ARTIFICIAL INTELLIGENCE AS AN EMERGING TECHNOLOGY FOR ADVANCING ADULT LITERACY EDUCATION IN NIGERIA

SHOLAGBERU Abdulsalam Oladimeji; KAYODE Sadiq Toyin; OKUNLOLA, Micheal Mobolaji

sholagberu.ao@unilorin.edu.ng; kayode.st@unilorin.edu.ng; michealokunlola444@gmail.com

Department of Adult and Primary Education, University of Ilorin

Abstract

Literacy is a fundamental human right and a prerequisite for lifelong learning, social inclusion, and economic empowerment and adult literacy refers to organized learning opportunities designed to help adults acquire, improve, or update their reading, writing, numeracy, and digital literacy skills. Artificial Intelligence (AI) has become a transformative force in contemporary society, significantly influencing the livelihood status of adults across economic, social, and professional through flexibility learning design. The emergence of Artificial Intelligence (AI) presents unprecedented opportunities to transform adult literacy education. AI-powered systems can deliver personalized, inclusive, and flexible learning solutions tailored to the unique needs of adult learners. This paper explores the potential of harnessing Artificial Intelligence as an enabling technology to address this imperative, examined their applications in enhancing learning experiences for the demands of the digital economy. Through a comprehensive and synthesizing literature review, this paper delineates the multifaceted landscape of AI-powered tools in the Nigerian Adult and literacy education context. It also discusses challenges and prospects of AI integration in adult literacy education in Nigeria. Conclusions were drawn based on the discussion and necessary recommendations for improvement provided.

Keywords: Adult Literacy Education, Artificial Intelligence, Emerging Technology, Imperative and Roles

Introduction

Adult literacy education remains one of the most pressing challenges in many developing and developed nations. Millions of adults lack basic reading, writing, and numeracy skills, which limits their employability, civic participation, and overall quality of life. Emerging technologies, especially Artificial Intelligence (AI), are reshaping how adult literacy programs are designed and delivered. AI-driven systems have the potential to provide personalized, flexible, and inclusive literacy education for adults who often face barriers such as time constraints, economic challenges, and limited access to formal schooling.

Literacy is a fundamental human right and a prerequisite for lifelong learning, social inclusion, and economic empowerment. Yet, despite global initiatives, literacy remains a challenge. According to United Nation Education Scientific and Cultural Organisation (UNESCO, 2022), more than 750 million adults worldwide still lack basic literacy skills, two-thirds of whom are women. Adult literacy education is particularly complex because adult learners often juggle work, family, and societal responsibilities, making it difficult to commit to traditional schooling models (Barton & Hamilton, 2018).

The integration of Artificial Intelligence (AI) into the field of education has emerged as a transformative catalyst, reshaping pedagogical approaches, and fostering heightened academic success across diverse domains. As stated by Lin (2018), AI possesses the potential to bridge the gap between online and in-person learning, offering a hybridized methodology. The adult learning environments have experienced the impact of AI-driven educational technology in this era characterized by swift technological breakthroughs. According to Dilmurod and Fazliddin (2021), the integration of AI in the realm of higher education has the potential to facilitate the identification of personalized learning strategies for students, which can be adapted to their individual capabilities and aligned with the demands of the labour market.

The convergence of AI and adult education is a dynamic and continuously expanding field, which facilitates the development of novel frameworks for teaching and learning.

The rise of emerging technologies particularly Artificial Intelligence (AI) offers new possibilities for addressing various issues and challenges in teaching and learning processes of adult education. AI refers to the capacity of computer systems to mimic human cognitive functions such as learning, reasoning, and natural language processing (Russell & Norvig, 2020). In the context of education, AI enables personalized, flexible, and scalable solutions that are especially beneficial for adult learners with diverse backgrounds and learning needs. Adult literacy education, however, faces unique challenges: many learners juggle work and family responsibilities, lack confidence in their learning abilities, and often have limited access to qualified instructors and resources.

