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Digital literacy, reading culture, and elementary teachers' readiness for AI and coding: A comparative study of Indonesia and Malaysia

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ABSTRACT

The transformation of twenty-first century education requires elementary school teachers to be well-prepared to integrate artificial intelligence (AI) and coding technologies into classroom practice. However, disparities in digital literacy and reading culture may influence teachers' readiness across different national contexts. This study aims to examine the role of digital literacy and reading culture in shaping elementary school teachers' readiness for AI- and coding-based learning through a comparative analysis of Indonesia and Malaysia. This study employed a qualitative approach with a comparative study design, combining a systematic literature review and in-depth interviews with expert informants. Secondary data were obtained from peer-reviewed journal articles, educational policy documents, ministry reports, and verified mass media sources. The findings reveal that digital literacy significantly enhances teachers' capacity to design, implement, and evaluate AI- and coding-based instructional practices, while a strong reading culture supports teachers' adaptability in responding to technological innovations. From a comparative perspective, Malaysia demonstrates a higher level of teacher readiness, supported by integrated digital literacy policies and continuous professional development programs. In contrast, Indonesia faces challenges related to digital infrastructure and unequal access to teacher training. These findings imply the need to strengthen digital literacy initiatives, foster technology-oriented reading cultures, and enhance cross-national policy collaboration to support teachers in implementing AI- and coding-based learning effectively. This study contributes to both theoretical and practical perspectives for policymakers and primary education practitioners in addressing the challenges of educational digital transformation.

INTRODUCTION

The transformation of twenty-first-century education has accelerated with rapid advances in digital technologies, particularly artificial intelligence (AI) and coding-based learning, which are reshaping global pedagogical practices. The integration of AI not only expands access to learning resources but also transforms instructional design through the use of data, learning analytics, and adaptive intelligent systems (OECD, 2019; Zawacki et al., 2019). This shift requires a transition from teacher-centered instruction to learner-centered approaches that emphasize personalization, the development of twenty-first-century skills, and the early introduction of computational thinking at the primary school level (Chen et al., 2020). Within this context,

elementary school teachers play a strategic role as facilitators of adaptive learning who can integrate technology in pedagogically meaningful ways (Papadakis, 2021).

Teachers' readiness to engage with this digital transformation is strongly influenced by their level of digital literacy. Digital literacy is no longer understood merely as technical proficiency in using digital tools, but rather as a combination of pedagogical, cognitive, and ethical competencies required to support meaningful learning through technology (Caena & Redecker, 2019; Falloon, 2020). Empirical studies indicate that teachers with strong digital literacy are better prepared to integrate AI-based technologies reflectively, to recognize both their potential and limitations, and to create inclusive learning environments that respond to diverse learner needs. In the context of coding-based instruction, teachers' digital literacy serves as a critical foundation for guiding students in understanding algorithmic logic and systematic reasoning, which are central to the development of computational thinking (Lin et al., 2025).

As the use of AI in education continues to expand, digital literacy increasingly evolves into AI literacy. AI literacy requires teachers not only to understand the technical aspects of intelligent systems but also to develop conceptual and ethical awareness of how algorithms function, how data-driven decisions influence learning processes, and how issues of privacy and data security should be addressed (Holmes et al., 2019; Long & Magerko, 2020; Ng et al., 2021). It is further emphasized that the educational use of AI must be accompanied by teachers' reflective capacity so that technology is not applied instrumentally, but rather aligned with pedagogical goals and educational values (Bray, 2023; Kasperski & Yehudah, 2024). From this perspective, digital literacy and AI literacy are complementary competencies that jointly shape elementary school teachers' readiness to engage with AI-driven learning ecosystems (Li et al., 2025). Beyond digital competence, reading culture plays a crucial role in shaping teachers' preparedness for educational innovation. Reading culture does not merely reflect habitual access to information, but also indicates teachers' reflective capacity and critical engagement with knowledge. Teachers who demonstrate strong reading habits tend to be more receptive to new ideas, more discerning in evaluating digital information, and more capable of situating technological developments within meaningful pedagogical contexts (Bo, 2025). Recent research suggests that reading culture contributes to the development of information literacy and evidence-based decision-making in classroom practice, both of which are essential for the responsible integration of AI in education (Wilcox et al., 2021; Miyamoto et al., 2017). The synergy between digital literacy and reading culture therefore constitutes a fundamental foundation for developing adaptive, reflective, and future-ready teachers in the digital era. While digital literacy enables teachers to explore and utilize technological innovations, reading culture deepens conceptual understanding, critical analysis, and ethical sensitivity toward technological change (Lindfors et al., 2021). Teachers who possess both competencies are more likely to implement AI- and coding-based learning in pedagogically sound ways, without losing sight of the core values and purposes of education.

