The Role of Artificial Intelligence in Enhancing Early Literacy in Early Childhood Education: A Systematic Literature Review

Sitti Noriana, Kamariah Abu Bakar

Universiti Kebangsaan Malaysia (UKM)

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0660

Received: 15 October 2025; Accepted: 22 October 2025; Published: 14 November 2025

ABSTRACT

This Systematic Literature Review (SLR) investigates how Artificial Intelligence (AI) enhances early literacy learning and examines its pedagogical, ethical, and cultural implications within early childhood education. Guided by the PRISMA 2020 framework, 18 peer-reviewed studies published between 2020 and 2025 in Scopus and Web of Science databases were systematically reviewed. The synthesis highlights key AI applications, such as adaptive storytelling platforms, robot-assisted literacy tools, and generative text systems that are able to support vocabulary growth, reading comprehension, and active engagement among young learners. Findings indicate that AI fosters personalized, inclusive, and culturally responsive literacy instruction while transforming teachers into reflective designers, facilitators, and evaluators of learning. Nevertheless, issues such as limited AI literacy among educators, unequal access to digital resources, and ethical concerns surrounding privacy and algorithmic bias remain significant. The study concludes that sustainable AI integration requires continuous teacher training, robust ethical frameworks, and equitable technological access to advance inclusive and innovative early literacy education.

Keywords: Artificial intelligence (AI); Early Childhood Education; Early literacy; Teacher competency

INTRODUCTION

Artificial Intelligence (AI) is increasingly shaping the global landscape of education by enabling personalized, data-driven, and adaptive learning experiences. While AI adoption is more established in higher and secondary education, its integration into early childhood education (ECE) represents a promising yet under-explored frontier (Kewalramani et al., 2021). The preschool years are foundational for literacy development, during which language, communication, and cognitive skills form the basis for lifelong learning. Integrating AI into early literacy instruction offers opportunities to enhance these skills through adaptive storytelling, intelligent feedback, and multimodal learning environments (Azhar et al., 2025).

Globally, AI technologies have been used to foster young children's reading fluency, vocabulary growth, and phonemic awareness through speech recognition, conversational agents, and robot-assisted learning (Al-Bogami & Alahmadi, 2025). These tools provide individualized instruction by analyzing children's responses and tailoring content according to developmental progress. However, challenges persist regarding teachers' AI literacy, ethical considerations, data privacy, and cultural relevance (Daher, 2025; Zaidi et al., 2024).

Given these opportunities and challenges, this Systematic Literature Review (SLR) aims to synthesize empirical evidence on how AI supports early literacy development among preschool children. Specifically, it explores the pedagogical approaches, learning outcomes, and contextual factors influencing AI integration in early literacy instruction. By examining studies indexed in Scopus and Web of Science, this review contributes to understanding how AI can be harnessed to promote equitable, developmentally appropriate, and culturally responsive early learning. The findings are expected to guide educators, researchers, and policymakers in designing future AI-infused literacy interventions that strengthen both teaching practice and young children's holistic development. The objectives of this study are:

1. To identify and synthesize how Artificial Intelligence (AI) applications enhance early literacy learning among young children.

2. To analyze the pedagogical, ethical, and cultural implications of AI integration in early literacy.

METHODOLOGY

Study Design

This study used the Scopus and Web of Science (WoS) databases to visualize and identify knowledge and methodological gaps related to the challenges and impacts of technology adoption in education. The data search was conducted between September 1, 2025, to October 15, 2025. Relevant articles were selected based on eligibility criteria to ensure that the review reflects the most recent developments. Scopus and WoS databases were chosen for their strong track record as globally recognized bibliographic databases (Zhu & Liu, 2020). Both meet the core requirements for a systematic review due to their broad disciplinary coverage, advanced search capabilities, including the use of Boolean operators, and transparent, replicable processes that maintain the integrity of the study (Gusenbauer & Haddaway, 2020). The use of these high-quality databases ensures the accuracy and reliability of conducting the literature review (Zhao, 2014). The review followed the PRISMA guidelines to evaluate and select articles. The process included identification, screening, eligibility assessment, and inclusion. The PRISMA flow chart used in this study (Figure 1) is an adaptation of the original chart developed by Moher et al. (2009) and subsequently modified by Page et al. (2021).

Prisma Guidelines

This SLR was conducted by using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis). The advantages of PRISMA are the elements of transparency, consistency, and high standards in the preparation of qualitative study reports through certain processes (Flemming et al. 2019). This systematic literature review followed the PRISMA 2020 framework (Page et al., 2021), which ensures transparency and replicability through four main stages: identification, screening, eligibility, and inclusion. In the identification phase, a structured search was conducted across Scopus and Web of Science using Boolean operators and field-specific keywords related to artificial intelligence, early childhood education, and early literacy. The search yielded 178 records (109 from Scopus and 69 from Web of Science). The exact search strings used in both databases are presented in Table 1.