The rise of artificial intelligence (AI) marks a significant paradigm shift in various industries, with its impact on education being particularly profound. In the realm of adult education, AI is hailed as a revolutionary tool with the potential to reshape teaching and learning experiences (Su et al., 2023). As AI continues to evolve, it brings innovative ways to enhance teaching methods and learning experiences (Burgsteiner et al., 2016; Kandlhofer et al., 2016). In the context of adult literacy education, AI serves as a crucial tool with the potential to shape adult's learning and development (Ng et al., 2022).
Emerging technologies, particularly Artificial Intelligence (AI), have the potential to address various issues and challenges confronting adult literacy. AI refers to the simulation of human intelligence by computer systems, enabling machines to perform tasks such as learning, problem-solving, and natural language understanding. By leveraging AI, adult literacy programs can provide learner-centered solutions that improve accessibility, inclusivity, and effectiveness of adult learners (Chen et al., 2020).

Concept of Adult Literacy Education

Adult literacy education refers to organized learning opportunities designed to help adults acquire, improve, or update their reading, writing, numeracy, and digital literacy skills. It is a vital component of lifelong learning that empowers individuals to participate fully in social, economic, political, and cultural life (Swanson, 2020). Unlike literacy education for children, adult literacy programs are tailored to the specific needs, backgrounds, and life experiences of adult learners. Adult literacy is more than the ability to read and write; it includes functional skills such as problem-solving, communication, and the capacity to apply knowledge in everyday situations. UNESCO (2020) defines literacy as a continuum of learning that enables individuals to achieve their goals, develop their knowledge and potential, and participate in their community and wider society.

In adult education, literacy goes hand-in-hand with empowerment. Knowles, Holton, and Swanson (2020) explain that adult learners are self-directed and motivated by immediate application of knowledge, making adult literacy education most effective when it connects directly to learners' real-life roles whether as workers, parents, or community members. Merriam and Baumgartner (2020) also emphasize that adult literacy programs should reflect the principles of andragogy, which focus on relevance, experience, and problem-solving. Thus, adult literacy education is not only a tool for reducing illiteracy rates but also a strategy for enhancing lifelong learning, social inclusion, and sustainable development.

Concept and Meaning of Artificial Intelligence
In general terms, AI refers to engines that are self-learning and can reason and act independently. At the same time, AI is also an academic sub-discipline of computer science that can be subdivided into different fields. However, when AI is referred to in everyday conversations or in the media, the term used is frequently not AI but machine learning (ML). ML is a branch of AI where algorithms scan data for patterns. When processing new data, the system independently generates solutions on the basis of statistical probabilities. Machine learning can be categorised as narrow AI. Models from this field can be deployed to fulfil specific tasks (play chess, generate texts, etc.). For such purposes, the system must be trained with a great amount of data

Artificial intelligence (AI) is a rapidly evolving field of technology that involves the development of intelligent machines that can perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, and making decisions based on data. AI is the ability of machines to adapt to new and emerging situations, problem-solve, answer questions, create plans, and perform other intelligent functions typically associated with human beings. AI refers to the field of computer science that involves creating computer programs capable of imitating intelligent behavior and ideally enhancing human-like abilities (Naqvi, 2020). AI, a swiftly expanding discipline, encompasses the development of intelligent robots capable of emulating human thought processes and actions, finding utility in diverse areas such as medical diagnosis, self-driving cars, and education (Elliott, & Soifer, 2023). In general terms, AI refers to engines that are self-learning and can reason and act independently. At the same time, AI is also an academic sub-discipline of computer science that can be subdivided into different fields. However, when AI is referred to in everyday conversations or in the media, the term used is frequently not AI but machine learning (ML). ML is a branch of AI where algorithms scan data for patterns. When processing new data, the system independently generates solutions on the basis of statistical probabilities. Machine learning can be categorised as narrow AI. Models from this field can be deployed to fulfil specific tasks (play chess, generate texts, etc.). For such purposes, the system must be trained with a great amount of data

Importance of Artificial Intelligence Integration in the Adult Literacy Programme

Technology integration refers to the meaningful use of digital tools and resources to enhance teaching, learning, and classroom management. In adult education, integrating technology is not merely about using computers or devices but about aligning technological tools with instructional goals and learners' needs. Adult learners are diverse in age, background, and experience, which makes technology integration both a necessity and a challenge in today's classrooms. According to Keller and Suzuki (2019), technology integration in adult learning means embedding digital tools, applications, and platforms into teaching and learning processes to improve instructional delivery, learner engagement, and knowledge acquisition. It allows educators to move from traditional teacher-centered methods to learner-centered, interactive, and flexible learning environments.

