement, and evaluate learning experiences that meaningfully integrate digital technology in ways that support curriculum objectives and students' cognitive development. This includes an understanding of appropriate pedagogical approaches, the ability to select and use digital tools effectively, classroom management

strategies in technology-rich environments, and the capacity to align assessment practices with digital learning outcomes. Teachers who lack pedagogical readiness may struggle to move beyond surface-level use of technology, resulting in teacher-centered practices or fragmented implementation that fails to develop students' higher-order thinking and problem-solving skills.

Despite the growing emphasis on digital technology education, research consistently highlights gaps in teachers' readiness, particularly in pedagogical aspects. Many teachers report confidence in using basic digital tools but experience difficulty in integrating technology into subject-specific pedagogy or adopting student-centered instructional strategies. Challenges such as insufficient professional training, limited instructional time, inadequate infrastructure, and unclear curriculum guidelines further complicate teachers' efforts. These issues are especially pronounced in contexts where digital technology has been newly introduced as a standalone subject, requiring teachers to adopt unfamiliar content and pedagogical frameworks.

Over the past decade, a substantial body of empirical research has examined teachers' readiness to teach digital technology across diverse educational contexts. These studies have explored multiple dimensions, including pedagogical knowledge, beliefs and attitudes, self-efficacy, instructional practices, and professional development needs. However, the findings are dispersed across disciplines, methodologies, and geographical regions, making it difficult to draw coherent conclusions about the overall state of teachers' pedagogical readiness. Moreover, variations in conceptual definitions and measurement approaches have resulted in inconsistencies that limit the comparability and applicability of existing evidence.

Systematic reviews play a vital role in addressing these challenges by synthesizing empirical findings in a transparent and rigorous manner. Unlike traditional narrative reviews, systematic reviews follow structured protocols to identify, evaluate, and integrate relevant studies, thereby reducing bias and enhancing the reliability of conclusions. In the context of digital technology education, a systematic review can provide a comprehensive overview of how pedagogical readiness has been conceptualized, the key factors influencing it, and the pedagogical challenges teachers face in practice. Such synthesis is essential for informing evidence-based policy decisions, teacher education programs, and future research agendas.

This systematic review aims to critically examine the existing literature on teachers' pedagogical readiness in teaching digital technology. Specifically, it seeks to (1) identify how pedagogical readiness is defined and operationalized in empirical studies, (2) synthesize evidence on the levels and dimensions of teachers' pedagogical readiness, and (3) examine the factors and challenges influencing teachers' readiness across different educational contexts. By consolidating current knowledge, this review intends to contribute to a deeper theoretical and practical understanding of pedagogical readiness in digital technology education.

In doing so, the review responds to the growing global need for well-prepared teachers who can effectively deliver digital technology education aligned with contemporary educational goals. The findings are expected to provide valuable insights for policymakers, curriculum developers, and teacher educators seeking to strengthen pedagogical capacity and ensure the sustainable implementation of digital technology in schools. Ultimately, enhancing teachers' pedagogical readiness is not merely a technical issue but a foundational requirement for equipping learners with the digital competencies necessary to thrive in an increasingly complex and technology-driven world.

## LITERATURE REVIEW

Pedagogical readiness has been widely acknowledged as a central condition for effective digital technology teaching, particularly as education systems undergo accelerated digital transformation. Studies across different educational contexts indicate that teachers' readiness is shaped not only by access to technology but also by professional training, pedagogical beliefs, and confidence in instructional design. Research in community college settings shows that teachers often demonstrate positive perceptions and motivation toward digital technology integration, yet still experience pedagogical uncertainty when aligning technology with subject-specific teaching practices (Channa et al., 2025). Similar concerns appear in STEM and science education contexts, where digitalization expands instructional possibilities but simultaneously demands deeper pedagogical adaptation (Reher et al., 2025; Amiruddin et al., 2024). These findings suggest that pedagogical

readiness represents a multidimensional construct combining knowledge, beliefs, and instructional competence rather than mere technological familiarity.

