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Artificial Intelligence (AI) in Early Childhood Education, Exploring Challenges, Opportunities and Future Directions: A Scoping Review

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Abstract: *AI literacy has emerged as a crucial aspect of digital literacy research in the field of education. Currently, there are limited studies about the implications of Artificial Intelligence (AI) in Early Childhood Education (ECE). Owing to the recent development of curricula for young learners in industrialized nations, developing countries are hesitant to adopt AI at the ECE level. A scoping review was undertaken on the content of fourteen research articles published between 2016 and 2023. This scoping review evaluates and reviews the contents of fourteen papers on the knowledge and comprehension of AI in ECE, which covers curriculum design, artificial intelligence tools, instructional methodologies, research designs, evaluation methods, findings, and various types of possibilities and problems linked to AI literacy and content. Several obstacles were identified, including (1) an insufficiently designed curriculum, (2) lacking instructors' understanding, experience, and trust in AI, and (3) the lack of an instruction manual. Engaging in reading can offer educational possibilities and foster the growth of AI literacy in young learners, encompassing AI concepts, actions, and perspectives. This study recommended AI literacy for the educators and learners of ECE to be suitable for their age group and level.*

Key Words: Artificial Intelligence, Early Childhood Education, Challenges, Opportunities

Introduction

The science and engineering of devising smart systems that use machine learning, neural networks, and natural language processing to solve a variety of problems is known as Artificial Intelligence (AI) (Mondal, 2020). To improve students' educational experiences, AI can benefit educators in envisaging pupils' performance, endorsing educational materials, and systematizing evaluation through intelligent systems (Liang et al., 2023).

Young learners are using AI apps, but there needs to be more focus on how vital it is for them to acquire AI literacy and the implications that go along with it. They make use of AI-powered goods, such as recommendation engines and chatbots, to make their daily life and academic pursuits easier (Gaube et al., 2021). ECE students could not understand how to use AI and its fundamental concepts. Behind these instruments, they might need to understand the full use of technologies. AI providing inaccurate and deceptive information or recommendations may risk their safety. Thus, it is imperative to increase young learners' awareness of Artificial Intelligence, especially about its drawbacks, ethical problems, and basic technological underpinnings (Kong et al., 2021).

Ng et al. (2021a,b) introduced "AI literacy" to highlight how important it is for everyone, especially young learners, to incorporate AI into their digital literacy. Furthermore, they also devised a framework of AI notions, methods, and perceptions that interact among AI and CT to help pupils improve their expertise in machine learning, cooperation, and communication skills, as well as model training abilities. Druga et

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al. (2021) acclaimed learning initiatives and activities such as Anki's Cozmo and Jibo robots developed with an emphasis on establishing young learners's AI comprehension and attitudes. AI has become a vital literacy ability for every person, even young learners, to recognize and apply AI to learn and work in this digital era (Steinbauer et al., 2021).

Recently, there have been considerable advancements in the development of age-specific applications, providing young students with increased possibilities to study and interact with artificial intelligence. Secondary or higher education is the emphasis of most current investigations on AI literacy (Eguchi et al., 2021). However, these programs cover much more than just multifaceted computer science notions and mathematical procedures. Rather, the content gave the learners a fundamental understanding of AI theories, as well as knowledge and self-confidence in applying AI (Kong et al., 2022).

Toys driven by Artificial Intelligence (AI) are intended to teach young learners how to code while providing them with an enjoyable opportunity to interact with and learn about robotics and kits. By creating more carefully crafted AI toys and services, young learners may be enabled to attain AI literacy even at the KG level. To learn about issues connected to AI, including knowledge-based systems, supervised machine learning, and generative AI, students engage with robotic toys and services driven by AI, like Quickdraw and PopBots. Learners can enjoy and play with AI devices for learning different concepts even if they do not understand the underlying ideas (Williams et al., 2019 a,b).

Previous studies (Tseng et al., 2021; Yang, 2022) have shown the viable challenges of incorporating AI technology into the ECE curriculum. Basic AI literacy is essential for learners in order to enhance different areas of child development, such as creative inquiry, emotional development, and collaborative learning. However, limited research has been done on AI literacy for learners aged 3-8 years at the ECE level.

