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Leveraging Artificial Intelligence for Enhanced Assessment in Early Childhood Education in Nigeria

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Abstract

Early Childhood Education (ECE) is a critical stage in a child's developmental journey. Accurate assessment of learning outcomes is essential to ensure children are adequately prepared for future academic success. However, traditional assessment methods have limitations. In contemporary times, Artificial Intelligence (AI) literacy has become an emerging topic in digital literacy education research. However, it is still under-explored in Early Childhood Education (ECE) since the AI curriculum for young children has just been designed in recent years. This paper explores the potential of Artificial Intelligence and how educators can leverage on it in enhancing assessment in early childhood education in Nigeria. It discussed AI benefits, challenges, and opportunities. The paper concludes by forecasting a growing number of age-appropriate curriculum and assessment tools for the ECE in the future. The paper also suggested that researchers and educators are to improve AI literacy research and learning design in early childhood education, training and retraining of teachers in AI teaching strategies, production of teaching guidelines since it is an emerging field and very fragile ,design a standardized assessment with global best practices and provision of adequate infrastructures for the effective implementation of AI program by the relevant agencies and ministries of the government in order to enable educators' leverage on AI for enhanced assessment in ECE in Nigeria among other points.

Keywords: *Artificial Intelligence, Artificial Intelligence Literacy, Artificial Intelligence Education, Assessment, Early Childhood Education*

Leveraging Artificial Intelligence for Enhanced Assessment in Early Childhood Education in Nigeria

In contemporary times, Artificial Intelligence (AI) literacy has become an emerging topic in digital literacy education research. However, it is still under-explored in early childhood education (ECE) since the AI curriculum for young children has just been designed in recent years. A scoping review was conducted to examine the thematic and content analysis of 16 empirical papers from 2016 to 2022. This scoping reviews evaluate, synthesize, and display 16 studies on AI literacy in early childhood education, including curriculum design, AI tools, pedagogical approaches, research designs, assessment methods, and findings, Jiahong, et al, (2023). Early childhood education lays the foundation for future academic achievement. Assessment is crucial to evaluate learning outcomes and identify areas for improvement (UNESCO, 2020).

Traditional assessment methods, however, have limitations, including subjectivity and time-consuming processes (Gronlund & Brookhart, 2009). Artificial intelligence (AI) offers a promising solution. AI can enhance assessment in early childhood education in Nigeria but careful planning, implementation, and evaluation are necessary to ensure effective integration. There are few studies in the fields of AI literacy education in ECE settings. In these studies, researchers focus on topics such as pedagogies, content knowledge, and technologies to uncover what, why and how to teach AI literacy for young learners (Yang, 2022). However, reviews of research on AI literacy in ECE are less common and there seems to be no review studies summarizing how educators develop young children literacy in terms of age-appropriate instructional design and tools, and what types of assessment methods have been used to examine their AI literacy in the early AI curriculum, as well as its learning outcomes throughout the interventions in ECE settings. To fill these gaps in the literature, this paper presents a review of the literature on AI literacy in ECE. The paper systematically analyses and discusses existing works from the aspects of instructional design, tools, assessment methods and learning outcomes. This paper concentrates on the challenges and opportunities for AI to assist educators or researchers in locating relevant and important information in ECE. Our review focused on key aspects of the challenges and

opportunities of improving AI literacy in early childhood education and how to leverage on AI for enhanced assessment in ECE in Nigeria. For the purpose of this paper, a search was made for published studies, with keywords. The literature search identifies several studies that met the following criteria: (a) they were written in English, (b) they contained the keywords in their title or abstract and (c) they were published recently.

Conceptual Clarification of Artificial Intelligence

John McCarthy first used the phrase 'Artificial Intelligence' (AI) in 1955 to describe a computer that could carry out a variety of cognitive tasks that are typically performed by humans, including speaking, thinking, learning, and solving problems (Nilsson, 1998). Artificial intelligence has been used to mimic intricate cognitive functions like sensing, learning, and prediction, (Russell and Norvig, 2010). Artificial Intelligence, as described by Barabas, et al, (2018) and Berendt, et al, (2020) is the capacity of a digital computer or computer-controlled robot to carry out tasks that are frequently associated with intelligent individuals. The broad definition of artificial intelligence encompasses a wide range of technologies and algorithms (Baker & Smith, 2019; Jantakun, et al., 2021). It is the study of using contemporary technology, such machine learning and neural networks, to solve problems (Wang, 2019; Yang, 2022).