Professional development initiatives play a crucial role in strengthening teachers' pedagogical readiness for digital education. Evidence from in-service STEM teacher training programs demonstrates that structured, domain-specific training can significantly improve teachers' self-assessed professional knowledge related to digital technologies (Reher et al., 2025). However, such improvements do not always translate into increased self-efficacy or long-term technology commitment, indicating that readiness development may require sustained and context-sensitive professional learning models. Parallel insights emerge from chemistry teacher education, where targeted TPACK-based interventions enhanced both declarative and procedural pedagogical knowledge for inquiry-based digital learning (Nugraheni & Srisawasdi, 2024). Bibliometric evidence further confirms that teacher training grounded in pedagogical–technological integration remains a dominant research focus, particularly within science education, highlighting its perceived importance for educational quality in digital environments (Amiruddin et al., 2024).

Teachers' pedagogical readiness is also influenced by contextual and institutional factors, including infrastructure, curriculum expectations, and school culture. Research conducted in Pakistani community colleges reveals that even when digital infrastructure is relatively adequate, pedagogical challenges persist due to limited access to specialized facilities, unstable connectivity, and insufficient needs-based training (Channa et al., 2025). Comparable issues are reported in rural South African schools, where teachers actively develop strategies to mitigate ICT-related challenges in geography classrooms despite infrastructural and systemic constraints (Gubevu & Mncube, 2025). These studies collectively illustrate that pedagogical readiness is not an individual attribute alone but is embedded within broader institutional ecosystems that can either support or hinder effective digital teaching practices.

Early childhood and preschool education contexts further reveal tensions between pedagogical beliefs and digital technology use. Preschool teachers often perceive digital tools as potentially disruptive to established pedagogical philosophies, particularly play-based and child-centered approaches (Lund et al., 2025; Omidire et al., 2025). While some teachers recognize the potential of digital tools to enrich learning experiences, hesitancy arises from concerns about compromising pedagogical integrity. Nonetheless, when digital technologies are carefully integrated into play-responsive or Montessori-aligned pedagogies, opportunities emerge for enhanced engagement and content representation (Lund et al., 2025; Omidire et al., 2025). These findings highlight that pedagogical readiness in early education requires alignment between technological use and deeply held instructional values, reinforcing the need for pedagogically sensitive professional development.

The growing incorporation of immersive technologies and artificial intelligence further complicates the landscape of pedagogical readiness. A synthesis of studies on immersive learning, AI-supported instruction, and STEAM education identifies teacher preparedness as a major determinant of successful implementation, accounting for a substantial proportion of reported challenges (Semerikov et al., 2025). Although digital innovations demonstrate measurable gains in student engagement and learning outcomes, insufficient pedagogical integration and limited teacher digital literacy remain persistent barriers. Similar patterns are observed in conference-based research addressing gamification, digital storytelling, and blended learning, where teacher readiness mediates the effectiveness of advanced educational technologies (2nd International Workshop on Psychology, Learning, Technology, PLT 2022). These findings emphasize that technological sophistication alone cannot compensate for inadequate pedagogical preparedness.

Assessment and measurement issues also shape the understanding of pedagogical readiness. Research examining self-reports of technological pedagogical knowledge indicates that commonly used instruments may capture generalized confidence rather than actual pedagogical competence (Baier-Mosch et al., 2024). This methodological concern complicates interpretations of teacher readiness, particularly in studies relying heavily on self-assessment data. When combined with evidence from professional development and classroom-based studies, these findings suggest that pedagogical readiness should be evaluated through multiple lenses, integrating self-perceptions, observed practices, and instructional outcomes. Such comprehensive assessment is necessary to inform teacher training designs and policy decisions in digital education contexts.

Overall, the reviewed literature demonstrates that pedagogical readiness in teaching digital technology is a complex and context-dependent phenomenon shaped by professional development, pedagogical beliefs, institutional conditions, and evolving technological demands. While teacher training initiatives grounded in pedagogical frameworks such as TPACK show promise, persistent challenges related to infrastructure, belief alignment, and assessment validity remain. The convergence of findings across diverse educational levels and disciplines underscores the need for coherent, pedagogy-centered professional development strategies to ensure sustainable and meaningful digital technology integration in education.

## MATERIAL AND METHODS

### Identification

This study employed a systematic literature review guided by the PRISMA framework to ensure a transparent and rigorous process. A comprehensive search was conducted in February 2026 using two databases, namely Scopus and Web of Science (WoS), based on predefined search strings related to teachers’ pedagogical readiness in digital technology education. The initial search yielded a total of 404 records, comprising 217 articles from Scopus and 187 from WoS.

Table 1. The search string.

