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Bridging the Digital Divide in Malaysian Education

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EXECUTIVE SUMMARY

- Malaysia's education system is undergoing a digital transformation amid persistent significant disparities, particularly between urban and rural schools.

- Despite the government's commitment—evident in increased education budgets—funding allocations for digital learning remain inadequate, especially for rural schools.

- Many schools still lack high-speed internet, digital devices, and teacher training. The deteriorating physical infrastructure in some of them further hinders efforts to integrate digital learning tools.

- If this gap is not addressed, students in underdeveloped areas will continue to face limited access to digital literacy training, reducing their future employability.

- Without sustainable policies that integrate digital learning with the construction of digitally equipped schools, future generations of students in Malaysia will remain ill-prepared for the digital economy.

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1.0 Introduction

Artificial intelligence (AI), virtual reality (VR) and the Internet of Things (IoT) are transforming how societies work, learn, and communicate. Their rapid adoption, however, poses serious policy challenges, and raises concerns regarding data governance and mental health. In education, evolving labour market demands now require more agile, future-proof learning systems.

In rural China, AI tools like the LeWaijiao AI classroom support teachers by providing expert assistance, monitoring student performance, and facilitating professional development. Within the "dual teacher model," AI may eventually function as direct assistant either to the expert teacher or the local teacher. The primary aim of such tools is to ease the teacher's workload while decisions about what and how to teach remain with the human educator (UNESCO, 2021).

In Malaysia, digital technologies are similarly transforming the education landscape. However, significant disparities between urban and rural areas persist. The Ministry of Education (MoE) has acknowledged that poor digital infrastructure in rural schools places students at a disadvantage. While policies like the Malaysia Education Blueprint (2013–2025) and the Digital Education Policy (2023) emphasise ICT integration and equitable access, challenges in implementation—particularly in rural schools—continue to hamper progress. The persistent digital divide, marked by inadequate infrastructure, limits capacity-building efforts and disrupts policy alignment, undermining the goal of inclusive and high-quality education for all.

2.0 Rational for the Study

Malaysia has introduced numerous initiatives such as the Malaysia Digital Economy Blueprint, National Digital Education Policy, 1BestariNet, the Smart School Initiative, the Malaysia Education Blueprint 2013–2025, and the Jalinan Digital Negara (JENDELA) Plan to drive digital transformation in education. These aim to improve infrastructure, digital literacy, and equitable access nationwide.

Despite these overlapping efforts and significant investments, implementation challenges persist due to policy fragmentation, inconsistent execution at the ground level, infrastructure gaps in rural areas, and a lack of sustained coordination between federal, state, and private stakeholders. These issues continue to hinder effective realisation of a truly inclusive and digitally-enabled education system.

A study conducted by Universiti Teknologi Malaysia (UTM) revealed that only 35% of schools in the country currently utilise cloud-based education—a powerful tool in enhancing teaching and learning experiences, particularly in STEM. The study also identified lack of teacher training and support as the primary barrier to adoption (Nurshamshida et al., 2023).

Meanwhile, many schools, particularly in rural areas, still lack the necessary infrastructure, high-speed internet, and modern devices (Nur Maslina, Khairunnisa, & Rozniza, 2024). Educators have highlighted the urgent need for significant improvements in educational infrastructure, given that conventional classroom environments often fail to cultivate critical thinking, creativity, communication, and collaboration.

Vocational and tertiary education also tend to focus heavily on job-specific skills; less attention is given to developing competencies and adaptability in using technology. This imbalance has contributed to a job mismatch in the labour market (Malaysia Digital Economy Blueprint, 2023). Meanwhile, inadequate infrastructure and outdated teaching approaches exacerbate the digital divide.

Additionally, initiatives to upgrade school facilities are not mentioned despite the pressing need to align with contemporary educational demands. Addressing these challenges requires urgent policy intervention, greater investment in digital infrastructure and resources, and comprehensive technology training.

Education policy prioritises improving the education system, and digital learning encompassing online learning platforms, digital tools, and electronic resources is critical for shaping students' learning experiences. Although initiatives such as 1BestariNet, the Smart School Project, and DELIMa promote digital learning, problems such as limited bandwidth, inadequate ICT facilities, and insufficient emphasis on computational thinking remain. The persistence of digital inequalities necessitates a deeper investigation into how infrastructure, training, and implementation strategies can be strengthened.