Artificial Intelligence Literacy

The term “AI literacy” was first coined by Burgsteiner et al. (2016) and Kandlhofer et al. (2016) who describe the competencies to understand the basic knowledge and concepts about AI. In addition, Long and Magerko (2020) defined it as a set of competencies that enables individuals to critically evaluate, communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace.AI literacy has become an essential literacy skill that is required for everyone (including young children) to know and use AI as a tool to live, learn, and work in our digital world, and it should be taught in grades K-12 (Burgsteiner, et al, 2016; Kandlhofer, et al, 2016; Ng, et al, 2021a, b; Steinbauer, et al, 2021). Beyond merely becoming end users of AI tools, AI literacy is a set of competencies that enables people to critically evaluate, communicate and collaborate effectively with AI (Druga, et al, 2021). Recent researchers proposed the term “AI

literacy" to put forth the importance of adding AI to the 21st century digital literacy skills for everyone, including young children (Ng, et al., 2021a, b).

Artificial Intelligence Education

Ng, et al. (2021b) further designed a framework of AI concepts, practices and perspectives that interplay between Computer Technology (CT) and Artificial Intelligence (AI) that students can learn machine; learning knowledge, model training skills, collaboration and communication skills. Recently, the development of more age-appropriate software has enabled young learners to extend their possibilities to learn and explore AI. The majority of current AI literacy research focuses on secondary or higher education (Ng & Chu, 2021; Kong, et al., 2021; Eguchi, et al., 2021; Su, et al., 2022). For example, non-computer science undergraduates and secondary students started to develop AI concepts and ethical awareness to empower them to become educated digital citizens (Kong, et al., 2023; Ng & Chu, 2021). However, these courses do not focus on complex computer science concepts or mathematical formulas. Instead, the courses enabled students to develop basic understanding of AI concepts, literacy and confidence of using AI (Kong, et al., 2022; Ng, et al., 2022a). This courses are actually basically designed for the ordinary person and obviously, the children in ECE with their mind so blank (tabula rasa) and armed with curiosity and adventurous spirit to become the best candidate for AI education, thereby bringing to life the phrase 'catch them young'.

Educational Assessment

According to *Nelson, et al, (2014), t*he word "assessment" came into use in an educational context after the Second World War. Educational assessment is the systematic process of documenting and using empirical data on the knowledge, skill, attitude and beliefs to refine programs and improve students' learning. Assessment data can be obtained by examining students' work directly to assess the achievement of learning outcomes or it is based on data from which one can make inferences about learning, (*Allen 2004).* Assessment is often used interchangeably with test but is not limited to tests, *Kuh, et al. (2014).* Assessment can focus on the individual learner, the learning community (class, workshop, or other organized group of learners), a course, an academic

program, the institution, or the educational system as a whole (also known as granularity), National Council on Measurement in Education (2022). As a continuous process, assessment establishes measurable students' learning outcomes, provides a sufficient amount of learning opportunities to achieve these outcomes, implements a systematic way of gathering, analyzing and interpreting evidence to determine how well students' learning matches expectations, and uses the collected information to give feedback on the improvement of students' learning, *Suskie & Linda (2004)*. Assessment is an important aspect of educational process which determines the level of accomplishments of students.

Early Childhood Education

Early childhood refers to the period between birth and 8 years of age, when a child's brain is highly sensitive to the environment around them. This time of "remarkable growth" requires a specialized educational approach to ensure that children learn key skills and foundational concepts to prepare them for later life. Early childhood education is focused on the critical developmental milestones, skills, and concepts that children attain during this period of their lives, from social-emotional skills to the beginnings of numeracy, literacy, and critical thinking. UNESCO (2024) believes Early Childhood Education (ECE) that is truly inclusive is much more than just preparation for primary school. It can be the foundation for emotional well-being and learning throughout life and one of the best investments a country can make as it promotes holistic development, gender equality and social cohesion. This foundational aspect of education directly contributes to better lives for children, and resounds through national improvements to prosperity, social inclusion, and economic development.