This study focuses on the scoping review of fourteen articles and concludes the problems and prospects of the usage of AI in the ECE. This study also aims to provide recommendations for researchers seeking engaging activities for learners while contributing to the understanding of AI literacy instruction. This inquiry emphasizes the challenges and opportunities of AI literacy in ECE and highlights the need for further exploration and development of successful teaching and learning methodologies in this area. This paper identifies relevant studies that utilize various research methods such as qualitative video data, quantitative assessments, surveys, interviews, observations, and mixed methods to investigate early AI literacy. It has highlighted the significance of AI literacy for everyone, especially young learners in the digital age, emphasizing the significance of integrating AI into digital literacy for the 21st century.

Literature Review

This scoping review provides educators and early childhood researchers with thoughtful directions for the research and practice related to AI literacy in ECE. Different sections of this article address the present status of the use of AI, its associated challenges, and some future directions in the ECE arena.

Artificial Intelligence

The discussion on artificial intelligence and its inclusion in all levels of education, including ECE, has been started in different educational forums. Even though it is a very early stage to decide about its integration into ECE, there are still numerous benefits for ECE classrooms. Such applications include chatbots designed for language teaching, robotic kits used for learners, and intelligent tutoring systems that can help special education learners. (Yang, 2022). There is an increasing interest in studying artificial intelligence (AI) in education, and more efforts are required to determine the utilization of advanced AI approaches for effective learning and teaching in classroom environments (Chen et al., 2020).

AI Literacy

To understand the notion of "AI literacy" and associated capabilities, it is essential to have a deep understanding of fundamental knowledge and concepts of AI. According to Long and Magerko (2020), AI literacy refers to a collection of skills that enable humans to analyze, interact with, and utilize AI as a tool in various settings, such as online, at home, and in the workplace. In their work, Ng et al. (2021 a,b) included Artificial Intelligence (AI) into the digital literacy of all students, emphasizing its importance as

a fundamental skill applicable in both professional and everyday contexts. They argue that AI proficiency is not limited to computer scientists alone but rather a crucial competency for everyone. He extensively utilized the Technological Pedagogical Content Knowledge (TPACK), the Bloom Taxonomy methodology, theories, methods, and concepts connected to AI.

AI Literacy in ECE

AI education has brought both potential and challenges to ECE. These include the reasons for teaching AI to young students in their formative years, the subgroup of crucial AI notions that are age-specific, and the strategies for including young students in worthwhile learning experiences that facilitate the acquisition of these ideas. There are several arguments for why young learners ought to learn about AI: (1) to be AI literate in this digital era, all citizens must be able to use AI applications and comprehend its fundamental competencies; (2) learners must be provided with the tools necessary to comprehend, practice, and assess AI purposefully; and (3) learners should be able to comprehend the basic workings of AI, primarily as more carefully crafted AI toys become a part of their daily lives (Kewalramani et al., 2021). In their study, Su and Yang (2022) focused on the integration of AI in ECE. They utilized AI learning tools such as PopBots and Zhorai to teach KG pupils about AI principles.

Some past research suggested what young learners ought to learn and how to assist them in understanding the senses, perceptions, interactions, and generation processes of Artificial Intelligence (AI). Yang (2022) developed a curriculum called "AI for Kids" that makes use of Quickdraw, AI toys to magnify the role of AI-based technologies in everyday life and to empower learners to study AI-embedded and project-based methods. Williams et al. (2019a) developed an AI-interfaced robot in order to help young learners grasp the potential and limits of AI agents and toys. Students can interact with these toys while learning about supervised machine learning, generative artificial intelligence, and knowledge-based systems through games. By employing these exercises and resources that are suitable for students' developmental stages, they can identify the principles of artificial intelligence and gain knowledge about the constraints and moral dilemmas related to these technologies. These studies provide educators with strategies and techniques to help young learners by using activities and materials that are developmentally appropriate (Ng et al., 2022c; Su & Yang, 2022).

Methods

The concept of AI literacy in Early Childhood Education and its challenges are under research, and debates are continuing. Therefore, the primary purpose of this review is to appraise the volume of research studies and explore the problems and prospects of AI literacy in ECE.

This study has followed the five-step framework given by Arksey and O'Malley (2005) as the foundation for the review methodology, which involves a rigorous technique to enhance the validity of the study results. This five-step framework includes: (1) developing the primary research questions, (2) recognizing relevant research, (3) choosing research, (4) graphing the results, and (5) assembling.

