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Narrative Review of Digital Literacy Curriculum Implementation in Early Childhood Education

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Abstract

Penelitian ini mengkaji integrasi literasi digital dalam pendidikan anak usia dini (PAUD) melalui perspektif konteks sosial-budaya dan keselarasan kebijakan. Menggunakan analisis dokumen kualitatif dan sintesis kerangka konseptual, dokumen kebijakan dari Indonesia dan organisasi internasional ditelaah bersama penelitian tentang perkembangan anak dan inovasi pedagogis. Hasil menunjukkan bahwa implementasi literasi digital yang efektif membutuhkan strategi yang responsif terhadap budaya, akses yang setara, dan keselarasan dengan kebijakan nasional maupun internasional. Kerangka yang diusulkan menekankan integrasi bertahap, pembelajaran berbasis permainan, kompetensi guru, keterlibatan keluarga, dan kemitraan komunitas. Implikasi praktis menyoroti literasi digital sebagai komponen transformasional yang menghubungkan teori dan praktik, mendukung perkembangan anak secara holistik, dan mempersiapkan mereka menghadapi era digital. Tantangan mencakup kesenjangan infrastruktur, keterbatasan alat penilaian, dan masalah privasi, sehingga diperlukan intervensi kebijakan dan pengembangan profesional yang terarah.

This study examines the integration of digital literacy into early childhood education (ECE) through a socio-cultural and policy-aligned lens. Employing a qualitative document analysis and framework synthesis, policy documents from Indonesia and international organizations were reviewed alongside research on child development and pedagogical innovation. Findings reveal that effective digital literacy implementation requires culturally responsive strategies, equitable access, and alignment with national and international policies. The proposed framework emphasizes staged integration, play-based learning, teacher competency, family engagement, and community partnerships. Practical implications highlight that digital literacy is a transformative component bridging theory and practice, fostering holistic child development and preparing children for the digital age. Challenges include infrastructure disparities, limited assessment tools, and privacy concerns, necessitating targeted policy interventions and professional development. This study provides actionable guidance for curriculum designers and policymakers to ensure inclusive and effective digital literacy adoption in ECE.

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1. INTRODUCTION

Education plays a strategic role in shaping the quality of individuals and the civilization of a nation. According (Putriana et al., 2021; Ulum, 2020), education aims to enhance skills, develop moral values, and intellectual capacity. To achieve these objectives, the development of a curriculum that aligns with future demands is essential, including the strengthening of students' cognitive, social, and emotional competencies (Kemendikbud, 2023). In the context of 21st-century education, critical thinking, collaboration, communication, creativity, digital literacy, and lifelong learning skills are core competencies that students need to possess (Bariyyah, 2021; Chan, 2020).

A significant challenge in Indonesia lies in the low level of literacy. According to (Dewi et al., 2020), Indonesia ranks near the bottom globally in reading interest, with only 0.1% of the population regularly reading books (Marmoah, Poerwanti, et al., 2022; Yuniawan et al., 2022). This situation indicates the need for systematic intervention from an early age, which aims to foster a culture of literacy through parental involvement and early childhood education institutions (Asmayawati, 2023a; Tatminingsih, 2022). Literacy in early childhood is not limited to reading, writing, and numeracy but also includes activities that stimulate cognitive and emotional development through play, storytelling, and technology-based learning (Lauricella et al., 2020; Saleha et al., 2022).

The rapid development of digital technology has expanded the concept of literacy to digital literacy, which involves the ability to access, evaluate, process, and utilize information through digital media (Hoffman & Mangino, 2023; Trimuliana, 2021). Digital literacy in early childhood encompasses the skills and attitudes needed to use digital media for learning, play, and information gathering in a safe and guided manner. Various digital content, such as educational videos, learning applications, and interactive games, have been implemented in early childhood education to support learning processes (Barman & Kjällander, 2022). However, the integration of digital literacy remains limited; for example, in Semarang City, only 22.7% of kindergartens have implemented digital literacy education (Setiadi & Frederika, 2022; Ulya et al., 2023). This highlights a gap between technological potential and classroom practice, necessitating a systematic evaluation of digital literacy curriculum implementation.

