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# Artificial Intelligence (AI) Literacy in Early Childhood Education: A Scoping Review

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**Abstract.** In the past decade, artificial intelligence (AI) literacy has become a primary focus in digital literacy education research. However, the use of AI in early childhood education remains largely unexplored, prompting experts to conduct a scoping review. This scoping review aimed to explore various forms of AI application in early childhood education, and to identify commonly used methods in this topic. The database searches for scientific articles covered the period between 2016 to 2023. Inclusion and exclusion criteria were established, focusing on reviews related to AI literacy and early childhood education. Electronic databases such as Scopus, EBSCO Sciences, Emerald, Sinta, and Science Direct were used from December 2023 to February 2024. From the total of 260 articles selected for this analysis, only 10 met the inclusion criteria and were reviewed. The results showed that most articles used learning media tailored to children's developmental stages to enhance literacy. These included smart toys integrating AI technology, particularly speech synthesis, virtual reality, robots, KIERO, and chatbots. Qualitative methods were commonly adopted, although some research used experimental methods and literature reviews. In summary, the integration of AI literacy in early childhood education contributed significantly to the development of active learning interventions for children.

**Keywords:** Artificial Intelligence, AI literacy, early childhood education, scoping review

# Literasi melalui Artificial Intelligence (AI) dalam Pendidikan Anak Usia Dini: Tinjauan Pelingkupan

**Abstrak**. Dalam satu dekade terakhir, literasi melalui kecerdasan buatan (AI) telah menjadi perhatian utama dalam penelitian pendidikan literasi digital. Namun, penerapan AI dalam pendidikan anak usia dini masih belum banyak dieksplorasi, mendorong peneliti untuk melakukan tinjauan pelingkupan. Tujuan tinjauan pelingkupan ini adalah untuk mengeksplorasi berbagai bentuk penerapan AI dalam pendidikan anak usia dini, dan untuk mengidentifikasi pendekatan penelitian yang umum digunakan dalam topik ini. Pencarian dilakukan untuk rentang waktu 2016 hingga 2023. Kriteria inklusi dan eksklusi telah ditetapkan, yaitu penelitian yang berkaitan dengan literasi AI dan pendidikan anak usia dini. Penelitian ini menggunakan pangkalan data elektronik seperti Scopus, SAGE, EBSCO Sciences, Emerald, Sinta, dan Science Direct dari Desember 2023 hingga Februari 2024. Dari 260 artikel sebanyak 10 artikel yang memenuhi kriteria. Hasil penelitian menunjukkan bahwa sebagian besar penelitian memanfaatkan media pembelajaran yang sesuai dengan perkembangan anak untuk meningkatkan literasi, seperti mainan pintar yang mengintegrasikan teknologi AI seperti sintesis ucapan, realitas buatan, robot, KIERO, dan chatbot. Pendekatan penelitian yang umum digunakan adalah kualitatif, tetapi beberapa penelitian juga menggunakan pendekatan eksperimental dan telaah literatur. Penerapan literasi AI dalam pendidikan anak usia dini ini memberikan kontribusi penting dalam pengembangan intervensi pembelajaran AI yang melibatkan anak usia dini secara aktif.

**Kata Kunci:** kecerdasan buatan, literasi kecerdasan buatan, pendidikan anak usia dini, tinjauan pelingkupan

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The use of Artificial Intelligence (AI) in educational context, known as Artificial Intelligence in Education (AIEd) has transformed AI into an effective tool to pave the way for new methods in instructional design, technological developments, and educational research. These methods were previously difficult to achieve within the conventional educational framework (Hwang et al., 2020; Luckin et al., 2016). Despite the revolutionary potential of AI, it is important to observe that positive educational results do not solely depend on the use of modern technology (Castañeda & Selwyn, 2018; Shofiah et al., 2023). The main objective of AI is to individually provide guidance and learning assistance tailored to the needs of each children, considering their learning status, preferences, and characteristics. By combining the knowledge and intelligence of experienced teachers in decision-making, the learning system becomes an important aspect of educational framework. This method shows the importance of providing prevention and intervention practices that address childrens' specific needs, achievable through analysis of their learning or behavioral status (Hart, 2016). In educational context, AI can help teachers to predict learning performance, recommend learning resources, and automate assessments to improve children learning experiences through a system of intelligent tools, chatbots, as well as recommendation system (Mousavinasab et al., 2021; Su et al., 2022; Zawacki-Richter et al., 2019).