3.0 Literature Review

3.1 Overview of Digital Literacy in Malaysia

Digital literacy has emerged as a core competency in Malaysia's national education and development agenda, particularly in light of rapid digitalisation and post-pandemic learning disruptions. Defined broadly as the ability to use digital technologies to find, evaluate, create, and communicate information, digital literacy is now recognised as essential for education, workforce readiness, and social inclusion.

Malaysia has made significant strides in digital infrastructure development, including the implementation of initiatives like JENDELA (Jalinan Digital Negara) and the Malaysia Digital Economy Blueprint (MyDIGITAL). However, challenges remain particularly in ensuring equitable access and meaningful use of technology across socio-economic and geographic divides. While urban areas show relatively strong adoption of digital tools in education, rural and underserved communities continue to lag behind due to limited internet connectivity, insufficient device ownership, and low levels of digital proficiency.

In the context of schools, the Ministry of Education has introduced several digital platforms and programmes to integrate digital learning into classrooms, such as the Digital Educational Learning Initiative Malaysia (DELIMa) and Advanced Integrated NILAM System (AINS). Despite these efforts, implementation is uneven, with many schools especially in rural regions still facing barriers related to teacher readiness, infrastructure, and socio-cultural issues.

The following literature review synthesises current academic findings on digital literacy in Malaysia. It is organised thematically to highlight key issues such as digital engagement in rural communities, student competencies, teacher challenges, inclusive education, pedagogical innovations, and regional disparities.

3.1.1 Digital Competencies and Student Readiness

Siti Noorsuriani et al. (2018) reported that rural students often lack competencies in content creation and digital problem-solving, highlighting that surface-level familiarity with technology does not equate to deeper digital proficiency. More recently, Hamid et al. (2024) observed that while rural students possess basic digital literacy such as the ability to search for, retrieve, and interpret information; they struggle with more advanced skills like photo and video editing, troubleshooting, and understanding digital ethics, despite having some familiarity with basic software. These findings

indicate significant gaps in the skillsets of rural students, particularly in content creation and problem-solving.

Shamila et al. (2022) found that learning engagement among secondary school students is strongly influenced by their digital literacy levels, learning environment, and socio-cultural context. Their findings underscore the need for integrating digital competencies into mainstream curricula to prepare students for independent and workforce-relevant learning.

3.1.2 Barriers Faced by Teachers and Schools

While student readiness is critical, the role of teachers and institutional capacity cannot be overstated, especially in rural contexts. Teachers play a central role in cultivating digital literacy. However, Salsuhaida et al. (2023) and Nurshamshida et al. (2023) highlighted that teachers, especially in rural areas, often face multiple barriers, including time constraints, resistance to change, and a lack of professional development in using digital tools. In the case of STEM cloud-based classrooms, both teacher readiness and infrastructure limitations pose significant hurdles.

Additionally, Haizatul Afni et al. (2024) observed that while teachers are familiar with basic digital tools like Google, they lack advanced search strategies and the critical evaluation skills necessary for effective digital information literacy (DIL) instruction. Training initiatives and inter-institutional collaborations, especially between public libraries and schools, were recommended as viable solutions.

3.1.3 Inclusive Education and Special Needs in the Digital Age

The digital divide is further exacerbated for students who often require more tailored approaches. Mastam et al. (2024) found that students with disabilities or learning difficulties face barriers such as lack of resources, inadequate teacher training, and poor infrastructure. These challenges call for professional development programmes that are sensitive to diverse learning needs and disabilities.

3.1.4 Pedagogical Innovations

Innovative pedagogies such as Digital Storytelling (DST) have demonstrated significant potential in enhancing student engagement, creativity, and critical thinking. Over the years, DST has increasingly gained recognition as a valuable instructional approach across multiple educational levels. Its applications range from student-generated digital narratives to pre-produced stories, offering varied opportunities to enrich learning experiences.

Frecylla et al. (2024) conducted a systematic literature review to explore the potential of DST in Malaysian education, focusing on prevailing trends, implementation strategies, and associated challenges. Adopting the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, the researchers reviewed 14 relevant articles from major academic databases such as Scopus, ProQuest (Education Collection), and Google Scholar. Their findings reveal a notable lack of systematic research on DST's pedagogical applications in the Malaysian context.

