

ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON ACADEMIC ENGAGEMENT AND LEARNING OUTCOMES IN ABUJA'S SELECTED INTERNATIONAL PRIVATE SECONDARY SCHOOLS

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Abstract: The integration of Artificial Intelligence (AI) education has transformed instructional methods, particularly in advancing personalized learning that adapts to individual students' needs, pace, and learning styles. However, its implementation and impact in the Nigerian context, especially in international private secondary schools, remain limited. This study investigated the extent to which artificial intelligence (AI) technologies are implemented to support personalized learning and assessed their impact on students' academic engagement and learning outcomes in selected international private secondary schools in Abuja, Nigeria. The study answered two research questions, while a descriptive survey research design was used. Using a purposive sampling technique, a 360-study sample of 60 teachers and 300 senior secondary school students was chosen from a population of 1,200 teachers and more than 8,000 enrolled senior secondary school students. A structured questionnaire validated by experts in this area of study was designed and used to collect relevant data. Cronbach's alpha method was used to assess the internal consistency of the instrument, and the reliability coefficient was 0.89. The collected data were analyzed using simple percentages, frequency distributions, and mean statistical ratings. Findings revealed that AI technologies were moderately implemented to support ML, with greater use observed in administrative and assessment functions than in AI delivery. Additionally, AI-powered PL tools had a positive impact on students' academic engagement, motivation, and perceived learning outcomes. The study concluded that AI has significant potential to transform learning experiences when implemented and supported. Therefore, teachers' training should be enhanced in the area of AI usage and adoption, and localized AI-driven educational platforms should be developed to promote equitable and effective personalized learning of students and achieve high academic performance.

Keywords: Artificial Intelligence, Personalized Learning, Academic Engagement, Secondary Schools, Abuja, and Educational Technology

Introduction

The growing integration of digital technology into educational environments has opened new pathways for enhancing teaching and learning outcomes. Artificial intelligence (AI) is one of the most transformative innovations in recent years, which is increasingly applied to redefine how students engage with learning materials,

instructors, and the curriculum. As global educational standards evolve, learning systems that adapt to individual students' needs and potential have become imperative. Personalized learning, which tailors' educational experiences to individual learners' strengths, needs, and interests, is by artificial intelligence (AI) technologies. This transformation is particularly significant in the context of international private secondary schools in Abuja, Nigeria's Federal Capital Territory. Given their access to better infrastructure, global curricular alignment, and high parental expectations, these institutions often serve as pacesetters in adopting cutting-edge technologies (Adelabu, 2018). Yet, despite their thought and perceived advantages, questions remain regarding the actual impact of AI on enhancing personalized learning outcomes among students.

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems (Russell & Norvig, 2020). Russell and Norvig emphasized that these processes include learning (acquiring data and rules for using the data), reasoning (using rules to reach approximate or definite conclusions), and self-correction. Holmes, Bialik, and Fadel (2019) argued that AI systems are designed to emulate tasks such as grading, tutoring, and data analytics for decision-making in the education sector, thereby improving the efficiency and effectiveness of education delivery. Holmes et al. further reiterated that AI technologies range from machine learning algorithms and natural language processing to robotics and intelligent tutoring systems (ITS), which automate routine tasks, analyze student performance data, and offer real-time feedback. This perhaps explains why Mondal (2020) viewed AI as machines' ability to perform tasks typically requiring human intelligence, such as understanding natural language, recognizing patterns, and learning from experience. AI is deployed in education through adaptive learning platforms, virtual assistants, automated feedback systems, and intelligent tutoring systems. Artificial intelligence (AI)-powered educational technologies use algorithms to analyze student data, predict learning needs, and offer tailored interventions, creating a more efficient and individualized learning process.

AI is not just a technological tool but a pedagogical enabler capable of transforming educational practices at all levels. Ubabudu (2024) argued that digital, virtual, and augmented realities, as well as the various forms of innovative teaching methodology, must be integrated into teaching and learning in higher tertiary institutions to ensure the long-term viability of the field of study.