Table 1

Included publications' PRISMA diagram

Process	Articles
Identification	517
Excluded by Title	471
Screened	46
Duplicate Removed	21
Processed	25
Further Scrutinized and Excluded	9
Eligible at the Final Stage	14
Included	14

Identifying the Relevant Researches

Broadening the meaning of key terms in exploring queries helps achieve "broad coverage" of the number of current literature (Arksey & O'Malley, 2005). Global term and search query usage was investigated in the corpus of research on early AI literacy. Among the online catalogs used to find research were ACM, EBSCO, Google Scholar, IEEE, Scopus, and Web of Science. To improve database search, this study examined peer-reviewed scholarly articles published in the English language till May 2022. The researchers created a search cord by utilizing pertinent search threads from earlier studies as well as researchers' knowledge and understanding of AI in the field of ECE. The search phrases that were utilized for the evaluation were "artificial intelligence literacy" OR "AI literacy" AND "young child" OR "early childhood" OR "preschool" OR "KG" OR "pre-k" OR "childcare" OR "daycare" OR "learners."

Selection of Research Articles

Using the author's important search criteria, 517 articles were explored. The procedure of articles' selection followed the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher et al., 2009 as cited in Su et al., 2023). There were four hundred and thirty entries available (n=430) throughout databases [one from ACM, four from EBSCO, four hundred and thirty from Google Scholar, six from IEEE, fifteen from Scopus, and one from Web of Science].

The subsequent studies were not included in the research: Firstly, articles irrelevant to the title and abstract of the research were excluded (E1) (n = 390) since they were unrelated to the research question: (a) those who concentrated on other topics, like Artificial Intelligence (AI), medicine, etc. (n = 209); (b) those who concentrated on secondary education, colleges and universities, and kids in grades 3-6 (n = 181). Fifteen duplicate studies made up the second exclusion criterion (E2). The third exclusion criterion (E3) was met by one publication (n = 1) that did not have any subjects or settings for early years, i.e., three to eight years old. Based on the 4th elimination criterion (E4), works with a focus or theme other than EAI literacy (n = 7) were excluded. The final elimination criterion (E5) was satisfied by articles that were authored in languages other than English (n = 1).

Data Charting and Collection

Charting is the final phase of Arksey and O'Malley's (2005) review methodology. The fourteen publications that addressed AI literacy in ECE (one from 2016, one from 2018, three from 2019, two from 2020, four from 2021, and three from 2022) were thoroughly examined.

Research Design

The designs used in AI literacy studies in ECE are presented in Table 1. Two publications were with a mixed-research approach, six articles with a quantitative design, and six articles with a qualitative design. Different data collection methods, such as surveys, questionnaires, and assessments of knowledge and theory of mind abilities, were used in the six quantitative investigations. For instance, Lin et al. (2020) used knowledge tests for assessments to look at learners' machine learning proficiency using Zhorai. The tool helps kids grasp concepts related to machine learning. Data were gathered for the four qualitative studies through a variety of methods, such as field notes, interviews, observations, films, pictures, and comments. Observation and interviews were used by Kandlhofer et al. (2016) to gauge how a learner's AI developed. The outcomes showed how effectively these could impart the principles of computer science and artificial intelligence to young learners in a pleasant way. The remaining papers gathered information through a variety of mixed research methods, such as observations, pre/post-perception game answers, training data, and machine learning metrics. No data were collected since the AI curricula in ECE that were described and shown in two articles (were not put into practice (Su & Yang, 2022; Su & Zhong, 2022).

States and Countries

This analysis stated that the researches were carried out in advanced states or nations, including Australia, Austria, Denmark, Germany, Hong Kong, Japan, Sweden, and the US). Moreover, this type of paper, which includes AI education from many countries, is robust enough to deliver useful AI literacy research in the ECE discipline.

