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Defining Core Competencies for Artificial Intelligence in Early Childhood Education

Ruuhina Mohd Sani & Qurat-ul-Ain Inayatullah
Faculty of Social Sciences, Quest International University, Malaysia

Corresponding author: ruuhina.msani@gmail.com

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ABSTRACT

In today's day and age, technology has become a significant part of education worldwide. It has drastically changed the way education is given out, received, and discovered. Artificial intelligence (AI) has become known as a game-changing technology that has the power to completely disrupt several sectors of the economy, especially in education and our way of life. The use of (AI) in education holds the ability to change current methods of teaching. Teachers are encouraged to involve more students in the knowledge production process actively, but they have not fully realised the potential of integrating the application into the teaching process yet. We are still in the early stages of teachers using artificial intelligence for student engagement and active participation, indicating a need to create more rigorous research and study related to it. One of the issues identified based on the current research was because of the teachers' training programs which have yet to be improved. One evident gap in current research lies in the lack of focus on the use of the application during teacher training programs. Satisfaction with digital training programs is critical for improving teachers' digital proficiency and fostering a learning environment rich in digital knowledge. This paper will also focus on the AI literacy concept, including its importance in today's educational settings. This literature review exists to define early childhood education (ECE) teachers' AI literacy. This paper discussion will help enlighten the Ministry of Education on the importance of enhancing teachers' AI literacy through comprehensive and targeted training programs.

Keywords: Artificial intelligence, Bloom Taxonomy, early childhood education, teacher training, TPACK

INTRODUCTION

Artificial Intelligence, or the acronym, AI, is human intelligence but made into machinery programs. This means that human intelligence is replicated and made to work in machines or on computer systems. The field of artificial intelligence (AI) in computer science aims to build extremely clever machines that can do activities that have historically required human intelligence. AI has transformed several businesses and facets of our lives over time, going from an idea to a reality. This literature review will investigate the concept and history of AI. Learning from data and enhancing their efficiency without having to be specifically programmed, is one of the key ideas in AI (Goodfellow et al., 2016).

According to Russell and Norvig (2020), AI is the replication of human intellect in computers that enables them to carry out tasks independently, gain knowledge through experience, and adjust to changing circumstances. Machine learning, which uses algorithms to let computers do Natural Language Processing is a key idea that focuses on giving computers the ability to comprehend and produce spoken language (Jurafsky & Martin, 2019). AI has developed from just an idea that was

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futuristic at that time to now a revolutionary technology with numerous applications in several fields. Natural language processing and machine learning, two of its fundamental components, have facilitated advancements and innovations that will continue to influence the future. To fully realize AI's potential for the good of humanity, it is crucial to take ethical considerations, protect data privacy, and promote responsible AI research. It is clear as day that many have worked very hard to make AI a possibility and transform an idea into a reality and a wonderful one at that.

AI software has large amounts of material that teachers can use to either learn from or use to teach students. Teachers now have access to a wide library of instructional resources because of the efficient creation and curation of educational content by AI algorithms (Pedro et al., 2019). Finding current and pertinent resources that are in line with curriculum standards is made easier for teachers by AI-driven content curation. Another way AI can help teachers is through assistance in grading students' work. Teachers can save significant time and effort by automating assessments with AI-based grading systems (Vittorini, 2021). Complicated projects, essays, and tests can be analysed by these systems, resulting in unbiased evaluations and freeing teachers to concentrate on improving instruction.

LITERATURE REVIEW

AI literacy and its importance in education

A paradigm shift in educational systems has been brought about by the rapid growth of AI technology. AI-enabled technologies are currently being incorporated by educational institutions more frequently to provide students with individualized learning experiences. Modern, student-centered pedagogies are gradually taking the place of outdated teaching and learning approaches in education because of artificial intelligence. AI is used to monitor instructional procedures, carry out academic analysis and diagnosis, and improve learning and teaching efficacy (Zhai et al., 2024). Through intelligent agent systems, chatbots, and recommendation systems, artificial intelligence (AI) can assist teachers in predicting students' learning status and performance, recommending learning materials, and automating tests to enhance the learning experience for students (Liang et al., 2021). The young students we know today are growing up with these AI applications, but not many studies focus on the issue related to competency, especially teachers' competence and how well their awareness of the use of AI in education. This paper will focus on early childhood education (ECE) teachers' AI literacy.