Table 1 Search strings used in the databases

Database	Search String
Scopus	TITLE-ABS-KEY=("artificial intelligence" OR AI OR "machine learning" OR "intelligent tutoring system*" OR "adaptive learning system*") AND ("early childhood education" OR preschool* OR kindergarten* OR "early years" OR "pre-primary") AND ("literacy" OR "early literacy" OR "reading skills" OR "emergent literacy")
Web of Science	TOPIC=("artificial intelligence" OR AI OR "machine learning" OR "intelligent tutoring system*" OR “adaptive learning system*”) AND (“early childhood education" OR preschool* OR kindergarten* OR "early years" OR "pre-primary”) AND ("literacy" OR "early literacy" OR "reading skills" OR "emergent literacy")

During the screening stage, duplicate and irrelevant articles were removed using Microsoft Excel, followed by application of the inclusion and exclusion criteria outlined in Table 2. Only English-language, peer-reviewed journal articles published between 2020 and 2025 and indexed in the Social Science Citation Index were retained.

Table 2 Inclusion and exclusion criteria

Criteria	Inclusion Criteria	Exclusion Criteria
Literature type	High Impact Article Open Access journal	Low-impact articles, systematic literature reviews, conference proceedings, book series, book chapters

Language	English	Non English
Timeline	2020–2025	≤ 2019
Index	Social Science Citation Index	Non Social Science Citation Index
Countries	Worldwide	No

In the eligibility and inclusion phases, the remaining studies were assessed in full text to ensure methodological rigor and alignment with the review objectives. After excluding unrelated and inaccessible papers, 18 high-quality studies were finalized for synthesis. The overall process is summarized visually in the PRISMA flow diagram (Figure 1), demonstrating the systematic progression from initial retrieval to final inclusion.

Quality Assessment

The quality of the selected studies was assessed using Kitchenham's (2004) systematic review guidelines, adapted to the context of this study. Each of the 18 articles was evaluated against 15 quality assessment (QA) questions covering research objectives, methodology, data sources, analysis, limitations, and practical recommendations related to AI, early literacy, and early childhood education. The questions are:

QA1	Does the study clearly state its main objective or research problem in the context of AI and early literacy in early childhood education?
QA2	Does the study provide a clear description of the educational context where the AI intervention is applied?
QA3	Does the study identify and discuss key challenges or barriers in implementing the AI intervention for early literacy learning?
QA4	Does the study describe specific impacts or outcomes of AI integration on children's early literacy skills?
QA5	Does the study clearly explain the data sources used to evaluate the AI intervention?
QA6	Does the study describe the methods of data collection in sufficient detail?
QA7	Does the study apply appropriate tools, instruments, or analytical to analyze the data?
QA8	Is the sample size and participant profile adequate and appropriate to support the study's conclusions?
QA9	Does the study implement strategies to reduce bias in data collection and analysis?
QA10	Does the study adopt suitable methods to evaluate the impact of AI on literacy outcomes?
QA11	Are the results presented clearly, with well-structured findings directly linked to AI interventions and literacy outcomes?
QA12	Does the study compare or relate its findings to previous empirical research in early childhood education or AI-based literacy learning?
QA13	Does the study justify its chosen research design and analytical methods?
QA14	Does the study acknowledge its limitations?
QA15	Does the study provide clear and practical recommendations for future research or practice on the use of AI in enhancing early literacy?

Each criterion was rated 1 (Yes), 0.5 (Partially), or 0 (No), with a maximum possible score of 15. Based on total scores, studies were categorized as Excellent (13.5–15), Good (9.5–13.5), Average (5–9), or Failed (0–4.5). The average score across all studies was 10.6, indicating that most fell within the Good category and were suitable for inclusion in the synthesis. The detailed evaluation of each article is presented in Table 3, which demonstrates that the selected studies met the methodological standards required for rigorous systematic analysis.

