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Optimizing Digital Literacy Integration in Early Childhood Education: A Case Study of Tarbiyatul Athfal Bulumanis Kidul Kindergarten

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Abstract
Digital literacy is increasingly recognized as a fundamental component of early childhood education, equipping young learners with essential skills to navigate digital environments. This study investigates the implementation of digital literacy in the independent curriculum at Tarbiyatul Athfal Bulumanis Kidul Kindergarten, focusing on organizational strategies, challenges, and pedagogical impacts. Employing a qualitative case study approach, data were gathered through observations, semi-structured interviews, and document analysis involving key stakeholders such as teachers, curriculum coordinators, and administrators. The findings indicate that while educators possess foundational digital competencies, continuous professional development is required for effective technology integration. Infrastructure limitations, financial constraints, and technical difficulties remain significant barriers to optimal digital literacy adoption. However, structured pedagogical strategies that incorporate information and communication technology (ICT) have been shown to enhance student engagement and learning outcomes. The study underscores the necessity of robust teacher training programs, improved digital infrastructure, and multi-stakeholder collaboration to ensure the sustainable integration of digital literacy in early childhood education. A key finding reveals that despite existing challenges, schools that implement digital literacy with structured teacher support and adaptive learning strategies demonstrate significant improvements in students' digital competencies and cognitive engagement. Future research should explore the long-term effects of early digital literacy exposure on cognitive and social development across diverse educational settings.

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Introduction

The integration of digital literacy into early childhood education has become an urgent global concern as societies transition into an increasingly digitalized world. Digital literacy is recognized as a fundamental skill for participation in the modern economy and society, influencing access to education, employment, and civic engagement (Feerar, 2019; Martín et al., 2019; Reddy et al., 2023). Given the rapid pace of technological advancement, early exposure to digital literacy is essential to ensure that children develop foundational competencies for future learning. However, the digital divide remains a significant challenge, particularly for young children who lack structured opportunities to develop digital competencies from an early age (Apps et al., 2022; Choudhary, 2024). Early childhood education institutions, particularly kindergartens, play a critical role in fostering digital literacy through structured and developmentally appropriate learning experiences (Cao et al., 2024; Yetti, 2024). Despite these efforts, the absence of standardized frameworks and pedagogical strategies for incorporating digital literacy into early childhood curricula continues to pose challenges for educators and policymakers worldwide (De León et al., 2023; Nash, 2024). This raises an important question: how can digital literacy be effectively integrated into early childhood education to maximize its benefits while mitigating potential challenges?

Several studies highlight the benefits of integrating digital literacy into early childhood education, emphasizing its role in enhancing cognitive development, communication skills, and

creativity (Habibah et al., 2021; Phaisamran & Phaisamran, 2024). Research from China, for instance, suggests that developing a structured digital literacy framework for early childhood education can help categorize skills according to different developmental stages (Phaisamran & Phaisamran, 2024). Similarly, studies in Indonesia indicate that incorporating digital literacy through local wisdom-based pedagogies positively influences children's engagement and linguistic skills (Yetti, 2024). These findings align with global perspectives highlighting how digital technologies in kindergarten settings enable young learners to engage with educational content in more interactive and immersive ways, leading to improved learning outcomes (Owen & Davies, 2020; Suwarto et al., 2022). However, despite these advantages, concerns persist regarding the appropriate use of digital tools in early childhood settings, particularly in relation to screen time, online safety, and ethical digital engagement (Buchan et al., 2024; Reddy et al., 2023). Thus, a balanced approach is necessary to ensure that the benefits of digital literacy outweigh its potential drawbacks.

Teacher preparedness is a crucial factor in the successful integration of digital literacy into early childhood education. Research indicates that teachers' digital competencies, instructional leadership, and emotional intelligence significantly influence their ability to implement digital literacy effectively in classroom settings (Forsling, 2023; Tongli et al., 2024). However, many early childhood educators report a lack of structured professional development opportunities in digital literacy education (Aluko & Ooko, 2022; Smith & Storrs, 2023). In Denmark, for example, digital literacy has been integrated into secondary school curricula, yet its implementation varies across subjects, underscoring the need for a more standardized approach in early education (Svendsen & Svendsen, 2021). Furthermore, studies emphasize that pre-service teacher training programs should adopt collaborative and technology-enhanced instructional methods to strengthen teachers' digital teaching competencies (İlhan et al., 2024; Li & Zhang, 2024). Addressing these gaps is essential to equipping early childhood educators with the necessary skills and resources to foster digital literacy effectively.