Theoretical Framework

This paper is hinged on system theory. The systems theory holds that an organization is a social system made up of integrated parts. The theory was propounded by a biophysicist Ludwig Von Bertalanffy in 1920. The system was seen as a series of interrelated and interdependent parts in such a way that the interaction of any part of the system affects the whole system. That is, one part of the system must interact and depend on the other parts around it to function effectively. The

system theory is relevant to this paper because education (school) is a system and the concept of interaction and interdependence of parts like all other social systems has identical properties. The implication of this theory to this paper is that education can be likened to be a system made up of different parts and components with the same objectives and goals and working inter-dependently and interrelated with one and another. Every part and component matters and plays crucial roles in the attainment of the system goals. Here, Nigerian educational system is made up of Early Childhood Education (ECE), Primary school education, Junior Secondary School education, Senior Secondary School education and Tertiary education. All these units or forms of education are important and need to function well to realize the objectives of education in Nigeria, Edinoh, et al, (2024). It is therefore very relevant to this paper as it leverages on AI for enhanced assessment of ECE in Nigeria.

Artificial Intelligence (AI) and Early Childhood Education (ECE)

Future generations of children will interact with technology very differently from those of previous generations due to artificial intelligence. AI is transforming our daily lives, work, and leisure (Ali et al., 2019). In Early Childhood Education (ECE), AI tools are being employed more and more to improve the learning and development of young children (Su & Yang, 2022). The majority of research demonstrated how AI has improved children's understanding through robotics, computer science, machine learning, and related fields dramatically. Additionally, it has improved children's abilities in reading, creativity, emotional regulation, cooperative learning, and computational thinking (Su & Yang, 2022). In Early Childhood Education (ECE), Artificial Intelligence (AI) tools are being employed more and more to improve young children's learning and development (Lin et al., 2020; Su & Yang, 2022; Vartiainen, et al, 2020). In early childhood education, educators tried to explore the use of AI technologies to facilitate their work and enhance students' learning. For example, Jin (2019) explored the potential of AI applications in four examples: AI evaluation of children, AI teaching system, AI educational robot, and AI virtual reality teaching, and further proposed the use of AI in family education to enhance parental knowledge. Lin et al. (2020) interacted with a dialogue system that enabled children to interact

with the chatbots to enhance language learning and visualization training. Nan (2020) used an AI teaching system to motivate students' learning in a collaborative AI-assisted environment and stimulate children's interest in learning. These studies provide ample evidence to show the effectiveness of using AI technologies at kindergarten level.

Furthermore, it is essential to equip children with digital skills and mindsets to get them ready for future studies and facilitate their everyday living. The discussion of the AI literacy implementation in ECE contributes to providing references for educators and researchers to design interventions to engage young children in AI learning. AI education has posed challenges and opportunities to early childhood education, including why young learners should learn AI in their early years, the subset of key AI concepts that can be understood by children, and how children were engaged in a meaningful experience for them to acquire these concepts (Yang, 2022). Yang pointed out several reasons why young children need to learn AI; knowing and understanding the basic competencies of AI and using AI applications is important for all citizens to become AI literates in today's digital world (Ng et al., 2021a, b); children need to be empowered to understand, use, and evaluate AI with purposeful guidance (Williams, et al, 2019a); children should have the capability to understand the basic functions of AI, especially when more well-designed AI toys appear in their everyday experience (Kewalramani,et al, 2021). Su & Yang (2022) further identified AI in ECE studies that have introduced AI concepts to kindergarteners using AI learning tools such as PopBots and Zhorai.

Learning and Teaching Artificial Intelligence in Early Childhood Education

In recent years, a growing number of researchers (e.g., Chen et al., 2020; Su & Yang, 2022) have started to discuss how to teach and learn AI from K-12 to higher education. Although the AI-related ECE studies is still in its infancy, researchers have started to discover how AI applications is used to facilitate kindergarten teachers' administration and students' learning through intelligent tutoring systems for special education, Chabot for language education, and robotic kits in computer science education . These AI applications facilitate children in computer-supported collaborative learning, teaching automation and evaluation, detecting learners' emotions, and

recommend useful materials for students. Several facts were uncovered in Chen, et al. (2020)'s paper on how to use AI technologies in the educational industry. Although a growing interest in and the impact of research on AI in education are identified, further effort is necessary to inform how to integrate advanced AI techniques and deep learning technologies into educational settings. Also, there exists a scarce number of studies that drive the use of AI technologies into educational theories. This is consistent with another review conducted by Hwang et al. (2021), which categorized AI applications into four general roles, including intelligent tutor, tutee, learning tool/partner, and policy-making advisor. In early childhood education, AI-powered toys are made to provide children with a playful experience to learn and interact with the robots and kits, and teach coding skills. With more well-designed AI toys and services, young children could develop their AI literacy even at a kindergarten level. Williams, 2018 & Williams et al., 2019a,b affirmed that children experience AI-driven robotic toys and services (e.g., PopBots, Quickdraw) to explore AI related concepts like knowledge-based systems, supervised machine learning, generative AI. Although young children may not know and understand the knowledge behind AI-driven robotic toys and services, they can explore and appreciate these AI technologies, and foster their digital literacy in their everyday lives. Some may challenge whether children are too young to explore and learn AI knowledge (Su,et al., 2022).