AI in early childhood education (PAUD) has been explored since 1977 (Kahn, 1977). The act of educating children about the technology is to ensure that it is efficiently used by future generations (Kahn et al., 2018). Familiarizing children with AI features aims to make them comfortable and happy, fostering motivation and empowerment to build highly capable artifacts. This is because such a habit can lead to the pursuit of meaningful goals (Wood & Rünger, 2016). To define AI (Russell & Norvig, 2010), it is essential to understand the key three parts, including the agent's environment, perception, and actions. As a result, the most likely way to introduce the technology to children is to expose them to AI features and provide hands-on experience with programming.

The development of early childhood is greatly accompanied by the introduction of AI. However, there is still minimal attention to the importance of developing AI literacy and understanding its related impacts. Most children use products such as chatbots and recommendation tools to simplify their daily life and learning. Despite such great importance, they still become unfamiliar with how to use AI and understand the associated basic principles, as well as have misconceptions about the technology. There is also a potential threat to the safety of

children when the technology provides incorrect and misleading information or advice (Gaube et al., 2021). Therefore, developing AI literacy is necessary, specifically focusing on understanding the limitations, ethical considerations, and the associated basic principles of the technology (Long & Magerko, 2020; Ng et al., 2022).

The term "AI literacy" is used to signify the importance of introducing AI to 21st-century digital literacy skills for everyone, including children (Ng et al., 2021a; 2021b). Learning programs and activities, consisting of the Jibo robot and Cozmo Anki robot were introduced to foster the understanding and positive attitudes of the technology (Druga & Ko, 2021). AI literacy has become an important skill for everyone, particularly children to know and use AI as a tool for living, learning, and working in the digital world. Moreover, it should be taught in K-12 classrooms (Kandlhofer et al., 2016; Steinbauer et al., 2021). Beyond simply being the end user of AI tools, AI literacy is a set of competencies that enable individuals to critically evaluate, communicate, and collaborate with the technology. Therefore, experts began to suggest different methods to conceptualize the term AI literacy (Touretzky et al., 2019).

The development of more age-appropriate software has allowed children to expand their possibilities for learning and exploring AI. However, most current AI literacy investigations focus on secondary or higher education (Eguchi et al., 2021; Kong et al., 2021). For instance, non-computer science graduate and secondary students are beginning to develop AI concepts and ethical awareness to empower them to become educated digital citizens. This allows children to develop a basic understanding of AI concepts, literacy, and confidence in using the technology (Kong et al., 2021; Ng et al., 2022).

In early childhood education, AI-based toys are created to provide enjoyable learning experiences for children to interact with robots and learn coding skills. With well-designed toys and services, kindergarten children can start developing their AI literacy. Additionally, Snap! is one of the programming tools that provides a child-friendly interface for AI Cloud services (Kahn & Winters, 2017). Through platforms such as eCraft2Learn, children can learn about robot behavior and perceptive applications in the process of discovering an understanding of the technology. Block-based programming can be used to improve children's computational thinking by providing instructions to follow (Figueiredo & García-Peñalvo, 2017). Furthermore, AI-driven robotic toys and services, particularly PopBots and Quickdraw allow the exploration of AI-related concepts, including knowledge-based system, supervised machine learning, and generative AI (Williams, 2018; Williams et al., 2019b). Although children may not fully understand the knowledge behind AI, they can explore this technology to develop daily digital literacy.

Some may question whether kindergarten children and elementary school students are too young to learn AI concepts (Su et al., 2022). Research by Qotrunnida et al. (2023), Sahputra and Muzakir (2021), Lin et al. (2020), and Williams et al., (2019b) showed the promising effect of introducing the technology into early childhood education classes. In fact, AI literacy is important for early childhood to improve many aspects of child development, such as cognitive skills, creative investigation, emotional development, and critical thinking.

Kewalramani et al. (2021) investigated the use of interactive AI to foster inquiry literacy in early childhood education settings. However, there have been limited investigations on AI literacy for children aged 3–8 years compared to other age groups (3–6 years primary education, secondary education) (Su et al., 2023). It was only two reviews that have tried to discuss the use of AI in early childhood education settings (Su & Yang, 2022). These reviews even failed discuss the mapping of existing learning outcomes, assessment methods, as well as the opportunities and challenges related to AI literacy. Yi et al. (2024) conducted a bibliometric analysis focusing solely on the introduction of AI in early childhood education, while Rahmawati (2023) conducted a literature review by exploring 10 AI journals in early literacy in the Indonesian context.

