

Technology and Artificial Intelligence; a Tool for Transforming Early Childhood Education in Nigeria: Prospects and Challenges

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Abstract

Artificial intelligence (AI) is a veritable tool for transforming teaching and learning into the 21st-century novelty of educational pedagogy. Digital assistants such as chatbots, facial recognition apps, self-driving cars, robots, etc., which used to be considered science fiction and elements of the distant future, are now a part of our everyday lives. Therefore, Artificial Intelligence (AI) has ushered in a paradigm shift toward a more technologically driven landscape, demonstrating its efficacy as an emergent strategy in transforming knowledge and society. Despite these advancements in expertise, early childhood education (ECE) has yet to leverage AI technologies in Nigeria. Recognizing the expanding significance of AI in education, this paper examines artificial intelligence (AI) as a tool for transforming early childhood education by considering the benefits of AI apps and tools for children's learning and identifying ways to usher children into the world of AI, among others. The various ways of enhancing teaching using AI-driven tutoring systems, adaptive learning platforms, and intelligent classroom assistants were constructively considered. The study is centered on applying constructivist learning principles in leveraging AI to foster a dynamic, engaging, and deeply impactful educational environment. This theoretical approach advocates for active student engagement through direct interaction with AI technologies, bridging the gap between theoretical knowledge and practical application. The literature review showed ways artificial intelligence has been used in education by helping to mitigate learning disparities in diverse student populations, overcoming language barriers through AI translation, and bridging the digital divide. The challenges and ethical considerations in AI were identified, and the various strategies for overcoming these challenges were addressed. The outcome of the investigations in the literature showed that with the active collaboration of the major stakeholders in education (educators, students, parents, and government), artificial intelligence skills can upgrade and improve the quality of early childhood education in Nigeria. Conclusively, the paper recommends that government and school owners ensure teachers employ AI tools to support students' learning needs in ECE. Teachers should also leverage AI analytics to track and analyze student performance data. Likewise, the government and Early Childhood Association of Nigeria (ECAN) should enhance Teacher Professional Development through training and retraining on the use of AI Tools in ECE.

Keywords: Technology, Artificial Intelligence, Early childhood education, To Transform.

Introduction

In recent years, AI-driven technological advancement has emerged as a major disruptor in science, engineering, business, and marketing and has even transformed education with tools like Duolingo, Prodigy, Alexia, Robot Turtles, DALL·E, ChatGPT, Grammarly, Artbreeder, etc., thereby enhancing learning experiences. Organizations across the globe are moving towards automation as AI is transforming how education is accessed and information utilized; the ability to effectively prompt the use of AI tools will soon be a critical skill in the academic world, which ushers students into the brink of a new era where AI becomes the norm in academia. New technologies cannot be avoided as part of students' futures, and it is up to educators to ensure that AI is brought into the classroom as it is beneficial to all learners. Ignoring or failing to prepare children for AI classrooms means poor preparedness for future classrooms in an advancing world (UNICEF, 2022). Therefore, early childhood education must not be left behind. There is a need to embrace these technological advancements and

prepare children for the exciting opportunities ahead on the use and application of tech tools in learning to be at the forefront of societal changes.

With the rapid advancement of technology, AI devices such as voice-activated personal assistants, home robots, and smart connected toys are increasingly becoming a part of young children's daily lives. These AI tools are promising to enhance learning and developmental outcomes in early childhood. For example, Zhang and Chen (2020) developed an intelligent tutoring system for math instruction specifically designed for young children. Their study demonstrated that this AI-driven course not only improved children's math performance but also helped sustain positive attitudes toward the subject. The earlier learners are ushered into the wonderful world of AI, the easier it will be for them to comprehend and learn how to use it to their advantage. Interacting with AI at an early age will equip learners with an indistinguishable sense of curiosity for learning and enable them to develop advanced problem-solving skills. As a result, children will be prepared to make an impact in the tech-centric future that awaits them (Camesaria, Rigueira-Diaz, Janeiro, Torres, Prado & Kreibel, 2023). Similarly, incorporating AI into early childhood classrooms will present children with new opportunities for learning and challenge their curiosity or thirst for knowledge, leading to discoveries and ideas for educators and students. This paper underscores the need for collaborative efforts among educators and policymakers on how AI can help transform early childhood education in Nigeria.