Artificial Intelligence Assessment Methods in Early Childhood Education

The teaching and learning experiences are incomplete without a robust assessment of learning outcome. Regarding the assessment methods to be used for evaluating young children's AI knowledge and skills in ECE, three data collection techniques were proffered by Lin et al, (2020) including knowledge and theory of mind assessments, questionnaires and observation ,It should be noted that although there were some overlaps among different assessment methods, this paper quotes the names used in the reviewed papers directly. For example, Williams et al. (2019a,b) and Williams (2018) used three activities (i.e., *Rock-Paper-Scissors*, *Food Classification*, *Music Remix activities*) to evaluate children's different AI knowledge (i.e., knowledge-based systems, supervised method, and generative AI). Results show that AI

curriculum helped children improve three concepts; knowledge-based systems, supervised methods, and generative AI.

The questionnaires include: AI perception questionnaire and robots' perception questionnaire. The AI perception questionnaires include several dimensions; intelligence attribution, truthfulness attribution, and perceived understanding (Druga et al., 2019). Druga et al. (2019) developed an AI perception questionnaire for assessing children's feelings about the agents (Jibo robot, Anki's Cozmo robot and Amazon's Alexa, home assistant). The researchers found that 68% of children thought the agents understood them the most.

Different observations were employed for examining children's learning effects, such as observations of learning activities, young children's and educators' play experiences, and interaction with AI robotics. For example, some researchers designed one activity about interacting with an AI robot (RoBoHoN) and used observation to study children's interaction with RoBonHoN. Results show that children engaged in experiences that promoted the development of non-cognitive abilities. Tazume et al. (2020 also opined same

This kind of assessment is holistic in its approach as every level of the child domain is being assessed, AI-powered assessment tools analyze large datasets, identify patterns, and provide insights into students' learning. AI supports adaptive assessments, automated scoring and real-time feedback too.

Benefits of Artificial Intelligence in Early Childhood Education

Artificial intelligence (AI) presents a unique opportunity in Early Childhood Education (ECE) for enhancing soft skill development and better preparation of children for the challenges of a world that is changing rapidly. Among others, below are some of the implications of artificial intelligence in Early Childhood Education (ECE) in Nigeria as presented by these researchers, (Crescenzi-Lanna, 2023; Mousavinasab, et al, 2021; Su, et al, 2023, 2022; Zawacki-Richter, et al., 2019; and Zheng, et al, 2021; & Ogunode, et al,2023). The benefits of AI in ECE includes but not limited to the following;

i. Aiding effective conduct of examinations: AI can help conduct fair examinations with the use of AI-powered remote proctoring. With its help, school authorities can easily conduct examinations for remote learners. The authorities can prevent cheating during exams by analyzing the images/video streams produced by AI proctors. These proctors keep an eye on the candidate by detecting voices or the presence of another person apart from the examinee.

ii. AI helps young students develop their soft skills. While artificial intelligence is commonly linked to technology, there is increasing acknowledgment that AI can improve children's abilities in communication, critical thinking, teamwork, and adaptability. Through interactive platforms and customized learning experiences, artificial intelligence (AI) has the ability to enhance creativity, strengthen social relationships, and sharpen problem-solving abilities. Through the use of customized approaches and flexible algorithms, Artificial Intelligence (AI) has the ability to enhance the development of a wide range of soft skills and suit individual learning styles.

iii. Artificial intelligence (AI) offers an exciting opportunity to boost children's creativity and enjoyment in early childhood education. Thanks to AI-powered tools and platforms, kids can engage in creative and engaging activities. This could pique their curiosity and encourage creative play. These sites offer customized learning opportunities that promote fun and playfulness in academic pursuits. Artificial intelligence (AI) has the potential to make learning activities more entertaining. Soft skills have a good effect (positively) on the use of artificial intelligence in early childhood education because, in early childhood education, creativity and enjoyment can enhance learning.