Table 2

Design and approaches used in the research on early AI literacy

Title of Study	Authors	Research Design	Instruments
Learners's Perceptions of Machine Intelligence	Druga and Ko (2021)	Mixed Methods	Observations, game responses, pre-post perception
Inclusive AI Literacy for Learners around the World	Druga et al. (2019)	Quantitative	Questionnaire
Family as a Third Space for AI Literacies	Druga et al. (2022)	Qualitative	Video recording and comments
Introducing Learners to Machine Learning	Dwivedi et al. (2021)	Mixed Methods	Machine learning metrics
AI and Computer Science in Education: From KG to Higher Education	Kandlhofer et al. (2016)	Qualitative	Observations, Video data, pictures, field notes
AI-Interfaced Robotic Toys in Early Childhood Settings	Kewalramani et al. (2021)	Qualitative	Interviews and observations
Zhorai: Designing a Conversational Agent for Learners	Lin et al. (2020)	Quantitative	Pre- and post-assessments
Young Learners' literacy and Cognition to interactive AI Robots: A multifaceted study of potential enhancement to Early Childhood Education	Tazume et al. (2020)	Qualitative	Observation
PlushPal: Storytelling with Interactive Plush Toys and ML	Tseng et al. (2021)	Quantitative	Surveys
Learning ML with Very Young Learners: Who is Teaching Whom?	Vartianinen et al. (2022)	Qualitative	Video recording
PopBots: Leveraging Social Robots to Aid Preschool Learners's AI Education	Williams (2018)	Quantitative	Assessments, pre- and post-tests, and attitudes assessment
PopBots: Designing an AI Curriculum for ECE	Williams et al. (2019b)	Quantitative	Assessments
Popbots: Designing an Artificial Intelligence Curriculum	Williams, Park, and Breazeal (2019)	Quantitative	Knowledge assessments
AI Education for Young Learners: Why, what, and How	Yang (2022)	Qualitative	Not specified

AI Literacy in ECE

This article examined the curricular design, materials, assessment methodology, and additional learning objectives established in earlier research in response to the three research topics, as shown in Table 2. The coding system was used to analyze the selected articles' technological applications and definitions. The researchers resolved disagreements and reached a result after extracting the text segments and coding them in accordance with a procedure. The categorizing and coding processes were validated, and then the findings were descriptively presented according to the themes discovered. By concentrating on instructional design, resources, assessment methodologies, and learning objectives, researchers and educators can develop and enhance the current AI education practices and curriculum in a way that best supports early learners's AI literacy. The concept of AI literacy in ECE studies is thus followed by this review research in relation to curricular design, assessment methodology, and learning objectives.

Every article is completed in a distinct table, complete with tags for the first and second writers. Researchers discussed instructional design, evaluation methods, and learning objectives. Following a

comparison and discussion of the variations between the findings from the first two researchers, the tables were updated.

Purpose of the Study

In addition to offering recommendations to researchers and searching for interesting activities for KG kids, this research contributes to a timely overview of AI literacy instruction. Policymakers can use the findings as a guide when making crucial decisions on how to effectively set educational standards and steer future development. Finding subjects that will always be significant in the field is made easier by examining past research in the area. There is a dearth of research on AI literacy instruction in early childhood school settings. Researchers in these studies focused on themes including pedagogy, knowledge of subject matter, and technology to ascertain what, why, and how to teach AI literacy to young learners. Less frequently, however, are review studies that recapitulate how teachers foster young learners' literacy through age-specific instructional design and resources, the kinds of assessment techniques that have been employed to assess the students' AI literacy in the early AI curriculum, and the learning objectives of those mediations in ECE settings. To plug in these knowledge gaps, this study provides a review of the scholarly work on AI literacy in ECE. This review gives a comprehensive analysis and findings of earlier studies on the Artificial Intelligence (AI) curriculum in ECE, exploring challenges and opportunities by a scoping review of fourteen research articles to assist academics and educators in tracing appropriate and main data in ECE. The main concerns and chances for improving AI literacy in ECE remained the focus of this review. Below is a list of three research topics to help focus the search.

Table 3

Theme, subtheme, explanation, and examples

The theme of the Study	Sub-theme of the Study	Explanation of the Study	Examples of the Study
Research Question No. 1: What is the Learning Design?	To explore the learning content	This sub-theme focuses on identifying AI knowledge and skills deemed suitable for young learners in KG.	Kandlhofer et al. (2016)
Research Question No. 2: What are the Assessment Methods?	To test the knowledge, skills, and the assessments	This area explores the approaches used to assess the acquisition of AI literacy among students, including various assessments to measure their understanding and abilities.	Williams et al. (2019); Lin et al. (2020)
Research Question No. 3: What are the Learning Objectives?	To analyze learning activities	This theme is concerned with documenting and analyzing students' interactions and experiences during AI learning activities.	Druga and Ko (2021)

Results

RQ 1: How do the AI Curriculum and Instructional Designs Support Young Learners in Acquiring AI Literacy?