The integration of artificial intelligence (AI) into education has significantly redefined individualized learning by enabling adaptive systems that respond dynamically to student behavior and learning progress. Baker and Inventado (2014) noted that AI systems can analyze large sets of student data to detect patterns in learning styles, strengths, and weaknesses and allow for the creation of personalized learning paths that are continuously refined based on real-time inputs. Woolf (2010) further clarified this by providing some examples that intelligent tutoring systems, such as Carnegie Learning or DreamBox Learning, help assess student responses and adapt the difficulty and style of content delivery accordingly. Similarly, AI-powered learning analytics platforms are understood to aid in monitoring student interactions, providing educators with insights into learning gaps and optimal intervention strategies. These advances have made learning more student-centered, allowing for differentiated instruction and timely remediation that are imperative for academic success.

Personalized learning may be seen as an approach to educational endeavors that seeks to customize learning experiences to suit individual learner profiles, including interests, prior knowledge, preferred learning styles, and learning pace. Zawacki-Richter, Marín, Bond, & Gouverneur (2019) avowed that personalized learning is an instructional approach that tailors educational content, pace, and learning strategies to individual student

preferences, needs, and strengths. AI can enhance personalized learning by enabling systems to dynamically adapt materials and assessments to students' learning patterns in real-time.

Pane, Steiner, Bair, and Hamilton (2015) argued that, unlike the one-size-fits-all traditional model, personalized learning fosters autonomy and agency by aligning instruction with each learner's unique needs. Additionally, personalized learning has become more sophisticated and scalable with the advent of AI. This affirms the widely held belief that AI promotes dynamic content generation, performance tracking, and automated feedback, all of which enhance learning experience effectiveness and engagement. Understandably, students receive personalized pathways that help them master subjects at their own pace while staying aligned with curriculum standards through platforms like Khan Academy, Google Classroom with AI plugins, and Microsoft Education tools.

Students are the central stakeholders in the education ecosystem and are the primary beneficiaries of AI-powered personalized learning. Prensky (2020) submitted that contemporary learners, especially those in international private schools, are digital natives accustomed to interacting with intelligent systems in daily life, from voice assistants to recommendation engines, along with their educational expectations, including but not limited to: immediacy, interactivity, and relevance. Adelabu (2018) asserted that personalized learning benefits students as it fosters greater engagement, motivation, and academic achievement. Hence, learners are more likely to retain information and apply knowledge when AI tools provide content in digestible and relatable formats.

Luckin et al. (2016) asserted that AI enhances student engagement, motivation, and SDL. AI enables the development of intelligent tutoring systems that mimic one-on-one human tutoring by providing step-by-step guidance, hints, and personalized feedback based on individual learning styles. For example, Carnegie Learning's MATHia is an IT'S that adapts to each student's cognitive model and offers individualized instruction (VanLehn, 2011), leading to more personalized support and deeper conceptual understanding, especially in STEM fields. AI-powered analytics track learner progress over time, allowing educators and systems to predict performance and recommend interventions before issues arise. AI facilitates early identification of at-risk learners and data-informed decision-making in curriculum design (Siemens, 2013). AI can accommodate diverse learning needs, including those of students with disabilities, by providing speech-to-text, text-to-speech, translation, and tailored content. This improves inclusivity and accessibility in learning environments (Woolf, 2010). This becomes especially critical for diverse learners, including those with special needs, language barriers, or differing cognitive abilities.

International private secondary schools in Abuja offer globally recognized curricula, such as the British IGCSE, American High School Diploma, or the International Baccalaureate (IB), and often have better infrastructure, smaller class sizes, and more qualified teachers than their public counterparts (Creswell, 2014). They often integrate cutting-edge technologies to maintain global standards (Ayoade & Akinyemi, 2021). Adelabu (2018) added that these schools cater for both expatriate and elite Nigerian families and are often seen as innovation leaders in the educational sector. The urban setting of Abuja, Nigeria's federal capital, which is added to the 36 states of the country, provides infrastructure that supports tech-enabled learning, making it a relevant context for studying AI applications in education. Many universities have already begun implementing AI-driven learning platforms, automated grading tools, and data dashboards to monitor student performance. However, despite this technological advantage, empirical evidence on the effectiveness of these tools in achieving personalized learning outcomes is limited.

Despite the promise of AI in transforming ML, several challenges impede its effective implementation. For instance, Luckin, Griffiths, and Forcier (2016) observed the cost and sustainability issues and argued that AI

technologies require significant investment in infrastructure, training, and maintenance, which may strain even well-funded private schools. Similarly, Williamson and Piattoeva (2019) expressed concerns about data privacy, the ethical use of student information, and algorithmic bias, which can erode trust in AI tools. Similarly, Eubanks (2018) affirmed that AI systems can unintentionally reinforce biases in training data or algorithms, leading to discriminatory outcomes in ML. For instance, students from underrepresented or marginalized groups may receive biased, data-based, inaccurate recommendations or assessments.