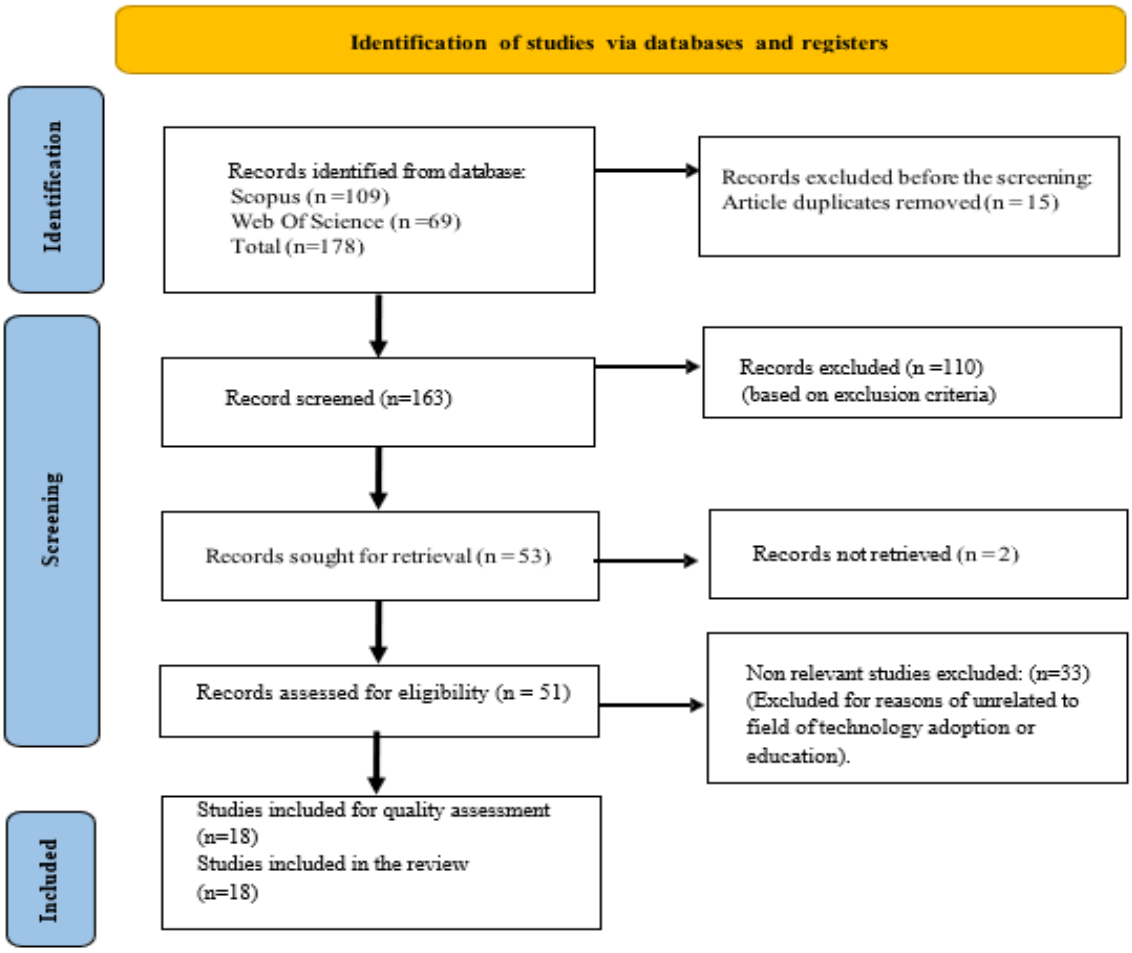
Table 3: Article's quality assessment (Kitchenham, 2004)

No	Author (Year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Score
1	Kölemen, & Yıldırım, (2025)	1	0.5	0.5	0	1	1	1	1	0.5	0	1	0.5	0.5	1	1	10.5
2	Bem-Haja et al., 2025	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	14
3	Muhammad Arif et al., 2025	0.5	1	0	0.5	1	1	1	1	0	1	1	0.5	0.5	1	1	11
4	Zhang, 2025	1	1	0.5	0.5	0.5	1	1	1	0.5	1	1	1	1	0.5	1	12.5
5	Lu et al., 2024	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	9.5
6	Arn and Huang. 2024	0.5	1	0	0.5	1	1	1	1	0.5	0.5	0.5	1	1	1	1	11.5
7	Kazanidis and Pellas (2024)	1	1	0.5	0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	13
8	Su and Yang (2024)	0.5	1	0.5	0	0	0	0.5	0	0	0	0.5	1	0.5	1	1	6.5
9	Luo et al., (2024)	1	0.5	0.5	0	1	1	0.5	0.5	0.5	0	1	0.5	1	1	1	10
10	You and Yang (2024)	0.5	1	0	0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	12
11	Sanusi et al. (2024)	0.5	1	0.5	0	0.5	1	0.5	1	0	0.5	0.5	1	1	1	0.5	9.5
12	Su and Zhong 2022	1	0.5	1	0.5	0	0	0	0	0	0.5	1	1	1	1	1	8.5
13	Yang 2022	1	1	1	0.5	0.5	0	0	0	0	0	0.5	1	0.5	0.5	1	7.5
14	Sun et al., 2025	1	1	1	0	0.5	1	1	1	1	0	1	1	1	0.5	0.5	11.5
15	Li and Yu (2025)	1	1	1	0.5	1	1	1	0.5	0.5	0.5	0.5	1	1	1	1	12.5
16	Xu et al. (2024)	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	14.5
17	Park & Hassairi, 2021	0.5	0	0	0	1	1	1	0	0.5	0	0.5	0.5	1	1	0.5	7.5
18	Messinger et al., 2022	0.5	0	0	0	1	1	1	0.5	0.5	0	0.5	0.5	1	1	0.5	8.0
	AVERAGE 10.6																**190**

Data Extraction and Analysis

Data extraction was done based on the study objectives and entered into a table to facilitate the analysis process. The thematic analysis approach was used to identify relationships between subthemes (Braun & Clarke, 2006). This technique was considered appropriate because of its flexibility and descriptive nature, allowing researchers to organize findings systematically in line with the study objectives.

