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HARNESSING ARTIFICIAL INTELLIGENCE FOR BUILDING SUSTAINABLE CREATIVITY IN EDUCATION IN THE 21ST CENTURY

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Abstract

The integration of Artificial Intelligence (AI) in education is reshaping the landscape of teaching, learning, assessment, and administration, offering new pathways to foster sustainable creativity in the 21st century. This paper examined the importance of AI in fostering adaptive, inventive, and personalised learning experiences that enhanced students' creative and critical thinking abilities. It also analysed the principal obstacles related to AI implementation. Notwithstanding these challenges, the strategic and ethical implementation of AI possessed the capacity to improve educational fairness, efficacy, and resilience. The study provided pragmatic recommendations, such as enhancing teacher ability, ethical governance, infrastructural advancement, and ongoing evaluation. These initiatives are crucial to guarantee that AI significantly and sustainably enhances creativity and innovation inside global educational frameworks.

Keywords: Artificial intelligence, Sustainable creativity, 21st century education

Introduction

In the 21st-century, there are three channels through which education affects a country's productivity. First, it increases the collective ability of the workforce to carry out existing tasks more quickly. Secondly, it facilitates the transfer of knowledge about new information, products, and technologies created by others (Barro & Lee, 2010). Finally, by increasing sustainable creativity, it boosts a country's own capacity to create new knowledge, technologies, and products (Grant, 2017; World Economic Forum, 2016). The third channel suggests that sustainable creativity is a useful element in 21st century education.

Sustainable creativity is the capacity to generate new ideas and solutions, break new ground, invoke fresh ways of thinking, pose unfamiliar questions, and arrive at unexpected answers at a continuous level that improves the lives of future generations (Joynes, Rossignoli, & Fenyiwa, 2019). Nwagwu, Okere and Branch (2021) posited that sustainable creativity is continued thinking through information in new ways, making new connections and coming up with innovative solutions to present and future problems. Both scholarly and popular discourse points to the importance of continued creative thinking skills for learners (Harris, 2016; Runco, 2014). The importance of sustainable creativity in education which involves preparing young people to be able to use their creative abilities for the uncertain and complex world of work has been widely recognized (Soriano de Alencar, de Souza Fleith & Pereira, 2016).

However, in some developing nations like Nigeria, building creative educational capacity of learners seems to be a challenge as the country's education has been observed to lack sustainable creativity. Most of the learners who are products of the country's educational system have been observed to have insufficient and sustained creative capacity for the world of work. They are almost unable to proffer universal, continuous and maintained creative solutions for the future generations. Some of the teachers' pedagogies are also not creative but common mundane tasks. There is therefore needed to find out if harnessing technological learning tool such as artificial intelligence (AI) could build sustainable creativity in education in the 21st century.

AI is defined as a computer with the ability to carry out a number of cognitive human tasks, such as communications, reasoning, learning, and / or solving problems Nilsson (in Chong, Jian & Zhiying, 2020). It is a technology or a system that perceives the environment and therefore performs certain actions with some degree of autonomy to reach a desired goal (Krafft, Young, Katell, Huang & Bugingo, 2020). This electronically communicative environment creates an emerging high-tech environment which is the re-engineering of the human brain (Mynbayeva, Sadvakassova & Akshalova, 2017). If the human's brain is reshaped, so can be formed a persistent creativity in learners. Computer as Digital Resource Computer is a digital resource that has promoted beneficiary for applied science, medical healthcare and commerce industry (Baker & Inventado, 2014). However, effective use

of artificial intelligence in developing sustainable creative professionals in the 21st century education has yet to receive much attention, thus the need for this paper.

In Vikoo, 2016 p.35 Clark (2016) explains that education is a reactions of a teacher and a learner that the teachers' is responsible in doing this before the learner is to be able to behave as expected. Education is personal training and rearing provisions of a person in a school or similar environment, to equip him with the needed skill to meet a trade or profession (Yusuf, 2014). The purpose of education is to create a rounded set of abilities children can use to sustain themselves, develop sustainable livelihoods, contribute to peaceful and democratic societies and enhance individual well-being (Wani, Dhami & Sidana, 2022). According to Okereke, Ukpai and Okereke (2013), Ebonyi defined education as a strong tool for development of man and the society. it is a methodical means of passing on culture from one generation to the next Culture is transmitted not through genes but by means of language Language is the main vehicle of culture Language in its different forms like reading, writing and speaking makes it possible for the present generation to understand the achievements of earlier generations.