Additionally, Burrell (2016) submitted that many AI models, especially deep learning systems, operate as black boxes, making it difficult for educators and learners to understand how decisions are made. Reduced trust in artificial intelligence tools and difficulty in verifying or challenging system-generated feedback. Moreover, developing and deploying AI-based personalized learning tools can be expensive, require advanced infrastructure, skilled personnel, and continuous maintenance, and widen the digital divide, especially in developing countries or underfunded schools (Holmes, Bialik & Fadel, 2019).

Furthermore, relying too much on AI systems runs the risk of dehumanizing education by ignoring critical thinking, social-emotional learning, and human teacher-student contact. According to Selwyn (2019), teaching responsibilities are becoming weaker, and complete educational experiences are being lost. This is compounded by another critical challenge of a lack of adequately trained educators who can integrate AI meaningfully into their pedagogical practices. This is because the focus is often on acquiring technology without a corresponding emphasis on professional development and instructional design. Moreover, localized content is still underdeveloped, and many AI platforms do not perfectly align with Nigerian curricula or even with the hybrid curricula used by international schools.

Several studies have explored the global role of AI in personalized learning. For example, Zawacki-Richter, Marín, Bond, and Gouverneur (2019) conducted a systematic review and concluded that AI holds substantial promise for ALE but noted that implementation is uneven across regions. Similarly, Pane et al. (2015) found positive correlations between personalized learning and student performance in the United States, whereas Holmes et al. (2019) emphasized the importance of teacher involvement in the adoption of AI. Ubabudu (2024) identified several emerging technologies, such as artificial intelligence and machine learning, cloud computing and virtualization, user experience (UX) design, architecture, digital marketing and social media utilities, digital imaging and photography, the Internet of Things (IoT) and interconnectivity, and data science and analytics, that need to be redesigned and incorporated into Nigerian university education curricula without mentioning international private secondary schools. However, research on this topic is still lacking in Nigeria, particularly in international private secondary schools in Abuja. Existing studies tend to focus on public institutions or general digital literacy without addressing the nuanced dynamics of AI-powered ML in high-capacity educational environments.

This study aims to bridge that gap by specifically investigating the extent of AI implementation and impacts in enhancing personalized learning outcomes for students in uniquely selected school settings. Furthermore, this study is hinged on Piaget's constructivist learning theory, founded around 1936 with the publication of 'The Origins of Intelligence in Children' due to its capability and principles. For instance, learners actively construct knowledge through experience and interaction. Learning is an active, constructive process where learners build new knowledge based on their prior experiences and cognitive structures. Learners are not passive recipients of information; they actively interpret, internalize, and reorganize knowledge through experience, reflection, and interaction with the environment. Learning is most effective when it is learner-centered, allowing for exploration,

discovery, and adaptation. These principles are highly relevant to AI-powered personalized learning, which seeks to replicate and enhance individualized, learner-driven educational experiences.

Statement of the problem

The integration of AI in education has become a hallmark of modern instructional delivery systems, promising to enhance the quality, efficiency, and inclusiveness of teaching and learning processes. One of the most significant benefits attributed to AI in education is its capacity to support ML, an approach that adapts instructional content and strategies to the individual needs, learning styles, pace, and interests of students. In global contexts, AI-driven ML systems have been linked to improved academic engagement, performance, and learner autonomy. However, despite the potential of AI technologies, their adoption and effectiveness in enhancing personalized learning remain largely underexplored in many developing countries, including Nigeria.

International private secondary schools in Abuja, Nigeria's capital city, are generally well-resourced and technologically advanced compared with public institutions. These schools are presumed to be more capable of implementing AI-powered solutions because of their access to funding, qualified personnel, and exposure to international best practices. However, anecdotal evidence and limited empirical studies show that the application of AI in facilitating truly personalized learning experiences may be fragmented, inconsistent, or underutilized even within these privileged settings. There are concerns about whether these technologies are being integrated in pedagogically meaningful ways, whether students truly benefit from individualized instruction, and whether teachers possess the competence and support necessary to effectively leverage AI.