The integration of digital literacy into national curricula has been an ongoing effort in several countries. However, challenges persist in defining standardized learning objectives and assessment frameworks. In Canada, Australia, and South Korea, curriculum analyses indicate that digital literacy remains a secondary priority within early childhood education policies (Roh et al., 2024). Similarly, in the United Kingdom, digital literacy education in national curricula has yet to fully incorporate expertise from media and technology professionals (Polizzi, 2020). In Indonesia, while the curriculum framework acknowledges the importance of digital literacy, it lacks clear guidelines for structured implementation at the kindergarten level (Nawangsari & Sutomo, 2023; Sherly et al., 2020). Research suggests that curriculum innovation plays a vital role in shaping digital literacy instruction, particularly when aligned with technological advancements and local socio-cultural contexts (Astuti et al., 2021; Ofem et al., 2024). Given these challenges, there is a pressing need to develop clear policies and structured guidelines to facilitate the integration of digital literacy in early childhood education.

Disparities in access to digital literacy resources remain a critical challenge, particularly in developing regions where socio-economic inequalities affect technology availability and usage in early childhood education (Apps et al., 2022; Subaveerapandiyan et al., 2024). Studies indicate that children from marginalized communities often have limited exposure to digital tools, resulting in a gap in digital literacy skills compared to their more privileged peers (Choudhary & Bansal, 2022; Martínez-Bravo et al., 2020). Moreover, parental support and home access to technology significantly impact young children's ability to develop digital literacy competencies (Ayalon & Aharony, 2024; Sunny & Ramasamy, 2025). Research from Australia demonstrates that students with greater access to digital resources at home exhibit higher levels of digital engagement and competency in early education (Apps et al., 2022). These findings highlight the necessity of targeted policy interventions to promote equitable access to digital literacy resources in kindergartens and early childhood settings.

Despite growing research on digital literacy in early childhood education, significant gaps remain in understanding its implementation within structured curricula. Many existing studies focus on digital literacy in higher education and secondary schooling, with fewer addressing its pedagogical integration in early childhood settings (Son & Ha, 2024; Steinfeld et al., 2023). Additionally, while various models of digital literacy exist, they often lack contextual adaptation to early childhood learning needs, leading to inconsistencies in instructional methods (Bruckhaus et al., 2024; Son & Ha, 2024). Another limitation in the literature is the absence of comprehensive frameworks that guide early childhood educators in balancing digital literacy instruction with traditional play-based learning methodologies (Owen & Davies, 2020; Yetti, 2024). Furthermore, limited research explores how digital literacy interventions impact broader developmental skills such as social-emotional learning and problem-solving abilities in young learners (Bender, 2024; Bin Bidin et al., 2021). Addressing these research gaps is essential for developing structured and contextually relevant digital literacy frameworks that enhance early childhood education.

To bridge these gaps, this study aims to analyze the implementation of digital literacy within the kindergarten curriculum under the "Kurikulum Merdeka" framework in Indonesia. Specifically, it seeks to identify the challenges and barriers faced by educators, evaluate the factors that contribute to successful digital literacy integration, and assess its impact on learning effectiveness, teacher preparedness, and children's acquisition of 21st-century skills. By addressing existing gaps in research and policy, this study provides empirical insights into the role of digital literacy in early childhood education and offers recommendations for curriculum enhancement and teacher training programs. The findings will contribute to the ongoing discourse on digital literacy education, particularly in developing contexts where structured early childhood digital education remains underexplored. Through its case study approach, this research will serve as a foundational reference for policymakers, educators, and curriculum developers in designing effective digital literacy programs for young learners.