These conditions highlight a clear research gap, as most existing studies continue to examine digital literacy and reading culture as separate constructs rather than exploring their combined influence on teachers' readiness for AI- and coding-based learning (Bo, 2025). Moreover, cross-national comparative studies particularly those examining Indonesia and Malaysia remain limited, despite the two countries sharing similar visions for twenty-first-century education while adopting different policy approaches (OECD, 2021). Accordingly, a comparative investigation that integrates digital literacy and reading culture as interrelated foundations of

elementary school teachers' readiness is essential to provide a more comprehensive understanding and to inform relevant educational policy and practice in the era of artificial intelligence (Zhang & Zhang, 2024). This study contributes to the literature by explicitly integrating digital literacy and reading culture within a cross-national comparative framework between Indonesia and Malaysia, thereby offering a more holistic model of teacher readiness for AI- and coding-based learning.

METHOD

This study employs a qualitative approach with a comparative research design to examine the role of digital literacy and reading culture in shaping elementary school teachers' readiness for AI- and coding-based learning in Indonesia and Malaysia. A qualitative design was chosen to enable an in-depth understanding of educational contexts, policy frameworks, and instructional practices influencing teacher readiness in both countries (Creswell, 2018). The comparative perspective allows for the identification of similarities, differences, and contextual challenges related to the integration of artificial intelligence and coding in primary education Dai et al., (2022).

Data collection was conducted through two main techniques: in-depth interviews and document analysis. Primary data were collected through semi-structured, face-to-face interviews with two key informants from Malaysia: a lecturer from Universiti Tun Hussein Onn Malaysia (UTHM) specializing in educational technology and a doctoral student from Universiti Pendidikan Sultan Idris (UPSI) whose research focuses on literacy and learning technologies. Each interview lasted between 45 and 60 minutes and explored themes related to digital literacy practices, reading culture, and teacher readiness for technology-enhanced learning.

Secondary data were collected through document analysis of peer-reviewed journal articles indexed in Scopus and DOAJ, national education policy documents including Malaysia's Digital Education Policy 2021–2025 and Indonesia's Merdeka Belajar framework, as well as reports from international organizations such as UNESCO and the OECD. A systematic literature review was conducted following the PRISMA 2020 guidelines, focusing on publications from 2018 to 2025 that address digital literacy, AI-based education, coding literacy, teacher readiness, and comparative education in Southeast Asia (Page et al., 2021).

Data analysis was carried out using thematic analysis, following the six-stage framework proposed by Braun and Clarke (Naeem et al., 2023). The analysis enabled the identification of key themes related to digital literacy, reading culture, and teacher readiness, which were then compared across the Indonesian and Malaysian contexts to highlight patterns, gaps, and best practices.

To enhance trustworthiness, this study applied source and method triangulation by cross-validating findings from interviews and document analysis. Member checking with key informants and the maintenance of an audit trail further strengthened the credibility and dependability of the findings (Carcary, 2020). It is important to acknowledge that the primary data were derived from only two informants from Malaysia, which may limit the generalizability of the findings. However, the study prioritizes analytical depth over statistical generalization. The selected informants were chosen based on their expertise in educational technology and literacy, allowing for rich and context-specific insights. This limitation was further addressed through triangulation with extensive secondary data sources to strengthen the validity of the findings.

RESULTS

1. General Findings

The findings indicate that both Indonesia and Malaysia show increasing attention to digital literacy and reading culture as foundational elements of elementary school teachers' readiness for AI- and coding-based learning. However, the level of readiness and the strength of systemic support differ across the two contexts. A systematic literature review (SLR) of 25 peer-reviewed articles and policy documents identified three overarching themes shaping teacher readiness: (1) digital education policies and teacher professional development, (2) teachers' digital literacy and its integration into teacher education and school curricula, and (3) reading culture as a foundation for reflective and adaptive literacy practices.