Figure 1: PRISMA systematic literature flow chart adapted from Page et al. (2021)



Findings

AI-Supported Literacy Learning Environments

Artificial intelligence (AI) has redefined the landscape of early literacy instruction by transforming conventional classrooms into interactive and adaptive learning environments. These environments encourage active participation, creativity, and sustained engagement among young learners. Recent studies indicate that AI-powered storytelling platforms integrate visual elements, narration, and speech recognition features to create dynamic literacy experiences that stimulate imagination and enhance comprehension (Lu et al., 2024; Arn & Huang, 2024; Su & Yang, 2024). In addition, play-based and robot-assisted activities have been shown to strengthen vocabulary development and reading fluency through dialogic interaction, physical engagement, and responsive feedback (You & Yang, 2024; Kölemen & Yıldırım, 2025). AI-driven adaptive systems further personalize literacy instruction by analyzing each child's learning progress, language proficiency, and emotional responses. This adaptive mechanism ensures that literacy support is aligned with the developmental readiness and linguistic diversity of individual learners (Zhang, 2025; Bem-Haja et al., 2025). Wagner (2024). It is also demonstrated that AI tools such as ChatGPT and Google Bard enable educators to generate differentiated reading materials suited to varying levels of vocabulary mastery and comprehension. Teachers reported that these tools enhanced children's engagement and offered greater flexibility in managing multilingual classrooms. Collectively, these findings suggest that AI functions not merely as a technological tool but as a pedagogical

partner that supports teachers in designing creative, equitable, and developmentally appropriate literacy experiences in early childhood education.

AI as a Tool for Personalized and Data-Driven Literacy Instruction

Artificial intelligence (AI) functions as a transformative mechanism for personalized and data-driven literacy instruction, enabling educators to make pedagogical decisions grounded in precise and continuous learner analytics. Through the application of predictive modeling, AI systems identify early literacy risk factors by analyzing multifactorial datasets that encompass children's language exposure, cognitive processing speed, and behavioral engagement. Such predictive diagnostics support early intervention strategies, allowing educators to tailor instruction before literacy challenges become entrenched (Bem-Haja et al., 2025). Furthermore, AI enhances the precision of literacy assessment by integrating diverse data streams such as cognitive, linguistic, and emotional, into comprehensive learner profiles. This integration enables educators to track reading fluency, vocabulary growth, and motivation levels in real time, providing a more holistic picture of literacy progress (Sun et al., 2025). Beyond diagnostic capabilities, AI facilitates data-informed teaching strategies by offering actionable insights derived from large-scale analyses of classroom and policy-level data. Machine learning and natural language processing (NLP) models, for instance, have been applied to examine educational policies and early learning outcomes, revealing the contextual factors that sustain or hinder literacy equity (Park & Hassairi, 2021). Similarly, AI-driven computational tools have been employed to analyze children's classroom interactions, such as capturing phonemic diversity, conversational turn-taking, and engagement levels for teachers' reflection and instructional refinement (Messinger et al., 2022). It shows that AI transcends the role of a technological supplement into an intelligent partner in literacy pedagogy, empowering educators to interpret data meaningfully, individualize learning pathways, and continuously enhance literacy instruction through evidence-based decision-making.

AI-Enhanced Communication and Language Development

According to Lu et al. (2024), artificial intelligence (AI) storytelling platforms have transformed early literacy instruction by enabling young children to co-construct digital narratives through visual prompts, voice input, and interactive dialogue. These multimodal experiences stimulate imagination, encourage self-expression, and strengthen engagement in language learning. Arn and Huang (2024) further observed that AI-generated storytelling enhances comprehension by linking visual and auditory elements, helping children form stronger connections between spoken and written language. Recent studies also revealed that play-based and robot-assisted AI applications improve vocabulary and reading fluency through conversation, movement, and real-time feedback (You & Yang, 2024; Kölemen & Yıldırım, 2025). Similarly, Zhang (2025) found that adaptive AI systems personalize literacy instruction according to each child's learning pace and emotional engagement, while Bem-Haja et al. (2025) emphasized their effectiveness in supporting linguistic diversity. Wagner (2024) noted that tools such as ChatGPT and Google Bard allow teachers to create differentiated reading materials that align with children's vocabulary and comprehension levels. Complementing these findings, Xu et al. (2022) demonstrated that dialogic reading with a conversational AI agent significantly improved children's story comprehension by sustaining engagement and prompting relevant dialogue. This evidence underscores the role of AI as a responsive literacy partner that promotes interaction, comprehension, and communication in early learning contexts.

