
ACHIEVING SUSTAINABLE DEVELOPMENT OF TERTIARY INSTITUTIONS IN NIGERIA THROUGH ARTIFICIAL INTELLIGENCE

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ABSTRACT

Artificial intelligence (AI) has emerged as a transformative force in the education sector; offering unprecedented opportunities driven towards enhancing learning outcomes, improving operational efficiency, and fostering innovation. The motivation for the study emanated due to lingering issues and educational concerns bordering on inadequate infrastructure, overcrowded classrooms, and limited access to modern teaching resources. These challenges have therefore hindered the quality of education in tertiary institutions in Nigeria. To address these abnormalities in the education system, the introduction of AI technologies such as personalized learning, automated grading and virtual tutoring offers solutions to these mitigating challenges by personalizing learning, enhancing access to quality education and achieving sustainable development of Nigerian tertiary institutions. Therefore, this research work aimed to investigate how sustainable development of tertiary institutions in Nigeria could be achieved through artificial intelligence. Specifically, the study aimed to examine how personalized learning, automated grading and virtual tutoring will enhance sustainable development of selected Polytechnics in south-east of Nigeria. Accordingly, the study adopted a descriptive research design using a survey method to source the needed data from the respondents. The target population of the study consists of staff from selected tertiary institutions in South East, Nigeria. Partial least square structural equation modelling (PLS-SEM) was used to test the formulated hypotheses of the study at 5% level of significance. The findings of the study revealed that personalized learning, automated grading and virtual tutoring significantly and positively led to and enhance sustainable development of tertiary institutions in Nigeria. The researchers recommended that tertiary institutions should invest heavily in robust and scalable ICT infrastructure so as to support the deployment of AI technologies for effective implementation of personalized learning in tertiary institutions in Nigeria. It was also recommended that Lecturers should be trained on AI grading tools such as Gradescope, Turnitin feedback studio in order to maintain academic integrity. Tertiary institutions in Nigeria especially Polytechnics should collaborate with software developers so as to customize virtual tutoring systems that align with Nigerian curricula in order to assist students beyond classroom hours thereby reducing academic workload on Lecturers for improved students' satisfaction and sustainable performance.

Keywords: Artificial intelligence, Sustainable development, Personalized learning, Tertiary institutions, Nigeria.

1. INTRODUCTION

Tertiary education is the foundation stone of any economy to develop because of its ability to equip individuals with the advanced skills and knowledge necessary to drive economic progress, foster innovation, and address societal challenges (Egbeji, 2024). The role of tertiary institutions in shaping a nation's future cannot be overemphasized. They are the crucibles where knowledge, innovation, and leadership are shaped (Ogunode & Gregory, 2023). In Nigeria, however, tertiary institutions face several challenges ranging from inadequate funding and infrastructure to issues of inclusivity and global competitiveness. Amidst these challenges, artificial intelligence (AI) emerges as a transformative force, offering innovative solutions to achieve sustainable development in the education sector (Alagbe, Awodele & Ayorinde, 2021). In recent years, artificial intelligence (AI) has emerged as a transformative force across various sectors, including healthcare, agriculture, and finance. Its application in education offers unprecedented opportunities to address systemic challenges and unlock new potential. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) highlights the importance of leveraging AI to achieve inclusive and equitable quality education; a key goal under the United Nations Sustainable Development Goals (SDG 4) (UNESCO, 2020). For Nigeria, adopting AI-driven solutions in tertiary institutions could pave the way for sustainable development by enhancing learning outcomes, improving operational efficiency, and fostering innovation. By integrating AI technologies, Nigerian tertiary institutions can not only overcome existing barriers but also position themselves as hubs of knowledge and innovation in the global arena (Bordia, 2023).

Pertinently, Artificial Intelligence refers to the development of computer systems and machines capable of performing tasks that typically require human intelligence (Ajakpo Anetoh, Anetoh, Chiekezie, Attah & Uzundu, 2025; AFSA, 2022; Ogunode & Gregory, 2023). These tasks include learning, reasoning, problem-solving, perception and natural language understanding. Artificial Intelligence technologies encompass various techniques and approaches, such as machine learning, deep learning, natural language processing, computer vision and robotics (Orjinta & Anetoh, 2025). These technologies enable computers to analyze vast amounts of data, recognize patterns, make predictions and automate complex processes. Artificial Intelligence has applications across numerous fields, including health care, finance, transportation, customer service and education. The use of personalized learning, automated grading, predictive analytics, virtual tutoring and smart infrastructure have gained prevalence in many tertiary institutions in Nigeria fostering sustainable education in the education sector (Akinyemi, 2023). It has the potential to transform the education sector by improving efficiency and promoting eco-friendly practices (AFSA 2022).