Scopus	(((“technological pedagogical knowledge” OR TPACK OR “pedagogical technology knowledge”) AND teacher* AND (“digital technology” OR “technology education”)))  <b>Date Of Access: February 2026</b>
WOS	(((“technological pedagogical knowledge” OR TPACK OR “pedagogical technology knowledge”) AND teacher* AND (“digital technology” OR “technology education”)))  <b>Date Of Access: February 2026</b>

### Screening

During the screening phase, duplicate records were identified and removed; however, no duplicate articles were found (n = 0). All 404 records were then screened based on titles and abstracts using predefined inclusion and exclusion criteria. A total of 214 records were excluded at this stage due to lack of relevance to pedagogical readiness or digital technology education, non-English publications, publication before 2022, and non-journal sources such as conference proceedings, books, and review papers. As a result, 190 articles were retained for further assessment.

Table 2. The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2022 – 2026	< 2022
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject	Social science	Besides Social science

## Eligibility

In the eligibility phase, the full texts of the 190 articles were carefully examined to ensure alignment with the objectives of the study. A total of 152 articles were excluded due to insufficient focus on pedagogical readiness, irrelevance to digital technology teaching contexts, lack of empirical evidence, or unavailability of full texts. Consequently, 38 articles met all inclusion criteria and were included in the final analysis.

## Quality Appraisal

To ensure methodological rigor, a quality appraisal process was conducted for all included studies. Each article was evaluated based on the clarity of research objectives, appropriateness of research design, validity and reliability of data collection methods, transparency of data analysis, and relevance to the review objectives. Only studies that met acceptable quality standards were retained, thereby enhancing the credibility and trustworthiness of the findings.

## Data Abstraction and Analysis

An integrative analysis approach was employed to synthesise findings across diverse methodological designs. Relevant data were systematically extracted, including study context, conceptualisation of pedagogical readiness, and key findings related to readiness and implementation challenges. The analysis involved iterative coding and thematic development, where emerging themes were continuously refined through collaborative discussions among the authors to ensure coherence and consistency. Any discrepancies were resolved through consensus. To further strengthen validity, the developed themes were reviewed by subject-matter experts to ensure clarity, relevance, and alignment with the study objectives.

The questions are as follows:

1. How is teachers' pedagogical readiness for digital technology integration conceptualised in existing literature?
2. What contextual and instructional challenges influence the implementation of digital pedagogy in teachers' classroom practices?

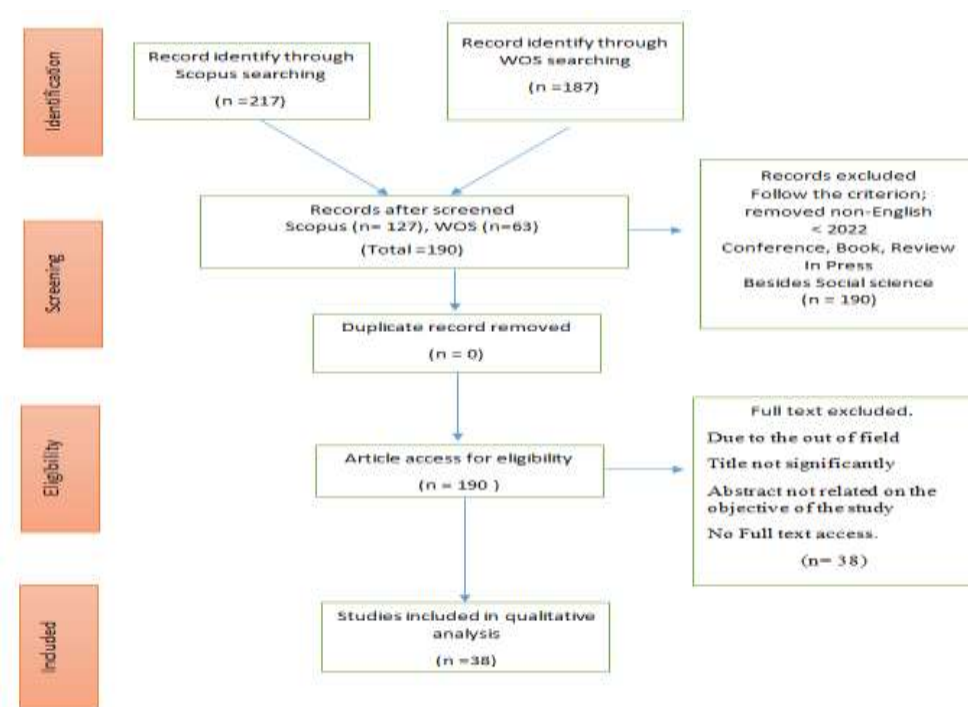


Figure 2. Flow diagram of the proposed searching study [1]