Culturally Responsive and Ethical AI Literacy Practices

While previous studies have highlighted the pedagogical value of AI in literacy learning, recent attention has turned to its cultural and ethical dimensions in early childhood education. Research by Li and Yu (2025) indicates that AI-generated storytelling enables educators to design literacy materials that embed local traditions, values, and community knowledge, allowing children to see their identities reflected in classroom learning. Culturally adaptive AI models, as demonstrated by Sun et al. (2025), enhance comprehension and engagement by aligning narratives with children's linguistic and cultural contexts. Yang (2022) and Luo et al. (2024) further found that AI-mediated storytelling fosters empathy and intercultural awareness by exposing learners to diverse perspectives and global experiences. However, the increasing integration of AI into education heightens ethical concerns. Kölemen and Yıldırım (2025) and Su and Zhong (2022) underscore the teacher's role as an ethical

mediator who safeguards privacy, ensures responsible AI use, and mitigates algorithmic bias. Ethical reflection is crucial, especially when literacy activities involve children's cultural identity and data sensitivity. These findings reveal that AI operates as both a pedagogical and moral framework, cultivating inclusivity, empathy, and digital ethics within early literacy education.

AI-Infused Teacher Competency and Pedagogical Innovation

Artificial intelligence (AI) is redefining the professional identity of early childhood educators by enhancing their roles as designers, facilitators, and evaluators of literacy instruction. Developing AI literacy is essential for teachers to integrate digital tools meaningfully into early literacy pedagogy. When educators possess AI competence, they are better able to design inclusive, data-informed, and creative literacy experiences that correspond to children's developmental and cultural needs (Li & Yu, 2025; Zhang, 2025). This professional advancement encourages a transformation in teaching practices, where AI supports the integration of storytelling, robotics, and reflective dialogue to create engaging and imaginative classroom environments that combine play, inquiry, and digital exploration. AI-based platforms also enable teachers to guide collaborative literacy activities such as co-creating digital stories or engaging with intelligent robots, which foster expressive and critical language use among young learners (Kazanidis & Pellas, 2024; Su & Yang, 2024). In addition, the use of generative AI systems helps to ease teachers' administrative responsibilities by assisting in lesson planning, literacy assessment, and differentiated material development, giving them more time for reflection and interaction with children (Sun et al., 2025). Rather than replacing teachers, AI strengthens their professional judgment through intelligent automation and continuous feedback.

Research and Policy Implications for Equitable Literacy Development

Artificial intelligence (AI) is reshaping the research and policy landscape of early childhood education by providing data-driven insights and analytical tools that advance equitable literacy development across diverse contexts. Through machine learning and natural language processing (NLP), policymakers and researchers can systematically evaluate early childhood legislation and identify the structural factors that predict the success of literacy-related policies. Such computational approaches reveal how investments in teacher training, curriculum reform, and family engagement influence literacy outcomes, thereby promoting evidence-based governance and informed decision-making (Park & Hassairi, 2021). At the curriculum level, AI supports evidence-based innovation by enabling educators and researchers to design developmentally appropriate and inclusive literacy frameworks that align with children's cognitive, linguistic, and cultural needs. By integrating adaptive technologies, AI-enhanced curricula can personalize literacy learning while maintaining developmental integrity and ethical balance (Su & Zhong, 2022; Yang, 2022). Moreover, AI contributes to equity and accessibility by addressing disparities in literacy learning opportunities, particularly for children from marginalized or multilingual backgrounds. Intelligent assessment systems, automated speech analysis, and culturally responsive AI tools help educators identify learning barriers and provide individualized interventions that promote inclusive participation (Messinger et al., 2022; Li & Yu, 2025). These findings underscore AI's potential to act as both an instrument of educational reform and a catalyst for social equity, bridging the gap between policy, practice, and pedagogy. By leveraging AI in research, curriculum design, and policymaking, early childhood education systems can move toward more just, inclusive, and data-informed literacy environments that ensure all children have equitable access to foundational learning opportunities.

DISCUSSION

The integration of Artificial Intelligence (AI) in early childhood education marks a transformative shift in teachers' professional identity from content deliverers to designers, facilitators and evaluators of learning. AI-driven platforms empower educators to personalize literacy instruction, analyze learner data and create adaptive pedagogical environments that align with children's developmental needs. This transformation enhances teachers' professional autonomy by enabling them to interpret real-time analytics, design responsive literacy materials and engage in reflective decision-making processes. To fully leverage these opportunities, teacher education programs must embed AI literacy and data interpretation skills into their curricula, ensuring personalizing learning, automating tasks and fostering critical thinking and innovation among educators (Daher, 2025).