This segment presents an overview of the opportunities, learning materials, resources, duration of the intervention, and pedagogical design researchers used to build young learners' AI literacy. The materials used for instruction in the research curriculum design may be reviewed first since they provide educators with a foundation for creating curricula and programs tailored to their students' needs. Even if they might not fully understand the underlying concepts, young learners may comprehend AI ideas through engaging experiences like supervised machine learning, generative AI, and knowledge-driven systems (Lin et al., 2020). Educators can select appropriate learning materials for young learners centered on the recommended knowledge contents (Table 2—AI instruments). Fourteen research studies that were evaluated involved young learners using AI platforms and technologies. PopBots were utilized in three studies to teach KG kids about supervised machine learning, generative AI, and knowledge-driven systems. Among the supplementary AI tools and platforms mentioned in the research, e.g., Jibo robot, Cosmo, Blue-

Bot, Zhorai, Vernie-Lego Boost Bot, Google's Teachable Machine, and WowWee's Coji (Williams, 2018; Williams et al., 2019 a,b).

According to Lin et al. (2020), learners may acquire machine-learning ideas using a conversational platform called Zhorai. AI education for young learners was previously impossible, but with these technologies, KG instructors are investigating methods to introduce AI to their students to improve their technical proficiency and make life easier for them. As shown in Table 3, kids pick up concepts through AI quite quickly. Six studies involve students in quick learning sessions that last one to four hours. Longer interventions and pedagogical design must be considered in future studies to support students' AI literacy. Numerous research approaches have been utilized in the study of pedagogy design. The two pedagogies that are most used are experiential learning (n = 3) and activity-based learning (n = 4). "The activity-based approach, with constructivist goals, makes use of cooperative interface and knowledge-rich resources" (Macdonald & Twining, 2002, p. 604 as cited in Su et al., 2023). Research has demonstrated that students may effectively use hands-on activities to examine AI concepts (Druga et al., 2019). Teachers can assist kids learn through hands-on experiences, e.g., knowledge-based systems, supervised machine learning, generative AI, and how AI works in robots and toys to increase kids' AI literacy (Williams, 2018).

Experiential learning enables pupils to learn by doing and relating ideas and knowledge acquired in the classroom to everyday situations through hands-on activities and introspection (Morris, 2020, as cited in Su et al., 2023). Furthermore, Kewalramani et al. (2021) launched AI-embedded hands-on learning games for kids ages 4-5 that included using Vernie robots for play. The learners' three inquisitive literacy skills, creative, emotional, and collaborative skills, increased as a result. Learners can enhance their creative inquiry literacy—the capacity to understand technology and think creatively by playing with AI toys. The two pedagogies may support learners in studying and interacting with artificial intelligence, even though it is not necessary for them to fully comprehend the concepts behind AI.

Finally, only a limited number of AI researchers (n = 2) have developed programs to improve 21st-century skills, i.e., communication skills, cooperation skills, and critical thinking skills of young learners (Tseng et al., 2021). For instance, Jibo, Cozmo, and Alexa home assistants are examples of AI agents that Druga et al. (2019) devised for play and communication activities, and they requested kids to devise AI agents in the future. While it seems reasonable that young learners may not be capable of processing large amounts of information, they must allow them to use AI for peer interaction and collaboration. Teachers can utilize experiential learning, hands-on experience, and activity-based learning as three pedagogical techniques to assist young learners in studying how to use AI technologies, communicate with others who use AI, and comprehend how AI works. These may enable learners to grow and learn in the contemporary digital environment.

RQ 2: How was the AI Curriculum Assessed to Explore the Challenges and Prospects of AI Literacy of Young Learners?

Three data assembly strategies—questionnaires, observation, and knowledge and theory of cognitive assessments were used to explore young learners' awareness and abilities as challenges in AI (4 papers total). Despite certain commonalities among different evaluation techniques, this study used the names from the assessed research.