Based on the foregoing, this paper set out to achieve the following objectives:

- Define the concept of artificial intelligence and give examples of AI-assisted tools for children;
- Identify how early childhood education can be transformed by AI;
- Explore the benefits of AI apps and tools for children's learning;
- Identify ways to usher children into the world of AI
- Examine challenges facing the use of AI

Concept of Artificial Intelligence (AI)

Artificial intelligence has been a topic of interest and has raised curiosity in various disciplines and applications. Artificial intelligence (AI) is a branch of computer technology that uses algorithms and machine learning techniques to replicate or simulate human intelligence (Helm; Swiergosz; Heather; Karnuta; Jonatha; Viktor, *et. al.*, 2020). The Oxford Dictionary (2023) defines artificial intelligence as the theory and development of computer systems that can carry out tasks that normally require human intelligence, decision-making, and language translations. Artificial Intelligence (AI) is the ability of a computer, a computer-controlled robot, a machine, or software to think like the human mind and perform tasks that generally require human intelligence. It involves creating algorithms that allow computers to learn from and make decisions, predictions, or recommendations based on data rather than following only explicitly programmed instructions (Verma, 2023). Artificial intelligence is based on algorithms, a set of rules and instructions that computers follow while performing problem-solving operations to complete the final goal. AI algorithms analyze data to identify patterns and build a model and then calculate future values based on these models (Akgun and Greenhow, 2021). In general, the effectiveness of AI learning depends on the data and its characteristics, as well as the performance of the learning algorithms. Therefore, the final goal of different learning algorithms may differ. The outcomes of different learning algorithms in one subset may differ greatly because of the initial characteristics and input data (Sarker, 2021).

Artificial intelligence transforms all aspects of socio-economic life and integrates communication technology into virtual reality. Artificial intelligence in education has changed not only the education system but knowledge sharing approaches to learning, cognition and development of civilization (Kaur, 2021). Artificial intelligence creates new opportunities for education providers and bridges the gap between technological innovations and their implementation in education (Zhang & Aslan, 2021).

Theoretical Foundations

The theoretical framework for the study is centered on the application of constructivist learning principles in leveraging AI to foster a dynamic, engaging, and deeply impactful educational environment. This theoretical approach advocates for active student engagement and the development of learning through direct interaction with AI technologies, bridging the gap between theoretical knowledge and practical application. The integration

of AI in education aligns seamlessly with constructivist learning theory, emphasizing the importance of active engagement and knowledge construction by learners (Blikstein & Worsley, 2016). AI effectively creates a dynamic educational environment that encourages students to construct meaning through hands-on experiences.

Artificial intelligence for children

Artificial intelligence for children is the art of teaching computers how to "think" and how students can become the designers of the computer "brain" through coding and programming. It allows older students to become creators of the latest technology. AI systems are fundamentally changing the world and affecting present and future generations of children. Children are already interacting with AI technologies in different ways; they are embedded in toys, virtual assistants, video games, and adaptive learning software. Algorithms provide recommendations to children on what videos to watch next, what news to read, what music to listen to, and who to be friends with. Children today are growing up surrounded by applications of AI, from chatbots to virtual assistants, search engines, language translation services, autonomous vehicles. It is, therefore, imperative to equip children with Artificial Intelligence and Machine Learning skills (Bahroun, Anane, Ahmed, & Zacca, 2023). This way, they can understand how the technology works and be prepared for future usage.

According to UNICEF (2022), teaching AI to children is important because it is already a constant presence in their day-to-day activities. After all, children are frequently exposed to AI-powered technologies in many ways. Teaching children the principles of AI, its applications, and its limitations at an early age is a great way to kick-start their critical thinking and prepare them to become intelligent consumers of technology. By learning about AI at an early age, children can better understand how to apply AI tools to solve difficult problems and improve the world.

Several online platforms that teach children about AI start from 6 years of age and above. Studies show that by that age, abstract thinking develops, and they can grasp concepts more easily (UNICEF, 2022). AI is revolutionizing early childhood education, offering unprecedented opportunities for young learners to receive personalized, engaging, and effective educational experiences. By integrating AI into the learning environment, educators can tailor educational content to individual needs, enhancing language development through interactive tools that adjust to each child's speech patterns and learning pace. AI-driven robots and educational toys create dynamic, fun-filled learning environments that encourage active participation and sustained interest among young students. AI tutors extend learning beyond the classroom, providing accessible, personalized assistance that reinforces learning continuity. It equips children with the skills necessary to navigate the increasingly digital world, making it a crucial component of modern educational strategies (Holmes, Wayne, Maya Bialik, & Charles Fadel, 2023).

Children come from various linguistic backgrounds. AI supports children with speech difficulties by offering tailored exercises that meet their unique needs. Additionally, AI systems also support teachers by providing detailed insights into a child's progress and areas needing attention, facilitating more effective teaching strategies tailored to enhance language development (Mustafa, 2023).