There is still limited attention to the use of AI in early childhood education and its related impact on developing AI literacy. Although children usually use products such as chatbots and recommendation tools, they are still unfamiliar with the basic principles and how to use the technology. There is also a potential safety threat when AI provides incorrect and misleading information or advice (Gaube et al., 2021). Therefore, it is necessary to develop AI literacy in children, specifically focusing on understanding the limitations, ethical considerations, and basic principles of the technology (Long & Magerko, 2020; Ng et al., 2022). This research then becomes important to fill the gaps identified in previous literature reviews. Currently, most AI literacy investigations focus on secondary or higher education, with limited analysis on early childhood education settings (Eguchi et al., 2021; Kong et al., 2021). The purpose of this research is to identify the types of AI that exist in early childhood education and the predominant methods used.

## Method

This research adopted a scoping review method, which aimed to map concepts and identify gaps on a particular topic (Arksey et al., 2007). To ensure quality report, the PRISMA Extension for Scoping Review (PRISMA-ScR) guidelines were used, as explained by (Tricco et al., 2018). The scoping review method included (1) identifying research questions, (2) identifying relevant research, (3) selecting research, (4) mapping data, (5) collecting,

summarizing, and reporting results, and (6) consultation exercise (Arksey & O'Malley, 2005).

**Scoping review question**

The identification of research questions was used to explore several results. These questions included: (1) What are the types of AI in early childhood education? (2) what are the methods commonly used in research on AI in early childhood education?

**Identifying relevant research**

Experts conducted database searches and adopted a scoping review method. Searches for scientific articles were carried out on 7 international journal sites and 1 national journal, including SAGE (journals.sagepub.com), Scopus (scopus.com), Research Gate (researchgate.net), Semantic Scholar (sematicscholar.org), Google Scholar (scholar.google.com), Web of Science (webofscience.com), Science Direct (sciencedirect.com), and Garuda SINTA Portal (garuda.kemdikbud.go.id). These searches were carried out using the keywords, consisting of AI literacy, early childhood education, and AI education for early childhood. Additionally, reference lists of all included reviews were searched for more relevant articles.

**Research selection: Inclusion and exclusion criteria**

The first search was carried out in December 2023 and it continued until February 2024. A total of 260 articles were collected from international and national journal sources. After analyzing all these articles, only 10 were found to meet the requirements and were selected for review.

Inclusion criteria covered all factors that were relevant to this research and they included population, concepts, and context. The populatian consists of preschool children (0-7 years and 3-7 years), first grade elementary school children (6-7 years), teachers, and parents. Concepts in this research covered AI literacy and early childhood education. Family, home, and school environment were the context in this criteria. Inclusion criteria reviewed by considering: (1) Research on AI literacy, early childhood education, articles, proceedings; (2) Handling early childhood (3-7 years) or preschool, elementary school, teachers, or parents; and (3) Publishing original articles and literature reviews.

Exclusion criteria covered all factors that cause articles not to be reviewed. The factors were: not using AI literacy and early childhood education; children aged above 7 years; opinions, letters, and other works that were not original; unpublished literature such as theses and working papers; and handling dyslexia, children with reading difficulties, animals, deaf children, risk children, impaired children, and intellectual disability.

**Data collection process**

This research was carried out through the method of consultation and charting that was assisted by several experts. The

consultation was carried out after analyzing the data and making a report by early literacy expert (NF), AI expert (SM), and literature review expert (AR, PR) from the Faculty of Psychology, Airlangga University. Therefore, this method helped to provide valuable insights beyond what has been captured through literature searches. Some key recommendations from consultation results included using the rayyan.ai application, using the Prisma 2020 chart list and flowchart, identifying inclusion and exclusion criteria, focusing on charting, signifying research gaps, examining research methods, results, and limitations, as well as adjusting research questions. Furthermore, data charting was assisted by two experts comprising NS and NF.