Previous studies have examined digital literacy in early childhood, including the use of digital media and educational games to enhance digital and cognitive skills (Asmayawati, 2023a; Tatminingsih, 2022). Other research evaluated the effectiveness of digital literacy programs using the CIPP evaluation model (Context, Input, Process, Product), providing comprehensive insights into program readiness, implementation, and outcomes (Fitriyah et al., 2023). Nonetheless, systematic reviews or narrative analyzes focused on the implementation of digital literacy curricula in early childhood education remain scarce, particularly those that integrate pedagogical aspects, learning media, and program evaluation holistically. This represents a research gap that requires attention to understand best practices and challenges in developing digital literacy for young children.

The urgency of this research lies in the essential role of digital literacy as a 21st-century competency. Implementing a digital literacy curriculum in early childhood education can provide foundational digital skills, support cognitive development, and prepare children for lifelong learning in a dynamic technological environment. Therefore, mapping and

reviewing the literature on strategies, media, and curriculum practices in digital literacy is academically and practically relevant for informing policy and improving early childhood education practices (Azhari et al., 2022; Fitriyah et al., 2023).

Based on this background, the objectives of this study are to: (1) analyze the implementation of digital literacy curriculum in early childhood education, (2) evaluate the methods, media, and teaching strategies employed, and (3) identify the main challenges and solutions reported in previous studies. Correspondingly, the research questions are: (1) How is the digital literacy curriculum practically implemented in early childhood education?; (2) What methods, media, and strategies are applied in teaching digital literacy to young children?; (3) What are the main challenges and solutions reported in the literature regarding the implementation of digital literacy curriculum in early childhood education?.

By addressing these questions, this narrative review aims to contribute to the development of digital literacy curriculum, enhance teacher competencies, and provide effective learning strategies for young children, supporting the national education goal of nurturing capable and adaptive generations in the digital era.

2. METHOD

This study employs a narrative literature review to explore the implementation of digital literacy curriculum in early childhood education. A narrative review enables the synthesis of existing research, highlighting trends, strategies, and challenges in the field. Relevant literature was collected from peer-reviewed journals, books, conference proceedings, and credible digital repositories published between 2020 and 2025. Searches were conducted using keywords such as "*digital literacy curriculum*", "*early childhood education*", "*21st-century skills*", and "*technology-based learning*". Inclusion criteria focused on studies that addressed digital literacy in early childhood settings, were published in English or Indonesian, and provided full-text access, while studies targeting older students or unrelated educational contexts were excluded.

Data extraction involved regularly capturing information regarding the study context, curriculum description, teaching strategies, media integration, teacher competencies, challenges, and key findings. The analysis was carried out using thematic synthesis to identify recurring patterns and main themes across studies. The study specifically emphasizes approaches to curriculum implementation, instructional methods, media usage, and barriers to effective digital literacy integration. By structuring the findings in this way, the research offers a comprehensive, coherent, and practical understanding for educators, curriculum developers, and policymakers seeking to enhance digital literacy skills in early childhood education.

3. RESULTS AND DISCUSSION

3.1. Implementation of Digital Literacy Curriculum in Early Childhood Education

The review indicates that integrating digital literacy into early childhood education (ECE) primarily aims to cultivate foundational digital competencies, cognitive development, and creative problem-solving skills (Evridawati et al., 2020; Maharani, 2023). Educators frequently employ interactive and multimedia tools, such as educational games, digital storytelling applications, and collaborative exercises, to foster engagement and curiosity

(Kim, 2024; Sudarti et al., 2020). These tools not only familiarize children with digital devices but also promote analytical thinking and cooperative learning (Redondo-Rodríguez et al., 2023). For instance, sequencing events in digital narratives or solving puzzles in game-based activities enhances logical reasoning, decision-making, and adaptive skills (Yelland, 2018). Such structured interventions effectively support early digital literacy while concurrently nurturing creativity and cognitive growth, aligning with the study's objective of evaluating curricular outcomes.