To complement these document-based findings, primary data from semi-structured interviews and field observations were also analyzed. The interviews with a lecturer at Universiti Tun Hussein Onn Malaysia (UTHM) and a doctoral student at Universiti Pendidikan Sultan Idris (UPSI) revealed that AI and coding integration at the primary level is strongly influenced by teachers' digital competence and sustained institutional support. Both informants emphasized that Malaysia's relatively structured training ecosystem enables more consistent teacher readiness compared to Indonesia, where professional development opportunities remain uneven. In addition, observational data from selected school contexts in both countries further supported these findings. In Malaysia, classroom observations showed more frequent use of digital tools and structured integration of technology-supported learning activities, particularly in teacher-led instructional design. Teachers appeared more confident in using digital platforms and incorporating coding-related tasks in guided learning activities.

In contrast, observations in Indonesian school settings indicated that digital tools were used more selectively and were often limited to basic instructional support rather than embedded pedagogical integration. Teachers demonstrated varying levels of confidence in applying digital literacy practices, which reflected disparities in access to training and infrastructure across regions. Overall, the triangulation of SLR findings, interview data, and observational evidence suggests that while both countries recognize the importance of digital literacy and reading culture, Malaysia demonstrates a more coherent and practice-oriented implementation. Meanwhile, Indonesia shows promising potential but still faces challenges in ensuring equitable capacity building, consistent policy implementation, and classroom-level integration of AI- and coding-based learning.

2. Comparison of Elementary School Teachers' Digital Literacy in Indonesia and Malaysia

The comparison between Indonesia and Malaysia reveals significant differences in the development of teachers' digital literacy, particularly in terms of policy support, professional development, infrastructure, and the integration of AI-based learning. These differences reflect the varying levels of institutional readiness in supporting elementary school teachers' adaptation to digital transformation in education. Table 1 presents a comparative overview of these dimensions.

Table 1. Digital Literacy of Elementary School Teachers: A Comparison between Indonesia and Malaysia

Aspect	Indonesia	Malaysia
Main Policy Framework	No fully integrated national digital literacy policy; initiatives remain sectoral and are primarily implemented through the *Merdeka Belajar* program (Rusydiyah et al., 2020)	Implementation of the *Digital Education Policy (DEP) 2021–2025* as a comprehensive national framework for digital education (Othman et al., 2022).

Aspect	Indonesia	Malaysia
Teacher Training	Digital training is largely incidental and not yet competency-based, resulting in uneven teacher preparedness (Rusydiyah et al., 2020).	Professional development is conducted in a tiered and competency-based manner through the *Malaysia Digital Educator Competency Framework* (Othman et al., 2022).
Access and Infrastructure	Limited digital infrastructure in remote and underdeveloped (3T) regions, leading to unequal distribution of teachers' digital literacy (Wulandari et al., 2026)	Digital infrastructure is relatively evenly distributed and well integrated into school systems nationwide (Othman et al., 2022).
Use of AI in Teaching and Learning	AI use remains largely experimental; some teachers utilize generative AI tools (e.g., ChatGPT) and basic coding platforms without systematic curricular integration (Rusydiyah et al., 2020).	AI has been more systematically integrated, particularly in technology and STEM subjects, supported by AI-enabled learning management systems and curricular guidance (Othman et al., 2022).

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3. Teachers' Reading Culture in Indonesia and Malaysia

Teachers' reading culture in Indonesia and Malaysia demonstrates notable differences in terms of motivation, institutional support, and integration with digital learning practices. These differences are evident across policy implementation, institutional ecosystem, and classroom-level practices. In Indonesia, teachers generally show positive attitudes toward digital reading materials. However, their reading practices are often constrained by limited time, heavy workload, and uneven access to curated academic resources. As a result, reading activities tend to be irregular and primarily task-oriented rather than sustained as part of professional development. This condition is supported by observational data, where teachers were frequently found to rely on general internet searches rather than structured academic repositories:

> *"Most teachers use online search engines for quick teaching preparation rather than accessing institutional digital libraries" (OBS-IDN-01).*

In contrast, Malaysian teachers benefit from stronger institutional support systems that promote reading culture as part of professional growth. Initiatives such as the *Reading School Initiative* and the *Digital Reading Hub* encourage structured engagement with digital academic resources and continuous professional learning. This institutional role is reflected in the interview with a lecturer from Universiti Tun Hussein Onn Malaysia (UTHM):