Methods

This study employed a qualitative research approach using a case study method to evaluate the organization of digital literacy within the kindergarten curriculum (Clark, 1999; Sugiyono, 2018). The research was conducted at Tarbiyatul Athfal Bulumanis Kidul Kindergarten, Margoyoso District, Pati Regency, which was selected based on its relevance to digital literacy implementation. Participants included the principal (1), the vice principal for curriculum affairs (1), and three classroom teachers, selected through purposive sampling to ensure their direct involvement in curriculum planning and digital literacy practices. Data collection methods comprised structured and unstructured observations, semi-structured interviews, and document analysis. Observations were carried out over four weeks to assess classroom interactions and instructional strategies incorporating digital tools. Semi-structured interviews explored curriculum design, challenges in technology adoption, and the perceived impact of digital literacy on student learning. Document analysis involved reviewing lesson plans, digital resources, and institutional policies to triangulate findings.

Data analysis was conducted using an interactive model consisting of data reduction, data display, and conclusion drawing/verification. Thematic analysis was employed to identify recurring patterns and categorize the findings based on key themes related to digital literacy integration. Triangulation was applied by cross-referencing data from observations, interviews, and document analysis to enhance the credibility of the study. To ensure data reliability, member checking was conducted by allowing participants to review and validate preliminary interpretations. Additionally, peer debriefing was used to reduce researcher bias and strengthen the rigor of the analysis.

Ethical considerations were carefully addressed throughout the study. Informed consent was obtained from all participants before data collection, ensuring they understood the research objectives, procedures, and their right to withdraw at any time without repercussions.

Participants' identities were anonymized, and all data were securely stored to maintain confidentiality. The study adhered to ethical guidelines for educational research, ensuring respect for participants' autonomy, accuracy in data representation, and the minimization of potential risks associated with participation. Through this methodological approach, the study provides a comprehensive analysis of digital literacy implementation in early childhood education, offering valuable insights for curriculum development and policy enhancement.

Result

The findings of this study illustrate how digital literacy is incorporated into the curriculum at Tarbiyatul Athfal Bulumanis Kidul Kindergarten. The study aims to assess the readiness and capability of teachers in delivering digital literacy education, ensure the availability of infrastructure that supports digital literacy learning, and evaluate the effectiveness of integrating digital literacy-based education. Based on interviews, observations, and document analysis, the results are as follows:

Teacher Organization

Tarbiyatul Athfal Kindergarten employs educators and staff who are proficient in ICT competencies. The educators possess essential digital skills, including an understanding of digital technology and its applications, awareness of how digital technology enhances learning effectiveness and efficiency, ownership of digital devices, the ability to use applications as educational media and resources, proficiency in utilizing ICT for administrative tasks and learning management, competence in developing digital learning materials, and an understanding of digital safety to enhance their professionalism. The educational staff, including school principals and administrative personnel, also have digital competencies, such as the ability to use applications for managing school administration and leveraging digital data to improve administrative efficiency.

The organization of digital literacy content in the operational curriculum at Tarbiyatul Athfal Kindergarten considers the readiness and capability of teachers to implement digital literacy in their teaching. Based on interviews with the principal and teachers, it was found that the integration of digital literacy within the independent curriculum requires further preparation, as the school is still adapting to new teaching methods.

> *"We are still in the process of adapting to the independent curriculum, so training for teachers is essential to boost their confidence in integrating technology into teaching."* (Principal)

To address this challenge, the school has organized In-House Training (IHT) sessions in collaboration with the Learning Committee. Additionally, the principal and teachers collectively analyze the Learning Outcomes (CP), which are then formulated into Learning Objectives and Learning Objective Flow (ATP). They also participate in various training sessions to develop skills that support the integration of digital literacy content into the independent curriculum. The teachers have agreed to collaboratively enhance their proficiency in using educational IT tools to make classroom learning more engaging and interactive.

> *"We have started designing digital-based materials, but many teachers still need training to effectively utilize educational applications."* (Curriculum Vice Principal)

To further support teachers at Tarbiyatul Athfal Bulumanis Kidul Kindergarten, preparations are being made for them to participate in a capacity-building program by the Ministry of Education and Culture. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) has developed the Merdeka Mengajar Platform (PMM), an educational platform designed to support educators. This platform aids teachers in fostering Pancasila Students and provides features for Learning, Teaching, and Working.

> *"The features on the PMM platform are very helpful, especially in obtaining digital-based teaching references. However, we still need time to become familiar with this platform."* (Teacher)

Observations in the classroom indicate that teachers are making efforts to integrate digital tools into learning. During one session, a teacher used a projector to display an educational video but encountered technical difficulties in operating the device independently.