Previous research has demonstrated that AI has greatly enhanced kids' understanding of AI, robotics, machine learning, computer science, and other related topics as well as other abilities including creativity, emotional regulation, cooperative learning, literacy, and computational thinking (Su & Yang, 2022). This is demonstrated by the growing need for AI technologies in early childhood education (ECE) to improve young children's learning and development (Lin et al., 2020). Today, we can see that AI technologies are causing significant issues for public policy, especially in educational settings like plagiarism issues, privacy issues involving young children, and such. Due to this, everyone must be aware of the basics of AI. Children need to be adequately trained to work with and use AI to provide them with the abilities they need to face the quickly changing and tech-driven world and to also help them ensure their employability and career potential in the future (Preface, 2021; Touretzky et al., 2017). Most of the developed countries in the world like China and the United Kingdom are now making sure that AI in education needs to be standardized, especially about what students should learn at different levels (Su & Zhong, 2022).

The use of AI in teaching also helps teachers to better themselves and develop them into more knowledgeable individuals, guiding them to teach and mentor better. This can be achieved by teachers attending online teaching courses and workshops, online seminars, and virtual training sessions or workshops that enable teachers to continue their professional development. This up-to-date and continuous education keeps teachers in the know of the most recent educational trends and the latest tech integration techniques (OECD, 2019; Ertmer & Ottenbreit-Leftwich, 2021). Moving on, AI can aid teachers in their jobs. For example, AI can help teachers in several ways, freeing them up to concentrate on higher-order learning activities. To free up teachers' time for preparing lessons and offering focused interventions to problematic students, platforms powered by AI may automate administrative tasks like grading and data analysis. Additionally, AI can help teachers determine where their lessons need to be modified by locating gaps in their students' knowledge. This means that teachers can use AI to help in grading exams, coming up with activities for students, and overall student work management.

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RESULT AND DISCUSSION

Underpinning Theory and Model

Bloom Taxonomy: Critical Thinking and Information Literacy

Different abilities related to different kinds of interactions are described by Bloom's taxonomy (Bloom et al., 1956). The taxonomy was created to provide a standard language for education and to act as a guide for choosing the courses that should be covered in a certain field of study (Krathwohl, 2002). Independent of the specific topic of study, Bloom et al. (1956) cluster competencies based on the underlying educational purpose. This paradigm is frequently used in academia, and one of its authors added a second dimension to it (Krathwohl, 2002). Bloom's Taxonomy is an approach used for classifying the degrees of reasoning abilities and organized thinking needed in various learning environments. There are six levels in the taxonomy: remembering, understanding, applying, evaluating, and creating (Krathwohl, 2002). Retrieving pertinent information from memory is referred to as remembering, whilst being able to deduce meaning from instructional messages is referred to as understanding. Applying involves carrying out a process in a specific setting, whereas analysing entails breaking down information into its component elements. Finally, assessing involves the ability to make decisions based on standards, and generating is the act of combining components to create something new.

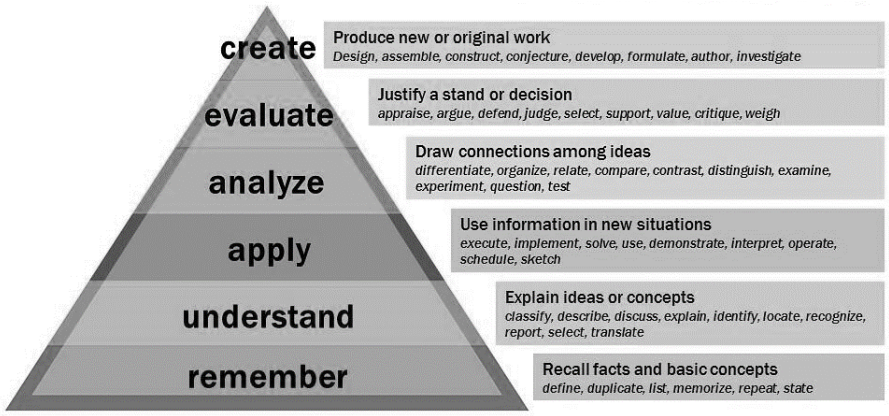

Figure 1. Bloom taxonomy revised (Krathwohl and Anderson, 2001)