Education is for the mind, body, heart and spirit of the citizens of a country. Education is the process of learning, or the process through which individuals acquire knowledge, skills, values, morals, beliefs, habits, culture and personal development (Onebunne, 2022; Ebonyi in Okereke et al., 2013). One of the aims of education is to give a human being a healthy atmosphere so that whatever possibility is there in him does reflect and grow. Thus, education is the act of imparting learning or acquiring knowledge, competences, values, norms, beliefs, and suspicion, and skills (Chimombo in Nwagwu, et al., 2021). It may be formal or informal, and any experience that has a formative effect on the way one thinks, feels, or acts may be considered educational. The pedagogy of teaching is referred to as methodology (Nwagwu et al., 2021).

21st century learning is flexible, creative, challenging, and complex. It deals with a fast-moving world of great new challenges as well as opportunities (Okereke et al., 2013). The 21st century education is predicated on empowering learners with the skills to function in the new world and to provide learners with the confidence to practice

these skills in the face of abundance of information available to them (Nwagwu et al., 2021). 21st century education trains generations and is one in which learners can utilize technologies to augment reasoning and learning, digital literacy, communication, collaboration, social and cross-cultural skills, and media literacy. It depends on the science and technology that requires human resources to possess various forms of critical thinking and problem-solving skills of a country (Gunawan et al., 2020).

21st century education is an education that responds to the new global economic, technological and societal changes occurring at a breakneck pace. It enables kids to succeed in a world where more than half the jobs they will have throughout their careers don't even exist today. It offers the skills the 21st century student needs to flourish. It is founded on the association between different subjects in a unified way, which enforces an application of knowledge across different fields. This learning is fully computer and internet supported and the multi-media has been a means to enhance teaching and learning. It strives to create global citizens by educating students about issues in their area and worldwide. These students are volitional learners who are trained to respond and react to problems in the world as they are global citizens. The unique learning needs of each learner are responsive (Rodriguez, 2021).

The 21st century education is focused on providing learners with skills that are transferable in nature and which will be stable and valuable in the face of a changing world to IT tools, but not knowledge, assuming the knowledge in question is a "knowledge of an earlier day" selected for its past relevance (Nwagwu et al., 2021). For 21st century education to succeed, age groups must use a never-before offered level of content knowledge, skill sets, expertise, and literacies as a means to longstanding and on-the-job learning (Bedir, 2019). 21st century teachers also have to engage the learners so that they can construct their own thinking through everyday applications and in interaction with their peers in several cooperative group activities (Okereke et al., 2013). The 21st century teachers should 'guide' their students, not the 'teach them everything they need to know. Teachers should therefore be supported to facilitate learning to empower the learners (Nwagwu et al., 2021).

Sustainable means being able to support an action indefinitely, a process that can be maintained over the long term. It ensures that natural (or physical) resources are preserved and not overtapped. It's popularly understood to mean something that can be continued indefinitely without depleting natural resources or causing severe ecological damage. It is a regenerative system that operates in such a way that it sustains its own viability using methods that enable its system to remain indefinitely and constantly reusable (Mollenkamp, 2023).

Sustainable creativity involves the ability to think and create anew, to 'trackless waste', to generate fresh thinking, ask questions in new ways and to arrive at new answers at an ongoing, unrelenting level (Joynt et al., 2019). Nwagwu et al. (2021) argues that sustainable creativity is considering information in novel ways, connecting connections, and thinking up new problem solving solutions. Sustainable creativity stems from further demonstrations of one's comprehension of knowledge by designing new arrangements of established equations, as well as solving challenges by reconfiguring previously mastered behaviours and thoughts (Gruner & Csikszentmihalyi, 2019). There is so much at stake in sustainable creativity — not the least of which is innovation and development of a social and economic kind, but on a personal level a lot about health. It is the persistent need to express and have an identity (Collard & Looney, 2014).