Previous research has consistently shown that individualized learning experiences assisted by AI-driven educational systems are successful. An investigation conducted by El-Sabagh (2021) revealed that the utilization of adaptive learning platforms yielded notable enhancements in the engagement levels and information retention of adult learners when compared to conventional instructional approaches. In a similar vein, the study conducted by Chen et al (2020) highlights the utilization of machine learning and adaptability in educational systems. This approach has resulted in the customization and personalization of adult literacy curriculum and content to align with the specific needs of students. Consequently, this has facilitated increased adoption and retention rates, leading to enhanced learner experiences and overall improvements in the quality of education.

AI possesses the ability to automate the process of assessment, enabling the evaluation of individual learners' work and progress, while also offering tailored feedback. The current trajectory of AI in the field of education is focused on enhancing learner agency and personalization. This involves enabling learners to engage in reflective practices and providing feedback to AI systems, which then adjust their approaches accordingly. Consequently, this iterative process contributes to the advancement of learner-centred, data-driven, and personalized learning methodologies (Ouyang & Jiao, 2021).

Artificial Intelligence (AI) has become a transformative tool in educational systems worldwide, offering innovative solutions to challenges in adult literacy curriculum management and instructional practices. Over the past years, AI's role in education has expanded significantly, including its application in enhancing teaching strategies, personalizing learning experiences, and managing curriculum content efficiently. In a study carried out in the United States of America, Johnson (2021) revealed that AI is increasingly being utilized in educational settings, particularly in adult literacy centers and in most schools. AI-based tools, such as personalized learning platforms, are helping to address individual student

needs. For example, AI-driven systems like DreamBox and Knewton adapt content to the learner's pace and style, thus optimizing literacy curriculum delivery.

Artificial Intelligence (AI) has become a transformative force in contemporary society, significantly influencing the livelihood status of adults across economic, social, and professional. Livelihood status refers to the ability of individuals to secure sustainable income, maintain economic stability, and improve their overall quality of life. According to Lawal (2022), the imperative roles of AI in enhancing adult livelihood status are felt in the following areas and were discussed below:

1**. Employment Creation and Job Transformation:** AI has generated new job opportunities in areas such as data analysis, machine learning, digital marketing, cybersecurity, and AI system maintenance. While some traditional jobs are automated, AI also transforms existing roles by enhancing efficiency and productivity, enabling adults to upskill and remain relevant in the labour market.
2. Skills Development and Lifelong Learning: AI-powered learning platforms support adult education by providing personalized, flexible, and self-paced learning opportunities. Adults can acquire new vocational, technical, and entrepreneurial skills that improve employability and income generation, especially in rapidly changing economies.
3. Entrepreneurship and Small Business Growth: AI tools assist adult entrepreneurs in market analysis, customer engagement, inventory management, and financial forecasting. These innovations reduce operational costs, improve decision-making, and increase profitability for small and medium-scale enterprises, thereby strengthening livelihoods (Williams, 2018).
4. Increased Productivity and Work Efficiency: Through automation and intelligent systems, AI reduces repetitive tasks and enhances work accuracy. Adults in sectors such as agriculture, healthcare, education, and manufacturing benefit from improved productivity, which can lead to higher earnings and better job satisfaction.
5. Financial Inclusion and Economic Empowerment: AI supports financial services such as mobile banking, credit scoring, fraud detection, and digital payment systems. These services improve access to loans and savings opportunities for adults, particularly those in informal sectors or underserved communities.
6. Improved Agricultural Livelihoods: In agriculture, AI applications such as precision farming, weather prediction, and pest detection help adult farmers increase yields, reduce losses, and manage resources efficiently. This directly improves income stability and food security (Lawal, 2021).
7. Healthcare Access and Workforce Well-being: AI enhances healthcare delivery through telemedicine, diagnostics, and health monitoring systems. Healthier adults are more productive and capable of sustaining their livelihoods, reducing income loss due to illness.
8. Remote Work and Flexible Employment: AI-driven digital platforms enable remote work opportunities, allowing adults to engage in global labour markets without geographical constraints. This flexibility is especially beneficial for adults balancing work, family, and community responsibilities.
9. Decision-Making and Policy Support: AI-generated data insights help governments and organizations design targeted employment and social welfare programs. These interventions improve adult livelihood outcomes by addressing unemployment, poverty, and skill gaps.
10. Social Inclusion and Reduced Inequality: When equitably deployed, AI can bridge socio-economic gaps by providing adults with access to education, jobs, and markets regardless of location, gender, or physical ability (Selwyn, 2016).