> *"Digital reading practices among teachers are not incidental; they are embedded in structured programs supported by institutional incentives" (INT-MLY-01).*

Furthermore, a doctoral student from Universiti Pendidikan Sultan Idris (UPSI) emphasized the integration between digital literacy and reflective practice:

> *"We are not only developing digital skills, but also ensuring that reading culture becomes part of AI-based learning modules to support continuous professional reflection" (INT-MLY-01).*

Supporting this view, another reflective statement from the same informant highlights the pedagogical dimension of reading culture:

> *"A teacher who is digitally literate but does not engage in reflective reading will struggle to adapt to future learning demands" (INT-MLY-02).*

The triangulation of SLR findings, interviews, and observations suggests that Malaysia has developed a more integrated ecosystem in which digital literacy, reading culture, and professional development are systematically interconnected. In this system, reading is positioned not only as an academic activity but also as a professional habit supported by policy and institutional infrastructure.

In contrast, Indonesia shows strong individual motivation among teachers to access digital reading materials, yet this potential is not fully supported by systemic structures. As one observation notes:

> *"Teachers demonstrate willingness to read digitally, but institutional support for structured reading practices is still limited" (OBS-IDN-02).*

Overall, these findings indicate that while both countries recognize the importance of digital reading culture in supporting AI- and coding-based learning readiness, Malaysia demonstrates a more mature and structured model. Indonesia, meanwhile, shows strong potential that requires stronger alignment between policy, institutional support, and classroom-level practice. The triangulation of findings across SLR, interviews, and observations is summarized in Figure 1.

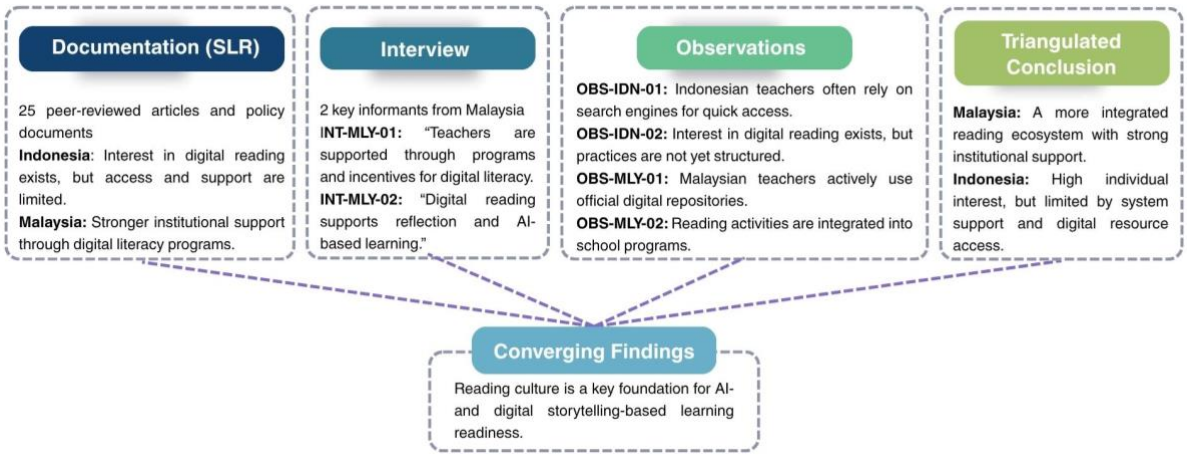


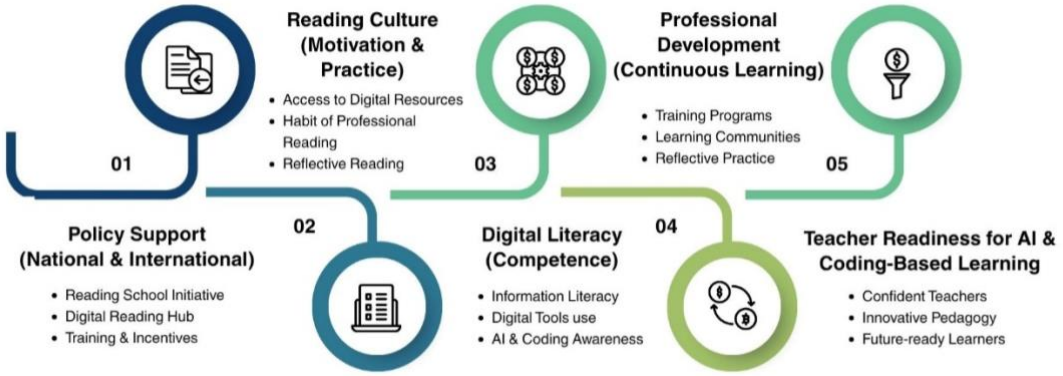
Figure 1. Triangulation of Findings: Teachers' Reading Culture in Indonesia and Malaysia