While DST holds promise, its implementation in Malaysia remains limited due to several factors. These include time constraints, poor digital infrastructure, and limited teacher competencies in digital content creation. Frecylla et al. (2024) highlight an evident implementation gap between emerging pedagogical innovations and real-world classroom practices; particularly in under-resourced settings.

Challenges such as insufficient time, inadequate digital skills, and a lack of content knowledge in video production continue to hinder the full integration of DST into mainstream teaching practices.

Additionally, the study emphasises that the limited adoption of DST is compounded by inadequate teacher training, restricted access to technological tools, and insufficient policy support. While DST has been shown to improve student engagement, creativity, and digital literacy, the existing digital divide—especially in rural areas—prevents its broader implementation. To address these barriers, the authors advocate for structured teacher training programmes and greater investment in digital infrastructure to support DST as an effective pedagogical tool.

The integration of DST also supports broader educational goals related to digital literacy by encouraging students to express their ideas creatively, while developing essential skills in multimedia communication and critical analysis of digital content (Kakungulu, 2024). Hashim and Abdul Rahman (2024) further underscore DST's effectiveness in language learning, where it enhances students' narrative abilities and conceptual understanding through interactive, technology-enhanced storytelling techniques.

In a complementary study, Haizatul Afni, Roziya, and Norshila (2024) examine the role of digital information literacy (DIL) in Malaysian schools, linking it to sustainable development and educational collaboration. Using a qualitative methodology, the study collected insights from librarians and key education stakeholders. Findings indicate that while many educators are familiar with basic digital tools such as Google, there remains a substantial gap in advanced internet search skills and critical information evaluation. The authors stress the need for comprehensive teacher training programmes to develop stronger digital literacy skills, which are a prerequisite for effective student instruction. Furthermore, promoting collaboration among educators is seen as key to diversifying search strategies and enhancing the impact of DIL initiatives.

3.1.5 Localised Efforts and Regional Disparities in Digital Literacy

While national strategies aim to bridge Malaysia's digital divide, place-based disparities remain significant. Lee et al. (2025) examined initiatives by the Rural Education Research Unit (RERU) at Universiti Malaysia Sabah to foster early digital engagement among children in Sabah's impoverished villages. Their mixed-methods study reveals that although e-learning can spark curiosity and engagement, implementation is challenged by limited device ownership, unreliable internet connectivity, and socio-economic constraints. Cultural factors also shape community receptiveness to digital education. The authors advocate for offline-compatible learning tools, locally contextualised content, and community-driven literacy programmes to ensure inclusivity and relevance in rural digital interventions.

In contrast, Penang, though more urbanised; still contains underserved pockets such as Balik Pulau, parts of Seberang Perai, and island villages, where digital access and integration in education remain uneven. In a study of SJKC teachers in Seberang Perai Tengah, Jeng and Zaini (2025) found only moderate use of digital technology in classrooms. Barriers included insufficient infrastructure, lack of targeted professional development, and limited administrative support. Their findings reinforce the need for systemic solutions, including sustained investment in infrastructure, structured teacher training, and school-level digital leadership. These localised studies underscore that even in semi-urban regions, successful digital integration in education depends on contextual understanding, resource allocation, and continuous capacity-building efforts.

Inadequate infrastructure and poor internet connectivity hinder access to integrated educational systems, including online courseware, digital management platforms, and technical support. These constraints directly affect students' digital literacy development, placing rural learners at a

disadvantage compared to their urban peers who enjoy better technological resources. As a result, rural students struggle to acquire advanced digital skills. Bridging the urban-rural digital divide requires targeted strategies and policy interventions to ensure equitable access to technology-enhanced learning opportunities for all students.

4.0 Methodology

This study employed a systematic literature review to examine the challenges and needs of teachers in rural schools within the context of digital literacy in Malaysia. The review followed a structured and replicable process to ensure inclusion of high-quality and relevant sources.

A comprehensive search was conducted across academic databases using key terms "digital literacy in Malaysian schools", "rural education Malaysia", "digital divide", and "teacher challenges in digital learning". Studies published between 2018 and 2025 were prioritised to capture recent education trends.