Roles of Technology in Adult Learning Classroom

Multiple studies investigations have provided evidence supporting the favourable results linked to adult learning through the utilization of AI-based educational technology (Salas-Pilco et al., 2022). A thorough meta-analysis was conducted to examine the effects of AI-powered educational tools on adult learners. The results indicated a consistent enhancement in learning outcomes across several topic areas, as reported in previous studies by (Ma et al., 2014; Grgurovic et al., 2013). The findings emphasize the potential of AI in addressing educational gaps and enhancing the effectiveness of adult education initiatives.

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) 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 artificial intelligence (AI).

Researchers have examined the inclusivity of AI-driven technology (Salas-Pilco et al., 2022). The research conducted by Sanchez-Gordon et al (2018) centred on the examination of the accessibility elements that are incorporated into AI-driven educational platforms. The study demonstrated how these features specifically addressed the requirements of adult learners who have disabilities. According to Salas-Pilco et al (2022), the utilization of AI technology has the potential to enhance educational inclusivity by accommodating diverse adult learners through content adaptation and the provision of alternate formats.

This paper also discusses some matters arising from integrating AI in adult education, and teaching and learning process in adult literacy classes. Applications of Artificial Intelligence tools in Education enhance effective classroom coordination and facilitate the overall objectives of teaching-learning process. AI has been transforming education in recent years. This increasing significance of AI has garnered the interest of numerous scholars actively exploring diverse methods to incorporate various AI tools within the classroom environment (Halaweh, 2023). With the increasing availability of data and the growing sophistication of machine learning algorithms, AI has the potential to revolutionize the way we learn, teach, and assess student progress. Several benefits of using AI in education have been advanced. For example, Adiguzel et al. (2023) presented some benefits of using Al for administrators, teachers and learners.

According to Brookfield (2018), AI-powered in the field of adult and literacy education offered the following benefits

1. Enhancing Accessibility and Flexibility: Online platforms and mobile apps allow adults to learn at their own pace and schedule, distance learning platforms such as Moodle, Google Classroom, or Zoom enable working adults to combine education with job and family responsibilities.

2. Facilitating Collaborative Learning: Social media platforms, discussion forums, and collaborative tools (e.g., Google Docs, Microsoft Teams) help adult learners share experiences and build knowledge collectively.

3. Supporting Personalized Learning: Adaptive learning systems powered by Artificial Intelligence adjust content to learners' needs, providing customized pathways for literacy, numeracy, or professional training.

4. Promoting Digital Literacy: By using technology in classrooms, adults not only acquire subject knowledge but also gain essential digital skills that are vital in the modern workplace.

5. Engaging Learners through Multimedia: Videos, simulations, podcasts, and interactive games make learning more engaging and practical, for learners with limited formal schooling, visual and audio content supports understanding better than text-heavy instruction.

6. Assessment and Feedback: Learning Management Systems (LMS) and educational apps provide immediate feedback through quizzes, assignments, and progress tracking, helping adult learners monitor their growth.

In a similar view, Yusuf (2022) observed that technology has become a vital tool in modern education in today's classrooms interaction. Technological devices such as projectors, interactive whiteboards, tablets, laptops, and educational apps are increasingly being used to enhance teaching and learning as well as facilitate effective interaction in adult literacy classes. The integration of these tools can improve facilitators' instructional delivery, boost learner engagement, and lead to better learning outcomes (Swanson, 2020). AI offered the following advantages in adult literacy classes;

