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ARTIFICIAL INTELLIGENCE IN TECHNOLOGY EDUCATION FOR SUSTAINABLE DEVELOPMENT IN NIGERIAN UNIVERSITIES.

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ABSTRACT

The 21st century has witnessed rapid technological advancements, with Artificial Intelligence (AI) emerging as a pivotal force in transforming education globally. This paper examines the role of AI in reshaping technology education in Nigerian universities and its contribution to achieving sustainable development. It explores how AI can enhance curriculum design, improve practical skills acquisition, facilitate personalized learning, and support research and innovation despite challenges such as inadequate infrastructure, financial constraints, and ethical concerns. The paper further highlights the alignment of artificial intelligence with Nigeria's Sustainable Development Goals (SDGs), emphasizing its potential to improve quality education, healthcare, agriculture, and economic growth. It also suggests Implementation of comprehensive training programs and workshops to up skill faculty and administrative staff in AI, machine learning etc. Advocacy for increased government funding dedicated to AI infrastructure, research, and training in universities. Engaging of all stakeholders early in the AI adoption process to reduce resistance and encourage buy-in highlights the challenges Nigerian universities face in adopting AI and also provides recommendations to address these challenges.

Keywords: Artificial Intelligence, Technology Education, Sustainable Development

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INTRODUCTION

The 21st century has brought rapid changes in how people live, learn, and work. One of the biggest drivers of this change is Artificial Intelligence (AI) which is a fast-growing area of computer science that allows machines to think, learn, and make decisions like humans. Across the world, AI is being used to improve industries such as healthcare, finance, agriculture, and transportation. But one of the most important areas where AI can make a big difference is education. Haenlein, M. & Kaplan, A. (2019)

In many developed countries, AI is already helping schools and universities improve teaching, support students, and speed up research. With smart tutors, personalized lessons, virtual labs, and data analysis tools, AI is transforming how education is delivered and experienced. In developing countries like Nigeria, where education faces serious challenges, AI presents a unique opportunity to improve quality, access, and innovation especially in the field of technology education.

Nigeria has a large and growing youth population, and higher education is expanding rapidly. However, Nigerian universities still face many problems. These include overcrowded classrooms, poor infrastructure, old teaching methods, and a major gap between what students learn and the skills needed in today's digital job market. These problems make it hard to produce graduates who are ready to contribute to the country's economic and technological development. This is especially worrying in a world that is becoming more digital and competitive. Eze, S.C., Ndubuisi, C, and Agbo, B (2022)

This paper argues that the integration of AI in Nigerian universities is not only necessary but urgent. AI can help solve many of the problems in the education system by offering smart, flexible, and cost-effective solutions. It can personalize learning to meet individual student needs, automate administrative tasks to reduce pressure on staff, and provide powerful tools for research and innovation. More importantly, AI can support Nigeria's national goals for sustainable development, by improving access to quality education, reducing inequality, and encouraging innovation. Owolabi, A., Adegbola T., & Musa, A. (2021)

However, while AI offers great benefits, there are also major challenges. Many Nigerian universities lack the digital infrastructure needed to support AI. Internet access is unreliable, funding is limited, and many educators and students are not trained in using these technologies. There are also concerns about privacy, ethics, and how AI might affect traditional teaching roles.

To address these issues, there must be a clear and coordinated strategy involving the government, universities, private sector, and international partners. Investments in infrastructure, policy reforms, teacher training, and support for local research are critical for AI to succeed in Nigeria's higher education system.

This paper will explore the role of AI in reshaping technology education in Nigerian universities and its contribution to achieving sustainable development. It will:

1. Explain the concept of Artificial Intelligence, Technology Education and Sustainable development
2. Explain how AI can improve technology education in Nigerian universities.
3. Show how AI supports Nigeria's Sustainable Development Goals (SDGs)
4. Discuss the challenges that Nigerian universities face in adopting AI.
5. Recommend solutions to overcome these challenges.

The overall goal is to show that integrating AI into Nigeria's university system is a key step toward building a stronger, more inclusive, and future-ready education system that can drive national development in a digital age.