**Selection process**

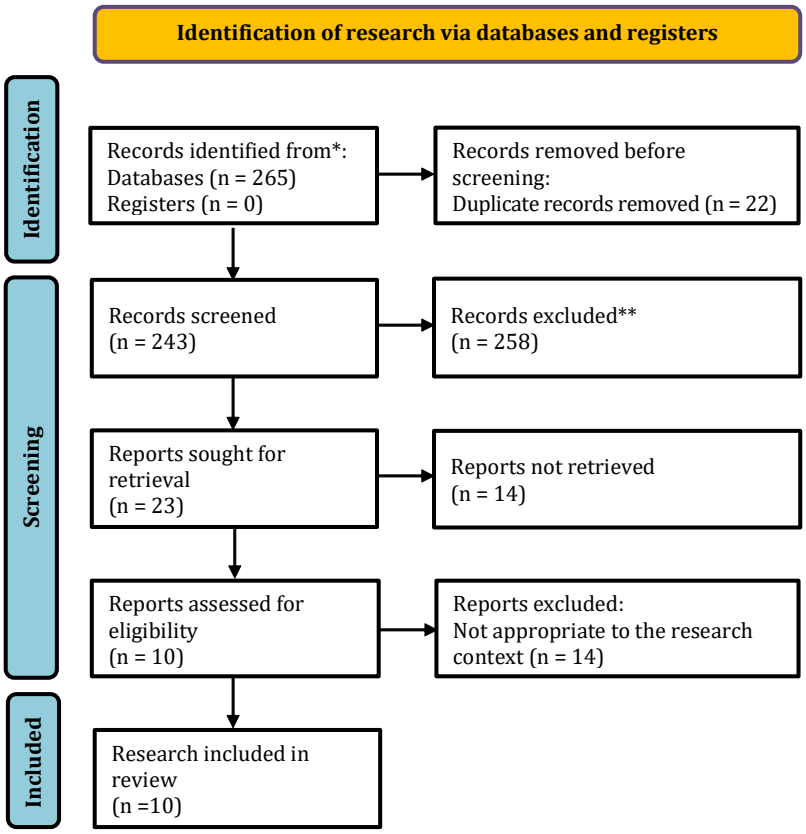
The initial search yielded 366 relevant abstracts and citations which were then analyzed through https://www.rayyan.ai/. After filtering, about 22 duplicate articles were found, leaving 258 articles in the exclusion category. It was observed that only 10 articles met the inclusion requirements and were selected for review.

**Data items**

Data were analyzed based on the protocol of data that were previously extracted. All data would be presented in tables, diagrams, or images to ensure there was an easy analysis and comparison of identified criteria. Further analysis was reported descriptively and narratively, and results implications, practice, and future policy were discussed in this research. The PRISMA-ScR checklist was adopted as a reporting guide and would continue to be used throughout the analysis.

**Figure 1**

*PRISMA 2020 Flow Diagram*




*Note*. PRISMA 2020 Flow Diagram for new systematic review which included searches of databases and registers only from rayyan.ai (Page et al., 2021).

## Results

This scoping review found that only 10 articles out of the 260 selected from both international and national journals were considered to meet the inclusion criteria, as shown in Table 1.

**Table 1**

*Summary of 10 Research*

| Author | Title | Method | Results | Forms of AI |
|---|---|---|---|---|
| (Affandi et al., 2023) | Penggunaan alat permainan edukatif sebagai media pembelajaran dalam kegiatan bermain sambil belajar | Qualitative research with a case research method | The use of educational game tools as a learning medium in playing and learning activities has high potential in increasing the level of learning ability, but appropriate use is needed as well as support from parents and teachers. | Use of educational game tools via AI as a learning medium. |
| (Nugraha et al., 2023) | KIERO (Kids Education Robot) educational robot for children's learning friends | Arduino software research and development | Using KIERO (Kids Education Robot) Educational Robot for Children's Learning Friends in learning | KIERO (Kids Education Robot). |