Furthermore, while some international research has shown the positive impact of AI on learning outcomes, a notable gap exists in the literature that specifically examines this impact within the context of Nigerian international schools. Existing studies often focus on general digital education, information and communication technology (ICT) integration, or public education systems, thereby neglecting the unique dynamics of private, international institutions that operate under a hybrid of local and global educational frameworks. Without localized evidence, school administrators, policymakers, and educators find it difficult to make informed decisions on how to implement AI for personalized learning. Therefore, this study seeks to fill this critical gap by investigating the extent to which artificial intelligence (AI) technologies are used to enhance personalized learning for students in international private secondary schools in Abuja. The actual impact of AI adoption on student learning experiences is also evaluated.

Research Questions

The following research questions were used to guide the study:

1. To what extent are AI technologies being implemented to support ML in international private secondary schools in Abuja, Nigeria?
2. What is the perceived impact of AI-powered PL tools on students' academic engagement and learning outcomes in these schools?

Materials and Methods

This study adopted a descriptive survey research design. This design allowed for the systematic collection, analysis, and interpretation of data from a sample of respondents to understand the prevailing situation regarding the use and impact of AI on ML. Explaining more, Creswell (2014) posited that a survey research design is particularly suitable for studies that seek to gather quantitative data on opinions, practices, and perceptions from a specific population over a defined period of time. This design enabled the researcher to explore and describe

the extent to which AI technologies are integrated into PL experiences, as well as their impact in the selected international private secondary schools in Abuja.

The study population comprised all teachers and senior secondary school students (SS1-SS3) in international private secondary schools located in Abuja, Nigeria. As of the 2024 academic session, there are approximately 28 registered international private secondary schools in Abuja, employing an estimated 1,200 teachers and enrolling over 8,000 senior secondary school students (FCT Department of Quality Assurance, 2024). These schools were selected because they are more likely to adopt AI-enabled learning technologies due to their resources and alignment with international curricula and standards. A total of 360 respondents, comprising 60 teachers and 300 students from 10 purposively selected international private secondary schools across six area councils in Abuja, were selected for the study. Schools were selected based on the following criteria: offering an international curriculum (e.g., IGCSE, IB, or American diploma); demonstrable integration of digital technology in teaching and learning; and willingness to participate in the study. Purposive sampling was used to select the schools based on their use of AI technologies, while stratified random sampling was employed to select teachers and students. Students were stratified by class (SS1 to SS3), and random samples were drawn to ensure fair representation across grade levels. Teachers were selected based on their involvement in the use of digital or AI-enabled instructional tools.

The main instrument for data collection was a structured questionnaire designed by the researcher. The questionnaire consisted of Likert scale-based items. It was structured on the basis of a five-point Likert scale, as follows: very low extent (1); low extent (2); moderate extent (3); high extent (4); and very high extent (5). The study was divided into three sections: Section A: Demographic information of respondents; Section B: Extent of AI use in ML; and Section C: Perceived impact of AI-powered ML on student engagement, understanding, and performance. The instrument was designed to elicit quantitative data suitable for statistical analysis.

The draft questionnaire was submitted to three experts in educational technology and measurement and evaluation from the Faculty of Education at the University of Abuja to ensure content and face validity. The experts reviewed the instrument for relevance, clarity, comprehensiveness, and alignment with the study objectives and research questions. Minor revisions were made based on their feedback to improve the wording of items and ensure that all critical aspects of the research were covered.

The instrument's reliability was determined through a pilot study conducted in two international private secondary schools in Gwarinpa and Maitama, which were excluded from the main study. A sample of 10 teachers and 30 students participated in the pilot study. The internal consistency of the questionnaire items was assessed using Cronbach's alpha. The obtained reliability coefficient was 0.89, indicating a high level of internal consistency and reliability of the instrument for data collection.

The data collection process was conducted over a period of three weeks. With the assistance of four trained research assistants, the researcher visited the selected schools to administer the questionnaires. The respondents were briefed on the purpose of the study and assured of confidentiality. Participation was voluntary, and all respondents provided informed consent (including parental consent for students below age 18). Questionnaires were distributed during non-instructional periods and collected immediately after completion to minimize non-responses and ensure high 100% return rate.