> *"I can use some educational applications like Canva and Kahoot, but I still struggle with creating interactive materials using platforms such as Google Classroom."* (Classroom Teacher)

The findings suggest several measures to enhance the implementation of digital literacy at Tarbiyatul Athfal Bulumanis Kidul Kindergarten. These include training provided by IGTKI, training through the Kemendikbud PMM platform, online seminars, and In-House Training organized by the school. These initiatives aim to better equip teachers to deliver effective digital literacy education.

> *"We have some digital devices, but they are still limited. We hope for further support to update facilities so that digital learning can be more effective."* (Curriculum Vice Principal)

Observations of the school's digital learning environment reveal that while digital infrastructure is available, some devices are outdated and require maintenance. Teachers often rely on their personal devices to conduct digital-based learning effectively. These findings underscore the need for ongoing professional development and infrastructure improvements to ensure the successful integration of digital literacy in early childhood education.

Organization of Facilities and Infrastructure

Digital schools require institutions to have the necessary tools to access, manage, create, store, present, and utilize digital information. TK Tarbiyatul Athfal Bulumanis Kidul provides various digital infrastructure and facilities to support this initiative. Digital school devices are categorized into those provided by the school and those available for students. The school offers infrastructure such as internet access, a digital library (e-library), digital classrooms, and computer/multimedia laboratories. For students, available devices include tablets, smartphones, laptops, or computers. Additional supporting equipment includes displays (LED TVs or LCD projectors) and internet connections.

According to the principal, while the school recognizes the importance of digitalization, financial constraints pose a significant challenge in providing adequate infrastructure.

> *"We are striving to equip our school with digital facilities, but budget limitations remain a significant obstacle. Without sufficient funding, we cannot upgrade or increase the number of devices as needed."* (Principal)

Infrastructure facilities play a crucial role in implementing digital literacy in schools. At Tarbiyatul Athfal Bulumanis Kidul Kindergarten, facility organization—based on observations and interviews—ensures that devices are available to access, manage, create, store, present, and utilize digital information.

These facilities include Internet Access Facilities, which provide fast access to learning resources and facilitate efficient information transfer. Digital Classroom Facilities integrate classrooms with ICT systems, such as WiFi, LCD projectors, and internet networks, to support digital learning. Additionally, the Computer/Multimedia Laboratory serves as a medium for developing digital teaching materials and enhancing students' digital literacy skills.

The vice principal for curriculum emphasized the need to integrate digital tools into learning processes, highlighting infrastructure limitations as a major challenge.

> *"We have incorporated digital learning into the curriculum, but the execution is still hindered by the lack of supporting infrastructure. Teachers and students are willing to adapt, yet the available facilities sometimes fail to meet their needs."* (Curriculum Vice Principal)

Observations indicate that the facilities and infrastructure at Tarbiyatul Athfal Kindergarten are not yet fully adequate in quantity or quality and are often makeshift. This inadequacy hinders the effective implementation of digital literacy learning, primarily due to insufficient funding. It is evident that well-supported learning facilities would greatly benefit

both students and teachers, enabling more efficient and effective teaching and learning activities.

Teachers have also voiced concerns regarding technical challenges during the learning process.

> *"Sometimes, the internet connection is unstable, which disrupts the class. We also face issues with outdated devices that cannot support the latest digital learning applications."* (Teacher)

This underscores the urgency of updating school infrastructure to ensure smoother digital learning experiences.

Students' adaptability to digital learning tools varies. Observations suggest that while some students are already familiar with using digital devices, others struggle due to limited exposure at home. The vice principal acknowledged this disparity:

> *"Most students are comfortable using smartphones and tablets, but there are still those who have difficulty operating these devices. We need to provide additional guidance and support to ensure that all students benefit from digital learning."* (Curriculum Vice Principal)

The principal further emphasized the need for external support to enhance digital learning facilities.

> *"We hope for additional support from the government or external partners to improve our school's digital infrastructure. Collaboration with parents and the community could also play a vital role in providing better resources for our students."* (Principal)

These findings highlight the importance of addressing the gaps in digital facilities at the school. Without sufficient infrastructure, the potential benefits of digital learning cannot be fully realized. The school must seek innovative solutions and explore partnership opportunities to overcome financial barriers and optimize digital education for both teachers and students.