1. **Personalized Learning Pathways:** AI-powered platforms diagnose learners' strengths and weaknesses through adaptive assessments. This enables the creation of tailored learning experiences that adjust in real-time based on learners' progress (Chen et al., 2020). Such personalization helps adults learn at their own pace, reducing frustration and dropout rates.
2**. Intelligent Tutoring Systems:** Intelligent tutoring systems (ITS) simulate human-like guidance by providing real-time explanations, feedback, and reinforcement (VanLehn, 2021). For adults lacking access to qualified literacy instructors, ITS act as virtual tutors, ensuring consistent and individualized support.
3. **Speech and Language Processing:** AI-driven Natural Language Processing (NLP) and speech recognition technologies enhance both oral and written literacy skills. For example, text-to-speech tools help learners with low reading ability, while speech-to-text applications support writing practice (Li et al., 2021). Multilingual NLP applications also help learners overcome language barriers.
4. **Gamification and Motivation:** Motivation is a major barrier for adult learners. AI-enhanced gamified learning apps integrate storytelling, challenges, and rewards to keep learners engaged (Keller & Suzuki, 2019). By turning literacy practice into interactive experiences, adults are more likely to persist in their learning journeys.
5. **Accessibility and Inclusion:** AI promotes inclusivity by supporting learners with disabilities and those from marginalized linguistic groups. Text-to-speech and visual recognition tools enhance accessibility for visually impaired learners, while machine translation tools break down linguistic barriers for immigrants and refugees (World Bank, 2021).
6. **Data-Driven Insights for Educators and Policymakers:** AI generates insights into learner behavior, difficulties, and progress. These analytics inform educators and policymakers in refining curricula and literacy strategies (Luckin et al., 2016). Data-driven approaches improve the scalability and effectiveness of literacy initiatives.
7. **Flexible and Mobile Learning:** Many adult learners cannot attend formal literacy classes due to work and family obligations. AI-powered mobile apps provide flexible, on-the-go learning opportunities, often functioning offline in low-connectivity areas (Trucano, 2019). This flexibility makes literacy education more practical and sustainable.

Challenges in AI-Driven Adult Literacy Education in Nigeria

Recent scholarly research has brought attention to the ethical considerations associated with safeguarding data privacy in educational systems powered by AI (Simbeck, 2023; Hunkenschroer & Luetge, 2022). While AI has the potential to transform adult literacy curriculum development by making it more data-driven, adaptive, and relevant to 21st-century skills, its adoption is hampered by infrastructural, financial, cultural, and policy-related challenges. Overcoming these issues will require strong political will, investment in ICT infrastructure, teacher capacity building, and development of clear ethical guidelines to ensure AI supports national values while advancing educational innovation.

Despite its potential, AI implementation in adult literacy education faces several barriers. Usman, (2021) identify the following challenges in integrating AI in adult literacy classroom;

1. Infrastructural Limitations: One of the biggest challenges is the lack of adequate infrastructure to support AI-driven adult literacy curriculum development. Many developing nations face unstable electricity supply, weak internet connectivity, and poor access to modern digital devices. Without reliable infrastructure, integrating AI into adult literacy curriculum design and implementation becomes unrealistic.

2. High Cost of Implementation: AI systems, including adult literacy curriculum development platforms, require significant financial investment for software, hardware, training, and maintenance. Many education ministries operate on tight budgets, making it difficult to justify the cost of AI against other pressing needs like teacher recruitment, classroom construction, and provision of textbooks.

3. Shortage of Skilled Personnel: The use of AI in adult literacy curriculum design demands experts in educational technology, data science, and pedagogy. However, there is a shortage of skilled literacy curriculum developers who understand both AI technologies and subject-specific content, especially in the social sciences like Government. This gap limits effective integration.

4. Ethical and Cultural Concerns: AI systems rely heavily on data, which raises ethical issues such as privacy, bias, and cultural relevance. Imported AI tools may reflect Western political systems and

ideologies that do not align with local values or government policies. This may lead to a curriculum that undermines national identity, history, or civic education priorities.

5. Resistance to Change: Teachers, curriculum planners, and policymakers may resist AI integration due to fear of job displacement or lack of trust in technology. Traditional adult literacy curriculum development processes are deeply institutionalized, and stakeholders may be reluctant to embrace AI-generated recommendations.

6. Over-Reliance on Technology: While AI can process large amounts of data and suggest literacy curriculum patterns, excessive dependence on technology may weaken human judgment and creativity in the curriculum design. Important contextual factors such as cultural nuances, moral education, and national values may be overlooked if AI dominates the process.

Strategies for Effective Integration of Artificial Intelligence in Adult Literacy Education

Artificial intelligence (AI) is a rapidly evolving field of technology that involves the development of intelligent machines that can perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, and making decisions based on data. AI is the ability of machines to adapt to new and emerging situations, problem-solve, answer questions, create plans, and perform other intelligent functions typically associated with human beings. AI refers to the field of computer science that involves creating computer programs capable of imitating intelligent behavior and ideally enhancing human-like abilities (Naqvi, 2020).

