

E-LEARNING, ARTIFICIAL INTELLIGENCE AND STEAM PEDAGOGY: TRANSFORMING TEACHER EDUCATION FOR A SKILLED WORKFORCE IN NIGERIA.

Hassana Abubakar, Sobowale Favour, Fati Ali, Habiba Muhammad & Umar Nurudeen Kuta

Department of Educational Technology, Federal University of Technology Minna, Nigeria.

Email: hassanaabubakar2010@gmail.com **Phone No:** 08035997011

Abstract

E-learning, Artificial Intelligence (AI), and STEAM (Science, Technology, Engineering, Arts, and Mathematics) pedagogy is transforming the education structure of the 21st -century workforce. The paper is based on the literature review of the ways technology-enhanced learning platforms particularly, e-learning synchronous and asynchronous, transform teacher preparation in Nigeria Colleges of Education. It puts forward the role of Artificial Intelligence, which is combined with digital pedagogies, in promoting innovation and collaboration, critical thinking, and inclusiveness among pre-service teachers. Based on the current research, the paper will contend that successful implementation of technology in teacher training reinforces academic success and retention and engagement as well as bridging the gender and digital gap. It concludes that the introduction of AI tools, including adaptive learning systems, chatbots, and data-driven assessments, to STEAM education will result in digitally competent, competent, and innovative teaching workforce that is necessary in the national development. The article advises the strategic policy changes, the investment in the infrastructure, and the training of educators in AI literacy as a measure to maximize the transformative potential of E-learning and STEAM pedagogy in Nigeria.

Keywords: *E-learning, pedagogy, teacher education, artificial intelligence, workforce*

Introduction

E-learning and Artificial Intelligence have become part of educational innovation due to the global move towards digitalization and automation. The teaching education system in Nigeria is facing the pressure of adapting to international standards, which demand technological competency, innovation, and interdisciplinary problem solving. The STEAM model, which includes Science, Technology, Engineering, Arts and Mathematics, encourages project-based inquiry learning that is responsive to the 21st century labour market. Its full potential, however, will be achieved by the effectiveness with which technology and AI are used in teacher preparation programs.

E-learning, which is both a synchronous (real-time) and asynchronous (self-paced) model, offers the possibility of flexible and interactive learning. Tools like Google Meet, Zoom, and Google Classroom enable pre-service teachers to collaborate, think critically, and become digital literate which is essential in the current classroom. In conjunction with AI-based analytics and feedback loops, E-learning will be able to personalize learning, improve the experience of learning, and develop the necessary skills of the digital economy.

The Nigerian teacher education is at the edge of digital innovations and traditional pedagogies, especially in Colleges of Education. Although education in the country has been encouraged to use ICT, infrastructural issues, inequality in digital access, and lack of awareness about AI have slowed down the process. However, with AI still reshaping industries, teacher education should

change to create educators that can educate students who will be able to survive in the technology-driven world.

Review of Related Literature

E-Learning and Digital Transformation in Teacher Education

E-learning is a paradigm shift of traditional teaching to technology mediated education. It makes use of digital platforms, multimedia, and online learning management systems to accomplish communication, content delivery, and assessment (Adedoyin and Soykan, 2020). Research in the Nigerian Colleges of Education emphasizes that a synchronous and asynchronous approach enhance flexibility, inclusiveness, and access to learning materials (Adegbija and Olaore, 2021). Immediacy, social presence, and collaboration are essential elements of pre-service teachers and are promoted by synchronous learning, through real-time systems, like Google Meet. On the other hand, reflection, autonomy, and critical thinking is improved in asynchronous learning, like in Google Classroom or in recorded lectures.

The digital environments are instrumental in the application of STEAM pedagogy, with its emphasis on creativity, experimentation, as well as interdisciplinary connections. Using E-learning, pre-service teachers are involved in project-based assignments, simulations, and problem-solving activities, which are reflections of problems in the real world. Nevertheless, the challenges of poor internet connectivity, electricity, and lack of digital literacy are still major challenges to the realization of these benefits in Nigeria (Nchunge, 2022).

Artificial Intelligence in Education

Artificial Intelligence has become a game changer in education as it allows adaptive learning, automatic assessment, and personalized feedback (Holmes et al., 2021). Learning behaviors are analyzed with the help of AI technologies that change the content according to the needs of students, thus enhancing efficiency and engagement. In the case of pre-service teachers, AI-based systems, including intelligent tutoring systems and learning analytics dashboards provide details about the progress of the students and can be used in evidence-based choices in teaching.

The AI is used in STEAM environments to support virtual laboratories, simulated AR, and data visualization tools, which contribute to the development of concepts and creativity. AI also helps to make the administrative work of Colleges of Education efficient through the automation of grading, attendance, and resource allocation. However, the ethical considerations, privacy concerns, and the tendency to overtrust technology prompts the need to regulate the policy carefully and prepare teachers (UNESCO, 2023).

The addition of AI to teacher education in Nigeria would need specific capacity generation. Teachers need to know how to structure AI-supported lessons, to analyze the results of information and to model ethical applications of AI. With appropriate encouragement, AI will not only increase academic performance but also promote creativity, interest and critical digital literacy- major qualities of a competent workforce.