Digital literacy extends traditional literacy into the digital domain, emphasizing the ability to critically access, evaluate, and utilize information across digital platforms (Anghelo Josué et al., 2023; Janattaka & Adella, 2021). Conceptualized digital literacy not merely as technical proficiency but as a cognitive skill requiring critical engagement with digital content (Chang & Yang, 2023; Yusuf et al., 2022). In education, this paradigm shift underscores the need to prepare learners for global challenges by fostering intellectual, ethical, and social competencies (Pang et al., 2023). Early exposure to digital literacy equips children to navigate globalization's dual effects: expanded access to knowledge and intercultural exchange, alongside challenges like academic competition and misinformation (Park et al., 2021; Reddy et al., 2023).

The rapid evolution of digital literacy has reshaped curriculum, prompting institutions to integrate media literacy, cybersecurity, and critical thinking into pedagogy (Asmayawati, 2023b; Lim & Tan-Chia, 2022). For young learners, diverse teaching strategies, such as guided play with educational apps help develop responsible information interpretation and dissemination, mitigating misinformation risks. These approaches align with broader educational goals of cultivating adaptable, discerning individuals capable of thriving in a digitized world (Foster & Piacentini, 2023).

The implementation of a digital literacy curriculum in Early Childhood Education (ECE) necessitates a holistic approach that aligns with children's cognitive, social, and motor development (Supriyadi, 2022; Tatminingsih, 2022). Research indicates that children aged 3–6 years can effectively engage with foundational digital literacy concepts through structured, play-based activities. Below are key principles and models for successful implementation:

Key Principles of Digital Literacy in ECE

The National Association for the Education of Young Children (NAEYC) three guiding principles:

a) Digital tools as a complement, not a replacement, for social interaction: For instance, tablets should facilitate active learning (e.g., documenting block-building projects) rather than passive consumption (e.g., watching videos).
b) Interactive content that fosters creativity: Applications like Draw and Tell enable children to create digital stories, enhancing narrative and fine motor skills.
c) Limited, age-appropriate screen time: The NAEYC recommends no more than 30 minutes per day for children aged 4–5 to mitigate risks of overexposure .

Effective Implementation Models

a) Guided Introduction to Digital Devices Children learn basic tablet or computer use under teacher supervision, engaging with drawing apps or interactive e-books to ensure active rather than passive technology use.
b) Cross-Curricular Integration Digital literacy should be embedded within existing curricula, such as: Digital storytelling to reinforce language development. Nature exploration using digital microscopes or cameras.
c) Digital Ethics and Safety Early lessons on privacy (e.g., not sharing personal photos) help cultivate responsible digital citizenship.
d) Play-Based Learning (Finland Model) Finnish ECE programs incorporate programmable robots (e.g., Blue-Bots) to teach sequencing and collaboration.
e) Local Context: Challenges in Developing Countries A JPPI (2024) study in Indonesia found that while 65% of urban private ECE programs use educational videos, only 12% teach digital safety. Infrastructure gaps further hinder adoption in low-resource settings.

Despite the potential benefits of digital literacy in early childhood education, issues such as limited access to technology and excessive screen time remain critical concerns. Educators need to ensure that digital activities are purposeful, engaging, and complement, rather than replace, hands-on and social play experiences. Implementation also differs across contexts: in countries like Finland, digital literacy is embedded within the national curriculum, while in many developing countries, inadequate infrastructure continues to hinder effective adoption. To maximize learning outcomes, technology should be used thoughtfully, fostering interaction and creativity without compromising direct social engagement.

3.2. Challenges in Curriculum Implementation

Despite documented benefits, digital literacy programs in early childhood education (ECE) face significant implementation challenges. Infrastructural inequities, particularly in rural and low-income regions, restrict access to devices and reliable internet, exacerbating disparities in learning opportunities (Woulfin & Jones, 2024). For example, only 35% of Southeast Asian ECE institutions have integrated digital literacy, compared to 78% in OECD countries, reflecting a global "*digital divide*" (Foster & Piacentini, 2023).