These AI tools respond to voice commands, answer questions, and engage children in educational activities. Such interactions are designed to make learning more enjoyable and stimulating, which is crucial in maintaining young children's attention spans. Moreover, these robots can introduce basic concepts of mathematics, science, and literature in a playful context, making complex ideas more understandable for young minds. By transforming learning into a form of play, AI helps lay the groundwork for lifelong learning, ensuring children associate education with fun and creativity.

Transforming early childhood education through AI

AI is revolutionizing early childhood education, offering unprecedented opportunities for young learners to receive personalized, engaging, and effective educational experiences. By integrating AI into the learning environment, educators can tailor educational content to individual needs, enhancing language development through interactive tools that adjust to each child's speech patterns and learning pace. AI-driven robots and educational toys create dynamic, fun-filled learning environments that encourage active participation and sustained interest among students (UNESCO, 2019). AI tutors extend learning beyond the classroom, providing

accessible, personalized assistance that reinforces learning continuity. It equips children with the skills necessary to navigate the increasingly digital world, making it a crucial component of modern educational strategies. Studies (Chen, Chen, & Lin, 2020) have shown that AI can be used to transform early childhood education in the following ways:

- **Personalized Learning Experiences**

Artificial Intelligence excels in delivering personalized education tailored to each child's unique learning styles and speeds. By utilizing AI, systems can track and analyze individual interactions and performance metrics in real time, adjusting the content and pacing accordingly. This ensures no child is left behind, making learning a more inclusive and individualized experience. Moreover, such personalized approaches help maintain children's interest and motivation (Conati, Barral, Putnam, & Rieger, 2021; Rane, Choudhary, & Rane, 2023).

- **Enhanced Language Development**

AI tools can transform language learning by providing young learners with immediate feedback and interactive experiences that adapt to their linguistic progress. These tools can analyze speech patterns and offer corrections, greatly benefiting pronunciation and grammar skills (Anis, 2023).

- **Interactive and Engaging Learning Environments**

AI technology helps in the creation of dynamic and interactive learning environments through smart educational toys and robots. These AI companions can respond to voice commands, answer questions, and engage children in educational activities. AI ensures that learners receive content that aligns with their current proficiency levels, preventing boredom or frustration and promoting optimal learning conditions (Anis, 2023; Khonturaev, 2023; Tapalova & Zhiyenbayeva, 2022).

- **Early Detection of Learning Disabilities**

AI systems analyze data from children's activities and recognize patterns that deviate from the norm, which might indicate dyslexia, dyscalculia, or other cognitive challenges. By catching these issues early, educators can intervene sooner, providing specialized support and adapting teaching methods to suit the needs of these children better.

- **Easy and accessible AI Tutors and Assistants at all Times**

AI tutors offer a personalized tutoring experience that is accessible anytime and anywhere, which is highly beneficial for reinforcing learning outside of traditional school hours. These systems can provide homework help, guide through problem-solving steps, and offer explanations for complex concepts, ensuring continual learning. This constant availability and personalized assistance help prevent learning loss, especially during breaks in the traditional school calendar, and support a seamless educational experience for every child.

- **Develops Critical Thinking and Problem-Solving Skills**

The incorporation of AI in education significantly enhances students' learning experiences, providing them with varied learning opportunities, enhancing their problem-solving skills, and equipping them with essential digital competencies. AI apps like coding use gamified learning to teach programming fundamentals through story-based missions and puzzles. This method encourages logical thinking and creativity as children learn to see problems as challenges to overcome through coding. By integrating these competencies early in education, AI helps build a foundation for advanced learning and effective problem-solving later in life.

- **Streamlining Teachers' Administrative Tasks**

AI frees teachers from the burdens of paperwork, such as attendance tracking, grade recording, and report generation. Thus allowing teachers to devote more time and energy to interacting with students. Similarly, this automation gives room for better accuracy and efficiency in teachers' administrative processes, thus reducing the likelihood of human error and ensuring that data management is handled proficiently. Anderson, Corbett, Koedinger, and Pelletier (2005) observed from their experiments using a computer-based instructional technology called Cognitive Tutor that the best tutorial interaction style for learners was the one in which the tutor provided immediate feedback with short and direct error messages.

- **Encouraging Parental Involvement**

AI facilitates a stronger partnership between educators and families, which is pivotal in fostering an educational environment that supports students' overall development and success. AI-driven platforms can significantly boost parental involvement in their children's education. These systems offer user-friendly interfaces that provide regular updates on children's academic progress and classroom activities.