CONCEPTS OF ARTIFICIAL INTELLIGENCE

Artificial intelligence involves machines simulating human intelligence through learning, reasoning, problem solving, and perception, using data and algorithms to perform tasks like understanding language, recognizing patterns, and making decisions, with core ideas including machine learning, Neural networks, deep learning and natural language processing. These systems adapt and improve from experience, moving beyond simple programming to autonomous, human-like actions from self-driving cars to digital assistants. (Russell & Norvig 2020). AI is highly relevant in Nigerian universities for tackling large class size, improving personalized learning via chatbots, and adaptive systems, automating admin tasks, enhancing research with data analysis and bridging access gaps to global resources, ultimately boosting efficiency, engagement, and preparing students for a digital future, through implementation requires infrastructure and training. Luckin, R., Holmes, W. (2016)

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) refers to the ability of computers or machines to perform tasks that usually require human intelligence. These tasks include understanding language, recognizing patterns, solving problems, making decisions, and even learning from experience. In simple terms, AI allows machines to "think" and "act" like humans by using data and instructions given to them. It is the science of making machines that can perform tasks that would normally require human intelligence. These tasks range from simple ones like recognizing speech or images, to more complex ones like planning, reasoning, and learning from past actions. AI systems can be programmed to follow rules, but they can also use large amounts of data to improve their performance over time without being explicitly told what to do. This ability to learn and adapt is what makes AI so powerful and useful in many areas of life (Russell & Norvig, 2020).

AI is already being used in many industries. For example, in healthcare, AI helps doctors detect diseases faster. In transportation, AI powers self-driving cars. In education, AI is being used to personalize learning for students by adjusting lessons based on individual needs and progress (Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). These examples show how AI is not just about robots or machines rather it is about using computer systems to help solve real-world problems more efficiently. There are different types of AI. Some are narrow or weak AI, which are designed to do one task very well like virtual assistants (e.g., Siri or Alexa). Others are more general and can perform a wide range of tasks, although this kind of AI is still in development. There is also growing interest in ethical AI, which focuses on making sure AI systems are fair, safe, and respectful of people's rights (Jobin, Ienca, & Vayena, 2019).

As technology continues to grow, AI is becoming more important in everyday life. Understanding what AI is, how it works, and how it can be used responsibly is essential for students, educators, policymakers, and citizens alike.

Concepts Technology Education

Technology Education is a field of learning that helps students understand how technology works, how it is created, and how it affects our lives. It focuses on both the practical use of tools and machines, as well as the thinking and problem-solving skills needed to design, build, and improve technology. According to the International Technology and Engineering

Educators Association (ITEEA, 2019), Technology Education is about more than just using devices. It involves teaching students the process of innovation which includes how to plan, design, test, and improve technological solutions to real-world problems. Students also learn about the impacts of technology on society, the environment, and the economy.

In simple terms, Technology Education helps students answer questions like:

How do machines work? How are everyday products designed and made? And what are the benefits and risks of using technology?

It also encourages them to think critically about the role of technology in the world and to develop responsible attitudes toward using it. For example, students might learn how to code a simple app, design a bridge, or explore how renewable energy systems work while thinking about how these tools can help people and protect the planet (Williams, 2018).

Technology Education is not only for future engineers or inventors. It is important for all students because it builds essential skills like creativity, teamwork, communication, and logical thinking. These skills are necessary in today's world where technology is used in almost every job and industry

(Kelley & Knowles, 2016). Whether a student wants to work in healthcare, business, agriculture, or the arts, understanding technology helps them adapt and succeed.

As the world becomes more digital, technology education becomes more critical**.** It helps young people become not just consumers of technology, but active creators and informed decision-makers who can use technology to improve their communities and solve future challenges. Mandah, N.N.N. (2016).

Sustainable Development

Sustainable Development means finding ways to improve our lives today while making sure that future generations can also have good lives. It's about balancing three important things: economic growth, social fairness, and protecting the environment. The idea is that we should use resources like water, energy, and land in ways that do not harm the planet or make life harder for people in the future. For example, cutting down forests too quickly or polluting rivers can damage nature and make it harder for future people to live well. Sustainable development asks us to think carefully about how we live, work, and grow so that the world remains healthy and fair for everyone, now and later (United Nations, 2015).

The United Nations made a plan called the Sustainable Development Goals (SDGs**)** to help countries work toward this balance. The SDGs include 17 goals that cover a wide range of important issues such as ending poverty, providing quality education, ensuring clean water and energy, promoting gender equality, and taking care of the environment. These goals are meant to guide countries in making smart decisions that help both people and the planet (United Nations, 2015).