Sustainable development in education involves creating systems that are equitable, inclusive, efficient, and adaptable. For Nigerian tertiary institutions, this means delivering quality education while addressing societal needs and remaining resilient in the face of evolving challenges. Artificial intelligence, with its vast array of capabilities, can play a pivotal role in the transformation of the education sector in Nigeria by addressing several systemic challenges while promoting long-term growth and sustainability (Bello & Adebayo, 2023). Tertiary institutions are critical to a nation's socio-economic and technological advancement. They serve as hubs for knowledge creation, skill development, and innovation, directly contributing to the workforce and societal progress (Anyanwu, Okoroafor & Ikedimma, 2022). In Nigeria, tertiary education plays an especially vital role, given the country's large and youthful population, which requires quality education to unlock its potential. However, the current state of some tertiary institutions in Nigeria is worrisome because some of them are characterized with numerous structural and systemic issues that hinder their sustainability

and global competitiveness (Musa, Jamila & Murtala, 2021). One of the most pressing challenges is the persistent underfunding of tertiary institutions. According to a report by the National Bureau of Statistics (NBS), government allocations to education have consistently fallen below the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) recommended threshold of 15-20% of national budgets (NBS, 2022). This financial shortfall has led to inadequate infrastructure, overcrowded classrooms, and limited access to modern teaching resources, all of which compromise the quality of education delivered. Additionally, the inefficiencies in administrative processes have become significant barriers to effective governance in Nigerian institutions. Manual and outdated systems for student admissions, staff management, and resource allocation leading to delays, inaccuracies, and mismanagement. Such inefficiencies are worsened by a lack of reliable data for informed decision-making, further restricting the institutions' ability to plan strategically and respond to emerging challenges (Olalekan & Adebayo, 2023). Another critical issue is the misalignment between curricula and the demands of a rapidly evolving labor market. With the global economy increasingly driven by technology and digital innovation, Nigerian graduates face challenges in securing employment due to a lack of relevant skills. These skills gap not only hampers individual opportunities but also limits the country's ability to compete in the global economy (World Bank, 2021).

Succinctly, it is worthy to state that the above challenges highlight the urgent need for innovative solutions to achieve sustainable development in Nigerian tertiary institutions. Artificial intelligence (AI) has emerged as a powerful tool capable of addressing these systemic issues. By leveraging AI, institutions can automate administrative tasks, provide personalized learning experiences, and generate data-driven insights for strategic planning. However, adopting AI in the Nigerian context requires overcoming significant hurdles, including infrastructure deficits, skill gaps, and ethical considerations related to data privacy and fairness. Pertinently, academic researchers have revived their interest in Artificial intelligence over the past years in both developed and developing economies and have found mixed results. Thus few studies done on the subject matter focused on curriculum development in tertiary institutions. To close the research gaps; this study sought to investigate empirically on the effect of artificial intelligence on sustainable development of selected government-owned polytechnics in South East of Nigeria.

Research Objectives

The study seeks to achieve the under listed specific objectives which are to;

1. Investigate the effect of personalized learning on sustainable development of selected Polytechnics in South East of Nigeria.
2. Assess the effect of automated grading on sustainable development of selected Polytechnics in South East, Nigeria.
3. Examine the effect of virtual tutoring on sustainable development of selected Polytechnics in South East, Nigeria.

Research Questions

1. What is the nature of effect personalized learning on sustainable development of selected Polytechnics in South East of Nigeria?
2. To what extent has automated grading system enhanced sustainable development of selected Polytechnics in South East, Nigeria?
3. How far does virtual tutoring increase the sustainable development of selected Polytechnics in South East, Nigeria?

Hypotheses Postulation

H01: Personalized learning has no significant effect on education sustainable development of selected Polytechnics in South East, Nigeria.