- **Facilitating Inclusive Education**

There are learning software that adapt to various disability needs, and programmes which are designed to facilitate easier navigation of learning materials for physically challenged students. These tools help integrate students with special needs into regular classrooms and empower them by providing the means to participate fully in all educational activities. AI's ability to tailor learning experiences to fit various physical and cognitive abilities ensures that every child has the opportunity to achieve their educational potential (Anis, 2023). By leveraging AI technologies to tailor instruction, adaptive learning platforms can create more effective, engaging, and inclusive learning environments.

- **Addressing Educational Inequalities**

Warschaver and Matuchniak (2010) showed that new technologies and the digital world can be powerful tools for transforming learning and can be used in several ways to promote equality and justice in society by providing access to knowledge and improved communication to everyone, irrespective of their geographical location and socio-economic status.

AI Apps, Tools, and Resources for Children

There are several examples of AI-powered websites/ resources that aid children's learning, a few of which are described below:

- **eCraft2Learn** is an AI resource which allows beginners to create AI programmes in Snap!, a visual programming environment similar to Scratch.
- **STEM Learning-** STEM learning resources include Machine Learning for Kids projects, supplemented with teaching notes, presentation materials, prompt cards, and practical "unplugged" activities
- **AI Family Challenge:** The AI Family Challenge is a free, hands-on AI education program for families. They use Machine Learning for Kids and supplement it with a lot of additional support, such as technical coaches and mentors, a structured lesson plan, and supporting videos. The programme is based around a competition that challenges children to think of their own AI project ideas with the support of their families and technical mentors.
- **Raspberry Pi-** The Raspberry Pi Foundation provides resources for Code Clubs, with step-by-step instructions for a variety of creative projects.
- **Google Experiments-** Simple online experiments to start exploring machine learning through pictures, drawings, language, and music.
- **ChatGPT-** ChatGPT helps students to find answers and inspiration and be more productive.
- **AI-in-a-Box-** AI-in-a-Box is a bundle of robots, accessories and teaching resources. The kit can be used to teach projects that cover topics like visual recognition, facial recognition, speech generation, and speech recognition.
- **Docebo:** This provides a variety of efficient and customized learning programmes with special features that permit learners to create audience-specific pages using drag-and-drop functionality. Docebo encourages customized learning experiences with virtual coaching, content suggestion, and auto-tagging, thereby encouraging personalized learning. These Learning Management Systems (LMS) offer gamification, and assignment of training depending on the required skills of the learners. It also helps learners to streamline non-formal learning and automates learning management.
- **Squirrel AI:** This is an adaptive learning platform that uses AI algorithms to personalize learning for each learner. It provides tailored recommendations and feedback to improve learners' understanding.
- **Edmodo:** Edmodo uses AI to provide learners with personalized learning experiences. It offers features such as quizzes, assignments, and collaborative tools to enhance student engagement and performance.
- **Brainy:** This is a community-driven assistant that can help learners ask and answer academic questions. It uses AI to match questions with relevant answers, helping them find solutions quickly and efficiently.

- **Cognii:** This is a virtual learning assistant that relies on conversational technology to assist learners from an open resource format. It is designed to provide instant feedback with written responses. It utilizes a Natural Language Processing algorithm to evaluate essays, giving personalized feedback and thereby improving learners' writing skills.
- **IBM Watson Education:** This assistant provides AI-powered solutions for classrooms. Its tools leverage AI to enhance individualized learning experiences, enhancing learning outcomes and optimizing teaching techniques. It provides virtual tutors and adaptive learning systems as analytic tools.

Ways to Usher Children into the World of Artificial Intelligence

Several strategies engage children in realizing the countless applications of Artificial Intelligence in daily live activities, some of which are outlined below:

- **Include Hands-On Activities:** Make use of various interactive tools, software, and kits available that are designed to educate children on the basics of coding, robotics, programming, and other AI-related concepts. These resources give children a practical introduction to AI tools while also captivating their attention and igniting their curiosity.
- **Organize children's workshops and Camps:** Putting together workshops and camps specifically designed for younger learners. These events, which can either be in-person or online, focus on creating immersive experiences that encourage children to explore various AI concepts. Such programmes not only promote collaboration and teamwork but also foster a deeper understanding and appreciation of AI and other STEM-related subjects.
- **Find AI Examples in Everyday Life:** When introducing children to AI, it's important to clarify that it's not an abstract concept that does not affect them. Educators can help children realize how many times they interact with AI tools daily. How autonomous cars operate or how virtual assistants can answer any question asked. Helping children make these connections will increase their interest in AI and provide them with possible ways of expanding its capabilities.
- **Introduction to Coding:** Coding and programming can seem complicated to many, but they are essential skills for understanding AI. The sooner children are introduced to them, the easier it is for them to begin to understand coding and master the art. Numerous interactive platforms teach children coding by creating a child-friendly environment where they can explore and apply its fundamental principles. Children can use these platforms to experiment with the idea by giving machines specific instructions to complete tasks, such as building simple animations. Throughout these processes and assigned tasks, children push the boundaries of their imagination and hone their problem-solving skills.
- **Encourage Creativity:** The endless possibilities of AI make it a great tool with which children can expand their horizons and learn to think outside the box. So, after discussing the basic concepts and giving children a few initial instructions, the teacher must allow them to experiment with AI tools without limiting them. Art-related AI tools that produce music or poetry are perfect for this purpose. Additionally, educators should encourage questions and feed children's enthusiasm with age-appropriate resources that can be explored in their free time with or without the help of their parents. This way, the teacher can enhance children's understanding of AI and turn them into lifelong learners.

Challenges/Potential dangers of AI for children

Though the integration of AI in education offers unprecedented opportunities, it is not devoid of challenges, a few of which are outlined below:

- **Data Privacy and Security:** As AI technology expands, it opens up many privacy concerns thereby putting the traditional norms of personal data protection to many challenges. The insatiable appetite of AI for extensive personal data to supply its machine learning algorithm has brought about serious concerns regarding data storage, usage, and access. These have raised questions regarding data sources, storage, and accessibility, which traditional data protection cannot provide answers to.
- **Algorithmic Bias:** The potential for bias and unfairness in AI algorithms is a critical concern. AI systems are trained on data, and if these datasets contain biases, the algorithms can perpetuate and even exacerbate existing disparities. Thus, AI can spread hate, bias, and stereotypes because it learns from data it finds on the internet.

- **Teacher Training and Support:** Implementing AI requires educators to understand and effectively use the technology, necessitating training and ongoing support. The importance of professional development programs that equip educators with the skills to leverage AI tools effectively, fostering a collaborative relationship between human teachers and AI systems to optimize learning outcomes is therefore very crucial.
- **Cost and Infrastructure:** AI-driven personalized learning platforms may require significant investment in technology and infrastructure, making accessibility challenging.
- It can flood children with negative messages. AI data is generated from the internet. Children's search history may make them the target of relentless advertisement campaigns and negative messages parents would prefer them not to see.
- AI can be used for bullying and fraud. Generative AI can be used to create false or distorted images of children or teenagers. For instance, Deepfake, fake nudes, and voice cloning apps can be used to shame, threaten, or attack children into taking actions they ordinarily would never consider, like giving private information or sending money.

Summary and Conclusion

Since artificial intelligence is the way of the future, the best gift that government, parents, and teachers can give to children is ensuring that they know about AI technology from an early age. Integrating AI in early childhood education is paving the way for a future where learning is about experiencing and interacting with the world in novel ways. For educators, parents, and policymakers, embracing these technologies could be key to unlocking unprecedented opportunities that ensure young learners are not only consumers of information but are innovators and creators in their own right. By harnessing the power of AI, educators are on the cusp of nurturing a generation that is more knowledgeable, capable, and equipped to tackle future challenges.

Suggestions

Based on the foregoing, the following suggestions are proffered:

- **Government should integrate AI for Professional Development:** Implement AI tools such as Teach FX to provide teachers with real-time feedback and insights on their teaching practices, helping them improve their instructional strategies and better cater to student needs.
- **Analyze Data for Personalized Interventions:** Teachers should leverage AI analytics to track and analyze student performance data, allowing educators to identify learning gaps and tailor interventions to address specific student needs.
- **Government and school owners should ensure and practice inclusive Education** By encouraging teachers to employ the use of AI tools to support students with diverse learning needs, such as those with disabilities or from underrepresented backgrounds, to provide equitable access to personalized learning resources and support.
- **Government and Early Childhood Association of Nigeria (ECAN) should enhance Teacher Professional Development** through training and retraining on the use of AI Tools in ECE: To integrate AI tools such as TeachFX to provide continuous feedback and professional development for educators, helping them refine their teaching strategies and better support personalized learning.
- **Teachers are to utilize AI tools for Efficient Assessment:** They should adopt AI-powered grading tools like Gradescope to automate and streamline the grading process, allowing teachers to focus more on instruction and personalized student support.
- **Teachers should adopt Adaptive Learning Technologies:** They can use AI-driven adaptive learning platforms like Brisk, Knewton, and DreamBox to customize educational content based on individual student performance, ensuring tailored support and challenges for each learner.

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