Each of these skill categories facilitates different kinds of interactions. Each requires a higher level of complexity and ordered thinking from the students. It is believed that the levels are sequential, meaning that to advance to the next level, a previous level must be completed (Bloom, 1956). This paper will investigate the Bloom taxonomy design in assessing ECE teachers' AI literacy since teachers are not familiar with AI, and there is currently no framework for categorizing cognitive process stages in the context of AI learning. It is also because this model is a well-known pedagogical paradigm that lays the groundwork for teaching young students about artificial intelligence which will assist ECE teachers in the future. According to Ng et al.'s study from 2021, there are three components to Bloom's Taxonomy's cognitive levels: (1) know and comprehend; (2) use and evaluate; and (3) develop AI. "Remember" and "Understand" are covered in the first component referred to as "Know and understand AI." While "Evaluate and Create AI" refers to the three highest levels of analysis, evaluation, and creation. The last component is "use and apply AI". This concept and applications refer to the middle level which is "Apply".

AI-TPACK Framework

The TPACK theoretical framework has been used decades before, during which time information technology has rapidly improved, especially with the introduction of powerful artificial intelligence. TPACK framework developed by Punya Mishra and Matthew J. Koehler (2006) is an emergent form of knowledge that focuses on three components; content knowledge (CK), pedagogy knowledge (PK), and technology knowledge (TK).

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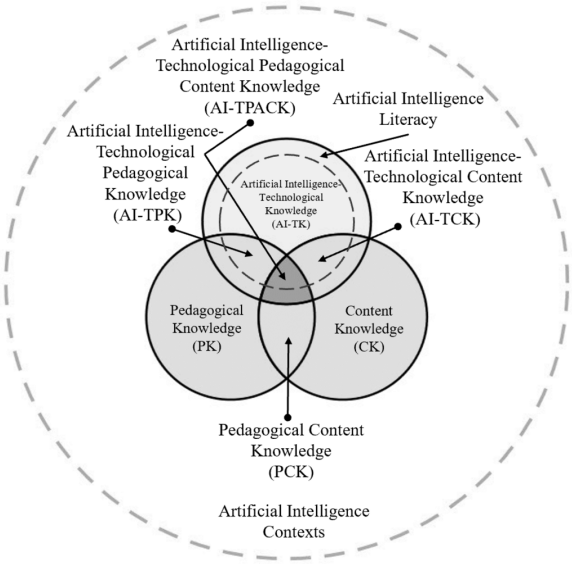

Figure 2. AI Literacy TPACK Framework proposed by Ning et al. (2024)

In educational settings, this framework has always been referred to, especially because it offers a productive approach to many challenges that teachers face in implementing educational technology in their classrooms. Teachers are aware that the teaching process is a complex profession that calls for the integration of numerous specialized knowledge domains. Teaching is an example of an unstructured field in this sense, requiring teachers to apply an intricate knowledge system in a variety of situations and contexts (Mishara, Spiro & Feltovich, 1996). The information age has effectively given way to a new era of enhanced intellect because of technological advancement. The most important issue in this situation is whether the existing TPACK framework can still follow the ongoing changes and needs in educational settings and teachers' need for professional development (Kanbul et al., 2022). Based on the study by Ning et al., (2024), they found that after revaluation of the relationships between the three components in TPACK (pedagogy, technology, and content) has become the key to the construction of the original TPACK framework rooted in the age of artificial intelligence. They proposed the new theoretical framework of AI-TPACK as shown in Figure 2.