The study selection process followed the PRISMA guidelines and is illustrated in Figure 2. A total of 404 records were identified through database searching (Scopus = 217; WoS = 187). After removing duplicates ( $n = 0$ ), all records were screened based on titles and abstracts, resulting in the exclusion of 214 articles. The remaining 190 articles were assessed for full-text eligibility, of which 152 were excluded due to lack of relevance, insufficient empirical evidence, or inaccessibility of full texts. Finally, 38 studies were included in the qualitative synthesis.

## RESULT AND FINDING

### Theme 1: Teachers' Pedagogical Readiness for Digital Technology Integration

Teachers' pedagogical readiness for digital technology teaching is consistently conceptualised as a multidimensional construct that extends beyond basic technological skills to include pedagogical knowledge, content understanding, and professional beliefs. Research grounded in the Technological Pedagogical Content Knowledge (TPACK) framework demonstrates that teachers' readiness is strongly shaped by the interaction between these knowledge domains rather than by technological knowledge alone. Studies across different subject areas indicate that many teachers possess familiarity with digital tools but struggle to integrate them pedagogically in ways that meaningfully support learning objectives (Bhila & Okwara, 2026; Brunetto & Dello Iacono, 2023; Sullivan et al., 2024). Similar patterns are observed in life sciences, mathematics, and physical education, where digital tools are often used for presentation or substitution purposes rather than for deeper pedagogical transformation. These findings suggest that pedagogical readiness is closely tied to teachers' ability to align technology use with instructional goals and disciplinary practices.

Professional development and teacher education play a central role in shaping pedagogical readiness for digital teaching. Evidence from pre-service and in-service contexts shows that structured training programmes grounded in TPACK can enhance teachers' pedagogical and technological integration capabilities. Studies involving pre-service teachers report measurable growth in TPACK, technology acceptance, and instructional confidence following technology-rich coursework or project-based learning experiences (Max et al., 2024; Lim et al., 2024; Bothe, 2023). In-service professional development initiatives similarly highlight improvements in teachers' professional knowledge, although several studies note that gains in pedagogical confidence and enactment may remain uneven without sustained support (Nilsson & Lund, 2023; Demissie et al., 2022; O'Connor et al., 2023). Collectively, these findings indicate that pedagogical readiness develops progressively and requires long-term, practice-oriented professional learning rather than isolated training sessions.

Teachers' beliefs, attitudes, and self-efficacy emerge as critical mediating factors in pedagogical readiness for digital technology teaching. Multiple studies reveal that positive perceptions of technology do not necessarily translate into high-quality pedagogical integration. For example, teachers often believe that technical proficiency alone is sufficient for effective digital teaching, despite evidence showing that pedagogically relevant knowledge is a stronger predictor of instructional quality (Brunetto & Dello Iacono, 2023; von Kotzebue, 2022; Febring & Risenfors, 2025). Research further indicates that self-reported competence may overestimate actual pedagogical capability, as performance-based assessments better predict the quality of technology-enhanced lesson design (Baier-Mosch et al., 2024; von Kotzebue, 2022; Wagner et al., 2024). These findings underscore the importance of addressing belief systems and reflective practice as part of developing genuine pedagogical readiness.

The emergence of artificial intelligence and advanced digital technologies introduces new dimensions to pedagogical readiness. Recent studies highlight that teaching *with* and *about* artificial intelligence requires specialised competencies that extend existing TPACK frameworks. Research on AI-TPACK demonstrates that teachers' readiness is influenced by both individual competencies and institutional digital strategies (Cao et al., 2026; Huwer et al., 2025; Oved & Alt, 2025). Frameworks such as DiKoLAN AI propose subject-specific competence models to guide teacher training and curriculum design, particularly in STEM education. However, several studies note that teachers often experience uncertainty and cognitive overload when adopting emerging technologies, leading to surface-level integration focused on lesson structure rather than student engagement (Aumann et al., 2024; Mishra et al., 2023; Semerikov et al., 2025). This highlights the need for pedagogically grounded approaches to AI integration that prioritise instructional coherence over technological novelty.