Organizing Learning

Organizing learning at Tarbiyatul Athfal Bulumanis Kidul Kindergarten involves structuring educational activities within a defined time frame. Interviews with the principal and teachers reveal that the primary goal is to develop key competencies. They anticipate that digital literacy will enhance students' cognitive abilities, particularly in understanding and organizing information from digital sources.

> *"We hope that by implementing digital literacy, children can understand information more quickly and engage more actively in learning."* (Principal)

The curriculum follows the nationally established Learning Outcomes (CP) and is implemented through structured learning activities based on the Flow of Learning Objectives (ATP), which are organized into teaching modules. The Tarbiyatul Athfal Kindergarten Operational Curriculum is designed to meet students' needs by fostering 21st-century skills, including the integration of PPP (Pedagogical, Psychological, and Philosophical aspects), literacy, 4C (Creativity, Critical Thinking, Communication, and Collaboration), and HOTS (Higher-Order Thinking Skills).

> *"We design the teaching modules by considering the needs of early childhood students, ensuring they align with national curriculum standards while integrating modern educational approaches."* (Vice Principal for Curriculum)

Observations indicate that teachers actively use digital learning materials to engage students. For instance, during morning activities, interactive videos are used to introduce basic numeracy and literacy concepts, effectively capturing students' attention.

From the interviews, it can be concluded that learning organization is structured around CP Learning Outcomes, which are then implemented through the ATP framework and compiled into teaching modules. This approach accommodates students' needs by fostering 21st-century skills, particularly in PPP integration, literacy, 4C, and HOTS.

Educational process standards serve as national guidelines for implementing learning within educational institutions to ensure students reach developmental milestones. In digital

schools, learning is the core component, supported by various elements that enhance education quality. Digital learning promotes student-centered learning, character development, and collaboration, while also fostering personalized and open learning and encouraging lifelong learning. Additionally, it emphasizes higher-order thinking skills and the development of 21st-century competencies, such as critical thinking, creativity, collaboration, and communication. The integration of diverse learning resources and activity-based learning further enhances student engagement, while multicultural education ensures inclusivity and broadens students' perspectives.

> *"Children grasp concepts more effectively when we use animated videos rather than static images."* (Classroom Teacher)

Observations during classroom sessions show that students are highly engaged when using interactive media. For example, when learning about colors, students responded enthusiastically to digital applications that allowed them to experiment with different color combinations.

To ensure effective and efficient learning while meeting quality standards, ICT (Information and Communication Technology) is utilized. Educators at Tarbiyatul Athfal Kindergarten must integrate ICT elements with pedagogy to create high-quality learning experiences. The use of ICT at Tarbiyatul Athfal Kindergarten can be categorized into the following areas:

Use of ICT as a Source of Information

Learning incorporates various information sources beyond printed materials and environmental resources. Students utilize digital resources such as videos, audio files, and digital books.

> *"We encourage children to explore various learning materials, including digital books and educational videos, to enrich their knowledge."* (Vice Principal for Curriculum)

Observation findings indicate that during group learning activities, students are often guided to watch educational videos before engaging in hands-on practice. This method helps them better understand abstract concepts.

Use of ICT as Learning Tools and Media

Digital learning aids and educational media can be developed and presented using ICT and artificial intelligence (AI), including virtual observations and simulations. These tools complement traditional learning methods, enhancing student engagement. Educators also integrate interactive applications for presentations and educational games.

> *"We integrate interactive media such as AI-based simulations to provide a more immersive learning experience for children."* (Classroom Teacher)

Observations indicate that children participate more enthusiastically when digital games and interactive presentations are incorporated into lessons compared to traditional teaching methods.

Use of ICT to Present Learning Outcomes

Students' learning outcomes can be presented using various digital applications, such as videos, websites, blogs, and vlogs.

> *"Students are excited to present their learning outcomes using digital platforms such as videos and blogs."* (Classroom Teacher)

During an observation of a project-based learning session, students enthusiastically recorded their activities and created short digital presentations to showcase their work. This suggests that ICT fosters creativity and reinforces learning experiences.