Defining Artificial Intelligence in ECE

Artificial Intelligence

Artificial intelligence is the capacity of a computer or robot under computer control to carry out actions often associated with intelligent beings (Copeland, 2024). AI has taken the form of interactive human computers, spanning across computerized industries. AI is defined in two ways in literature, the first is the informal way, which refers to AI as any (computer-generated) program that is smarter than human beings. The formal definitions avoid reference to human beings (Dobrev, 2013). While there is no concise and commonly agreed formal definition of AI, it was first described in 1956 and is commonly quoted in literature by McCarthy (2007) as "the science and engineering of intelligent machines.". The science of programming will simplify the process of developing AI to that of developing a suitable language for world description rather than mere computable functions (Dobrev, 2020). Pedro et al., (2019) have characterized AI with dimensions such as thinking and acting rationally and thinking and acting like humans.

Previous studies in defining "AI Literacy"

Historically, literacy refers to one's ability to read and write or be able to write letters (Elmborg, 2012). There has been the emergence of various forms of literacy such as information literacy, media literacy, digital literacy, and lately, AI literacy (Kong et al., 2021). The conceptualization of AI literacy is relatively new in educational research. Based on previous literature, Ng et al. (2017) have proposed

four dimensions of AI literacy, i.e., knowledge and understanding, use and application, evaluation, and ethical issues. In another study, Yi (2021) defines AI literacy as the prerequisite knowledge and skills needed to live independently in the AI-led era. According to UNESCO's Future Literacy and Education (2021), Metacognition and anticipation are the qualities needed for 21st-century learners living in the AI era. Hence, AI literacy's purpose is to anticipate metacognition's competency. The following table shows some of the previous constructs and definitions of AI available in the existing literature.

Table 1. Definitions of AI literacy in the available literature

Authors	Title	Definition
Kong et al. (2021)	Evaluation of an artificial intelligence literacy course for university students with diverse study background	The active capacity to use AI wisely to socially fulfil one's ideal or purpose and the passive ability to successfully secure personal information.
Yi (2021)	Establishing the concept of AI literacy	The prerequisite knowledge and skills needed to live independently in the AI-led era
Ng et al. (2021)	Artificial Intelligence in Perioperative management of major gastrointestinal surgeries	AI to every student's digital literacy in the twenty-first century for both professional and daily contexts and suggested that it be a necessary ability for everyone, not only computer scientists.
Burgsteiner et al. (2016)	Teaching the basics of artificial intelligence in high schools.	
Kandlhofer et al. (2016)	Artificial intelligence and computer science in education: From kindergarten to university.	AI literacy relates to the ability to comprehend fundamental AI information and concepts.
Long and Magerko (2020)	What is AI literacy? Competencies and design considerations	AI literacy is a set of skills that allows people to utilize AI as a tool online, at home, and at work, as well as to critically assess AI technologies and interact and collaborate with them.
Aoun (2017)	Higher education in the age of artificial intelligence	AI literacy is the capacity to recognize and make use of AI by comprehending its principles and applications.
Wong et al. (2020)	Broadening artificial intelligence education in K-12: where to start?	considered applications, ethics, safety, and principles of AI as sub-components of AI literacy
Chai et al. (2021)	Perceptions of and behavioral intentions towards learning artificial intelligence in primary school students.	AI literacy, which encompasses people's knowledge and comprehension of AI concepts and applications, is a crucial epistemic component.

Early Childhood Education (ECE) teacher's AI Literacy

There is limited data on ECE teachers' AI literacy and skills to date. There is a gap in the literature relevant to ECE teachers' knowledge, skills, and attitudes in this area. AI literacy assessment is rather a subjective evaluation and may depend on self-reporting and past exposure to digital literacy. Moreover, due to a lack of standard measurement tools for AI literacy, it is rather vague to measure teachers' objective AI literacy. Ding et al., (2024) reported that American pre-service and in-service teachers scored moderately in AI literacy assessed by a measurement tool developed to check non-technical individuals' AI literacy. Inconsistent responses suggested ambiguity in teachers' understanding of AI concepts. In another study conducted on Chinese kindergarten teachers, they showed strong knowledge of the use of advanced educational technology and had overall positive

attitudes and opinions toward the use of advanced technology in instruction (Wu, 2024). Most of the studies regarding AI use in ECE are conducted in Western countries (Su, 2022).