Inclusion criteria comprised peer-reviewed journal articles and empirical studies that focused on digital literacy in Malaysian primary and secondary school contexts, with particular attention to rural settings. Past studies outside the Malaysian context were excluded.

4.1 Thematic Findings from the Literature

Table 1: provides a summary of past literature reviewed on digital barriers in the Malaysian context.

Table 1: Digital barriers in the Malaysian context

	Title/Author	Objective	Method	Challenges	Proposed solution
1.	Into the unknown: Do people in low literacy rate areas practise digital reading? Samsul Farid et.al. (2021).	- to investigate digital reading practices among rural communities in low literacy rate areas.	- quantitative - 400 respondents - 4 states involved: Kedah, Kelantan, Sarawak, and Sabah - multi-stage and mixed sampling method used to administer the survey questionnaires	- rural Malaysians with low literacy use smartphones for digital reading - Digital reading is already practised in rural areas - Improving digital literacy can empower rural communities, and narrow the digital divide	- upgrade connectivity infrastructure - government needs to continue to invest in digital literacy training in rural areas to increase familiarity with digital platforms
2.	Exploring digital competency of rural students in Malaysia. Siti Noorsuriani et.al. (2018).	- to explore the state of digital competencies (information processing, communication and collaboration and basic ethics and security) among students in a rural areas.	- qualitative approach	students' lacking in the ability to create digital content and ability to solve digital problems.	- strategies should be placed for ensuring disintegration between Group,s or digital divide could be reduced

3.	Bridging the digital divide in Malaysia: Enhancing digital literacy for inclusive students in educational systems. Mastam et.al. (2024).	- to explore the concept of digital literacy specifically tailored to meet the diverse needs of inclusive students in Malaysia.	- observed and analysed existing information about digital literacy for inclusive students -utilised databases like Scopus, WoS, and Google Scholar and conducted brief interviews with six teachers.	- inclusive students encountered barriers that hindertg their ability to develop essential digital skills. - inadequate access to technology - limited training and support - lack of educational resources designed to accommodate diverse learning needs	- clear need for tailored approaches considering individual learning styles, disabilities, and socioeconomic backgrounds. - teacher training and professional development - programmes must be enhanced to ensure educators are equipped with the knowledge and skills needed to support inclusive students in developing digital literacy.
4.	Teachers' perceptions of DELIMa 2.0 in teaching and learning process. Low Wen Xuan & Nurfaradilla (2024)	- to identify the level of teacher perception in the use of the DELIMa 2.0 launcher in the teaching and learning process.	- quantitative - Statistical Package for Social Sciences(SPSS) software	- most teachers agree that the use of DELIMa 2.0 is appropriate in the teaching and learning process even though it is also found that teachers face the problem of time constraints or need to constantly remind students to login to DELIMa 2.0.	- the Ministry of Education Malaysia needs to take action to encourage all teachers and students in Malaysia to use DELIMa 2.0 effectively

5.	Preliminary analysis of schools in rural area towards Implementation of STEM cloud-based classrooms Nurshamshida, et.al. (2023).	- to investigate the feasibility and potential benefits of implementing a STEM - cloud-based classroom in schools located in rural areas - focuses on understanding rural schools' current infrastructure, technological readiness, and educational landscape, as well as the perceptions and attitudes of teachers and students towards cloud-based learning.	- rural schools were selected based on the following criteria: 1. Diverse geographical regions 2. Socioeconomic conditions 3. Internet connectivity 4. Existing technological infrastructure	- Internet connectivity - teachers are ill-equipped with the skills and knowledge to use cloud-based technologies - cost of accessing the internet, digital devices, and cloud-based educational resources can be a barrier for some rural families - Inadequate infrastructure and lack of technical support - Cultural resistance	- upgrade internet connectivity to bridge digital divide - provide training for teachers, - Implement a STEM cloud-based classroom to transform the learning experience and empower students with vital 21st-century skills.
6.	Navigating new horizons: Challenges of Malaysian secondary school teachers in cultivating Digital Information Literacy (DIL) competencies through ICT-based projects in design and technology (RBT) Salsuhaida et.al (2023).	- explores Malaysian secondary school teachers' challenges in integrating digital information literacy (DIL) into their teaching -to identify challenges in teaching ICT-based projects	- use qualitative phenomenological study and thematic analysis by Atlas.ti v23	- limited access to technology - teacher digital literacy time constraints -teacher resistance to change - fast-paced technological changes, and assessment challenges	- adequate training and support in digital information literacy skills to empower teachers to cultivate DIL through innovative teaching methodologies, stakeholder collaboration, and a culture of adaptability to navigate the digital era confidently and competently.
7.	Sustainable collaboration between public libraries and school resource centers: Advancing digital information literacy in the digital age Haizatul Afni et.al. (2024).	- explores the essential role of digital information literacy (DIL) in Malaysian schools and its integration within the context of sustainable development and educational collaboration. - investigates the	- qualitative method - interviews with librarians and key educational stakeholders	- Teachers know basic digital tools like Google but lack advanced search and critical evaluation skills.	- Teachers need comprehensive digital literacy training to teach effectively. - collaborative efforts among teachers are crucial to diversify information search methods and enhance the overall effectiveness of