H02: Automated grading has no significant effect on education sustainable development of selected Polytechnics in South East, Nigeria

H03: Virtual tutoring has no significant effect on education sustainable development of selected Polytechnics in South East, Nigeria.

2. RELATED LITERATURE

Artificial Intelligence

Artificial intelligence is an advanced technology that enables machines and computers to stimulate human learning, creativity, autonomy, comprehension, decision-making and problem solving (Ndungu & Sije, 2023) It is any artificial system that performs tasks under varying circumstances without human oversight. Artificial intelligence is a new age technological advancement which is tailored towards improving learning experiences, providing personalized content, adaptive assessment and intelligent tutoring systems. Hence, AI powered chatbots and virtual assistants can be of great benefit to students in institutions of higher learning by providing support for students in answering queries, guiding course selection and providing academic assistance. Artificial intelligence can also contribute to sustainability of tertiary institution in Nigeria by helping lecturers through automated grading, providing feedback and reduction of workload thereby allowing them to focus more on research and mentorship. Apparently, artificial intelligence has been used as a powerful tool in plagiarism detection by institutions of higher learning which has helped to maintain academic integrity and improve the quality of research output. Significantly, one of the most significant transformation in the academic sector in this present dispensation is the use of artificial intelligence (Anetoh, Anetoh Ajakpo, Onuorah, Okoro & Obiezekwem, 2025).

Artificial intelligence has also helped in infrastructural development in institutions of higher learning through smart campus solution which is the use of AI- powered IoT devices to optimize energy consumption, manage water resources and ensure security on campuses (Kemboi, 2018). The use of technology has overtime helped in fraud detection by detecting anomalies in financial transactions, preventing embezzlement and corruption thereby helping higher institutions to be sustained. Furthermore, both staff and students need to acquire new skills in order to collaborate productively with these sophisticated systems, the adoption of AI technologies often required huge or large as well as serious investments in training and upskilling the workforce (Prabu, Venkata, Pranjali & Poornima, 2024). The emergence of artificial intelligence into the education sector processes is seen to be disruptive. Tertiary institutions in Nigeria should leverage artificial intelligence tools to foster quality of education, drive institutional efficiency and foster long term sustainability in the Nigerian higher education sector. Hence, artificial intelligence is expected to have a significant impact on sustainable development of tertiary institutions in Nigeria.

Artificial Intelligence and Tertiary Education System

Artificial Intelligence has the potential to revolutionize education, transforming it from a system focused on memorizing facts into one that helps students unlock their full potential and learn necessary skills through more personalized learning. AI in education is applied to improve learning outcomes and supports teachers in developing better educational practices. From automatic assignment grading to tailored curriculums, there are many ways AI consultants can help educational institutions make use of the technology. AI-based platforms can collect and analyze student data on interaction with educational materials, exercise

completion time, test results, and overall performance to understand each student's attitudes and needs. Drawing on this data, AI tools can design personalized training pathways and adapt them in real-time to the learner's progress. AI can also predict student performance and identify students who may be at risk of falling behind. AI can automate mundane teacher tasks, such as grading assignments, freeing up time for teachers to focus on more important tasks. AI can also help teachers identify areas where students need extra help and provide them with the necessary resources. AI can also help students with special needs by providing them with personalized learning experiences. AI can also help educational institutions with resource planning, curriculum design, and ongoing assistance during learning (Anetoh, Anetoh Ajakpo, Onuorah, Okoro & Obiezekwem, 2025; Onyebuchi, 2023).

Personalized Learning and Sustainable Development

Personalized learning is an educational approach that tailors teaching methods, content delivery, and learning pace to meet the unique needs, abilities, and interests of individual students. By placing the learner at the center of the educational experience, this approach fosters deeper engagement, better retention, and enhanced outcomes (Akinyemi, 2023). In the context of Nigerian tertiary institutions, personalized learning offers transformative opportunities to address systemic challenges while fostering sustainable development. The increasing use of e-learning in personalized learning environments in higher education indicates a significant shift from traditional classroom models (Kibelloh, 2021). In contrast to conventional settings, virtual environments prioritize individual learners, providing personalized techniques designed to meet their specific educational needs (Reisoglu, 2017). However, learners encounter a notable obstacle when they navigate these systems independently, which may substantially impact their attitudes and actions toward learning (Fair et.al, 2017). Web-based learning offers an appealing proposition by overcoming temporal and spatial constraints, allowing students to interact with instructional content regardless of physical limits or time constraints (Sirisakpanich, 2022).