Within the domain of modern education, particularly in the era of Education 4.0, teachers find themselves in a complex role where they serve as both curators of content and designers of curriculum. Male (2016) stated that introducing technology into the classroom will provide more opportunities for teachers to connect with their pupils, resulting in improved networking, collaborative learning, and problem-solving. The process involves a careful and deliberate choice and application of digital resources such as AI that are in accordance with pre-established educational goals. Teachers employ a variety of readily accessible digital resources, digital platforms, and interactive content to enhance pedagogical practices and foster the development of digital literacy skills. By leveraging these tools, teachers aim to create engaging and interactive learning experiences that cater to the needs and preferences of modern learners. The utilisation of digital resources allows for the integration of multimedia elements, such as videos, images, and interactive simulations, which can enhance students' understanding and retention of complex concepts (De Sousa et al., 2017).

Additionally, digital platforms provide opportunities for collaborative learning, as students can interact with their peers and teachers in virtual spaces, fostering the development of critical thinking, communication, and problem-solving skills. Through the incorporation of interactive content, teachers can create dynamic and immersive learning environments that promote active participation and student engagement. Overall, the strategic use of these digital tools in educational settings holds great potential for transforming traditional pedagogical approaches and equipping students with the necessary digital literacy skills to thrive in the digital age.

Potential benefits and challenges associated with AI integration

Current literature available on AI integration in ECE highlights various challenges, such as a lack of teachers' AI knowledge, skills, and confidence; a lack of curriculum design; and a lack of instruction guidelines (Su, 2023). Although a review of past studies shows that teachers meet challenges at the early stages of implementation of AI, it has a deep potential for benefiting young learners both in their academic competence and digital literacy. Acquiring a greater understanding of teachers' ideas, worries, and expectations can be achieved by investigating their attitudes and perspectives regarding AI in early childhood education settings (Mohammed, 2023). Based on the study also found that limited access to suitable technology resources, such as AI tools and equipment, is one of the challenges that may prevent AI from being successfully implemented in ECE. Additionally, teachers may find it difficult to comprehend, integrate, and fully utilize AI technologies in their teaching methods in the absence of thorough training programs and assistance (Bautista et al., 2023).

In the context of Education 4.0, the incorporation of technology has become imperative, requiring teachers to consistently cultivate and augment their technological proficiencies. The present study examines the importance of possessing proficiency in educational software, digital tools, and learning management systems. These technological resources have become integral components of modern education, facilitating the delivery of instructional content and enhancing the learning experience for students. Proficiency in educational software like the use of AI tools refers to the ability to effectively navigate and utilise software applications specifically designed for educational purposes. Additionally, learning management systems play a crucial Teachers face the arduous task of surmounting technological challenges and remaining abreast of emerging technologies.

CONCLUSION

This paper discusses AI literacy concerning ECE knowledge, attitude, and skills. This paper discusses the basic definitions and concepts of AI literacy. This paper starts with the introduction of the concept of AI and AI in education, its background, and its importance in education particularly in early childhood education. This paper also discusses Bloom’s theory and the TPACK framework as the basis of the theoretical background. The conceptual framework for this paper is aimed at developing further studies and instruments to advance ECE teachers’ knowledge, skills, and use of AI in instruction. Although there is evidence of the use of AI and its benefits on children’s academic and computer learning in ECE instructions, there is limited availability of relevant data and studies for teachers' perceptions, knowledge, and skills in ECE. The previous studies show potential for future research in

the AI literacy of ECE teachers. Further studies related to evaluating ECE teachers' AI literacy will be able to determine if their AI literacy can be measured through knowledge, attitude, and skills. To conclude, Numerous benefits that foster personalized learning experiences, aid pupils as well as teachers and improve educational procedures are provided by the integration of AI in education. The potential for artificial intelligence in education is extensive and exciting, ranging from tailored learning pathways to effective content development and assessment. To fully utilize the promise of AI in education, however, great consideration must be given to addressing issues relating to privacy of information, bias, and ethical consequences.

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