However, despite these opportunities, AI integration introduces new professional challenges that may compromise teachers' agency and critical judgment. The over-reliance on AI-generated feedback and automated decision-making can lead to "technological dependency," where educators' reflective capacity and contextual sensitivity diminish over time. Furthermore, the increasing use of AI tools may intensify teachers' cognitive workload as they adapt to continuous data monitoring and system management. To mitigate these risks, educators must balance technological efficiency with pedagogical discernment using AI as a reflective partner rather than a prescriptive authority. Developing AI-competent teachers, therefore, requires not only technical training but also ethical awareness and critical pedagogy that uphold human-centered teaching values (Lakhe Shrestha et al., 2025).

Artificial Intelligence (AI) holds significant promise for inclusive literacy development when designed with cultural responsiveness in mind. AI-powered storytelling systems can embed local languages, narratives and values, thereby strengthening children's cultural identity and sense of belonging. For example, AI systems that adapt story content to align with a child's home language or cultural references can affirm their sociocultural backgrounds and support literacy engagement. As Yang et al. (2022) argue, early AI curriculum models should adopt "embodied, culturally responsive" approaches to help young learners meaningfully explore AI within their own contexts (Yang et al., 2022).

Contextual adaptation frameworks for AI in early childhood education emphasize tailoring technology to fit local cultures, resources, and pedagogical norms. In culturally diverse and resource-limited settings, AI tools must align with linguistic diversity, community values, and infrastructural realities rather than adopting Western-centric designs. It shows that an effective contextual adaptation involving local educators, policymakers, and technologists is paramount to ensure AI enhancements do not replace human-centered pedagogy.

Nevertheless, serious risks accompany AI adoption in literacy environments, especially where access and local adaptation are weak. A critical concern is the digital divide: children in low-income, rural, or marginalized communities may lack access to high-quality devices, stable connectivity, or AI-enabled tools, which exacerbates existing educational disparities. In fact, the growing gap between those who can harness AI and those who cannot may create a "new digital divide" as AI-enhanced learning becomes the norm for advantaged groups. In addition, many AI systems are designed with Western pedagogical assumptions and standardized language corpora, risking cultural homogenization in early literacy content. Without intentional localization, these systems may dilute or override indigenous pedagogies, linguistic diversity, and community values. Thus, balancing global AI design with local educational philosophies requires participatory co-design processes involving local educators, families and communities (Oyetade & Zuva, 2025).

Ensuring ethical and equitable AI integration in early literacy requires proactive and inclusive strategies. First, embedding digital ethics modules within teacher education programs can cultivate awareness of algorithmic bias, data security, and responsible AI use. Second, developing culturally localized AI literacy content in collaboration with educators ensures learning materials reflect children's linguistic and social realities rather than imported models. Finally, establishing child-data privacy frameworks aligned with UNESCO's AI ethics guidelines safeguards children's rights while promoting transparent data handling. Together, these strategies foster an AI ecosystem that upholds equity, cultural inclusivity, and human-centered pedagogy in early childhood education.

The findings of this study hold significant implications for advancing SDG 4 (Quality Education) through inclusive and equitable AI integration in early childhood settings. Artificial Intelligence (AI) can empower teachers to adopt data-informed, reflective, and culturally responsive literacy practices that honor the linguistic and social diversity of young learners. In alignment with UNESCO's AI competency guidelines, educators should develop digital ethics, critical thinking, and adaptive pedagogical skills to ensure that AI use remains responsible, transparent, and developmentally appropriate. Continuous professional development programs must strengthen teachers' AI literacy and ethical awareness, while policymakers should expand equitable access to digital infrastructure across preschools. When guided by child-centered and culturally grounded principles, AI becomes a transformative ally that advances creativity, inclusion, and lifelong learning for all children.

Despite growing evidence of AI's benefits in early literacy, several limitations remain across the reviewed

studies. Many rely on small, context-specific samples or Western-centric datasets, creating potential publication bias and limiting generalizability to diverse educational settings. Furthermore, most interventions emphasize technological efficiency over holistic child development, revealing an overdependence on automated tools for instruction and assessment. Such reliance risks diminishing teachers' reflective judgment and human connection in learning processes. Therefore, maintaining a human-centered pedagogy is essential to ensure balanced, ethical, and developmentally appropriate literacy education in early childhood contexts.

Future research on artificial intelligence (AI) in early childhood education should aim to develop culturally responsive, ethically sound, and pedagogically appropriate frameworks to guide AI integration in literacy teaching. Longitudinal studies are needed to understand how AI-supported learning environments influence children's language, cognitive, and socio-emotional development over time. Researchers should also examine the evolving roles of teachers in AI-mediated classrooms, focusing on ways to strengthen AI literacy, critical thinking, and reflective practice. In addition, cross-cultural comparative studies can provide valuable insights into how local contexts affect the equity and inclusivity of AI-based literacy interventions. Collaboration among educators, technologists and policymakers will be crucial to ensure that AI applications align with early childhood development principles and global goals for educational equity. Ultimately, future studies should design AI systems that are not only technologically advanced but also culturally sensitive, transparent, and empowering for both teachers and young learners.