Curriculum standardization remains another critical issue. The absence of unified guidelines leads to inconsistent pedagogical approaches, with schools adopting ad hoc strategies that fail to ensure equitable skill development (Poulton & Mockler, 2024; Su & Zhong, 2022). For example, while Finland's Koodi2016 program standardizes play-based coding for 5- to 6-year-olds using robots, Indonesia lacks a national ECE digital literacy framework, resulting in fragmented adoption limited primarily to urban private schools.

Teacher competency gaps further hinder implementation. Many educators lack training to integrate technology pedagogically, leading to underutilization or ineffective use of digital tools (Poulton & Mockler, 2024; Su & Zhong, 2022). In Indonesia, where 87% of children use social media before age 13 (Insani et al., 2021), insufficient teacher training exacerbates risks like misinformation exposure, underscoring the urgency of teaching critical digital literacy (Amin et al., 2023).

Parental supervision also plays a pivotal role. Inadequate oversight of children's social media use, coupled with rapid technological advancements, necessitates a curriculum that emphasizes digital ethics (e.g., privacy protection) and adaptive learning to keep pace with evolving technologies (Kafoussi et al., 2019; Papadakis et al., 2019). Addressing these challenges requires multi-stakeholder collaboration: (1) government intervention to subsidize infrastructure in underserved areas, (2) teacher professional development programs focused on digital pedagogy, (3) public-private partnerships to align curricula with technological trends.

Despite the positive outcomes, several challenges significantly affect the effectiveness of digital literacy programs in early childhood settings. Firstly, unequal access to technological devices and reliable internet connectivity remains a major barrier, particularly in rural or low-income areas. This disparity often limits children's ability to engage with digital content fully and creates inequities in learning experiences. Second, the absence of standardized curriculum guidelines and assessment mechanisms leads to inconsistencies in teaching practices and learning outcomes. Different schools and teachers adopt varied approaches, resulting in a lack of uniformity in skills development. Thirdly, teacher competency in using digital tools varies widely; while some educators are adept at integrating technology, others lack sufficient training and confidence to manage digital learning effectively. These challenges highlight the need for comprehensive support systems that address infrastructure gaps, standardize curriculum content, and build teacher capacity (Beane, 2020; Poulton & Mockler, 2024).

Several challenges hinder the effective implementation of digital literacy curriculum. First, limited parental supervision over social media usage poses risks; the widespread dissemination of misinformation by students is also concerning. Additionally, unequal access to digital technologies and infrastructure across urban and rural areas can create gaps in digital literacy skills. Rapid technological advances also pose a significant challenge, requiring curricula to adapt continually to ensure students remain relevant in the evolving information and communication technology landscape. Security and digital ethics are equally critical; curriculum must emphasize safe and responsible use of technology, including privacy protection and ethical online interactions. Teacher readiness is another key factor, necessitating professional development to equip educators with the skills and knowledge to integrate digital tools into learning effectively. Collaboration among stakeholders, including government, educational institutions, tech industries, and civil society is essential for ensuring that curricula are relevant and implementable.

The implementation of a digital literacy curriculum in early childhood education (ECE) faces various technical and non-technical challenges:

1) Digital Divide Children from low-income families often lack access to digital devices at home, creating early disparities in skills. In rural areas, poor internet connectivity also hinders learning.
2) Educator Readiness Many ECE teachers are not trained in using educational technology.
3) Teacher Readiness: many PAUD teachers are not trained in educational technology. A study in Indonesia showed that only 30% of teachers felt confident teaching with digital tools.

4) Parental Resistance: Parents' concerns about the negative effects of screen time (e.g., sleep disruption or addiction) often act as barriers. Some parents also believe that technology is unnecessary at an early age.
5) Lack of Clear Curriculum Guidelines In many countries, there are no national standards for ECE digital literacy, making it difficult for schools to design appropriate materials.

These challenges require multidimensional solutions, including teacher training, device subsidies for underprivileged families, and awareness campaigns for parents. Without policy interventions, the digital divide is likely to widen further.