The phenomenon of sustainable creativity is a combination of perceptions carried out in a new original way; the ability to establish new links, the activity of thinking that leads to new insights, a tendency to create and learn about innovations, experience of transformation in the new organization's activity, the ability to think certain new constellations of meanings, which is formed and stored throughout life (Hallmann in Matraeva et al., 2020). It may be said that sustainable creativity is all nonterminating progress and improvement that requires the possibility of new type of thinking, the refusal of the present, and the building of a new world (Dietrich & Kanso, 2010). It is defined as the continued capability or power to create, originate, develop and produce something new or a new concept for either process or products or new piece of work (Juliana, Hui, Clement, Solomon and Elvis, 2021).

As evident in sustainability and tenets of the 21st century learning, sustainable creativity is considered as a priority for 21st century education (but it is also an unfinished and contested territory (Runco, 2014). It is something we all possess, not an entitlement of the few. In a lesser, and sometimes a greater, degree, sustainable innovation is applicable to all phases of human endeavor. Just like a person can develop or lose any other human potential, depending on the environmental conditions in which he finds himself. It must, however, be noted that the school is perceived as an institution for the nurturing of the creative potential of individuals (Biljana, 2010). In the twenty first century, sustainable creativity might be a type of thinking skill or habit of mind that can be attained via learning, development and transformation that education is designed to offer (Henriksen, Henderson, Creely, Ceretkova, Černochová... & Tienken, 2018).

Sustainable creativity in the system of education is an indicator of the deep and integral understanding of the teacher of his learning and interpretation; can be expressed in the ability to transform theoretical and practical positions in terms of the educational process; constant self- development and self-skill, mastering new techniques, forms, methods, media, and their original combination; improvisation capabilities driven knowledge, imagination, intuition (Ibragimkyzya, Slambekovaa, Saylaubaya & Albytova, 2016). Researchers are concerned that, in the contemporary world where the role of education is crucial, the current curricula in educational institutions do not satisfy the needs of the economical and labour market due to the fact that the promotion of sustainable creativity is undervalued and underdeveloped (Maksić & Spasenović, 2018; Valgeirsdottir, Onarheim & Gabrielsen, 2015). One possible solution to this issue is the digitalization of technology in promoting sustainable creativity in education.

Artificial Intelligence (AI) is when a machine has human-like characteristics such reasoning, learning, planning and creativity. We may define predictive model as a tool that has been designed and developed to help in or replace decision making by analyzing data, predicting the best value for particular outcome variable(s) and presenting results through a user interface (Channa, Sarhandi, Bugti, & Pathan, 2021). It is the computer which has ability to do many types of things which human doing, for example communicating, reasoning, learning and/or problem solving (Nilsson n.Chong, Jian & Zhiying, 2020).

It is a technology able to solve tasks that usually need human intelligence (Select Committee on Artificial Intelligence SCAI, 2018), or 'a system able to perceive its environment and therefore undertake actions that takes towards achieving a desired purpose with some degree of independence' (Krafft et al., 2020).

More pertinently, AI can assist intelligent tutoring systems to solve user questions in a human-like and appropriate way, think about the process of the solution, and offer feedback (Ross cited in Chong et al., 2020). According to Hwang (2003), AI in Education refers to intelligent tutor system through which system knowledge and forward operational information is organized in order to enhance operator's performance and automatically paces and makes corrective actions on exercises based on prior learner's performance. AI tutors rely on their own problem and learner model analyses to produce intelligent real-time responses (Johnson et al., 2009). Popenici and Kerr (2017) have described AI as the ability of computational systems to churn, process and manipulate, synthesize, self-improve and utilise data in the solution of complex processing problems. AI learning-decision, intelligent behavior and prediction may be achieved by computing systems developed based on an intelligent analysis of digital data collected by different digital equipment (visual perception, facial recognition).

Methodology

This study adopted the qualitative, conceptual research design grounded in an extensive review of relevant literature. The purpose is to critically examine the role of Artificial Intelligence (AI) in fostering sustainable creativity within 21st-century education, while also identifying the challenges and offering evidence-based recommendations for effective integration.