		effectiveness of DIL initiatives in enhancing educational outcomes			DIL programmes.
8.	Digital storytelling (DST) in Malaysia: a systematic literature review Frecylla et.al. (2024).	- to provide a deeper understanding of the potential of DST in Malaysia education by examining current trends, implementation strategies and challenges associated with its integration	- use the Preferred Reporting Items for Systematic Review and Meta Analyses (PRISMA) guidelines, 14 relevant articles were reviewed, drawn from 3 major electronic databases: Scopus, ProQuest (Education Collection), and Google Scholar.	- lack of systematic examination of how DST can be utilised as a pedagogical strategy in Malaysia education context. - limited time - inadequate digital skills - insufficient infrastructure - lack of content knowledge in digital video production have restricted its full potential.	- the need to address the barriers to facilitate broader and more effective implementation of DST in Malaysian education.
9.	Challenges of digital literacy among urban and rural pre-university students Hamid et.al. (2024).	- investigates the primary challenges students face in both contexts, including access to technology, levels of digital literacy proficiency, quality of existing education, motivation towards technology, and digital ethics. - to identify and analyse key challenges in achieving optimal digital literacy competence.	- Descriptive analysis provides in-depth understanding of digital literacy challenges among pre-university students' in urban and rural areas.	- students in urban and rural areas face different challenges in accessing technology - rural students experienced more issues- lack of Equipment, and inadequate internet connectivity - rural students demonstrate proficiency in basic software use and personal information protection. -rural students have deficiencies in more advanced digital skills like photo/video editing and technical troubleshooting skills that require additional support. - a lack of knowledge about promoting responsible technology use and understanding ethical challenges between urban and rural areas.	- to develop high-impact strategies and initiatives to bridge the digital divide between these two groups of students. - the need for improvements in technology access, digital literacy, and digital ethics, especially in geographical differences.
10.	Perception of rural primary school students towards the Advanced	- explores the perceptions of rural primary school students	- concept paper	- poor infrastructure - limited internet access - low digital literacy	- infrastructure development - enhanced teacher

	Integrated NILAM System (AINS). Elly Suhaila & Intan Farahana (2025).	toward the Advanced Integrated NILAM System (AINS)		among both students and teachers	training - parental involvement
11.	Influence of digital literacy on learning engagement among secondary students in Malaysia Shamila et.al. (2022).	- to examine the influence of digital literacy on student learning engagement.	- Survey questionnaires distributed among secondary school students in Malaysia.	- students lack digital literacy skills, less knowledge and faced issues in digital tasks - individual factor, learning environment and socio-cultural have significantly influenced student learning engagement	- Enhance digital literacy among students as foundational skill - Promote independent learning capabilities by integrating digital tools into virtual and blended learning environments. - Align digital competencies with future workforce demands to ensure students are adequately prepared for evolving job markets
12.	The role of Rural Education Research Unit, Universiti Malaysia Sabah in E-Learning's impact on early curiosity in Sabah's poor villages Lee et.al. (2025)	- to examine the role of the Rural Education Research Unit (RERU) at Universiti Malaysia Sabah in implementing e-learning initiatives to foster early curiosity among children in Sabah's impoverished villages.	- mixed method - Quantitative survey - qualitative insights from interviews and ethnographic observations highlight the contextual challenges and socio-cultural factors influencing digital adoption	- limited device ownership - unreliable internet connectivity - socio-economic constraints - disparities in digital access and infrastructural limitations continue to hinder full realisation of e-learning's potential in rural communities	- integrate offline learning solutions - localised content - community-driven digital literacy programmes to bridge the digital divide - prioritise equitable access and adaptive learning strategies
13.	The level of use of digital technology for teaching and learning purposes among SJKC teachers in Seberang Perai Tengah district Jeng & Zaini (2025)	- to examine the level of maximisation of digital technology use by teachers in SJKC in the Seberang Perai Tengah district - to examine various factors that influence the effectiveness of its integration in the teaching and learning (T&L) process.	Not mentioned	- limited infrastructure - lack of targeted professional training - insufficient administrative support	- teacher empowerment, - sustained infrastructure investment - targeted professional development programmes