AI, a swiftly expanding discipline, encompasses the development of intelligent robots capable of emulating human thought processes and actions, finding utility in diverse areas such as medical diagnosis, self-driving cars, and education (Elliott, & Soifer, 2023). 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 adult literacy level. This might be used by academics and educators to develop learning-friendly AI games, tools, and curricula (Ng & Chu, 2021). It compiles data demonstrating the effectiveness of the AI curriculum in adult literacy classes. 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., 2022). According to Kewalramani et al. (2021), researchers could design fun activities for learners, such as interacting with AI robots, to help adults' perspectives of AI.

Similarly, Crawford (2021), identifies the following approach in promoting AI-driving Adult literacy Education

1. Start Simple: Use user-friendly tools before advancing to complex systems.
2. Provide Training: Offer digital literacy workshops for both learners and instructors.
3. Blend Learning Models: Combine face-to-face teaching with online learning (blended/hybrid learning).
4. Ensure Relevance: Use technology that aligns with learners' needs, workplace demands, and real-life applications.
5. Encourage Peer Support: Foster collaborative learning so learners help each other in mastering digital tools.

Conclusion

Technology integration in the adult learning classroom is not optional but essential for effective education in the digital age. It enhances accessibility, promotes engagement, and builds digital competence among learners. However, successful integration requires addressing challenges such as access, training, and learner readiness. When used thoughtfully, technology empowers adult learners to acquire not just academic knowledge but also the skills needed to thrive in a technologically driven society. Artificial Intelligence is a transformative force in adult literacy education. Its capacity to personalize learning, enhance accessibility, and deliver flexible solutions makes it an indispensable tool in bridging literacy gaps. While challenges such as cost, access, and ethical concerns remain, AI offers a promising pathway toward achieving inclusive and sustainable adult literacy worldwide. Integrating AI in adult literacy is not merely an option it is an imperative for social, economic, and human development. Artificial Intelligence plays an imperative role in enhancing adult livelihood status by promoting employment opportunities, skill development, productivity, and economic inclusion. However, to maximize these benefits, there is a need for ethical AI implementation, supportive policies, and continuous adult education to ensure that technological advancement leads to sustainable and inclusive livelihood improvement.

Recommendations

Based on the conclusions drawn, the following recommendations were made;

1. Governments should invest in low-cost, AI-powered literacy applications to ensure affordability and accessibility.
2. Public-private partnerships can support the development of localized AI solutions tailored to cultural and linguistic contexts.
3. Adult learners should be given basic digital literacy training to improve their confidence in using AI tools.
4. Ethical frameworks must guide AI deployment to protect learner data and ensure fairness.
5. Governments should subsidize AI-powered literacy platforms and ensure equitable access to digital devices.
6. Partnerships between governments, NGOs, and tech companies can support localized, culturally sensitive AI literacy solutions.
7. Digital literacy training should be integrated into adult education programs to increase learners' confidence with technology and ethical guidelines and policies should be enforced to protect learner data and reduce algorithmic bias.

References

Adedokun-Shittu, N. A., & Shittu, A. J. (2020). Artificial intelligence in education: Opportunities and challenges in Nigerian secondary schools. *International Journal of Education and Development using ICT,* 16(2), 45–59.

Adeoye, B. F., & Adeniran, R. A. (2021). Integrating artificial intelligence into teaching and learning for sustainable development in Nigeria. *Journal of Educational Technology and Instruction,* 4(1), 23–35.

Ahmad, K., Qadir, J., Al-Fuqaha, A., Iqbal, W., El-Hassan, A., Benhaddou, D., & Ayyash, M. (2020). *Data-driven artificial intelligence in education*: A comprehensive review.

Ahmi, A., & Mohamad, R. (2019). Bibliometric Analysis of Global Scientific Literature on Web Accessibility. *International Journal of Recent Technology and Engineering*, 7(6), 250– 258.

Alabi, T. (2019). The role of curriculum implementation in enhancing quality education in Nigeria. *Journal of Curriculum Studies and Instruction*, 8(1), 14–25.

Australian Council for Educational Research (2021). *AI in education*: Implications for teaching and learning in Australia. ACER Press.

Barton, D., & Hamilton, M. (2018). Local literacies: Reading and writing in one community. Routledge.