The triangulation presented in Figure 1 highlights the interconnected relationship between digital literacy, reading culture, and institutional support in shaping teachers' readiness for AI- and coding-based learning. The findings further indicate that differences in policy implementation and professional development systems contribute significantly to the varying levels of teacher readiness observed between Indonesia and Malaysia.

Table 2. Coding and Evidence Table

Code	Source Type	Country	Evidence / Quote	Theme
INT-MLY-01	Interview	Malaysia	"Digital reading practices among teachers are institutionally supported through structured programs and incentives for those who actively engage with digital repositories or develop AI-based learning materials."	Institutional Support
INT-MLY-02	Interview	Malaysia	"We are not only focusing on digital skills, but also on how reading culture can be integrated with AI-based learning modules to promote continuous professional reflection."	Integration & Reflection
INT-MLY-02b	Interview	Malaysia	"A teacher who is digitally literate but does not engage in reflective reading will struggle to adapt to future learning demands."	Reflective Practice

Code	Source Type	Country	Evidence / Quote	Theme
OBS-IDN-01	Observation	Indonesia	"Most teachers use online search engines for quick teaching preparation rather than accessing institutional digital libraries."	Access & Practice
OBS-IDN-02	Observation	Indonesia	"Teachers demonstrate willingness to read digitally, but institutional support for structured reading practices is still limited."	Institutional Challenge
OBS-MLY-01	Observation	Malaysia	"Teachers actively access digital repositories provided by the Ministry and schools, and integrate reading into teaching design and professional development."	Access & Integration
OBS-MLY-02	Observation	Malaysia	"Reading activities are embedded in school programs and professional learning communities."	Institutional Culture



Note: All of the step need to be continuous feedback and improvement. INT = Interview, OBS = Observation, MLY = Malaysia, IDN = Indonesia, SLR = Systematic Literature Review.

Figure 2. Triangulation of Findings: Teachers' Reading Culture in Indonesia and Malaysia

4. Teachers' Readiness for AI- and Coding-Based Learning

The synthesis of literature and interview findings indicates that teachers' readiness for AI- and coding-based learning is influenced by three interrelated factors: the availability of professional development and policy support, the level of teachers' digital literacy, and reflective reading habits related to educational technology and scientific resources. Overall, Malaysian elementary school teachers demonstrate a higher level of readiness than their Indonesian counterparts, primarily due to comprehensive policy frameworks and a more established digital ecosystem. Nevertheless, both countries face similar challenges, including resistance among some teachers toward emerging technologies and limitations within existing curricula that have yet to fully accommodate AI- and coding-based learning at the primary level.

5. Comparative Overview of Teachers' Readiness Levels

Table 3. A Comparison of Elementary School Teacher Readiness for AI- and Coding-Based Learning (Scale 1–5)

Key Aspect	Indonesia	Malaysia
Digital Literacy	3.1	4.4
Reading Culture	3.3	4.2
Policy Support	2.8	4.5
Readiness for AI & Coding Implementation	2.9	4.3

Based on the data above, Malaysia demonstrates higher scores across all assessed aspects, particularly in policy support and implementation readiness. In contrast, Indonesia still requires substantial strengthening through more systematic teacher training and the development of a digitally oriented reading culture. To provide a clearer cross-national comparison, Table 3 presents a synthesis of key dimensions of teacher readiness for AI- and coding-based learning in Indonesia and Malaysia.