The review of selected literature in Table 1 of Section 4.1 highlights several recurring and interrelated challenges faced by teachers and students in rural Malaysian schools with respect to digital literacy and access. These challenges, while diverse in their presentation, converge around four central themes: infrastructural limitations, insufficient digital competencies, pedagogical gaps, and policy implementation shortcomings.

First, infrastructural limitations such as poor internet connectivity, limit access to digital devices, and inadequate support systems emerge consistently as a factor across studies (Nurshamshida et al., 2023; Elly Suhaila & Intan Farahana, 2025; Lee et al., 2025). Despite government efforts, rural schools often remain disadvantaged, limiting their ability to use of ICT initiatives like cloud-based classrooms and AINS.

Second, gaps in digital competencies among both students and teachers are widely documented. While students in urban and rural contexts often demonstrate basic digital skills (e.g., operating software, navigating online platforms), many still lack more advanced competencies such as digital content creation, troubleshooting, and evaluating information critically (Hamid et al., 2024; Siti Noorsuriani et al., 2018; Shamila et al., 2022). Among teachers, digital competency remains uneven, with many reporting low confidences in integrating digital tools into pedagogical practices or adapting to new platforms such as DELIMa 2.0 (Digital Educational Learning Initiative Malaysia) (Low Wen Xuan & Nurfaradilla, 2024; Salsuhaida et al., 2023). Moreover, teachers often lack access to structured training programmes that target not just the technical use of digital tools, but also the pedagogical integration of digital literacy into subject-specific contexts.

Third, pedagogical gaps arise when digital tools are used without adequate support or instructional alignment. For instance, teachers who are not sufficiently trained in digital information literacy (DIL) or cloud-based learning platforms may resort to surface-level usage, such as passive content delivery, rather than promoting critical thinking or collaborative learning (Haizatul Afni et al., 2024; Nurshamshida et al., 2023). This issue is compounded by time constraints, rigid assessment structures, and limited institutional support, all of which inhibit experimentation and innovation in teaching methods.

Fourth, policy implementation shortcomings contribute to a disconnect between national ICT or digital education strategies and ground-level realities. Although initiatives such as DELIMa 2.0, AINS, and various e-learning platforms have been introduced with promising objectives, their rollout often faces practical challenges such as insufficient monitoring, lack of stakeholder engagement (particularly among parents and community actors), and inconsistent resource allocation (Elly Suhaila & Intan Farahana, 2025; Lee et al., 2025; Mastam et al., 2024). Moreover, the lack of tailored approaches for inclusive and special needs students further exacerbates inequality in digital access and outcomes.

4.2 Synthesis of Literature and Research Gap

The reviewed literature reveals that although national policies and digital platforms—such as DELIMa 2.0, Malaysia's enhanced digital learning platform—have been introduced to improve digital literacy, rural schools in Malaysia continue to face multifaceted challenges. These include infrastructural deficits, limited internet connectivity, inadequate teacher preparedness, and persistent socio-cultural barriers. Such socio-cultural barriers may include parents' limited exposure to digital tools, community resistance to change, linguistic mismatches between home and school environments, and a lack of digital learning support outside the classroom. Furthermore, while pedagogical innovations such as Digital Storytelling (DST) show promise in enhancing student

engagement and critical thinking, their implementation in rural contexts remains limited. These gaps underscore the need for empirical investigation into the specific barriers and support needs of teachers in rural schools, which this study aims to address.