A purposive sampling approach was used to select peer-reviewed journal articles, conference proceedings, policy documents, and technical reports published between 2018 and 2023. The sources were retrieved from academic databases such as Scopus, Web of Science, ERIC, and Google Scholar using keywords including Artificial Intelligence in Education, sustainable creativity, AI challenges in teaching and learning, and AI in educational administration. Selection criteria included relevance to the themes of AI-driven innovation, its

implications for pedagogical practices, and its practical or theoretical contributions to sustainable education.

The analysis employed thematic synthesis to identify recurring patterns, opportunities, and limitations of AI integration across four key domains: teaching, learning, assessment, and administration. Additionally, the study drew on critical perspectives to explore the socio-ethical implications of AI and its impact on educational equity and human agency.

Rather than relying on empirical data collection through surveys or experiments, this conceptual inquiry emphasizes theoretical interpretation and synthesis, aligning with the exploratory nature of the topic. The findings inform a set of recommendations aimed at guiding policymakers, educators, and stakeholders in the ethical and effective deployment of AI technologies in education.

Findings and Discussion

Research Question One: What is the importance of Artificial Intelligence in building sustainable creativity in education in the 21st century?

The integration of Artificial Intelligence (AI) in 21st-century education has become a transformative force capable of improving teaching, learning, evaluation, and educational administration. Here are four key significances of AI.

Artificial Intelligence (AI) in student learning fulfils four primary functions:

1. Task Personalisation — AI allocates tasks according to students' unique competencies, facilitating tailored learning experiences. Nonetheless, constrained resources and execution difficulties impede this methodology (Hirankerd & Kittisunthonphisarn, 2020; Munawar et al., 2018; Yang & Shulruf, 2019).
2. Human–Machine Interaction – Artificial intelligence tools, including chatbots and interactive books, facilitate student engagement in conversations, thereby improving communication skills through continuous dialogue and question-and-answer formats (Chew & Chua, 2020; Kim et al.,

- 2021; Koc-Januchta et al., 2020; Palasundram et al., 2019; Vazquez-Cano et al., 2021).
3. Feedback via Work Analysis — AI evaluates student achievement and delivers immediate feedback. AI apps can evaluate handwriting and observe behaviour to enhance learning and attention (Bonneton-Botte et al., 2020; Fu et al., 2020; Porter & Grippa, 2020; Vahabzadeh et al., 2018).
 4. Augmented Interactivity - AI enhances flexibility and engagement in digital learning environments, rendering learning more dynamic (Chiu et al., 2023).

AI in teaching plays three key roles:

1. AI technologies help improve instructors' pedagogical skills by analysing real-time classroom data and offering feedback on instructional approaches, behaviour, and questioning strategies (Gunawan et al., 2021; Lamos et al., 2021; Hu, 2021). This is one of the ways that AI technologies support teacher professional development. There are, however, very few studies that are entirely focused on professional growth, which indicates that this field is still in its infancy.
2. Artificial intelligence systems help teachers improve the effectiveness of their teaching by automating operations such as uploading, distributing resources, and converting text to speech. This makes it easier for teachers to manage their classrooms. (Yang, Oh, & Wang, 2020; Jaiswal & Arun, 2021; Gupta & Bhaskar, 2020; Zhang, 2021) These tools provide assistance to teachers in the delivery of lessons across a variety of topic areas and increase the effectiveness of instruction.
3. The provision of adaptive teaching strategies – systems driven by artificial intelligence make recommendations for personalised lessons and instructional approaches depending on the features and reactions of students. By analysing emotional and behavioural indicators using sensor data, these technologies assist educators in customised content and communication techniques, particularly for students with special needs (Aldeman et al., 2021; Lamos et al., 2021; Standen et al., 2018; Luo, 2020). This is especially helpful for students who have special needs.

AI in assessment focuses on two main roles:

1. **Predicting Student Performance** – AI helps forecast student outcomes in online learning by analyzing participation data, though challenges exist in using traditional socioeconomic variables for prediction (Akmese et al., 2021; Costa-Mendes et al., 2021; Yu, 2021).
2. **Automatic Marking** – AI grading systems, especially in language and math, offer faster and more accurate assessment than humans, providing instant feedback in online settings. However, their use is limited to a few subjects and is still in early stages of implementation (Sun, 2021; Fu et al., 2020; Kumar & Boulanger, 2020).