Sustainable development is important because the Earth's resources are limited, and many problems like climate change, poverty, and inequality are connected. By working toward sustainability, we aim to create a world where everyone has enough to live well without damaging the environment or leaving future generations worse off.

In education, sustainable development means teaching students not only to understand these challenges but also to find creative and responsible solutions. It encourages young people to think about their role in building a fairer, greener, and more peaceful future. For countries like Nigeria, sustainable development is particularly important because it faces challenges like rapid population growth, poverty, environmental degradation, and unequal access to education and healthcare. Implementing sustainable development goals in education and other sectors can help Nigeria build a better future for all its citizens.

How AI Can Improve Technology Education in Nigerian Universities

In Nigerian universities, AI can improve technology education in various ways. This includes:

1. **Enhancing Curriculum Design and Delivery:** One of the persistent challenges in technology education within Nigerian universities is the difficulty in maintaining curricula that reflect the rapid pace of technological advancement and industry demands (Owolabi, A., Adegbola, T., & Musa, A. (2021).). Traditional curriculum review processes are often slow

2. and unable to keep up with innovations such as artificial intelligence, block chain, cloud computing, and cyber security. This results in graduates who may lack competencies relevant to current job markets.
   AI can revolutionize curriculum design by employing data-driven approaches to continuously analyse labour market trends, industry requirements, and emerging technologies. For example, AI-powered labor market analytics platforms can scan job postings, industry reports, and professional skills databases to identify the most in-demand technical skills both locally and globally (Makridakis, 2017). This enables curriculum developers to proactively update course content to include skills such as machine learning, data analytics, and Internet of Things (IoT), which are increasingly vital in the digital economy.
   Moreover, AI-driven adaptive learning systems provide personalized learning experiences by adjusting course content, pace, and difficulty based on real-time assessment of students' performance ((Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Such platforms identify individual knowledge gaps and tailor instruction accordingly, which is especially valuable in Nigeria's context where large class sizes make personalized instruction challenging. Adaptive learning has been shown to increase student engagement and improve mastery of complex concepts such as programming paradigms and algorithms. Baker, R. S., D'Mello, S., Rodrigo, M. M. T., & Graesser, A. (2020).
   In addition to content delivery, AI tools can assist educators in curriculum planning by simulating the impact of different course structures on student outcomes and predicting the effectiveness of new modules before implementation (Rienties et al., 2020). This evidence-based curriculum design process helps optimize learning pathways for better educational outcomes.

3. **Improving Practical and Hands-On Skills:** Technology education is inherently experiential, requiring students to apply theoretical knowledge through practical tasks such as programming, hardware assembly, and system design. However, many Nigerian universities face significant infrastructure challenges, including poorly

equipped laboratories, outdate equipment, and insufficient access to specialized tools (National Universities Commission, 2020). These limitations restrict students' opportunities for hands-on learning, which is critical to developing technical competence.

AI technologies offer solutions through virtual laboratories and simulations that create immersive, interactive environments for practical experimentation (Woolf, 2010). Virtual labs simulate real-world scenarios such as network configuration, software debugging, or robotics control which allows students to practice safely and repeatedly at their own pace. This overcomes geographical and resource constraints by making high-quality practical experiences accessible remotely, which is particularly impactful in rural or under-resourced institutions.

Furthermore, AI-powered automated feedback systems within virtual labs provide instant, formative feedback on student performance, guiding corrections and reinforcing learning without requiring constant instructor intervention (Blikstein & Worsley, 2016). This facilitates a more scalable and efficient learning model. AI also supports remote collaboration platforms that enable students from different universities or regions to work on joint projects, fostering teamwork, communication, and innovation skills vital for the technology sector (Adewale & Olatunji, 2021). Collaborative AI tools can match students with complementary skills, assign tasks, and monitor progress, simulating professional software development or engineering workflows.

4. **Facilitating Intelligent Tutoring and Support**: AI-driven Intelligent Tutoring Systems (ITS) represent a significant advancement in supporting student learning, especially in technically demanding fields such as computer science and engineering. ITS utilize AI algorithms to replicate human tutor behaviors by providing personalized instruction, clarifications, and guided problem-solving strategies (Luckin et al., 2016). They dynamically adjust the difficulty and content based on learner responses, offering scaffolded support that

5. Helps students overcome conceptual difficulties in programming, circuit analysis, or data structures.

   Research indicates that ITS improves learning outcomes by increasing student motivation, reducing frustration, and promoting deeper conceptual understanding (VanLehn, 2011). In Nigerian universities, where faculty-to-student ratios can be overwhelming, ITS can supplement human instruction effectively.