iv. Individualized learning. Artificial Intelligence (AI) in early childhood education has the potential to significantly change how young children learn. A wider range of children can now access individualized learning that considers their individual

preferences, learning style, and areas of strength and weakness, all made possible by AI-driven platforms and technology. Because of their interactive and flexible nature, these technologies offer more effective and engaging learning opportunities.

v. AI could be used in early childhood education to help kids become more inquiry-literate.

vi. Children can express themselves freely and try out various ideas in a safe and encouraging learning atmosphere with AI.

vii. AI has a significant positive impact on early childhood education since it cultivates a lifelong love of learning.

viii. It also improves the learning experience. Artificial intelligence (AI) has the potential to completely transform early childhood education because it improves many aspects of learning.

ix. Artificial intelligence (AI) can be used to predict the learning status and performance of students, recommend learning resources, and automate assessments

x. AI can assist in the development of critical thinking, communication, teamwork, and other essential soft skills through customized techniques. The development of specific skills required for children to properly navigate a complicated world is aided by customized education

xi. By creating a creative and engaging environment that engages their younger senses, artificial intelligence (AI) integrated into educational systems can also assist younger students to succeed.

xii. AI has the potential to stimulate creativity in children by giving them access to design, music, and art resources.

xiii. Children are encouraged to experiment, explore their imaginations, and express themselves freely through the use of AI-powered tools such as creative

applications, interactive games, and adaptive tutoring systems. This innovative fusion of technology and education makes learning more enjoyable for pupils while also equipping them with the skills and mindset necessary for future success.

Challenges of Artificial Intelligence in Early Childhood Education in Nigeria

Scholars (Edinoh, et al, 2024; Touretzky, et al, 2019; Ng, et al, 2019a, 2022c; Tseng, et al, 2021) from various studies attested to the fact that despite the many benefits of AI in ECE, there are also challenges confronting the successful implementation of the program in Nigeria. The major issue in Early Childhood Education (ECE) development in Nigeria is shortage of funds which is a very serious problems threatening the survival of the educational systems in the face of rising demands and hence rising cost of management of early childhood education. This shortage of funds affects job performance and the growth of the early childhood education program in Nigeria. The program cannot perform optimally without funding. The inability of the Nigerian government to objectively accept and implement the 15%-20% funding formula for education as recommended by the UNESCO impacts negatively on the performance and sustainability of the Early Childhood Education (ECE) program in Nigeria.

Other challenges include;

i. lack of teachers with AI knowledge, skills, and competences;
ii. lack of curriculum design with local content to meet the need of the Nigerian child;
iii. lack of teaching guidelines for AI instruction at ECE level in Nigeria;
iv. the absence of infrastructural facilities.
v. undefined scope of assessment as well as what assessment instrument to be used.

Suggestions

This paper suggests the following as a way forward;

i. Researchers and educators should improve AI literacy research and learning design in early childhood education, training and retraining of teachers in AI teaching strategies, production of teaching guidelines since it is an emerging field and very fragile, designing a standardized assessment with global best practices and provision of adequate

infrastructures for the effective implementation of AI program in order to enable educators leverage on AI for enhanced assessment in ECE in Nigeria.

ii. To guarantee that AI is utilized responsibly and ethically, regulations must be established and the ethical implications of AI must be considered.

iii. Careful planning, on-going evaluation, and an appropriate strategy that strikes a balance between children's overall development and technological innovation are required, this is where authentic and global best practices in educational assessment comes in.

iv. Teachers must continue to play a crucial role in directing and improving AI-enabled learning activities, assisting students in growing as social workers, offering emotional support, and imparting values that transcend technology.

vi. In order to achieve a balanced approach that emphasizes holistic growth and fully utilizes the potential of AI in early childhood education, it is critical that educators get guidance on ethical issues and the application of AI in the classroom.

vii. While AI technology can provide tailored and interesting learning experiences, it cannot replace teachers in instilling moral principles, promoting social and emotional growth, and teaching vital life skills. Teachers are able to recognize each student's unique needs and give them individualized attention.

Conclusion

The discussion on leveraging AI for enhanced assessment in ECE in Nigeria contributes to providing references for educators and researchers to design interventions to engage young children in AI learning. Although educators will definitely meet challenges at the early stage of developing AI instructional design for young children, AI learning could bring learning opportunities and foster young children's AI literacy in terms of AI concepts, practices and perspectives. This paper foresee that there will be a growing number of age-appropriate curriculum and tools for the ECE level assessment in Nigeria but as at this moment in time, there is no concrete assessment of AI activities in ECE in Nigeria.

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