AI in Educational Administration

Artificial Intelligence (AI) plays a growing role in improving the administrative functions of educational institutions. Its use in this domain can be categorized into three key areas:

1. Improving the Efficacy of Management Platforms

Artificial intelligence technologies have been integrated into administrative management systems to improve operational efficiency. AI-powered solutions now streamline tasks such as scheduling courses, maintaining instructor and student records, and coordinating test logistics. These technologies automate routine processes, reduce manual work, and minimize errors. Additionally, security features like facial recognition for accessing portals and verifying examinations enhance system integrity and safeguard data (Khan & Alotaibi, 2020; Li, 2020; Liu & Wu, 2019). This transformation has resulted in more effective administrative procedures and increased reliability in managing institutional data.

2. Delivering Accessible and Customised Services

Artificial intelligence is harnessed to shape services to meet the varied needs of students and staff. Systems can recommend educational courses, tasks, or services tailored to one or a set of user profiles. The recommendations are based on the consideration of weights (age, gender, school achievement and use behavior). Gone are those days when you had to wait in the queue, which ultimately aided in improving

the employee productivity and made service delivery a lot faster. A major limitation is the accuracy of user modelling. The performance of the intelligent recommendations highly depended on the quality of user profile generation system, An error in the input data may weaken the effectiveness of the provided services (Li, 2021).

3. Facilitating Evidence-Based Educational Decision-Making

AI provides managers crucial analytical insights enabling them to plan their organisation and their students more efficiently. Leveraging big data, AI can detect patterns and predict results, such as academic trends, risks of student retention, and likelihood of course completion. This data helps education leaders to make data-driven decisions regarding curriculum planning, allocation of resources, and intervention strategies. Using AI tools, administrators can identify students who may be at risk of dropping out and implement timely support programs. However, challenges such as difficulties in choosing the appropriate data for accurate prediction continue to limit the full potential of AI in this field (Cukurova et al., 2019; Tsai et al., 2020).

Research Question Two: What are the challenges in integrating Artificial Intelligence for building sustainable creativity in education in the 21st century?

Artificial Intelligence (AI) promises to change education and sustainable creativity completely, but its effectiveness strongly depends on context and design. In order to ensure the ethical use of AI that is fair and equitable across all learners, it is critical to thoughtfully and intentionally integrate and partner with educators in the use of a new technology (as with any new technology). The potential of AI in educational settings implies the need to address various key issues:

1. Digital Divide may be widened. AI enablers such as power supply, internet connectivity, and digital equipment are substantially unavailable in many of the rural and poor urban institutions (Olaore, 2014). Without proactive efforts to close the gap, AI may even widen current education disparities, not narrow them.
2. The fear of job loss is real. Given the prevailing high unemployment and tight labour market, stakeholders might oppose the automation of administrative and teaching tasks via

AI since it is regarded as a threat to job creation by labour (Okoye & Bello, 2021). This concern highlights the need for AI policies that favour human-machine collaboration rather than substitution.

3. AI's inability to reckon with context of local socio-cultural factors that are intrinsic in Nigerian classrooms, is a The predisposed difficulties in AI another major challenges. While AI systems are known to handle large volumes of data, they are, however, deprived of the cultural sensitivity and emotional intelligence needed to effectively inculcate the learners, especially in the aspects of indigenous language instruction, civic education, and moral instruction which are interconnected with cultural elements and human relationship (Adedoyin, 2020).
4. Cybersecurity risks and lack of robust data protection mechanisms are serious concerns. It is indispensable for Nigeria to strengthen legal and technical mechanisms for averring invagination of educational data and unauthorised surveillance, misuse of educational data, particularly when it has hit the range of depending heavily on ICT for student management operations (Ayo & Folorunso, 2014).
5. In addition, the thoughtlessness of the teacher and the student might occur as whole certain processes are waking over by computerized [AI-ed] educational systems. The automation of grading, lesson planning and feedback could lead to both learners and teachers being recipients of information rather than active participants which in turn can result in less critical reflection and action (Zawacki-Richter et al., 2019).
6. There is also a possibility that the administrative AI that is now being used in schools will lead to staff cuts. There could be less demand for administrative support staff positions with the development of AI systems to take over scheduling, record-keeping, and communication (Wang & Cheng, 2021).
7. Although AI can replicate some of the functions of human cognition, it cannot understand context, intent and subtlety in a human way. Although it can handle data and create replies, it is not able to comprehend the emotion or the hidden intention behind educational content (Zawacki-Richter et al., 2019).