Brookfield, S. D. (2018). *Adult learning: An overview*. In V. Wang (Ed.), Handbook of research on learning in the age of transhumanism (pp. 1–13). IGI Global. https://doi.org/10.4018/978-1-5225-5463-9.ch001

Burgsteiner et al., (2016). Applications of speech recognition in literacy education. *Journal of Educational Technology Development and Innovations,* 1(22), 15–19.

Chen, L., Chen, P., & Lin, Z. (2020). *Artificial intelligence in education*: A review. IEEE Access, 8, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Chikunda, C., Sibanda, P., & Moyo, M. (2021). The role of AI in education: A South African perspective. *Journal of African Education Technology*, 12(3), 45-58.

Choi, Y., Park, S., & Kim, H. (2022). The effect of AI-based adaptive learning systems on student engagement and academic performance: A case study in the USA. *Journal of Educational Technology*, 33(2), 42-56.

Crawford, K. (2021). *Atlas of AI:* Power, politics, and the planetary costs of artificial intelligence. Yale University Press.

Keller, J. M., & Suzuki, K. (2019). Learner motivation and E-learning design: A multi-nationally validated process. *Journal of Educational Media,* 34(1), 1–24.

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2020). *The adult learner:* The definitive classic in adult education and human resource development (9th ed.). Routledge.

Lawal Y. (2021). Applications of speech recognition in literacy education. *Journal of Educational Technology Development and Exchange,* 14(2), 35–49.

Lin, P. H., Wooders, A., Wang, J. T. Y., & Yuan, W. M. (2018). *Artificial intelligence, the missing piece of online education*?. IEEE Engineering Management Review, 46(3), 25-28.

Liu, Y. X., Zhu, C., Wu, Z. X., Lu, L. J., & Yu, Y. T. (2022). *A bibliometric analysis of the application of artificial intelligence to advance individualized diagnosis and treatment of critical illness.* Annals of Translational Medicine, 10(16)

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed*: An argument for AI in education. Pearson.

Merriam, S. B., & Baumgartner, L. M. (2020). *Learning in adulthood:* A comprehensive guide (4th ed.). Jossey-Bass.

Mezirow, J., & Taylor, E. W. (Eds.). (2009). Transformative learning in practice: Insights from community, workplace, and higher education. Jossey-Bass.

Ng, R., et al. (2022). *AI as a key tool in shaping the foundational stage of children's learning and development*. Educational Technology & Society, 24(1), 174-187.

OECD. (2021). *Digital education outlook 2021*: Pushing the frontiers with AI, blockchain and robots. OECD Publishing. https://doi.org/10.1787/589b283f-en

Russell, S., & Norvig, P. (2020). *Artificial intelligence*: A modern approach (4th ed.). Pearson.

Selwyn, N. (2016). *Education and technology:* Key issues and debates (2nd ed.). Bloomsbury Academic.

Su, P., et al. (2022). Personalized learning systems driven by AI to cater to the diverse needs of young learners. *Educational Technology Research & Development,* 70(5), 1-19.

Su, P., et al. (2023). AI as a revolutionary tool with the potential to reshape teaching and learning experiences. *Journal of Educational Technology & Society,* 26(1), 97-112.

Trucano, M. (2019). *Will technology transform education for the better*? World Bank Blogs. https://blogs.worldbank.org

UNESCO, (2022). Institute for Lifelong Learning (UIL). Harnessing the power of technology for adult learning and education. UNESCO.

UNESCO. (2020). *Literacy for sustainable development and empowerment*. UNESCO Institute for Lifelong Learning. https://unesdoc.unesco.org

UNESCO. (2022). Global education monitoring report: Literacy for life. UNESCO.

Usman, R. A. (2021). Artificial intelligence and its implications for secondary education in Nigeria. *Nigerian Journal of Educational Research,* 18(2), 112–128.

VanLehn, K. (2021). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, 46(4), 197–221.

Wach, A., et al. (2023). Concerns regarding AI implications in educational environments. *SLE Journal, 10(7).* https://doi.org/10.1186/s40561-024- 00316-7.

Wang, V. C. X. (Ed.). (2020). *Handbook of research on program development and assessment methodologies in K–20 education*. IGI Global.

Williams, J. (2018). AI toys and their role in adapting to children's behavior. *Journal of AI and Robotics in Education,* 1(1), 33-45.

World Bank. (2021). *EdTech in practice:* Artificial intelligence for education. World Bank Publications.