The effects of Early Childhood Education were examined using various evaluation methods, such as theory of mind and knowledge tests. Knowledge assessments were developed and used to gauge young learners' proficiency with AI. Similarly, the Williams et al. (2019) study included three activities, i.e., food classification, rock-paper-scissors, and music, to measure the AI understanding of learners. The results revealed how AI-enhanced the comprehension of the three mentioned concepts.

The effects of learning on learners were examined using a variety of observations, such as learning activities, young learners' play experiences with instructors, and interactions with AI robotics. For instance, in one game the researchers (Tazume et al., 2020) developed, kids interacted with an AI robot named RoBoHoN. They followed methods of observation to do this. Findings indicated that kids were involved in activities that endorsed the progress of non-cognitive skills.

Challenges

Younger learners in ECE employ AI tools to enhance their parents' and teachers' social and cognitive development, e.g., chatbots, instructional robots, and evaluation systems. These applications are becoming more and more useful for automating grading, engaging with kids, and providing feedback. Artificial Intelligence (AI) has evolved into virtual tutors, study assistants, and caregivers that support young learners' social and cognitive growth. It might be necessary to educate young learners, who are the items' intended consumers, about the underlying technology. Their knowledge of AI concepts may be incomplete, and they may not be aware of its limitations (Lin et al., 2020).

As such, this study contributes to the growing body of knowledge regarding instructional design, tool utilization, and assessment strategies for promoting AI literacy in young learners. It also investigates how these educational efforts improve young learners' learning effects in ECE situations. Apart from these features, the subsequent segment explains the potential challenges and prospects linked to AI literacy in ECE. Instructors can use the resources to design curricula and activities that are age-appropriate for the learners (Laato et al., 2020, as cited in Su et al., 2023). Upcoming studies should look at the activities and resources better suited for ECE as well as the kind of teacher preparation KG students need.

Most ECE instructors require additional technical knowledge and experience. Because of this, they frequently lack the confidence to comprehend AI and have a bad attitude while developing lesson plans and extracurricular activities for their pupils. Instructors felt contended by the practice of trying out the latest digital tools and getting frustrated with minor technological issues (Horton & Horton, 2003, as cited in Su et al., 2023). This is made worse by the hectic schedules of teachers, who require more time to learn about AI. Learners might be too concerned because most AI goods in the market are toys designed to teach kids about artificial intelligence (Dyrbye et al., 2009, as cited in Su et al., 2023). Therefore, creating relevant AI resources and activities is greatly hampered by instructors' lack of preparedness for teaching with AI. Still, several companies and universities could contribute to developing AI resources (Ng et al., 2023).

There is a dearth of curriculum design; only a few articles have addressed what, why, when, and how learners must begin learning. However, studies on early AI education have paid less attention to curriculum design (Yang, 2022). Thus, the second challenge that educators encounter while developing and using early AI expertise is curriculum design.

Lack of guidelines for instruction; as the understanding of artificial intelligence develops, learners should be exposed to project-based and practical learning. Although not all KGs have access to these resources, the majority of research on these activities has demonstrated that kids use age-appropriate AI tools to scaffold their understandings. To enhance learners's exposure to these technologies, governments must help schools purchase them (Williams et al., 2019).

Future Directions AND ECE Implications

It initially provides a range of instructional tools, resources, and strategies appropriate for this age group to support young learners in cultivating AI literacy skills at the ECE level. This might be used by academics and educators to develop kid-friendly AI games, toys, and curricula (Ng & Chu, 2021). It compiles data demonstrating the effectiveness of the AI curriculum in ECE. Most of the studies indicated that the AI curriculum has meaningfully enhanced learners' theory of mind abilities, AI or machine learning concepts, and different inquiries, including creative, emotional, and collaborative (Ng et al., 2022a). According to Kewalramani et al. (2021), researchers could design fun activities for kids, such as interacting with AI robots, to help kids' perspectives of AI.

The study results presented in this paper highlight the many evaluation approaches used to support AI education in ECE research. The instruments of evaluation that were most frequently used were questionnaires, observations, knowledge, and skill-based assessments. For instance, Williams (2018) used knowledge evaluations to look at learners's AI knowledge and skills. The findings showed that learners's perceived AI knowledge has considerably increased because of the AI curriculum for ECE. Therefore, during the formative years, it is essential to progress pedagogically sound AI instruction.