3.3. Strategies for Effective Digital Literacy Integration

The literature identifies several strategies that enhance the effectiveness of digital literacy curriculum implementation. One widely recognized approach is blended learning, which combines face-to-face instruction with technology-mediated activities, ensuring that children receive guided support while exploring digital tools independently. Another critical strategy is continuous teacher professional development, focusing on both technical skills and pedagogical approaches to integrate digital media meaningfully into learning activities (Huang et al., 2023; Li et al., 2021). Additionally, the selection of age-appropriate and pedagogically sound digital content is essential to maintain engagement and support holistic development, including socio-emotional learning. Activities that promote collaboration, creativity, and problem-solving, such as group digital storytelling or interactive puzzle games, have been particularly effective. Collectively, these strategies address the challenges identified above and provide a practical framework for maximizing the benefits of digital literacy curricula in early childhood education.

Blended Learning Models

A blended learning approach, combining face-to-face instruction with technology-mediated activities, allows children to explore digital tools while receiving guided support (Shamsuddin & Kaur, 2020; Sihabudin, 2021). For example, teachers might introduce tablets during circle time for collaborative storytelling, followed by hands-on activities that reinforce narrative skills. This method balances structured guidance with independent exploration, fostering both digital fluency and critical thinking. A thoughtfully designed blended learning model, which integrates both digital and non-digital activities, has demonstrated effectiveness for early childhood learners (Khotimah et al., 2022; Preez & West, 2022).

Teacher Professional Development

Continuous teacher training is critical for effective integration. Professional development programs should emphasize: technical proficiency, pedagogical strategies (Edgel et al., 2021; Hubers et al., 2022). Continuous professional development is critical for equipping teachers to effectively integrate digital literacy into early childhood education (Maureen et al., 2020; Supriyadi & Juwita, 2023). Training programs should cover pedagogical strategies, such as embedding technology across curriculum areas, for example, using digital storytelling to enhance literacy skills. Additionally, teachers need guidance on identifying and mitigating online risks, including cyberbullying and exposure to

inappropriate content. Finally, effective assessment strategies should be emphasized, enabling educators to document and track children's progress in developing digital skills.

Parental Engagement and Education

Active parental involvement is essential for reinforcing digital literacy outside the classroom. Schools can support this by conducting regular workshops that guide parents in selecting age-appropriate and educational digital content and implementing strategies to manage screen time. In addition, providing take-home resources on digital safety and productive technology use helps parents extend learning at home and ensures a consistent, safe, and meaningful digital experience for young children (Insani et al., 2021; Yulianti et al., 2022).

Curricular Integration and Age-Appropriate Design

Digital literacy should be integrated into existing early childhood curricula rather than delivered as a separate subject. Effective integration requires careful consideration of both socio-emotional and developmental factors. From a socio-emotional perspective, educators should prioritize applications that encourage collaboration and interaction, such as group storytelling tools like Book Creator, rather than apps focused on passive consumption. In terms of developmental appropriateness, digital tools should support key skills relevant to young learners, including fine motor development through activities like drag-and-drop puzzles and executive function through logic-based games such as Thinkrolls (Kalogiannakis et al., 2021; Papanastasiou et al., 2019). By aligning digital literacy experiences with children's social, emotional, and cognitive development, technology can complement traditional learning while fostering meaningful engagement.

Stakeholder Collaboration and Values-Based Frameworks

Effective implementation of digital literacy in early childhood education benefits from collaboration among multiple stakeholders and the integration of values-based frameworks. Strategy demonstrates how digital literacy can be aligned with character education (Dimas & Laili, 2025). First, value internalization involves embedding core principles, such as Pancasila values like mutual respect, into lessons on digital citizenship. Second, positive behavioral modeling entails establishing school-wide norms that guide responsible and ethical technology use. Third, fostering community partnerships, particularly through parent workshops, helps families manage screen time and reinforce digital safety practices at home (Fatqurhohman, 2025). By connecting curriculum, school culture, and family engagement, this approach ensures.

Open Educational Resources (OERs)

Leveraging Open Educational Resources (OERs) provides a practical strategy to enhance equitable access to digital literacy in early childhood education (Aldosemani, 2023; Erny Arniza, 2024). Resources such as digital textbooks, instructional videos, and coding platforms offer cost-effective tools that support learning without requiring extensive infrastructure. In Indonesia, the Merdeka Curriculum exemplifies this approach by integrating OERs to bridge educational disparities between urban and rural settings (Intiana et al., 2023; Nisa et al., 2023). By incorporating freely accessible and adaptable learning materials, OERs not only expand opportunities for digital engagement but also promote inclusive and context-sensitive pedagogical practices.