This intrinsic flexibility highlights the growing popularity of web-based systems, which put learners in complete control of their academic paths (Chen, 2009). While this transformative growth continues, a significant worry emerges about identifying critical skills for learners' development in these dynamic situations (Miranda, 2022). Recent advances in educational technology highlight the effectiveness of personalized learning systems, which use AI to tailor educational experiences to specific students (Murtaza, 2022). Some countries have actually adopted personalized learning in their institutions such as Rwanda which have adopted the use of "smart classrooms" provides a model of how personalized learning can drive sustainable education. By introducing digital learning tools in rural schools, Rwanda has improved access to quality education and reduced inequalities. Nigerian tertiary institutions can draw lessons from this initiative, adapting the approach to their unique challenges and opportunities. By embracing personalized learning, Nigeria's tertiary institutions can transform their educational landscape, equipping students with the skills and knowledge needed to thrive in a dynamic global economy (Raiton, Lena, Shubi. & Mussa, 2024). This approach not only addresses immediate challenges but also ensures long-term sustainability, equity and excellence (Ajakpo Anetoh, Anetoh, Okafor, Anyadufu & Chiekezie, 2025).

Automated Grading and Sustainable Development

Automated grading, also referred to as automated assessment, utilizes technology to evaluate and score assignments, tests, and other student work. It is a transformative approach in the

field of education, offering several advantages, challenges, and applications. Its features include:

Natural Language Processing (NLP): It is AI driven tool that stands at the intersection of AI and linguistic communication that focuses on emulating human natural language patterns. This technology facilitates interaction with intelligent systems using natural languages, both written and spoken. Kolodny (2017) emphasizes the integration of NLP into various applications, such as talking calculators, enabling oral dictation of numbers and signs. NLP broadens access to information for individuals with visual impairments, hearing difficulties, and motor challenges, fostering independent conversations. Common services like Google Translate and chatbots exemplify the practical applications of NLP, providing multilingual access to information. The incorporation of Natural Language Processing into educational contexts offers avenues for enhanced language learning, spelling and grammatical corrections, and multilingual support. AI-driven writing assistants based on NLP and Machine Learning present opportunities to augment the writing process, providing corrective feedback and recommendations for improvement. This technology is used to analyze text-based responses, such as essays and short answers.

Machine Learning (ML): It encompasses the design, training, and deployment of models to applications, processes, and other machines. Chen (2019) delineates ML's core components, including algorithms, Application Programming Interfaces (APIs), development and training toolkits, data, and computing power. Goksel and Bozkurt (2019) emphasize ML's dynamic application, utilizing existing data for predictive analysis. In education, ML plays a pivotal role in optimizing course material selection through content providers, employing feedback and scoring systems for assignment grading, plagiarism detection, and student progress assessment. Integration with Natural Language Processing enhances applications like text-to-speech and language translation, exemplified by Google Translate. ML transforms information retrieval by automating suggestions and recommendations based on geographic location, search history, and user preferences, providing students and lecturers' access to a wealth of internet knowledge. The integration of Machine Learning into educational practices not only streamlines administrative tasks but also enhances the learning experience, offering personalized content recommendations and revolutionizing information retrieval for academic purposes. Algorithms are trained using large datasets of graded examples to recognize patterns and generate consistent scores.

Optical Character Recognition (OCR) and Facial Recognition (FR): this type of AI driven tool digitize handwritten content and streamline administrative processes like attendance tracking and exam monitoring (Richter et al., 2019). The utilization of Automated Facial Recognition, coupled with machine vision, not only streamlines administrative tasks but also contributes to a more efficient use of instructional time, fostering an environment conducive to focused and productive learning. The assessment of students, a responsibility often shouldered by lecturers, sees advancements through AI, particularly in the administration of online tests. AI automates the assessment and grading process, saving time and ensuring objective evaluation (Oztok & Zingaro, 2019). Large datasets of student information, including assessment scores and behavioral patterns, can be analyzed by AI to identify areas where students may be struggling, enabling targeted interventions (Singh & Singh, 2021). Additionally, the marking of students' scripts is streamlined through AI-powered grading software, combining machine learning to replicate the human grading process efficiently (Smith, 2021). These tools integrate seamlessly into virtual environments or cloud-based platforms, offering swift and accurate grading, particularly beneficial when

handling a substantial number of papers. Inadvertently, the use of automated grading system in higher institutions of learning in Nigeria will minimize the need for physical paper by supporting digital submissions, reducing waste and promoting eco-friendly practices. It will also encourage a paperless system, which will further enhance sustainability of tertiary institutions in Nigeria.