Contextual and systemic factors significantly influence teachers' pedagogical readiness for digital technology teaching. Studies conducted in diverse geographical contexts reveal persistent digital divides related to infrastructure, access to resources, and policy implementation. Comparative research between urban and rural schools shows substantial disparities in teachers' TPACK levels, professional development opportunities, and attitudes toward technology integration (Li, 2025; Muyambi & Ramorola, 2025; Almojano, 2025). In under-resourced contexts, teachers often demonstrate willingness to integrate digital tools but face constraints such as limited connectivity, inadequate institutional support, and time pressures. These findings indicate that pedagogical readiness cannot be understood solely as an individual attribute but must be situated within broader socio-technical and policy environments.

Overall, the analysed literature demonstrates that teachers' pedagogical readiness for digital technology teaching is shaped by the dynamic interaction of knowledge, training, beliefs, emerging technological demands, and contextual conditions. While frameworks such as TPACK and AI-TPACK provide valuable conceptual guidance, effective pedagogical readiness depends on sustained professional development, reflective engagement with pedagogical beliefs, and equitable systemic support. Without these conditions, digital technology integration risks remaining superficial, limiting its potential to enhance teaching quality and student learning outcomes.

Synthesising the reviewed literature, teachers' pedagogical readiness for digital technology integration can be characterised as multidimensional and context dependent. While many educators demonstrate foundational technological familiarity, gaps remain in pedagogical integration, reflective practice, and institutional support structures. Consequently, readiness levels vary considerably across contexts, with many studies indicating a moderate but developing level of pedagogical readiness, particularly in relation to emerging technologies such as artificial intelligence.

While the reviewed studies consistently highlight the multidimensional nature of pedagogical readiness, a critical comparison reveals notable inconsistencies across contexts and measurement approaches. For instance, studies relying on self-reported TPACK often report higher levels of readiness compared to those employing performance-based assessments, suggesting a potential overestimation of teachers' actual pedagogical capabilities. Furthermore, although professional development is widely identified as a key factor, its effectiveness appears uneven, with several studies indicating limited transfer of training into classroom practice. This suggests that existing professional development models may lack contextual relevance or sustained support mechanisms. These variations indicate that pedagogical readiness is not only context-dependent but also influenced by methodological differences, highlighting the need for more standardised and practice-oriented assessment approaches.

## **Theme 2: Contextual and Instructional Challenges in Implementing Digital Pedagogy**

The implementation of digital pedagogy in classroom practice is frequently characterised by a gap between teachers' theoretical knowledge and actual instructional use of digital technologies. Studies examining programming, ICT, and technology integration in science and technology education indicate that teachers often possess foundational knowledge but experience difficulty translating this knowledge into consistent pedagogical practice (Karlsen et al., 2025; Heine et al., 2023; Molotsi & van Wyk, 2024). Empirical evidence suggests that digital tools are commonly employed at a surface level, such as for demonstration or content delivery, rather than for supporting inquiry-based or learner-centred pedagogies. This pattern reflects persistent challenges in aligning technological pedagogical knowledge with subject-specific teaching demands, particularly when instructional routines and curricular expectations remain unchanged.

The literature consistently identifies several instructional challenges that hinder the effective implementation of digital pedagogy. These include difficulties translating technological knowledge into pedagogically meaningful practices, overreliance on presentation-based technology use, and tensions between digital innovation and existing curricular or assessment demands.

Contextual constraints strongly shape how digital pedagogy is enacted in real classroom environments. Research conducted in rural and under-resourced settings highlights infrastructure limitations, unreliable connectivity, and

insufficient access to digital devices as major barriers to effective implementation (Molotsi & van Wyk, 2024; Galeboe et al., 2025; Li et al., 2025). Even when teachers demonstrate willingness to integrate technology, inadequate institutional support and the absence of clear school-level ICT policies often restrict sustained pedagogical innovation. Comparative findings across contexts show that schools with limited resources tend to rely on sporadic or teacher-dependent digital practices, reinforcing inequities in students' learning opportunities and digital skill development.

In addition to instructional constraints, contextual factors strongly shape the implementation of digital pedagogy. Infrastructure limitations, inadequate access to devices, weak institutional policies, and inconsistent leadership support significantly influence teachers' ability to sustain technology-integrated teaching practices.