| Author | Title | Method | Results | Forms of AI |
|---|---|---|---|---|
| (Villegas-Ch. et al., 2022) | Assistance system for the teaching of natural numbers to preschool children with the use of AI algorithms | Qualitative descriptive research methods and observations | Overall, this research shows the effectiveness of AI recognition systems in increasing interest and number learning in school children. Results show improvements in number handling with AI system, although adjustments are still needed for better quantity recognition. | Create a game-like mechanism, where children draw numbers to be recognized by an AI algorithm. AI algorithm for number recognition uses Python for image processing and binarization. The system changes the image to recognize numbers written by children on the board. |
| (Yang et al., 2024) | AI education for young children: A case study of technology-enhanced embodied learning | Observation and interview methods | The results in this research show that technology-enabled learning facilitates multimodal learning, increasing children's understanding of AI concepts and applications. This research is the basis for further research on AI literacy education. | AI literacy activities with the support of intelligent agents implemented in kindergarten. The five big AI ideas that exist are AI application machine learning, AI ethics, and safety. |
| (Wang et al., 2021) | Smart design of intelligent companion toys for preschool children | Qualitative method, case research by analyzing 26 children | Designing smart companion toys for children, centered on the environment | *smart toys,* an AI concept emerging in the toy industry and academia that combines traditional toys with AI technology such as speech synthesis, and artificial reality. This research emphasizes the role of AI in smart toy design. |
| (Yi et al., 2024) | AI technologies in early childhood education: A review | Bibliometric methods for analyzing ECE-related articles | From the results of the analysis carried out, it was found that there was a significant trend in the application of AI technology in ECE, with bibliometric analysis showing an increase in the number of publications related to AI in ECE from 2010 to 2022. This shows an increasing interest in the use of AI in early childhood education. | AI-related to early childhood education, as showed by detailed research on various AI technologies. |
| (Kewalramani, 2021) | Using AI - interfaced robotic toys in early childhood settings: A case for children's inquiry literacy | Experimental research methods | Research results show that children creatively collaborate with their friends to create sustainable cities. These results highlight the importance of AI technology in developing early childhood inquiry literacy. | AI robots can form literacy in early childhood. |
| (Qotrunnida et al., 2023) | Penggunaan Chatbot Mela terhadap peningkatan kemampuan kosa kata Bahasa Indonesia anak di RA Darul Mu'minin | Quantitative methods of experiment and observation | The research results describe the increase in Indonesian vocabulary among RA Darul Mu'minin students with test analysis results. | Chatbot mela as a learning medium. |

| Author | Title | Method | Results | Forms of AI |
|---|---|---|---|---|
| (Rahmawati, 2023) | Mengeksplorasi literasi *Artificial Intelligence* dalam pendidikan anak usia dini: *Systematic literature review* | Systematic Literature Review method | Exploration results of 10 articles related to AI in early literacy education. | AI robots can form literacy in early childhood |
| (Su & Yang, 2023) | Unlocking the power of ChatGPT: A framework for applying generative AI in education | Literature review | The benefits of using ChatGPT in education, or more generally, educational AI, include a more personalized and efficient learning experience for students as well as easier and faster feedback for teachers. However, challenges such as the untested effectiveness of the technology, limitations in data quality, as well as ethical and security issues must also be considered. | using ChatGPT in education, or more generally, educational AI, includes a more personalized and efficient learning experience for students as well as easier and faster feedback for teachers. |

The research found that AI was used for active literacy activities in the classroom, making learning to be fun for children through smart toys. These toys combined traditional toys with AI such as speech synthesis and artificial reality, suggesting the role of the technology in smart toys design (Wang et al., 2021). Although the use of educational game tools as a learning medium in playing and learning activities showed a high potential in increasing the level of learning ability, appropriate usage as well as support from parents and teachers were needed (Affandi et al., 2023). AI in early childhood education covered the use of robots, particularly KIERO (Kids Education Robot) which served as educational tool for children (Nugraha et al., 2023). A significant example was the creation of a game-like mechanism, where numbers were drawn to be recognized by an AI algorithm. The algorithm used Python for image processing and binarization, changing images to recognize numbers written on the board (Villegas-Ch. et al., 2022). Furthermore, AI literacy activities with intelligent agent support have been adopted in kindergarten children, focusing on machine learning applications, AI ethics, and safety (Yang et al., 2024). Several reviews have detailed various AI related to early childhood education (Rahmawati, 2023; Yi et al., 2024a), such as AI robots that could form literacy in early childhood (Kewalramani, 2021). Furthermore, the technology used included the chatbot Mela, which served as a learning medium to improve language skills for children (Qotrunnida et al., 2023).

Based on the 10 selected articles, a qualitative design was mostly used (Affandi et al., 2023; Villegas-Ch. et al., 2022; Wang et al., 2021; Yang et al., 2024). Furthermore, a quantitative method was found using experiments (Kewalramani et al., 2021; Qotrunnida et al., 2023). It was observed that three previous literature reviews (Rahmawati,

2023; Su & Yang, 2022; Yi et al., 2024) provided additional context.