8. AI-based systems function only under the scope of programmed algorithms and settings. This makes them incapable of doing anything but what they've been programmed to do. They cannot autonomously cope with tasks or demands above their role definition, thereby limiting them in adapting to changing educational environments.
9. AI is designed mainly for monotonous and mundane tasks and good at parallel processing. However, it encounters problems when it is faced with tasks requiring creative problem solving and horizontal, integrative thought. For instance, an AI tool developed to evaluate a student might not be able to author new content or make sense while monitoring an incoming stream of answers.
10. AI systems are vulnerable to cyber-attacks since they are dependent on internet connectivity and also runs over digital systems. With the increased digitisation of storage of sensitive information of both students and institutions, there is an increased probability that unauthorised access, data compromise and malicious attacks will come from outside sources.
11. AI systems can go wrong, break, and decay over time, just as any human-made technology can. Data loss and disruption of essential educational operations can cause significant damage. To minimize the likelihood of this happening, strong backup algorithms and system redundancies must be in place.

It is believed that Nigeria could benefit immensely from AI if it adopts an ethical and human-centric approach, in spite of the challenges it is encountering. Sustainable implementation of AI will require AI education in teacher training programs, and investment in the ICT infrastructure and training of teachers. Furthermore, the Government has promulgated policies, like the National Digital Economy Policy and Strategy (NDEPS) 2020-2030, through which responsible AI advances in education could be driven.

Conclusion

By enabling personalised learning, encouraging innovation, and assisting with data-driven decision-making, artificial intelligence (AI) offers revolutionary prospects to improve sustainable creativity in education. It can transform educational practices in ways that are inclusive, flexible, and forward-looking through its integration into teaching, learning, assessment, and administration. But using AI effectively is not without its difficulties. It is imperative to critically address issues including technology constraints, data security threats, contextual ignorance, over-reliance on automation, and the possible replacement of human functions. Technological innovation alone cannot sustain creativity in education; pedagogical concepts, ethical considerations, and human monitoring are required. As a result, AI should be seen as a tool that supports human skill and creativity in the learning process rather than as a substitute for teachers and administrators.

Recommendations

The following recommendations were proposed:

1. Enhance Teacher Engagement and Professional Development

Educators should engage in the design, implementation, and assessment of AI systems. Professional development programs are essential for improving teachers' digital competence and confidence in the meaningful use of AI tools in their practice. Implement frameworks for ethical and inclusive artificial intelligence. Education stakeholders should develop explicit ethical guidelines to guarantee that the use of AI upholds student privacy, mitigates bias, and fosters equity. Policies must promote inclusivity and safeguard vulnerable populations from potential disadvantages arising from AI-driven decisions.

2. Enhance Infrastructure and Strengthen Data Security

Governments and institutions need to invest in robust technological infrastructure to facilitate the secure and sustainable integration of AI. Robust cybersecurity measures and data protection protocols are critical for the safeguarding of sensitive educational data. Promote collaboration across disciplines. Collaboration among educators, AI developers, researchers, and policymakers is essential for

the development of pedagogically sound and contextually appropriate AI applications. Partnerships can facilitate the alignment of AI tools with educational objectives and values.

3. Ensure Human Oversight and Creativity

Although AI can improve routine tasks, creative and critical thinking should continue to be a human-centered activity. Educational systems must prioritise the essential contributions of human judgement, empathy, and contextual understanding in the learning process. Continuously monitor and evaluate the impact of AI. Continuous research and evaluation are essential to evaluate the effectiveness, limitations, and unintended consequences of AI in educational contexts. Feedback loops must be implemented to modify AI tools based on empirical evidence and user experiences.

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