Assessment and measurement issues further complicate the implementation of digital pedagogy. Several studies reveal discrepancies between teachers' self-reported technological pedagogical knowledge and their demonstrated classroom practices. Investigations into self-report instruments indicate that these measures often capture generalized confidence rather than task-specific pedagogical competence, leading to overestimations of readiness for digital implementation (Baier-Mosch et al., 2024; Heine et al., 2023; Kastorff & Stegmann, 2024). Moreover, empirical analyses show limited or non-significant relationships between teachers' technological knowledge and students' ICT literacy outcomes, suggesting that knowledge alone does not automatically translate into improved learning (Kastorff & Stegmann, 2024; Karlsen et al., 2025; Molotsi & van Wyk, 2024). These findings point to the need for more authentic, practice-based assessment approaches that reflect classroom realities.

Pedagogical implementation is also influenced by subject-specific demands and instructional goals. Studies in mathematics, science, design and technology, and inquiry-based education demonstrate that digital pedagogy is shaped by disciplinary traditions and expectations (Galeboe et al., 2025; Li et al., 2025; Khaokhajorn & Srisawasdi, 2024). In mathematics education, teachers report balancing digital tool use with curriculum coverage and assessment pressures, often resulting in selective or constrained integration. In science education, the integration of digital technology into inquiry-based learning requires a strong understanding of both scientific inquiry and pedagogical design, which many pre-service and in-service teachers only partially demonstrate. These findings suggest that effective digital pedagogy must be contextualised within disciplinary epistemologies rather than applied as a generic instructional solution.

Institutional and systemic factors play a decisive role in determining whether digital pedagogy can be implemented sustainably. Studies emphasise that supportive leadership, coherent policy frameworks, and structured professional learning opportunities are critical for translating pedagogical knowledge into classroom practice (Heine et al., 2023; Li et al., 2025; Galeboe et al., 2025). Where such support is lacking, teachers tend to rely on individual coping strategies rather than collaborative or school-wide approaches. This reinforces fragmented implementation and limits the scalability of digital innovations. The literature collectively demonstrates that digital pedagogy is not solely a pedagogical challenge but a systemic one, requiring alignment between teacher knowledge, institutional conditions, and educational policy.

Overall, the reviewed studies indicate that the implementation of digital pedagogy is constrained by contextual challenges related to infrastructure, assessment practices, subject-specific requirements, and systemic support structures. While teachers increasingly recognise the pedagogical potential of digital technologies, practical enactment remains uneven and highly context-dependent. Addressing these challenges requires moving beyond individual teacher capacity to consider the broader environments in which digital pedagogy is situated, ensuring that conditions for meaningful and equitable implementation are established.

Synthesising the reviewed literature, the implementation of digital pedagogy is shaped by the interaction of instructional and contextual constraints. Instructionally, teachers face challenges in translating technological knowledge into meaningful pedagogical practices, particularly within subject-specific instructional traditions. Contextually, infrastructural limitations, policy gaps, and limited institutional support further restrict sustained implementation. Consequently, digital pedagogy often remains uneven and context-dependent, highlighting the need for coordinated efforts at both pedagogical and systemic levels.

A deeper examination of the literature indicates that challenges in implementing digital pedagogy are not merely technical or infrastructural but are deeply rooted in systemic and pedagogical tensions. While many studies attribute barriers to external factors such as limited resources or policy gaps, comparative analysis suggests that internal factors, including teachers' beliefs and resistance to pedagogical change, also play a significant role. Moreover, inconsistencies across studies reveal that even in well-resourced environments, meaningful pedagogical integration is not guaranteed, indicating that access to technology alone is insufficient. This highlights a critical gap between technological availability and pedagogical transformation, suggesting that future interventions must address both structural and cognitive dimensions of teaching practice.

## DISCUSSION AND CONCLUSION

This systematic review synthesises existing research on teachers' pedagogical readiness and the contextual challenges associated with implementing digital pedagogy in classroom practice. The findings indicate that teachers' readiness to integrate digital technology is a multidimensional and context-dependent construct shaped by the interaction of technological knowledge, pedagogical competence, professional learning experiences, belief systems, and institutional conditions. While theoretical frameworks such as Technological Pedagogical Content Knowledge (TPACK) provide a valuable foundation for understanding technology integration, the reviewed literature consistently reveals a gap between teachers' technological familiarity and their ability to enact meaningful pedagogical integration in classroom settings.