CONCLUSION

This systematic literature review concludes that Artificial Intelligence (AI) has transformative potential in enhancing early literacy within early childhood education. The findings demonstrate that AI can serve as a pedagogical partner, empowering educators to design adaptive, data-driven, and culturally responsive learning environments. However, realizing this potential depends on educators' AI literacy, equitable access to technology, and ethical implementation. While AI promotes inclusivity and creativity in literacy instruction, challenges such as digital inequality, cultural homogenization, and teacher dependency must be addressed through targeted policies and professional development. It can be concluded that AI should not replace the human element of teaching but rather augment it, fostering reflective, empathetic, and child-centered pedagogy. Future research and practice must continue to explore frameworks that ensure AI integration aligns with developmental appropriateness, cultural diversity, and the holistic goals of early childhood education.

REFERENCES

1. Al-Bogami, R. M., & Alahmadi, N. A. (2025). Effects of an AI-Based Reading Progress Tool on Third-Grade EFL Learners' Oral Reading Fluency. Computers and Education Open, 100283. https://doi.org/10.1016/j.caeo.2025.100283
2. Arif, M., Ismail, A., & Irfan, S. (2025). AI-powered approaches for sustainable environmental education in the digital age: A study of Chongqing International Kindergarten. International Journal of Environment, Engineering and Education, 7(1), 35-47. https://doi.org/10.55151/ijeedu.v7i1.184
3. Arn, L., & Huang, E. M. (2024). "Robots Can Do Disgusting Things, but Also Good Things": Fostering Children's Understanding of AI through Storytelling. ACM Transactions on Computing Education, 24(3), 1-55. https://doi.org/10.1145/3677613
4. Azhar, M., Hin, H. S., & Kian, N. T. (2025, April). Enhancing Early Childhood Reading Skills Through Immersive AR and Conversational AI. In 2025 13th International Conference on Information and Education Technology (ICIET) (pp. 71-75). IEEE. https://doi.org/10.1109/ICIET66371.2025.11046302
5. Bem-Haja, P., Nossa, P., Ferreira, A. J., Pereira, D. S., & Silva, C. F. (2025). AI analysis reveals top predictors of first grade success: Insights from multifactorial screening students' early days of school. Computers and Education: Artificial Intelligence, 100415. https://doi.org/10.1016/j.caeai.2025.100415
6. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101. https://doi.org/10.1191/1478088706qp063oa
7. Daher, R. (2025). Integrating AI literacy into teacher education: a critical perspective paper. Discover Artificial Intelligence, 5(1), 217. https://doi.org/10.1007/s44163-025-00475-7

8. Flemming, K., Booth, A., Garside, R., Tunçalp, Ö., & Noyes, J. (2019). Qualitative evidence synthesis for complex interventions and guideline development: Clarification of the purpose, designs and relevant methods. BMJ Global Health, 4(000882), 1–9. https://doi.org/10.1136/bmjgh-2018-000882
9. Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. Research Synthesis Methods, 11(2), 181–217. https://doi.org/10.1002/jrsm.1378
10. Kazanidis, I., & Pellas, N. (2024). Harnessing generative artificial intelligence for digital literacy innovation: A comparative study between early childhood education and computer science undergraduates. AI, 5(3), 1427-1445. https://doi.org/10.3390/ai5030068
11. Kewalramani, S., Kidman, G., & Palaiologou, I. (2021). Using Artificial Intelligence (AI)-interfaced robotic toys in early childhood settings: a case for children's inquiry literacy. European Early Childhood Education Research Journal, 29(5), 652-668. https://doi.org/10.1080/1350293X.2021.1968458
12. Kitchenham, B. (2004). Procedures for performing systematic reviews. Keele, UK, Keele University, 33(2004), 1-26.
13. Kölemen, E. B., & Yıldırım, B. (2025). A new era in early childhood education (ECE): Teachers' opinions on the application of artificial intelligence. Education and Information Technologies, 1-42. https://doi.org/10.1007/s10639-025-13478-9
14. Lakhe Shrestha, B. L., Dahal, N., Hasan, M. K., Paudel, S., & Kapar, H. (2025). Generative AI on professional development: a narrative inquiry using TPACK framework. In Frontiers in Education (Vol. 10, p. 1550773). Frontiers Media SA. https://doi.org/10.3389/feduc.2025.1550773
15. Li, X., & Yu, S. (2025). Culturally responsive AI module in early childhood teacher education: an action research. Journal of Early Childhood Teacher Education, 1-17. https://doi.org/10.1080/10901027.2025.2552973
16. Lu, R. S., Lin, H. C. K., Yang, Y. C., & Chen, Y. P. (2024). Integrating Urban Mining Concepts Through AI-Generated Storytelling and Visuals: Advancing Sustainability Education in Early Childhood. Sustainability (2071-1050), 16(24). https://doi.org/10.3390/su162411304
17. Lu, R. S., Lin, H. C. K., Yang, Y. C., & Chen, Y. P. (2024). Integrating Urban Mining Concepts Through AI-Generated Storytelling and Visuals: Advancing Sustainability Education in Early Childhood. Sustainability (2071-1050), 16(24). https://doi.org/10.3390/su162411304
18. Luo, W., He, H., Gao, M., & Li, H. (2024). Safety, identity, attitude, cognition, and capability: The 'SIACC'framework of early childhood AI literacy. Education Sciences, 14(8), 1-19. https://doi.org/10.3390/educsci14080871
19. Messinger, D. S., Perry, L. K., Mitsven, S. G., Tao, Y., Moffitt, J., Fasano, R. M., ... & Jerry, C. M. (2022). Computational approaches to understanding interaction and development. In Advances in child development and behavior (Vol. 62, pp. 191-230). JAI. https://doi.org/10.1016/bs.acdb.2021.12.002
20. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Bmj, 339. https://doi.org/10.1136/bmj.b2535
21. Oyetade, K., & Zuva, T. (2025). Advancing Equitable Education with Inclusive AI to Mitigate Bias and Enhance Teacher Literacy. Educational Process: International Journal, 14, e2025087. https://doi.org/10.22521/edupij.2025.14.87
22. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. PLOS Medicine, https://doi.org/10.1371/journal.pmed.1003583
23. Park, S. O., & Hassairi, N. (2021). What predicts legislative success of early care and education policies?: Applications of machine learning and Natural Language Processing in a cross-state early childhood policy analysis. Plos one, 16(2), e0246730. https://doi.org/10.1371/journal.pone.0246730
24. Sanusi, I. T., Sunday, K., Oyelere, S. S., Suhonen, J., Vartiainen, H., & Tukiainen, M. (2024). Learning machine learning with young children: Exploring informal settings in an African context. Computer Science Education, 34(2), 161-192. https://doi.org/10.1080/08993408.2023.2175559
25. Su, J., & Yang, W. (2024). Artificial intelligence and robotics for young children: Redeveloping the five big ideas framework. ECNU Review of Education, 7 (3), 685-698. https://us.sagepub.com/en-us/journals-permissions