Virtual tutoring and Sustainable Development

Virtual learning is closely linked with e-learning which extends education beyond the boundaries of the traditional classroom. It involves the use of internet technologies, satellite communication and digital platforms to access, analyze and exchange information. According to Olibie (2014), it is learning which is not limited within the walls of a classroom, but rather expands the possibility of using internet facilities, platforms, satellite links, and related systems to access, analyze, create, exchange, and use data, information, and knowledge in ways which until recently, were almost unimaginable. Chukwunonso (2013) affirmed that the adoption of Internet and web-based technologies in education delivery has led to overthrow of more traditional methods of teaching and learning from a simple and casual application of ICT to facilitate face-to-face classroom teaching and learning to the intensive use of ICT for educational purpose as in the case of virtual or online learning. Olibie (2014) posited that virtual technologies have brought insightful modifications to all aspect of life equipping students with the essential skills and knowledge to foster growth and development of independent, creative and lifelong learners, schools should use virtual learning to provide relevant experiences to support the students' intellectual development. Virtual Learning Environment (VLEs) also called e-Learning Management Systems (e-LMSs) support both synchronous and a synchronous instructions. These platforms allow institutions to design online courses, deliver content, and facilitate interaction through features like forums and live chats (Omoregbe, 2017). Virtual learning adds multiple technologies via emails, downloadable content, mobile apps and social media to deliver flexible learning experiences. Mobile learning which is the ability to obtain or provide educational content on personal pocket devices such as PDAs, smart phones and mobile phones, is also a form of virtual learning (Olibie, 2014). Examples of VLEs include Moodle, Blackboard, WebCT, Canvas, Sakai and many more. Moodle (acronym for modular object-oriented dynamic learning environment) is a well-known Course Management System (CMS) which has become very popular among educators around the world because of its easiness and economy (Kulshrestha & Kant, 2013). Effective VLEs support curriculum planning, content management, assessments, communication and performance reporting. These systems simplify administration, foster student engagement and support the long term goals towards the institutional sustainability of tertiary institutions in Nigeria (Sharma & Vatta, 2013).

THEORETICAL UNDERPININGS

This study is anchored on The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003)

The Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. in 2003 is a robust framework for analyzing technology adoption and use. It has been widely used and applied in studies to understand the factors influencing the acceptance of new technologies. In the context of achieving sustainable development of tertiary institutions through artificial intelligence (AI), UTAUT provides a comprehensive lens to explore the determinants of AI adoption and its integration into institutions practices. The Unified Theory of Acceptance and Use of Technology integrates the concept of improving performance expectancy in higher institutions by enhancing educational outcome through the use of AI driven tools which helps in streamlining administrative processes,

improving teaching methodologies, and optimizing research outputs. Sustainable development within tertiary institutions involves creating resilient, efficient, and innovative systems that can adapt to societal and technological changes. AI offers transformative solutions such as personalized learning, predictive analytics for institutional planning, and eco-friendly campus management through smart technologies. In conclusion, UTAUT provides a valuable framework for understanding and promoting the adoption of AI technologies in Nigeria's tertiary institutions. By aligning the constructs of UTAUT with the goals of sustainable development, this study can offer insightful pathways to revolutionize higher education and contribute to Nigeria's broader development agenda.