Overall, the integration of technology in learning at Tarbiyatul Athfal Kindergarten aims to enhance education quality, create more interactive learning experiences, and develop competencies relevant to the digital era. These findings emphasize the importance of ICT integration in early childhood education to support student engagement and learning outcomes while fostering 21st-century skills.

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Discussion

The integration of digital literacy in early childhood education is increasingly recognized as essential for preparing students for the digital era (Bin Bidin et al., 2021; Martínez-Bravo et al., 2020). This study examines how digital literacy is organized within the kindergarten curriculum at Tarbiyatul Athfal Bulumanis Kidul, focusing on teacher preparedness, infrastructure availability, and instructional practices. Previous research highlights that the implementation of digital literacy in early childhood education varies globally, influenced by national policies, teacher competencies, and resource availability (Cao et al., 2024; Yetti, 2024). While many studies emphasize the importance of early digital literacy development, challenges such as inadequate training and infrastructure constraints persist (Choudhary & Bansal, 2022; Phaisamran & Phaisamran, 2024). Given these ongoing issues, it is crucial to analyze the specific challenges and facilitators of digital literacy implementation within a kindergarten setting to gain deeper insights into how such programs can be effectively integrated.

Findings indicate that while teachers at Tarbiyatul Athfal Kindergarten possess foundational digital competencies, there is a need for continuous professional development to enhance their ability to integrate technology effectively into classroom instruction. Teachers can operate basic digital tools, such as projectors and educational applications, but struggle with more complex platforms, including Google Classroom and interactive digital resources (Svendsen & Svendsen, 2021; Tejedor et al., 2020). School-initiated training programs, including in-house training and online workshops, have been implemented to bridge this gap; however, some educators still require additional guidance (Li & Zhang, 2024; Smith & Storrs, 2023). Despite infrastructural limitations, teachers have demonstrated strong willingness to incorporate digital tools, highlighting an opportunity for further investment in digital literacy capacity-building initiatives (Aluko & Ooko, 2022; Subaveerapandiyan et al., 2024). Nevertheless, improving teacher competencies alone is insufficient without addressing the infrastructural challenges that impact digital learning integration.

Infrastructure availability at Tarbiyatul Athfal Kindergarten presents a significant challenge, with outdated devices and limited access to high-speed internet affecting digital learning implementation. The school provides basic ICT infrastructure, including internet access, digital classrooms, and multimedia facilities, but financial constraints limit the expansion and maintenance of these resources (Siswanto & Hidayati, 2020; Yangambi, 2023). As a result, teachers often rely on personal devices to conduct digital learning activities, indicating a gap in institutional support (Apps et al., 2022; Lauricella et al., 2020). Notably, students' digital adaptability varies, with some children demonstrating proficiency in using tablets and digital applications, while others struggle due to limited exposure at home (Ayalon & Aharony, 2024; Suwarto et al., 2022). These findings suggest that addressing infrastructure gaps and ensuring equitable access to digital resources should be a priority for enhancing digital literacy in early childhood education. While infrastructure remains a challenge, another crucial aspect of digital literacy integration is the structure of the curriculum itself.

The study reveals that digital literacy integration at Tarbiyatul Athfal Kindergarten is structured through a well-defined curriculum that aligns with national learning outcomes. The curriculum incorporates 21st-century learning competencies, such as critical thinking, communication, collaboration, and creativity, commonly referred to as the 4Cs (Calam et al., 2020; Vuorikari et al., 2017). eachers utilize digital resources, including videos and interactive applications, to engage students; however, the effectiveness of these tools is hindered by inconsistent internet connectivity and insufficient training on digital pedagogy (Bruckhaus et al., 2024; İlhan et al., 2024). The school's approach to digital learning follows a structured framework, incorporating elements of both formal curriculum design and teacher-driven innovation, reflecting broader trends in digital literacy education worldwide (Morgan et al., 2022; Pala & Başıbüyük, 2023).