Table 4. Comparative Summary of Teacher Readiness in AI- and Coding-Based Learning

Aspect	Indonesia	Malaysia	Key Implications
Digital Literacy	Developing, but uneven across regions	More advanced and systematically integrated	Need for equitable digital literacy programs
Reading Culture	Emerging, not yet technology-oriented	Stronger and linked to professional development	Strengthening reflective and digital reading practices
Policy Support	Fragmented and less integrated	Coherent and curriculum-embedded	Importance of aligned national policies
Professional Development	Unequal access and limited continuity	Structured and continuous training programs	Expansion of inclusive and sustained training
Infrastructure	Uneven digital infrastructure	More stable and supportive infrastructure	Investment in infrastructure equity
Teacher Readiness	Moderate, with high potential	Higher level of readiness	Cross-national learning and collaboration needed

Overall, the comparative findings indicate that teachers' readiness for AI- and coding-based learning is shaped not only by individual digital competence, but also by the extent of institutional support, policy coherence, and access to continuous professional development. Malaysia demonstrates a more structured and integrated approach in aligning digital literacy, reading culture, and educational policy, resulting in higher levels of teacher readiness. In contrast, Indonesia shows considerable potential but continues to face challenges related to unequal infrastructure, fragmented policy implementation, and limited continuity in teacher training programs. These findings suggest that strengthening teacher readiness requires a holistic strategy that integrates technological competence, reflective literacy practices, and sustainable institutional support systems.

DISCUSSION

The findings of this study confirm that digital literacy is a fundamental determinant of elementary school teachers' readiness to implement AI- and coding-based learning in the twenty-first century. Digital literacy should not be understood merely as technical proficiency in operating digital devices, but rather as a multidimensional competence encompassing conceptual understanding, ethical awareness, and pedagogical application. This perspective is consistent with the DigCompEdu framework proposed by Redecker and Punie, which conceptualizes teachers' digital competence as an integrated process that spans lesson planning, instructional implementation, assessment, and data-informed decision-making (Falloon, G. 2020). Teachers with strong digital literacy are therefore better positioned to understand algorithmic principles, critically engage with AI-generated data, and apply adaptive learning technologies in ways that support meaningful learning experiences.

However, the findings reveal a clear disparity between Indonesia and Malaysia in the distribution and application of these competencies. The unequal distribution of digital literacy

among teachers in Indonesia reflects broader structural challenges related to infrastructure limitations, uneven access to professional development, and regional disparities. Previous studies have similarly reported that Indonesian teachers' digital readiness remains constrained by inconsistent training opportunities and limited institutional support (Rusydiyah et al., 2020). In contrast, Malaysia demonstrates a more systematic and equitable development of teacher digital competence, largely supported by the implementation of the Digital Education Policy (DEP) 2021–2025, which explicitly positions digital competence as a core professional standard for educators (Othman et al., 2022). This contrast indicates that teacher readiness is not solely an individual capacity, but is strongly shaped by policy coherence and institutional support systems (OECD, 2019).

Beyond digital competence, the present study highlights reading culture as a critical factor that strengthens teachers' reflective and analytical capacities. Teachers who engage in sustained reading practices are more likely to critically interpret educational innovations and evaluate their pedagogical implications. This finding resonates with Clark and Teravainen-Goff's argument that professional reading fosters reflective thinking and professional judgment, particularly in rapidly evolving knowledge environments. Furthermore, reading engagement in digital contexts enhances information literacy and self-regulated learning, both of which are essential for navigating AI-supported educational ecosystems (Spann & Wagner, 2022).

From a comparative perspective, differences between the two countries are also evident in how reading culture is institutionally supported. In Malaysia, reading practices are more systematically integrated into professional development programs and teacher education curricula, reinforcing continuous learning habits among educators. In contrast, in Indonesia, reading culture tends to rely more on individual motivation or informal professional communities, resulting in less consistent engagement and weaker alignment with digital pedagogy. This gap suggests that without structured institutional support, reading culture may not effectively contribute to teachers' readiness for AI integration (OECD, 2021; Soekamto et al., 2022).

These findings further suggest that digital literacy and reading culture are mutually reinforcing dimensions of teachers' professional readiness. While digital literacy expands access to diverse sources of information and technology-supported learning resources, reading culture strengthens teachers' critical engagement with that information, enabling them to function as reflective knowledge managers rather than passive technology users. This relationship is supported by previous findings indicating a positive association between digital literacy and reading interest among pre-service elementary school teachers (Haeroni et al., 2023). Nevertheless, the extent of this synergy varies across national contexts. In Malaysia, the integration of digital literacy and reading culture appears to be more institutionally embedded through professional development programs and teacher education practices. In contrast, in Indonesia, these dimensions remain more fragmented and less systematically developed, a pattern similarly identified in studies on digital reading engagement and teacher professional learning (List, 2019).