26. Su, J., & Zhong, Y. (2022). Artificial Intelligence (AI) in early childhood education: Curriculum design and future directions. Computers and Education: Artificial Intelligence, 3, 100072. https://doi.org/10.1016/j.caeai.2022.100072
27. Sun, M., Yan, R., & Wen, R. (2025). Generative AI in Chinese Early Childhood Education: Teachers' Usage Patterns, Perceptions, and Factors Influencing Pedagogical Applications. International Journal of Teacher Education and Professional Development (IJTEPD), 8(1), 1-23. https://doi.org/10.4018/IJTEPD.382379
28. Wagner, C. J. (2024). Differentiating Children's Reading Materials with Artificial Intelligence: Exploring Possibilities for Personalized Learning. The Reading Teacher, 78(3), 191-194. https://doi.org/10.1002/trtr.2361
29. Xu, Y., Aubele, J., Vigil, V., Bustamante, A. S., Kim, Y. S., & Warschauer, M. (2022). Dialogue with a conversational agent promotes children's story comprehension via enhancing engagement. Child Development, 93(2), e149-e167. https://doi.org/10.1111/cdev.13708
30. Yang, W. (2022). Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation. Comput. Educ. Artif. Intell., 3, 100061. https://doi.org/10.1016/j.caeai.2022.100061
31. Yang, W. (2022). Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation. Comput. Educ. Artif. Intell., 3, 100061. https://doi.org/10.1016/j.caeai.2022.100061
32. You, J., & Yang, X. (2024). Evaluation of the effectiveness of robot-assisted teaching in the training room in preschool education. Applied Mathematics and Nonlinear Sciences, 9. https://doi.org/10.2478/amns.2023.2.00338
33. Zaidi, S. A. Z., Ahmad, E., & Shukla, N. (2024). Ethical Considerations in the Use of Artificial Intelligence (AI) for Education and Research: A Review. International Journal of Innovations in Science, Engineering And Management, 156-167. https://doi.org/10.69968/ijisem.2024v3si2156-167
34. Zhang, Y. L. (2025). Predicting Teachers' Intentions for AIGC Integration in Preschool Education: A Hybrid SEM-ANN Approach. Journal of Information Technology Education: Research, 24, 016. https://doi.org/10.28945/5502
35. Zhao J. G. (2014). Combination of multiple databases is necessary for a valid systematic review. International orthopaedics, 38(12), 2639. https://doi.org/10.1007/s00264-014-2556-y
36. Zhu, J., & Liu, W. (2020). A tale of two databases: the use of Web of Science and Scopus in academic papers. Scientometrics, 123(1), 321-335. https://doi.org/10.1007/s11192-020-03387-8