The findings align with previous research emphasizing the need for teacher digital literacy training to effectively integrate technology into learning (Madsen et al., 2018; Martzoukou,

2020). Similar studies in other regions highlight that while digital literacy programs enhance student engagement, their effectiveness depends on teacher preparedness and access to resources (Kim, 2020; Lauricella et al., 2020). Research in Norway and Denmark suggests that structured digital literacy frameworks integrated across school curricula yield better student outcomes, which aligns with the structured approach observed at Tarbiyatul Athfal Kindergarten (Aagaard et al., 2022; Svendsen & Svendsen, 2021). However, disparities in access to technology, as seen in this study, mirror findings from other developing regions, where financial constraints limit the reach of digital literacy initiatives (Apps et al., 2022; Choudhary, 2024).

Infrastructure challenges identified in this study reflect broader concerns in digital literacy implementation, where inadequate resources hinder effective technology integration (Siswanto & Hidayati, 2020; Yangambi, 2023). Studies in Thailand and Indonesia report similar obstacles, emphasizing that infrastructure limitations often lead to reliance on teachers' personal devices, creating inconsistencies in digital learning experiences (Phaisamran & Phaisamran, 2024; Yetti, 2024). Additionally, findings from Australia suggest that disparities in digital access between home and school environments significantly influence children's digital literacy skills, which aligns with the varying digital competencies observed among students in this study (Apps et al., 2022; Ayalon & Aharony, 2024). While the implementation of structured digital curricula, as observed at Tarbiyatul Athfal Kindergarten, aligns with best practices, sustained investment in infrastructure and training remains crucial for long-term success (Astuti et al., 2021; Bin Bidin et al., 2021).

Given these challenges, several strategic steps can be taken to enhance digital literacy integration in early childhood education. The study's findings underscore the complexity of this integration, influenced by teacher readiness, infrastructure availability, and curriculum design. While structured digital literacy frameworks enhance learning experiences, their success depends on ongoing professional development and sufficient resource allocation (Johnston, 2020; Nawangsari & Sutomo, 2023). The willingness of teachers to engage with digital tools suggests that with appropriate training and support, digital literacy integration can be more effective (Forsling, 2023; Li & Zhang, 2024). However, the disparities in students' digital skills highlight the need for collaborative efforts between schools, parents, and policymakers to bridge gaps in access and exposure (Ebyatiswara Putra et al., 2023; Strydom et al., 2021). A cautious approach is necessary in interpreting the findings, as school-specific factors, such as funding and administrative priorities, may influence digital literacy implementation differently across institutions (Calam et al., 2020; Martínez-Bravo et al., 2020).

These findings have several implications for policymakers, educators, and curriculum developers. First, professional development programs should be prioritized to ensure teachers are well-equipped to integrate technology effectively (Al-Hattami, 2025; Carl & Worsfold, 2021). Second, addressing infrastructure limitations through government support or public-private partnerships could improve digital learning environments, enabling equitable access for all students (Park et al., 2021; Santika et al., 2021). Third, integrating digital literacy within a broader educational framework can help develop essential competencies, preparing children for future technological demands (Campbell & Kapp, 2020; Wilkes, 2020). Ultimately, fostering a comprehensive digital literacy strategy will require a multi-stakeholder approach, ensuring sustainability and effectiveness in the evolving landscape of early childhood education (Morgan et al., 2022; Tinmaz et al., 2023).

Conclusion

This study analyzed digital literacy implementation within the independent curriculum at Tarbiyatul Athfal Bulumanis Kidul Kindergarten, focusing on challenges, success factors, and its impact on learning effectiveness, teacher readiness, and 21st-century skills. Findings indicate that successful integration depends on teacher competence, adequate infrastructure, and structured learning organization. While some teachers are proficient in digital tools, others

require further training. Additionally, limited funding and outdated equipment hinder optimal implementation. However, structured pedagogical approaches incorporating ICT have been found to enhance engagement and interactivity in early childhood education.

The implications of this study highlight the need for continuous teacher training, improved infrastructure through government or private support, and the integration of digital literacy into broader educational frameworks. The study's limitations include its single-location scope and qualitative focus, suggesting that future research should explore wider contexts using mixed-method approaches. Recommendations include investigating the long-term impacts of digital literacy on children's development, strengthening digital infrastructure, and fostering collaboration among educators, policymakers, and stakeholders to ensure sustainable digital literacy strategies. Addressing these factors will better equip early childhood education to prepare young learners for a technology-driven world.

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