REVIEW OF RELATED EMPIRICAL STUDIES

Raiton, Lena, Shubi & Mussa (2024) conducted a study on personalized learning in higher learning institutions in Tanzania. The study employed a mixed-methods approach to investigate universities' preparedness for implementing e-learning and evaluate the impact of e-learning platforms and Artificial Intelligence (AI) in facilitating personalized learning experiences. The findings emphasize the significance of tackling identified obstacles to enhance education quality and provide a basis for customized learning. The study suggests that institutions should allocate resources towards developing e-learning infrastructure, offer extensive training for instructors, and create customized e-learning methods. Sunday (2024) assessed the impact of artificial intelligence in promoting the sustainability of technical education in Nigeria. The quantitative research design that employs the descriptive study was used for the study. The sample for the study consisted of the entire population of 30 respondents. The instrument contains 20 items on the impact of artificial intelligence on technical education. The mean acceptance was set at 2.50 minimum for acceptability. The findings revealed that the adoption of artificial intelligence would positively influence the growth of technical education and the marketability of its graduates in the labor market. The study recommended the remodeling of the curriculum of technical education to suit the reality of artificial intelligence.

Egbeji (2024) investigated on the application of artificial intelligence and attainment of tertiary education goals: towards effective management of tertiary education in Cross River state, Nigeria. The ex-post facto research design was adopted during the study. The population of the study comprised academic, non-academic staff and students of tertiary institutions in Cross River State. The population stood at 12543, out of which University of Calabar had 5323, University of Cross River State had 3221, Federal College of Education Obudu, Cross River State had 2107 and College of Education, Akamkpa, Cross River State had 1892 respectively. Taro Yamane statistics was used to determine the sample size which stood at 388 respondents. Proportional and purposive sampling techniques were deployed in the selection of the sample representatives. The instrument for data collection was the questionnaire. The questionnaire was titled Artificial Intelligence and Tertiary Education Goal Attainment Questionnaire. Cronbach Alpha reliability was used to determine the degree of consistency of the instrument. The reliability coefficient obtained ranged from .80-.89 respectively. Three research questions were raised and three research hypotheses were formulated and tested using linear regression analysis. Results show that the use of AI in teaching, administration and research significantly influenced the attainment of tertiary education goals. Based on these findings, it was concluded that tertiary educational institutions in Nigeria could compete with other Nations of the World through making concerted effort in the provision of infrastructures that are favorable to the expansion of Artificial Intelligence practices in schools. It was recommended among other things that respective stakeholders should empower tertiary institutions to fund the installation of AI

technology infrastructures so as to enhance teaching and other activities that contribute to the attainment of tertiary education goals.

Eze (2024) assessed the impact of artificial intelligence on curriculum implementation in tertiary institutions in Nigeria. The paper used secondary data. The secondary data were collected from government documents, print resources and online publication. Inclusion and exclusion criteria were used to narrow the literature to the theme of the study. The paper concluded that artificial intelligence positively impacted curriculum implementation in tertiary institutions in Nigeria. Artificial intelligence aided effective teaching and research programme implementation in the tertiary institutions. Based on these findings, the paper recommends that government should increase funding of tertiary education in Nigeria. The budgetary allocation by the government should be increase in the tertiary institutions to enable the managers of the institutions to acquire more artificial intelligence facilities in their restive institutions. In a study by Ejeh and Igbokwe (2025) on Artificial intelligence and the future of Nigerian university students. The study explored how intelligence tutoring systems and smart classrooms enabled by AI, provides 24/7 personalized student support in Nigerian universities. It covers virtual assistants, Augmented Reality/Virtual Reality classrooms, real – time performance dashboards and global resource access. The findings from the study revealed that AI tools and infrastructure provides strategic vision which enhances quality education in tertiary institutions in Nigeria. The study concluded that intelligence virtual tutoring, smart infrastructure can help to harness the full potentials of university students by improving learning skills and increasing their employability in order to meet up with the 21st century world.

3. METHODOLOGY

This work adopted a descriptive research design using a survey method. The population of the study comprised the staff of the selected Polytechnics under review in South East of Nigeria namely; Federal Polytechnic Oko, Anambra State; Federal Polytechnic Nekede, Imo State; Abia State Polytechnic Aba, Abia State; Institute of Management and Technology (IMT) Enugu, Enugu State and Akanu Ibiam Federal Polytechnic Unwana, Ebonyi State. The population size was 1050 while the sample size is 290 determined using a Taro Yamane formula. The study adopted a simple random sampling technique. Primary source of data was used and sourced from the respondents. The questionnaire was used as the instrument for data collection. Likert scale was adopted and modified to suit the context of the present study. The validity and reliability of the research instrument was done. The reliability value = 0.7032 established the internal consistency of the measuring instrument. The researcher employed three field research assistants for the field survey. The formulated hypotheses were tested using multiple regression analysis at 5% level of significance. In addition, out of 290 copies distributed; only 235 valid copies were used in the analysis. The model for this study was specified as follows: $SD = a + \beta_1 PEL + \beta_2 AUG + \beta_3 VIT + e$ Where; SD = Sustainable Development, a = constant, β_1 - β_3 = coefficient of the parameters; e = error term. PEL = personalized learning, AUG = Automated grading, VIT = Virtual tutoring. Furthermore, the decision rule is to accept H_0 and reject the H_A if the p-value is greater than 0.05. Or to reject the null hypothesis and accept the alternative hypothesis if the p-value is less than or equal to 0.05; the stipulated level of significance for this study.