The possibilities and challenges of AI literacy in ECE are also covered in this study for academics and teachers. Ineffective curriculum design, low teacher confidence, a lack of knowledge and experience with

AI, and a lack of teaching standards are some of the barriers to AI literacy in ECE. This article offers recommendations for academics and teachers. To help young learners learn about AI, future educators might develop entertaining AI activities, such as engaging with AI robots. The discussion provides a great focal point for researchers to explore the efficiency of early AI literacy and for several stakeholders to design attractive AI curricula for the educational domain.

RQ 3. What were the Learning Opportunities and Threats that AI Literacy in ECE Contexts Aimed to Explore?

Numerous studies showed that the AI syllabus was efficient in augmenting young learners' understanding and abilities, which made it simpler for them to use AI technologies for everyday tasks and learning. The knowledge and skill-development learning as objectives were summarized in this section. The AI content has notably enhanced learners' understanding of AI topics through supervised learning and knowledge-based systems through machines. The researchers (Tseng et al., 2021) demonstrated that after basic classes on AI through online mode, the learners gained knowledge related to machine learning. Moreover, young learners can acquire new skills like theory of mind and inquiry (Kewalramani et al., 2021) with capabilities for creative, collaborative thinking and expression of their views. However, no research has been done on how AI learning systems influence learners' emotional learning, motivation, attitudes, and level of confidence. More research is needed to find out how students meet their emotional learning goals.

Opportunities

It was previously difficult to help young learners understand AI concepts and capabilities due to a deficiency of appropriate tools. More developmentally appropriate technology has made it possible for young learners to learn about artificial intelligence through play. Playing with AI social robots, toys, and facilities is one way that kids can learn how to communicate with AI technologies that react to their feelings and expressions. They will be inspired to learn more about AI technology daily by this (Kewalramani et al., 2021). While it is true that young learners at this age rarely comprehend or grasp AI, exposing students to AI can help them enhance their attitudes and skills related to digital literacy and better prepare them for their development in primary schools. With this additional knowledge, parents might become more accustomed to the technology and raise the likelihood that they will use AI products and services for future instructional design. These goods and services can also be used by parents to give their kids access to the digital world. For example, enhancing parent-child interactions using AI toys (such as LegoBoost Bot, Coji, Alpha Mini, and Qobo, the Snail) can help young learners develop socially and emotionally. AI viewpoints explain the attitudes and methods applied to problem-solving (Ng et al., 2021).

According to many studies, exposing young learners to AI concepts and skills greatly improves their comprehension of AI (Williams, 2018; Williams et al., 2019). Since AI in ECE is very unlike AI in primary-level and secondary-level education, kids need early assistance in comprehending the ideas and information that underpin AI. In ECE, for example, AI is mostly concerned with how students might use AI tools, such as AI toys, to assist their daily lives and academic endeavors. AI in elementary and secondary education places a strong emphasis on knowledge and skill acquisition via play and discovery, and young learners can acquire digital abilities that will enhance their inquiry, emotional, and collaborative literacy as well as linked AI viewpoints like curiosity and societal skills (such as engaging in play and social interactions with other kids) (Kewalramani et al., 2021). Every day, kids utilize AI tools (including chatbots, robotic toys, and drawing tools) to develop their digital storytelling and writing abilities, as well as to improve their group communication skills (Ng et al., 2022c). Considering this, it is reasonable to assist ECE students in developing their AI literacy.

Discussion

This study reviews research on AI literacy in ECE, emphasizing both the efficacy of treatments and the traits and attributes of AI literacy. While there is not much empirical research on AI literacy for ECE, the available ones offer a new perspective on various topics related to AI literacy. By addressing three research issues, this study offers various new insights into the field of AI literacies in ECE. Several conclusions were drawn from analyzing AI curriculum designs in the selected papers.

Firstly, to improve young learners' AI learning, the majority of the research employed platforms or tools that are age-appropriate. The most popular tool for improving learners' understanding of fundamental AI ideas is robotic kits, particularly PopBots (n = 3) (Williams et al., 2019; Williams, 2018).

Secondly, to improve kids' comprehension of AI concepts and knowledge, researchers (Druga & Ko, 2021; Lin et al., 2020;) used pedagogy design to provide a variety of learning activities. For instance, Williams (2018) and Williams et al. (2019a) developed three learning tasks to help kids grasp knowledge-based systems. Generative AI and supervised machine learning are three core AI concepts. Many researchers found that there are significant differences in the ways that AI is taught in elementary school, secondary school, college, and KG. Learners between the ages of three and eight can only comprehend basic AI concepts (Su & Zhong, 2022).