   Additionally, AI-powered chatbots serve as on-demand academic assistants, available 24/7 to answer queries related to coursework, deadlines, administrative procedures, and study resources (Woolf, 2010). This continuous support system enhances student engagement and reduces dependency on faculty availability, which is often limited due to workload or institutional constraints. Such chatbots can also be integrated with learning management systems (LMS) to monitor student progress, send personalized reminders, and recommend additional resources, thereby fostering a more autonomous and self-regulated learning culture (D'Mello & Graesser, 2015).

6. **Promoting Research and Innovation in Technology Fields**: Nigerian universities are increasingly recognized as centres for research and innovation, particularly in areas like ICT, renewable energy, agriculture technology, and healthcare informatics. Nonetheless, research efforts are often hampered by limited access to funding, research infrastructure, and global collaboration networks (Eze, S. C., Ndubuisi, C., & Agbo, B. M. (2022).

AI offers powerful tools to enhance research productivity and quality by automating complex data processing tasks such as big data analytics, image recognition, and natural language processing (Jordan & Mitchell, 2015). For example, machine learning algorithms can analyse large datasets generated by sensor networks, social media, or biomedical instruments, uncovering insights that human researchers might miss.

AI also accelerates literature reviews and knowledge discovery through Natural Language Processing (NLP) techniques that automatically summarize research papers, extract relevant concepts, and identify trends (Haenlein & Kaplan, 2019). This reduces time spent on manual information gathering, allowing researchers to focus on hypothesis formulation and experimentation.

Furthermore, AI-driven platforms can foster interdisciplinary collaboration by recommending research partners based on complementary expertise, shared interests, and previous publications (Eze et al., 2022). This connectivity is essential for solving complex challenges that require multi-faceted approaches.

How AI Supports Nigeria's Sustainable Development Goals (SDGs)

1. **Enhancing Quality Education (SDG 4):** Education remains a cornerstone of Nigeria's development agenda, yet disparities in access and quality persist especially between urban and rural areas. AI-powered learning platforms offer scalable solutions to these challenges. Intelligent tutoring systems (ITS) provide personalized instruction tailored to the learning pace and style of individual students, thereby addressing the problem of large class sizes and limited teacher availability (Luckin et al., 2016).

Moreover, AI-driven analytics help educators identify students at risk of falling behind and implement timely interventions (Baker et al., 2020). AI chatbots can support continuous learning by answering student questions and providing resources around the clock, promoting learner autonomy. For example, the integration of AI tools into Nigeria's higher education systems could help bridge the rural-urban divide, offering students in remote communities' access to quality educational content without the need for physical classrooms (Mtebe & Raisamo, 2014). By improving the quality and inclusivity of education, AI supports SDG 4's aim to ensure equitable access to lifelong learning opportunities for all Nigerians.

2. **Improving Healthcare Delivery and Outcomes (SDG 3):** Nigeria faces a significant healthcare burden characterized by high maternal and infant mortality rates, prevalence of infectious diseases, and under-resourced medical facilities. AI technologies can enhance healthcare delivery by enabling early disease detection, predictive diagnostics, and personalized treatment plans. For instance, AI algorithms applied to medical imaging can improve the accuracy and speed of diagnosing diseases such as tuberculosis, malaria, and cervical cancer, which remain leading causes of death in Nigeria (Topol, 2019). AI-powered telemedicine platforms are increasingly vital for extending healthcare access to underserved rural populations by connecting patients with doctors remotely and facilitating remote monitoring of chronic conditions.

Furthermore, AI-driven health information systems improve the management of medical supplies, reduce wastage, and predict outbreak patterns, enabling more effective public health responses (Eze et al., 2022). AI chatbots and virtual health assistants also support preventive care by providing health education, vaccination reminders, and mental health counselling,

helping to build healthier communities. These applications collectively contribute to achieving SDG 3, which focuses on ensuring healthy lives and promoting well-being for all.

3. **Supporting Sustainable Agriculture and Food Security (SDG 2):** Agriculture employs a large portion of Nigeria's population but is constrained by low productivity, inefficient resource use, and climate variability. AI offers transformative tools to optimize agricultural practices and enhance food security. Machine learning models process satellite and drone imagery, along with weather and soil data, to provide precise recommendations on irrigation scheduling, pest control, and fertilization (Kamilaris & Prenafeta-Boldú, 2018). These precision agriculture techniques help farmers maximize yields while conserving water and minimizing chemical use, fostering environmental sustainability.