Recent discourse on AI literacy further strengthens the theoretical grounding of these findings. Tenberga and Daniela argue that AI literacy represents an extension of digital literacy, requiring teachers to understand not only how AI systems function but also their ethical, pedagogical, and societal implications (Ng et al., 2021). This argument aligns with UNESCO's guidance on generative AI in education, which emphasizes teacher preparedness in addressing issues of algorithmic bias, data privacy, and responsible technology use (UNESCO, 2023).

Notably, Malaysian teachers appear better positioned to engage with these dimensions due to stronger systemic support, while Indonesian teachers may face additional challenges due to gaps in training and access.

Overall, the discussion suggests that teachers' readiness for AI- and coding-based learning is shaped by the interaction of digital literacy, reading culture, and policy support. More importantly, the comparative findings demonstrate that Malaysia's relative advantage lies in its policy coherence and institutional integration, whereas Indonesia's challenges are rooted in structural and systemic disparities. Integrating these dimensions provides a more holistic framework for understanding teacher readiness in the context of digital transformation. These findings contribute to the broader literature on twenty-first-century teacher competence by highlighting that technological readiness must be accompanied by reflective literacy and sustained professional learning.

CONCLUSION

To clarify the comparative findings, teacher readiness for AI- and coding-based learning in Indonesia and Malaysia can be understood through the interaction of digital literacy, reading culture, policy support, professional development, and infrastructure. In Indonesia, teachers' digital literacy is still developing and varies across regions, indicating the need for more equitable and sustained initiatives. In contrast, Malaysia shows a more advanced and systematically integrated approach, where digital literacy is consistently embedded in the education system. A similar pattern appears in reading culture. Indonesian teachers are still in the process of developing technology-oriented and reflective reading practices, while Malaysia demonstrates a more established reading culture closely linked to continuous professional development. This suggests the importance of strengthening digital and reflective literacy practices in Indonesia. Policy support also differs significantly. Indonesia's policies tend to be fragmented and less integrated into curriculum implementation, whereas Malaysia has a more coherent and curriculum-embedded policy framework that supports consistent implementation of AI and coding initiatives. In terms of professional development, Indonesian teachers often face unequal access and limited continuity, while Malaysia provides more structured and sustained training programs. Likewise, infrastructure in Indonesia remains uneven across regions, whereas Malaysia benefits from more stable and supportive systems that facilitate technology integration. Overall, teacher readiness in Indonesia can be described as moderate with strong potential for growth, while Malaysia demonstrates a higher level of readiness. These differences highlight the need for a more integrated and systemic approach to teacher preparation, as well as opportunities for cross-national collaboration to strengthen capacity for AI- and coding-based education in a more sustainable and human-centered direction.

REFERENCES

Bray, M. (2014). *Comparative education research: Approaches and methods* (2nd ed.). Springer. https://doi.org/10.1007/978-3-319-05594-7

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (DigCompEdu). *European Journal of Education, 54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Carcary, M. (2020). The research audit trail: Methodological guidance for application in practice. *Electronic Journal of Business Research Methods, 18*(2), 166–177. https://doi.org/10.34190/JBRM.18.2.008

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access, 8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Creswell, J. W. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Dai, Y., Liu, A., Qin, J., Guo, Y., Jong, M. S.-Y., Chai, C.-S., & Lin, Z. (2022). Collaborative construction of artificial intelligence curriculum in primary schools. *Journal of Engineering Education*. https://doi.org/10.1002/jee.20503

Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development, 68*, 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Haeroni, R., Saptono, B., Kawuryan, S. P., & Sayekti, O. M. (2023). Digital literacy and its impact on reading interest in prospective elementary school teachers. *Indonesian Journal of Elementary Education, 7*(3). https://doi.org/10.23887/ijee.v7i3.61819

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign. https://discovery.ucl.ac.uk/id/eprint/10139722/

Kasperski, R., & Ben-Yehudah, G. (2024). Developing digital academic skills in preservice teachers: Performance and metacognitive perspectives. *Journal of Education for Teaching, 50*(5), 613–626. https://doi.org/10.1080/02607476.2024.2323583