Thirdly, in terms of early learners' learning results, most of the studies examined the extent to which the intervention enhanced their comprehension of artificial intelligence or machine learning. Along with developing their knowledge of AI and machine learning, kids who studied the AI curriculum also showed improvements in their capacity for creative, emotional, and collaborative inquiry. Studies showed that young learners ages three to eight only recognize the most basic ideas of artificial intelligence (Lin et al., 2020).

To improve the instructional designs through preparation, support, development of learners' analysis abilities, teacher-learner, peer-to-peer collaborations, and evaluation of learners' learning for inquiry development, Kewalramani et al. (2021) also used a design-based research methodology. It enabled teachers to improve their lesson plans to help students become more proficient in AI. Fourthly, learners' AI literacy in ECE was assessed using four methods: assessments of knowledge and theory of mind skills, observation (three studies), and questionnaire (three papers). Future studies should evaluate learners' AI proficiency using performance-based criteria, as this study suggests. There is no accepted exam, questionnaire, or survey to evaluate young learners' AI understanding and abilities.

Lastly, more empirical research on implementation and research methodologies in the present literature on AI literacy in ECE classrooms needs to be conducted. Future researchers could employ more empirical and interventional study designs with well-defined control groups, curricula, and various data analysis methods (such as ANOVA and t-tests). While the included research has addressed the potential benefits of these learning systems for students' cognitive development, several studies have identified specific challenges students may face when studying AI. Learners with lower Socio-Economic Status (SES) typically outperform those with better SES backgrounds regarding AI abilities (Druga et al., 2019).

This circumstance also arises in the teaching of AI literacy. The social-economic background of parents may impact their learners' impression of AI. According to a study on whether socioeconomic status will influence this view because of their lack of coding and technology-related expertise, Druga et al. (2019) discovered that learners in low and medium Socio-Economic Status schools and centers tend to have stronger collaboration skills compared to high SES learners but had a harder time advancing.

Conclusion

This review facilitates the designing of the instruments, strategies, plans of intervention, study design, and research objectives credited to the emerging literature on early AI curricula. It also investigates AI literacy's benefits and drawbacks in early childhood schooling. The objectives of this review of the literature can direct futuristic investigations into the creation of instruments, instructional strategies, research designs, interventions, and evaluation methods for early AI curricula. Additionally, it can provide a framework for developing, implementing, and evaluating developmentally appropriate AI programs for young learners, researchers, and practitioners. This analysis provides recommendations for early AI education and will be a great resource for future ECE research in the digital environment.

This research is limited to two ways: primarily exploratory, descriptive, and preliminary. Most of the selected studies are still in the early phases of development. It is hoped that more scholars will weigh in on the topic and contribute more extensive research practices as well as effective teaching and learning methodologies for AI in ECE. Second, the study's range was controlled, and generalizations could not be quantified due to the dearth of literature on AI literacy for ECE. Nevertheless, early AI literacy is a desirable

subject and a useful area of new research for academics in the future, based on the material that is already available.

Recommendations

Based on a scoping review of different research-based articles of AI in ECE, the subsequent recommendations are made:

1. To address difficulties related to instruction, the schools may connect the teachers to the newest advancements in AI. For example, by using internet resources, early childhood educators can study AI subjects in their spare time.
2. As an all-inclusive approach, the adaptable AI instructional plans may be developed with learner relevance, teacher-student communication, AI knowledge, and the effect of AI on content and product, which are the fundamental components that should be created holistically.
3. The AI-based content having more engaging AI exercises may be developed for the children of ECE, which may enhance their concepts about artificial intelligence from the beginning.
4. Technological, Pedagogical and Content Knowledge frameworks may be considered as a reference for understanding how to properly incorporate AI literacy into classrooms to assist teachers in teaching more effectively.
5. The AI may be used in a local context to support early childhood educators in curriculum planning, classroom management, and personalized student feedback for children.
6. It is recommended that future researchers assess the effectiveness of AI-interactive tools like educational robots, apps, and games in promoting the cognitive and social skills of children at ECE.

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