4. RESULTS

The analysis was based on 235 valid copies of the instrument. Partial least square structural equation modeling statistical technique was used to test the significance of the model using bootstrapping procedure. The coefficient of determination (R^2) is 0.754 (75.4%) which is

clearly above the threshold as given by (Hair, Hult, Ringle, & Sarstedt, 2017). For the test of hypotheses, the significance as well as the extent of effect were estimated based on the values of the statistical t-values and the p-values as well as the path coefficients of the structural equation model.

Table 1: The PLS Results

Hypotheses	Hypotheses paths	Coefficients	T-values	P-values	Remarks
H1	PEL -> SD	0.956	10.640	0.000	Significant and positive effect
H2	AUG -> SD	0.724	7.612	0.002	Significant and positive effect
H3	VIT -> SD	0.521	5.565	0.004	Significant and positive effect

Note: Path coefficient is significant at 5% level of significance; t-value ≥ 1.96 , or p-value ≤ 0.05 .

PEL =Personalized Learning; AUG =Automated Grading;

VIT= Virtual Tutoring; SD = Sustainable Development.

Source: PLS-SEM Output, 2025.

A careful examination of the results on table 1, shows that personalized learning has a significant and positive effect on sustainable development ($\beta = 0.956$, $t = 10.640$ and $p = 0.000 < 0.05$). Therefore, the null hypothesis one (HO1) is rejected and alternative hypothesis one (HA1) is accepted which states that personalized learning has a significant and positive effect on sustainable development of selected Polytechnics in south-east of Nigeria. Table 1, also shows that automated grading has a significant and positive effect on sustainable development ($\beta = 0.724$, $t = 7.612$ and $p = 0.002 < 0.05$). Therefore, the null hypothesis two (HO2) is rejected and alternative hypothesis two (HA2) is accepted which states that automated grading has a significant and positive effect on sustainable development of selected polytechnics in south-east of Nigeria. A careful examination of the results on table 1, shows that virtual tutoring has a significant and positive effect on sustainable development ($\beta = 0.521$, $t = 5.565$ and $p = 0.004 < 0.05$). Therefore, the null hypothesis three (HO3) is rejected and alternative hypothesis three (HA3) is accepted which states that virtual tutoring has a significant and positive effect on sustainable development in selected Polytechnics in south-east of Nigeria. The results confirm that personalized learning, automated grading and intelligent virtual tutoring significantly fosters sustainable development of selected Polytechnics in South East, Nigeria

5. CONCLUSION AND RECOMMENDATIONS

The study revealed that personalized learning, automated grading and intelligence virtual tutoring significantly and positively enhance the sustainable development of selected Polytechnics in South East, Nigeria. The study recommended that tertiary institutions should invest heavily in robust and scalable ICT infrastructure to support the deployment of AI technologies for effective implementation of personalized learning in tertiary institutions in Nigeria. Based on the findings, the researchers recommended that Lecturers should engage more and have more training on leveraging on AI grading technologies such as Gradescope, Turnitin feedback studio in order to maintain and enhance more academic performance and integrity. The study therefore concludes that Tertiary institutions especially Polytechnics in south eastern part of Nigeria should collaborate with software developers to customize virtual tutoring systems that aligns with Nigerian curricula in order to assist students beyond

classroom hours thereby reducing academic workload on lecturers for improved student satisfaction. Conclusively, the effective integration of these AI components will not only improve institution teaching efficiency but also promote accountability, competitiveness, resilience, more inclusiveness and sustainable institutional development.

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