**Discussion**

This scoping review aimed to explore various forms of AI application in early childhood education, and to identify commonly used methods in this topic. This research presented a general overview of AI literacy in early childhood education, with a focus on the types of AI and new methods used. Although there was a limited empirical investigation on AI literacy for early childhood, the available resources provided new insights into many areas of this field. By addressing two main objectives, this review presented new insights into AI literacy, specifically the types of the technology and the commonly used methods.

Several conclusions could be drawn from the assessment of AI curriculum design in the analyzed articles. Firstly, most research adopted age-appropriate learning tools or platforms to enhance AI learning in children, such as smart toys that combined traditional tools with the technology, particularly speech synthesis, artificial reality, robots, KIERO, and Chatbot mela. Robotic Models were the most commonly used tools to improve basic AI concepts in early childhood. These models warranted further investigation to comprehend how AI integration could be achieved through a more concrete method (Su & Yang, 2022). Robotic models were often realized as AI-connected robotic toys, creating conditions that allowed children to develop their inquiry literacy through play. Teachers played an important role as facilitators, guiding children in understanding and using these toys effectively. The observation of (Yi et al., 2024) found various intelligent robots, including iRobiQ, NAO, KASPAR, Keepon, AIBO, IROMEC, iCat, PARO, Probo, and EngKey that could be used in introducing AI in early childhood education. Kewalramani et al. (2021) also reported AI robotic models toys provided opportunities for children to create learning environments that triggered their critical thinking and creativity (Giddings, 2019). Therefore, the integration of AI robotic models in game-based learning could enable creativity, improve problem-solving abilities, and strengthen children's resilience, while facilitating the development of their inquiry literacy skills.

Secondly, in terms of research methods, experts designed different learning activities to improve children's AI knowledge and concepts. Most investigations focused on how to improve early childhood skills using the technology. Research trends showed that children only understand basic AI concepts, such as knowledge-based system, supervised machine learning, and generative AI. The current investigation on AI literacy in early childhood classes lacked rigorous integration and methods. Future reviews should adopt more empirical designs and interventions to use clearly defined curricula and control groups as well as various data analysis methods.

Previous investigations have shown that the use of AI could significantly contribute to the teaching and learning process in early childhood education. For instance, research has proven that the technology improved children's understanding of concepts such as AI, machine learning, computer science, and robotics. AI could also help in developing other skills consisting of creativity, emotional control, collaborative inquiry, literacy skills, and computational thinking (Kewalramani et al., 2021), as well as cognitive and social development (Palaiologou et al., 2021). Other investigations have developed AI teaching platforms specifically designed to increase children's enthusiasm for learning (Nan, 2020). Moreover, Jin (2019) found that two specific applications, such as AI teaching system and an evaluation system, were particularly suitable for children. Further reviews were needed to understand the impact of AI on early childhood education settings and verify the published results.

### *AI literacy challenges in early childhood education*

The current state of AI use in early childhood education showed a significant increase, with more children using the technology as a learning companion, assessment system, educational robot, and chatbot. The tools aimed to support cognitive and social development by carrying out automatic assessments and providing feedback on learning activities. This showed AI has assumed the role of a virtual teacher and learning partner, providing cognitive and social support for children. However, there was concern that children who were direct users, might not fully understand the underlying technology. They could misunderstand the concepts of AI and be unaware of its limitations and impacts. Consequently, it was important to pay attention to educational methods that thoroughly introduce AI to children, ensuring they better understand the technology.

Some of the challenges in using AI in early childhood education included, firstly, a lack of understanding and ability among teachers. The technical skills in using the technology were identified as one of the obstacles faced by inexperienced teachers, but they were expected to build and use an AI literacy curriculum in schools. Future reviews should investigate appropriate learning activities and instruments for early childhood education, as well as determine the necessary teacher training for kindergarten children.

Secondly, there was a lack of research on the curriculum designed for AI in early childhood education (Yang et al., 2023). Only a few articles explained what, why, how, and when children should learn about the technology. This gap presented considerable challenges faced by teachers when developing and integrating AI literacy for early childhood education.

Thirdly, the lack of instructional guidelines was one of the main obstacles to integrating AI into preschool curricula.