In Nigeria, mobile-based AI platforms can deliver real-time market information, weather forecasts, and planting advice tailored to local conditions, empowering smallholder farmers to make informed decisions (Adewale & Olatunji, 2021). Such digital innovations help mitigate risks and reduce post-harvest losses. By improving agricultural productivity and resilience, AI aligns with SDG 2's goals to end hunger, achieve food security, and promote sustainable agriculture.

4. **Boosting Economic Growth, Innovation, and Infrastructure (SDG 8 and SDG 9):** Economic development in Nigeria depends heavily on innovation and industrialization. AI is a key driver of the Fourth Industrial Revolution, enabling automation, optimizing business processes, and fostering new products and services. In sectors such as manufacturing, telecommunications, and finance, AI applications improve productivity by automating routine tasks, enhancing customer service through chatbots, and providing predictive analytics for decision-making (Jordan & Mitchell, 2015). These improvements help build resilient infrastructure, promote inclusive industrialization, and stimulate innovation.

Moreover, AI can support entrepreneurship and job creation by lowering barriers to entry for tech startups, facilitating access to markets, and enhancing digital skills training (Eze et al., 2022). However, it is critical that Nigeria addresses potential workforce displacement through proactive policies and reskilling initiatives.

Challenges Nigerian Universities Face in Adopting AI

1. Inadequate Infrastructure: One of the most significant barriers to AI adoption in Nigerian universities is the lack of adequate digital infrastructure. Many institutions struggle with unreliable electricity supply and limited internet connectivity, particularly in rural areas. Since AI technologies often require stable internet and powerful computing resources, these infrastructural deficits hinder the effective deployment and use of AI tools (Eze et al., 2022; Mtebe & Raisamo, 2014).

2. Shortage of Skilled Personnel: Nigerian universities face a critical shortage of qualified faculty and technical staff with expertise in AI, machine learning, and data science. This skills gap is due partly to limited AI-focused academic programs and brain drain, where skilled professionals seek better opportunities abroad. Without skilled personnel, it is difficult to develop, maintain, and integrate AI systems effectively (Adewale & Olatunji, 2021; Eze et al., 2022).

3. Financial Constraints: The cost of acquiring AI infrastructure including high-performance computers, software licenses, and cloud services is often prohibitive for Nigerian universities, many of which operate under tight budgetary constraints. Funding shortages also limit investments in AI research, faculty training, and student support systems (Business Day Nigeria, 2023).

4. Ethical and Data Privacy Concerns: AI adoption raises concerns about data privacy, security, and potential biases embedded in algorithms. Nigerian universities generally lack comprehensive policies and regulatory frameworks to govern ethical AI use, leading to hesitation among stakeholders and mistrust among users (Floridi et al., 2018; Eze et al., 2022).

5. Resistance to Change: Faculty members and administrative staff may resist adopting AI tools due to fear of job displacement, lack of familiarity with AI, or skepticsm about its benefits. This cultural resistance slows AI integration into academic and administrative processes.

Conclusion

The integration of Artificial Intelligence into Nigerian universities' technology education systems is not just important but absolutely necessary and urgent. Without embracing AI, the challenges facing education such as out-dated teaching methods, lack of personalized learning, and weak research capacity will continue to hold back Nigeria's progress. AI has the power to transform education by improving curriculum, supporting students, and driving innovation that aligns with Nigeria's development goals.

However, this transformation will only happen if the government, universities, and all stakeholders commit to investing in infrastructure, training, and ethical policies. Ignoring AI's potential risks leaving Nigerian education behind in a fast-changing digital world. Therefore, Nigeria must take decisive action now to adopt AI thoughtfully and inclusively. This is the best path to building a stronger, more equitable, and future-ready education system that will empower students and contribute meaningfully to the country's sustainable development.

Recommendations

Based on the issues discussed, the following are recommended

Implementation of comprehensive training programs and workshops to up skill faculty and administrative staff in AI, machine learning etc.

Advocacy for increased government funding dedicated to AI infrastructure, research, and training in universities.

Engaging of all stakeholders early in the AI adoption process to reduce resistance and encourage buy-in.

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