Across diverse educational contexts, teachers frequently demonstrate confidence in using digital tools and possess basic technological knowledge. However, their classroom practices often remain limited to substitutional or presentation-based uses of technology rather than transformative pedagogical approaches that support inquiry-based, collaborative, or learner-centred learning. These findings suggest that technological competence alone does not ensure effective digital pedagogy. Instead, meaningful integration depends on teachers' ability to align digital technologies with instructional goals, disciplinary knowledge, and pedagogical strategies. Professional development programmes have been widely identified as important mechanisms for strengthening teachers' readiness. Nevertheless, the literature indicates that short-term training initiatives frequently produce uneven outcomes if they are not supported by sustained, practice-based professional learning and collaborative support systems.

The review also highlights the significant role of teachers' beliefs, attitudes, and self-efficacy in shaping pedagogical readiness. Although many educators express positive perceptions toward the use of digital technologies, such attitudes do not automatically translate into effective instructional practices. Several studies report discrepancies between teachers' self-reported competence and their actual pedagogical performance, suggesting that perceived readiness may overestimate teachers' capacity to design and implement technology-enhanced learning activities. These findings emphasise the importance of reflective pedagogical practice and authentic performance-based assessments in evaluating teachers' digital competence.

In addition to individual competencies, the rapid emergence of artificial intelligence and other advanced digital technologies introduces new dimensions to pedagogical readiness. Integrating emerging technologies into teaching requires specialised competencies that extend beyond traditional TPACK domains, including the ability to critically evaluate digital tools, design ethically informed learning activities, and guide students in understanding algorithmic systems. However, the literature suggests that many teachers experience uncertainty and cognitive overload when engaging with rapidly evolving technologies, which may lead to cautious or superficial implementation in classroom practice.

Beyond individual readiness, this review demonstrates that the implementation of digital pedagogy is strongly shaped by contextual and systemic conditions. Infrastructure limitations, unreliable internet connectivity, and limited access to digital devices remain persistent barriers in many educational contexts, particularly in rural or under-resourced schools. These structural constraints significantly affect teachers' ability to implement technology-enhanced instruction consistently and sustainably. Even when teachers demonstrate motivation to adopt digital pedagogy, insufficient institutional support, lack of coherent ICT policies, and limited opportunities for structured professional learning often result in fragmented and

teacher-dependent practices.

The findings further indicate that instructional and disciplinary contexts influence how digital pedagogy is enacted in classrooms. Subject-specific traditions, curriculum requirements, and assessment pressures frequently shape teachers' decisions regarding technology use. For example, teachers may prioritise curriculum coverage or examination preparation over exploratory digital learning activities, leading to selective and constrained forms of technology integration. This suggests that effective digital pedagogy cannot be implemented as a universal instructional strategy but must be adapted to the epistemological and pedagogical characteristics of specific subject areas.

Overall, the evidence suggests that digital pedagogy represents not only a pedagogical challenge but also a systemic one. Successful implementation requires alignment between teacher knowledge, institutional support, infrastructure availability, disciplinary expectations, and educational policy frameworks. Addressing these interconnected factors requires comprehensive strategies that extend beyond individual teacher training to include sustained professional development, supportive leadership, coherent policy implementation, and equitable access to digital resources.

In conclusion, this systematic review highlights that while teachers increasingly recognise the potential of digital technologies to enhance teaching and learning, meaningful pedagogical integration remains uneven across contexts. Strengthening digital pedagogy therefore requires a holistic approach that simultaneously develops teachers' pedagogical competencies and improves the broader institutional and structural conditions that support technology-enhanced education. Future research should focus on developing practice-oriented professional learning models, authentic assessment approaches for digital competence, and policy frameworks that support equitable and sustainable digital transformation in education.

### **Ethical Approval**

This study adhered to recognised research ethics standards. Approval was obtained from the Educational Policy Planning and Research Division (Bahagian Pembangunan dan Penyelidikan Dasar Pendidikan), Ministry of Education Malaysia (Approval Reference No. KPM.600-3/2/3-eras(27376).

### **Conflict Of Interest**

This article has been conducted and written without any conflict of interest. The authors confirm that there are no financial, personal, or professional relationships that could have influenced the research, analysis, or findings presented in this study

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