Unplugged Digital Literacy Activities

Research highlights the effectiveness of device-free approaches in introducing foundational digital concepts to young learners. For example, algorithmic thinking can be nurtured through card games or physical movement exercises that teach sequencing and problem-solving skills. Digital ethics can be conveyed through story-based lessons that emphasize online safety and responsible behavior (Fatqurhohman & Huda, 2025). Additionally, sensory activities that develop fine motor skills help prepare children for future device use (Papadakis et al., 2019; Papanastasiou et al., 2019). Collectively, these strategies provide a balanced approach to digital literacy, addressing challenges related to accessibility, teacher readiness, and developmental appropriateness in early learning contexts.

3.4. Synthesis and Implications

The findings indicate that effective implementation of digital literacy in early childhood education (ECE) requires a comprehensive, multi-dimensional approach. Technology provision alone is insufficient; Educators must possess the pedagogical skills to facilitate meaningful learning experiences, while the curriculum must balance digital engagement with developmental appropriateness. Equally important is addressing infrastructure and equity issues to ensure all children benefit from early exposure to digital tools (Meirbekov et al., 2022; Windram et al., 2023). These insights directly respond to research questions by clarifying the outcomes of digital curriculum implementation, the challenges encountered, and strategies that enhance effectiveness (Kim, 2024; Supriyadi, 2022). Ongoing evaluation and adaptation of teaching practices are essential to align digital literacy education with both technological advances and children's developmental needs, promoting cognitive, social, and creative growth.

Digital literacy offers substantial benefits, including efficient access to information, cost-effectiveness, data security, enhanced connectivity, improved decision-making, broader career opportunities, and positive societal impact (Kim, 2024). By fostering critical thinking, ethical awareness, and technical competencies, learners become capable of navigating the digital environment responsibly (Afrilyasanti & Basthomi, 2023; Amin et al., 2023). Implementing a digital literacy curriculum effectively requires addressing challenges related to equity, safety, ethics, teacher readiness, and technology availability. Strategic curricular integration, reinforced by collaboration among schools, families, and communities, ensures that learners acquire comprehensive skills necessary to thrive in a globalized, digital society. This approach enables students not only to access information but also to critically evaluate, analyze, and disseminate it responsibly, supporting informed and ethical participation in society.

Success in ECE digital literacy programs rests on three key pillars. First, systemic support, including competency-based teacher training (minimum 30 hours annually), access to affordable devices, and clear government policies, provides a crucial foundation. Second, contextual challenges such as limited resources in rural areas, parental concerns over screen time (45%), and variations in child developmental readiness must be addressed through localized strategies. Third, evidence from program evaluations demonstrates positive outcomes, such as guided discovery learning, digital manipulatives, and cross-platform activities were particularly effective.

4. CONCLUSION

This study underscores the importance of integrating socio-cultural context, policy alignment, and pedagogical innovation in early childhood digital literacy. Effective implementation requires culturally responsive strategies, equitable access, and alignment with national and international educational policies. Play-based and developmentally appropriate approaches, combined with family engagement and teacher preparedness, foster both digital competence and holistic child development. Challenges such as infrastructure gaps, limited teacher skills, stakeholder resistance, and privacy concerns highlight the need for targeted policy interventions, professional development, and multi-stakeholder collaboration. Contextualized solutions, including micro-credential training, open educational resources, and community partnerships, can mitigate these barriers.

Policy implications include establishing a national curriculum framework integrating technical skills with character education, sustained investment in infrastructure and teacher training, and holistic assessment systems, such as digital portfolios. Future research should examine the longitudinal impact of these frameworks on school readiness, digital equity, and pedagogical outcomes, particularly in diverse socio-cultural settings. Investing in early digital literacy not only equips children for the digital era but also promotes ethical, inclusive, and sustainable societal development.

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