Li, Y., Zhou, X., & Chiu, T. K. F. (2025). Design language learning with artificial intelligence (AI) chatbots based on activity theory from a systematic review. *Smart Learning Environments, 12*, Article 24. https://doi.org/10.1186/s40561-025-00379-0

Lin, C.-H., Zhou, K., Li, L., & Sun, L. (2025). Integrating generative AI into digital multimodal composition: A study of multicultural second-language classrooms. *Computers and Composition, 75*, 102895. https://www.sciencedirect.com/science/article/abs/pii/S8755461524000719

Lindfors, M., Pettersson, F., & Olofsson, A. D. (2021). Conditions for professional digital competence: The teacher educators' view. *Education Inquiry, 12*(4), 390–409. https://doi.org/10.1080/20004508.2021.1890936

List, A. (2019). Defining digital literacy development: An examination of pre-service teachers' beliefs. *Computers & Education, 138*, 146–158. https://doi.org/10.1016/j.compedu.2019.03.009

Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1–16). https://doi.org/10.1145/3313831.3376727

Miyamoto, A., Pfost, M., & Artelt, C. (2017). Reciprocal relations between intrinsic reading motivation and reading competence: A comparison between native and immigrant students in Germany. *Journal of Research in Reading, 41*(1), 176–196. https://doi.org/10.1111/1467-9817.12113

Naeem, M., Ozuem, W., Ranfagni, S., et al. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *Qualitative Research in Organizations and Management*. https://doi.org/10.1177/16094069231205789

Ng, D. T. K., Leung, J. K. L., Chu, K. W. S., & Qiao, M. S. (2021). AI literacy: Definition, teaching, evaluation and ethical issues. *Proceedings of the Association for Information Science and Technology, 58*(1), e487. https://doi.org/10.1002/pra2.487

OECD. (2019). *Future of education and skills 2030*. OECD Publishing.

OECD. (2021). *OECD digital education outlook 2021: Pushing the frontiers with artificial intelligence, blockchain and robots*. OECD Publishing. https://doi.org/10.1787/589b283f-en

Othman, I. W., Mokhtar, S., & Esa, M. S. (2022). The stages of national education system operation: Issues, rationale, and challenges for the Ministry of Education Malaysia (MOE) in facing post pandemic norms of COVID-19. *International Journal of Education, Psychology and Counselling, 7*(47), 616–638. https://gaexcellence.com/ijepc/article/view/3537

Page, M. J., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Papadakis, S. (2021). The impact of coding apps to support young children in computational thinking and computational fluency: A literature review. *Frontiers in Education, 6*, 657895. https://doi.org/10.3389/feduc.2021.657895

Rusydiyah, E. F., Purwati, E., & Prabowo, A. (2020). How to use digital literacy as a learning resource for teacher candidates in Indonesia. *Cakrawala Pendidikan, 39*(2). https://doi.org/10.21831/cp.v39i2.30551

Spann, H., & Wagner, T. (2022). Reading habits and attitudes in first-year EFL student teachers and their implications for literature course design in an Austrian study programme. *Language and Education*. https://doi.org/10.1080/07908318.2022.2138425

Soekamto, H., Nikolaeva, I., Abbood, A. A. A., Grachev, D., Kosov, M., Yumashev, A., Kostyrin, E., Lazareva, N., Kvitkovskaja, A., & Nikitina, N. (2022). Professional development of rural teachers based on digital literacy. *Emerging Science Journal, 6*(6). https://doi.org/10.28991/ESJ-2022-06-06-019

UNESCO. (2023). *Guidance for generative AI in education and research*. UNESCO Publishing.

Wilcox, G., Fernandez Conde, C., & Kowbel, A. (2021). Using evidence-based practice and data-based decision making in inclusive education. *Education Sciences, 11*(3), 129. https://doi.org/10.3390/educsci11030129

Wulandari, E., Ghaluh, B. M., Suryaman, M., & Sari, E. S. (2026). Innovative language education policies for literacy development in Indonesia's 3T regions: Addressing access and equity challenges. *Language, Culture and Curriculum*. https://doi.org/10.1080/14664208.2026.2656057

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education, 16*, 39. https://doi.org/10.1186/s41239-019-0171-0

Zhang, J., & Zhang, Z. (2024). AI in teacher education: Unlocking new dimensions in teaching support, inclusive learning, and digital literacy. *Journal of Computer Assisted Learning*. https://doi.org/10.1111/jcal.12988