Although some reviews showed the success of children in using age-appropriate AI tools, as suggested by Kandlhofer et al. (2016), Williams et al. (2019), and Williams et al. (2019), not all kindergarten educational institutions have adequate resources. This made financial support from the government to become crucial to ensure schools access the modern technology needed to enhance children's learning experiences. To overcome this challenge, several websites such as Machine Learning for Kids and IBM, provided open-source preschool-based AI curricula (Su et al., 2023). By using free web-based software, particularly Teachable Machine, children could learn the technology in an interactive and enjoyable way, opening the door to broader and more affordable learning experiences at early age.

### *Opportunities for AI literacy in early childhood education settings*

The use of AI in early childhood education has many opportunities to make learning more interactive and interesting for children. For instance, AI-based learning applications could be customized to meet children's needs and interests, making learning both enjoyable and effective. However, it was important to understand that children at early age might not yet have a deep understanding of AI concepts. In the context of early childhood education, the use of AI differed significantly from its use in primary and secondary schools. In early childhood education settings, tools, such as AI toys supported daily activities and learning, while in primary and secondary schools, it was more oriented towards the process of acquiring knowledge and skills. Despite this, children could still have opportunities to develop digital skills through play and exploration, improving their emotional, collaborative, and inquiry literacy. This tended to also expand their understanding of AI and other related social skills, such as how to play and interact with peers, along with curiosity (Kewalramani et al., 2021). Children actively use AI tools, including drawing tools, robotic toys, and chatbots to improve communication skills through group interactions and stimulate their imagination through digital stories and writing (Ng et al., 2022). Although the concept of AI might not be fully understood, its usage in an appropriate context provided many opportunities for children to learn and grow holistically.

The limitation of the research was that it conducted a literature review in the period between 2016 to 2023. Experts only searched electronic databases, such as Scopus, EBSCO Sciences, Emerald, Sinta, and Science Direct. The goals of this scoping review were to (1) explore various types of AI used in early childhood education, and (2) identify commonly used methods on this topic. Therefore, further investigations were still needed to address those aspects that have not been explored.

## Conclusions

In conclusion, this research aimed to determine the types of AI in early childhood

education and the new methods commonly used in the topic. Based on the research results, there were two main conclusions. Firstly, types of AI in early childhood education included smart toys, which combined traditional toys with the technology, particularly KIERO AI robots, and chatbots. Secondly, the research method used on the topic was qualitative, with quantitative methods, mainly experiments, and literature reviews also being adopted. Generally, this research showed that AI had great potential to support early childhood education through various forms of innovative and engaging technology. Both qualitative and quantitative methods have been used to explore and evaluate the effectiveness of AI.

**Suggestion**

The implication of this research suggested the need for further development of AI. The findings indicated the necessity of advancing the technology, specifically in early childhood education. This would include expanding smart toys and educational robot developed, as well as AI-based learning applications that cater to children's needs and development. The limitations were related to, firstly, the provision of resources and training. In this regard, educational institutions, parents, and teachers must pay attention to the significance of having adequate resources and training for using AI in early childhood education. This included understanding best practices for integrating AI into curricula, as well as effectively managing children's use of technology. Secondly, changes needed to be made regarding learning paradigms that have traditionally been used. Research showed traditional methods could be improved by integrating AI. It tended to challenge old-fashioned ways of teaching while highlighting the importance of using technology as a valuable tool when educating children. Thirdly, there was alignment between conventional teaching and tecchnology. Teachers must try to understand how to properly integrate AI into their teaching. This required combining AI with conventional learning principles to ensure that the technology enhanced children's learning experiences, rather than replacing the role of teachers.

Fourthly, there was increased parental involvement. Parents played an essential role in promoting the use of AI in early childhood education. They needed to be aware of the benefits and risks of the technology, as well as how to effectively assist their children's learning at home. By considering implications from this research, educational institutions could collaborate with parents and other stakeholders to ensure that the technology was productive and helpful for children's development.

Future research were expected to extend the literature review time to include a broader timeframe regarding the development and evolution of AI in early childhood education. This included the use of more electronic databases and other literature sources, particularly journals that might not be indexed

in currently used databases, to reduce bias and gain a broader view. Furthermore, it would be necessary to conduct empirical research covering direct experiments on field for evaluating the effectiveness of introducing AI. It has been suggested that integrating methods from various disciplines, such as psychology, education, and information technology could provide better understanding of how effectively AI could be used in early childhood education. By paying attention to these suggestions, future reviews tended to provide deeper and more comprehensive insight into the use of AI, as well as identifying and overcoming existing challenges.

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