STEAM Pedagogy and Workforce Readiness

STEAM education underlines interdisciplinary education to integrate scientific reasoning with creativity and innovation (Yakman and Lee, 2020). It prepares learners to solve problems and work

in teams, and think through design, which are critical in the fast-paced economy. In the case of Nigeria, where education system needs to address the challenge of technological disruption and employment of youth, it is tactical to incorporate STEAM principles into teacher training.

Effective implementation of STEAM needs flexibility and interactivity which are obtained through e-learning platforms. Concretely, synchronous platforms can enable real-time brainstorming and experimentation, whereas the research, reflection, and development of portfolios can be supported using asynchronous systems. Combined with learning analytics supported by AI, STEAM pedagogy becomes a dynamic one that promotes life-long and individual learning.

Teacher educators are instrumental as agents of inquiry-based projects, agents of innovation, and agents of technological literacy. The exposure of pre-service teachers to STEAM-related settings that are AI-enabled will help Colleges of Education produce teachers, who, in turn, will produce creative and talented students that will be able to address the requirements of the knowledge economy in Nigeria.

E-Learning, AI, and Learning Outcomes

The empirical data also indicates that the technology-enhanced learning positively influences academic performance, retention, and engagement (Hung et al., 2024). Synchronous learning facilitates collaborative learning and engagement, resulting in enhanced short-term learning, whereas asynchronous models facilitate long-term learning and self-regulated learning (Rapanta et al., 2020). These advantages can be enhanced by integrating AI, which can provide predictive analytics, smart feedback, adaptive pathways, and other processes that would suit the needs of different learners.

The factor of gender is still relevant. The study conducted in Nigeria shows that male students tend to be more confident about the ability to work with technology, and female students are more persistent in self-paced conditions (Ozudogru, 2021). Interventions based on AI can be used to minimize these gaps by providing individuals-specific support, content, and equal opportunity to participate.

Together, E-learning and AI technology improve engagement, self-efficacy, and problem-solving skills, which are the main competencies of STEAM learning. They give rise to a future-oriented, digitally literate and flexible teaching workforce.

Conclusion

The combination of E-learning, Artificial Intelligence, and the STEAM pedagogy is the key to the transformative teacher education in Nigeria. They open chances of producing critical, creative and technically able teachers capable of imparting in the Fourth Industrial Revolution era. A combination of AIs and AI-controlled tools with synchronous and asynchronous learning improves academic achievement, interaction, and professional preparation. These innovations however can increase inequalities instead of reducing them without proper infrastructure, capacity building and inclusive policies in digital space. Education institutions should hence consider total transformation in teacher education implementation where curriculum, pedagogy, and use of technology are integrated to generate qualified and progressive workforce in Nigeria.

Implications for Teacher Education and Workforce Development

Curriculum Redesign: Teacher training programs should include AI literacy, data ethics, and digital pedagogies in the curriculum in order to match the global STEAM standards.

Professional Development: Educate the lecturers and pre-service teachers to apply AI-based platforms in assessment, feedback, and classroom innovation.

Infrastructure Investment: Governments and institutions must increase access to broadband, offer low-cost gadgets, and reliable power supply to facilitate the implementation of E-learning.

Gender Inclusivity: Support equal engagement with digital resources and mentorship opportunities being gender sensitive.

Research and Policy: Support active research in AI and integration of STEAM in teacher education to promote evidence-based workforce development policies.

References

- Adebayo, T., & Akinola, B. (2020). Gender inequality and digital divide in Nigerian higher education: Implications for inclusive development. *Journal of Gender and Education Studies*, 12(3), 45–58.
- Adegbija, M. V., & Olaore, I. B. (2021). ICT integration and digital competence among pre-service teachers in Nigerian colleges of education. *African Journal of Teacher Education*, 10(2), 95–110.
- Adarkwah, M. A. (2021). “I’m not against online teaching, but what about us?”: ICT in Ghana post COVID-19. *Education and Information Technologies*, 26(2), 1665–1685. <https://doi.org/10.1007/s10639-020-10331-z>
- Adedoyin, O. B., & Soykan, E. (2020). COVID-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 28(6), 1–13. <https://doi.org/10.1080/10494820.2020.1813180>
- Holmes, W., Bialik, M., & Fadel, C. (2021). *Artificial intelligence in education: Promises and implications for teaching and learning* (2nd ed.). Center for Curriculum Redesign.
- Hung, M., Yang, S., & Liu, M. (2024). Synchronous vs. asynchronous e-learning: Impacts on achievement, engagement, and satisfaction in higher education. *Computers & Education*, 212, 104813.
- Iftakhar, S. (2020). Google Classroom: What works and how? *Journal of Education and Social Sciences*, 7(2), 12–18.
- Ozudogru, F. (2021). Gender and digital learning participation: Evidence from pre-service teacher education. *Education and Information Technologies*, 26(5), 5539–5558.

- Pan, S. C., & Rickard, T. C. (2018). Transfer of test-enhanced learning: Meta-analytic review and synthesis. *Psychological Bulletin*, 144(7), 710–756.
- Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the COVID-19 crisis: Refocusing teacher presence and learning activity. *Postdigital Science and Education*, 2(3), 923–945.
- UNESCO. (2023). *Artificial intelligence and education: Guidance for policy-makers*. Paris: UNESCO Publishing.
- Yakman, G., & Lee, H. (2020). Exploring STEAM education in the 21st century. *Journal of Science Education and Technology*, 29(1), 1–13.