Notably, there is a significant geographical gap in the literature. Most empirical studies tend to focus on rural schools in East Malaysia or underdeveloped parts of the peninsula, such as Kedah and Kelantan. There is scant research that specifically investigates digital literacy challenges in rural areas of Penang, despite the state's unique development trajectory, digital infrastructure initiatives, and a mix of urban-rural educational settings. This indicates a critical research gap that future studies should address to ensure regionally balanced educational policy planning and implementation.

4.3 Limitations

This review is subject to several limitations. First, the selection of studies was limited to English-language publications available in selected databases, possibly omitting relevant local research in *Bahasa Malaysia* or unpublished reports. Second, the inclusion of studies from 2018 to 2024 may exclude earlier work that remains relevant to digital literacy in rural contexts. Third, there was notable heterogeneity in study designs and contexts, which constrained direct comparison and required broader thematic synthesis. Additionally, there was a limited number of studies representing East Malaysian rural communities, which may affect the generalisation of findings across all rural regions in Malaysia.

5.0 Discussions

The findings from this study reveal several critical insights into the state of digital literacy in Malaysian schools, particularly with regard to teacher preparedness, student readiness, infrastructure limitations, and pedagogical adaptation. Despite various policy efforts at both federal and state levels, the research indicates that digital integration into teaching and learning remains uneven, with a notable gap between urban and rural contexts.

Teachers expressed varying degrees of confidence and competence in utilising digital tools, with those in urban areas demonstrating greater access to professional development opportunities compared to their rural counterparts. Meanwhile, students' digital readiness was often hindered by a lack of access to personal devices, unreliable internet connectivity, and limited exposure to technology at home. These structural inequalities not only widen the digital divide but also risk marginalising already vulnerable groups such as students with special needs or those from low-income families.

Another key finding relates to the mismatch between national digital literacy goals and local implementation capacities. While frameworks like the Malaysia Digital Economy Blueprint and the Digital Education Policy provide ambitious targets, many schools—especially in non-urban areas—struggle with basic enablers such as functioning ICT labs, skilled personnel, and maintenance support. Nonetheless, isolated innovations by proactive educators and community-led initiatives offer glimpses of potential scalability, if adequately supported by policy and funding mechanisms.

5.1 Relevance to Penang's Rural Schools and Digital Strategy

The findings from this study are particularly relevant to the context of Penang's rural schools, which have historically been underrepresented in research on digital literacy and infrastructure readiness. While Penang is often perceived as an urbanised and economically progressive state, significant

disparities remain between its urban and some rural districts—in terms of limited internet access, teacher training, and inclusive pedagogical innovations.

This study underscores the importance of addressing these intra-state disparities by promoting tailored digital strategies that reflect the unique challenges of Penang's rural communities. Some areas, like Pulau Aman, have suffered from limited telecommunications infrastructure even where towers exist—resulting in weak coverage (Mok, 2021). Poor internet connectivity in these areas hinders teachers' access to digital tools and limits students' exposure to digital pedagogies, ultimately making it difficult to deliver equitable digital education services. Students often struggle to keep up with modern digitally-driven learning methods further compounded by their parents' limited ability to afford fast and reliable internet connections.

Furthermore, the findings highlight that a "one-size-fits-all" national digital education policy may fall short in addressing the specific needs of local communities. While 5G technology is being deployed across Penang to enhance internet access, some rural schools have yet to experience its benefits. For instance, Intel's initiative to establish a 5G Digital School Library has successfully provided digital learning resources to about 50% of rural schools with existing internet access (Intel, 2024). However, some schools still face significant limitations in accessing digital resources, particularly in areas where low bandwidth continues to impede the effective delivery of online learning content. For these reasons, accessing online platforms can be time-consuming and inefficient ultimately disrupting teaching and learning processes (Jeng & Zaini, 2025, Zolhilmi & Hazrati, 2023).

The Penang State Government has committed to achieving 80% 5G network coverage across the state by the end of 2023 (Intel, 2024). To realise the full potential of this investment and contribute meaningfully to Malaysia's broader vision of digital nation-building, education stakeholders—including the Penang State Education Department, digital start-ups, and local NGOs—must continue working together to develop a more inclusive and locally responsive digital strategy. Key priorities should focus on strengthening teachers' digital competencies through targeted training programmes, setting up community-based digital learning hubs, and enhancing the relevance and accessibility of e-learning content. Such initiatives are vital to narrowing the digital gap between urban and rural communities. More importantly, they lay the foundation for equipping all students with the tools and opportunities needed to actively engage in Malaysia's digital future.

5.2 Implications for Policy and Practice

These findings have direct implications for educational policy and on-the-ground practice. Firstly, the evident gaps in infrastructure and digital access necessitate a differentiated policy approach that takes regional disparities into account. A tiered support framework could be implemented, whereby schools in underserved areas receive priority access to infrastructure upgrades, device provision schemes, and internet subsidies.

Secondly, teacher training must be central to any digital transformation agenda. Professional development should go beyond basic ICT competency and focus on pedagogical innovation, curriculum integration, and inclusive digital practices. Continuous learning platforms and peer mentoring models could be explored to support teachers, especially those in isolated or resource-poor schools.

Thirdly, the integration of digital tools should be aligned with inclusive education principles. This includes ensuring that e-learning content is accessible to students with disabilities and that culturally and linguistically diverse students are not excluded from digital curricula. Stakeholder collaboration between government bodies, tech companies, NGOs, and community leaders can help co-create locally relevant digital learning solutions.

Finally, monitoring and evaluation mechanisms must be strengthened to assess the actual impact of digital literacy policies at school level. Feedback loops involving school administrators, teachers, and students will ensure that policy design is grounded in real-world educational experiences and challenges.

6.0 Recommendations

This review has examined the state of digital literacy in Malaysian schools, with particular attention to the challenges and gaps in rural education settings. The findings highlight four recurring themes: uneven digital infrastructure and internet access; varied teacher readiness and professional development opportunities; insufficient alignment between national digital policies and local implementation capacities; and socio-economic disparities that exacerbate the digital divide, especially among marginalised students.

Despite existing national frameworks such as the Malaysia Digital Economy Blueprint and the Digital Education Policy, the review found that rural schools, including those in Penang's less developed districts, continue to face significant barriers to effective digital learning. These include resource limitations, lack of community support systems, and insufficient integration of inclusive digital pedagogies.

6.1 Recommendations for Policymakers, Educators, and Stakeholders

- Adopt a tiered, region-sensitive approach to digital education

  Policy frameworks must account for disparities between urban and rural areas. Schools in underserved regions should receive priority for infrastructure upgrades, internet connectivity, and device support schemes (Jeng & Zaini, 2025).

- Strengthen teacher professional development

  Training should extend beyond ICT basics to include pedagogical strategies for digital engagement, inclusive teaching practices, and integration of local cultural contexts into digital learning.

- Enhance multi-stakeholder collaboration

  Stronger partnerships between state education departments, schools, public libraries, NGOs, and tech providers can lead to more sustainable, locally relevant digital solutions (Haizatul Afni et al., 2024).

- Align digital education with workforce demands

  Community-based centres can serve multiple functions, including after-school digital learning spaces, internet access points, and training venues for students, teachers, and parents (Lee et al., 2025).

- Improve monitoring and feedback mechanisms

  Ensure that digital competencies taught in schools reflect evolving industry needs, improving students' employability and future-readiness (Shamila et al., 2022)

6.2 Suggestions for Future Research

To further support evidence-based policymaking, future studies should:

- Focus on longitudinal studies that track the impact of digital interventions in rural schools over time.
- Investigate teacher and student experiences with digital tools in low-resource settings.
- Explore inclusive digital strategies for students with disabilities, indigenous learners, and multilingual communities.
- Conduct more localised research in northern region.
- Examine the role of parents and communities in supporting digital literacy outside the classroom.

7.0 Conclusion

Policy-makers and educators are entering uncharted territory as they navigate the implications of AI in shaping the future of learning. To ensure AI functions as a public good, its integration into the education system needs to be guided by principles of equity and inclusion. In the Malaysian context, addressing digital disparities in rural schools is critical. This requires targeted infrastructure investment, teacher upskilling, and active collaboration with local communities. Without region-sensitive implementation of national strategies, rural students risk being further marginalised. At the state level, education authorities must identify and overcome both practical and technical barriers that hinder meaningful digital participation. A cohesive, locally grounded policy approach is essential to ensure digital literacy development and long-term sustainable learning opportunities for marginalised rural students.

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