Descriptive statistics, i.e., a precise mean rating, were used for analyzing the data of the research questions. For the remarks on each item, the following range of values was adopted:

1.0	-	1.49	=	Very Low Extent (VLE)
1.50	-	2.49	=	Low extent (LE)
2.50	-	3.49	=	Moderate extent (ME)
3.50	-	4.49	=	High extent (HE)
3.50	-	4.00	=	Very high extent (VHE)

This analytical approach ensured a comprehensive and robust description of the collected and analyzed data.

Results

Research Question 1: To what extent are AI technologies being implemented to support ML in international private secondary schools in Abuja, Nigeria?

Table 1:

Mean ratings of teachers and students regarding the extent to which AI technologies are being implemented to support ML in international private secondary schools in Abuja, Nigeria.

S/N	Items	N	Mean	Remark
1.	Adaptive Learning Platforms	360	2.54	ME
2.	Intelligent tutoring systems	360	2.51	ME
3.	Personalized content recommendations	360	2.58	ME
4.	Automated feedback systems	360	2.88	ME
5.	Predictive analytics	360	2.51	ME
6.	AI chatbots	360	2.77	ME
7.	Voice and language recognition tools	360	2.52	ME
8.	Automated essay scoring and feedback	360	3.03	ME
9.	Customized assessments	360	2.89	ME
10.	Gamified learning interfaces	360	2.53	ME

Table 1 presents the findings on the extent to which AI technologies are being implemented to support ML in international private secondary schools in Abuja, Nigeria. The table shows that the mean rating for each item, 1-10, falls within the range of 2.5–3.49, which is classified as moderate extent (ME). This means that, to a moderate extent, AI technologies are being implemented to support ML in international private secondary schools in Abuja, Nigeria. The AI technologies being moderately implemented include adaptive learning platforms, intelligent tutoring systems, personalized content recommendation, automated feedback systems, predictive analytics, AI chatbots, voice and language recognition tools, automated essay scoring and feedback, customized assessments, and gamified learning interfaces.

Research Question 2: What is the perceived impact of AI-powered personalized learning tools on the academic engagement and learning outcomes of international private secondary students in Abuja?

Table 2:

Mean ratings of teachers and students regarding the perceived impact of AI-powered PL tools on students' academic engagement and learning outcomes in international private secondary schools in Abuja.

S/N	Items	N	Mean	Remark
11.	Personalized experiences make learning more engaging by connecting content to students' interests and abilities.	360	3.08	ME
12.	Students remember more when instruction is tailored to their preferred learning style and pace.	360	2.97	ME
13.	AI tools help students achieve higher test scores and deeper understanding by targeting knowledge gaps.	360	2.88	ME
14.	Students become more self-directed and independent learners through AI-enabled learning paths.	360	2.70	ME
15.	AI provides dashboards showing growth and areas that need improvement, thus increasing self-awareness among students.	360	2.55	ME
16.	Personalized remediation enables slower learners to catch up, thereby reducing classroom disparities.	360	2.96	ME

17.	Immediate, constructive feedback boosts students' belief in their ability to succeed.	360	3.20	ME
18.	AI systems challenge learners with higher-order thinking tasks customized to their abilities.	360	2.69	ME
19.	AI can track mood and engagement	360	2.54	ME
20.	AI tools can accommodate students with disabilities through features such as text-to-speech, voice input, and predictive text.	360	2.77	ME

Table 2 shows that individual items, ranging from 11 to 20, have mean ratings ranging from 2.5 to 3.49, and are considered to be moderate extent (ME). This means that to a moderate extent, most respondents perceive every item of the research instrument to have an impact of AI-powered PL tools on students' academic engagement and learning outcomes in IPSs in Abuja. Meanwhile, the perceived impacts are as follows: personalized experiences make learning more engaging by connecting content to students' interests and abilities; students remember more when instruction is tailored to their preferred learning style and pace; AI tools help students achieve higher test scores and deeper understanding by targeting knowledge gaps; students become more self-directed and independent learners through AI-enabled learning paths; AI provides dashboards showing growth and areas needing improvement, increasing students' self-awareness; personalized remediation enables slower learners to catch up, reducing classroom disparities; immediate, constructive feedback boosts students' belief in their ability to succeed; AI systems challenge learners with higher-order thinking tasks customized to their ability; AI can track mood and engagement, and AI tools can accommodate students with disabilities through features like text-to-speech, voice input, and predictive text.

Discussion

The findings revealed a moderate level of implementation of AI technologies in international private secondary schools in Abuja. Data collected from both teachers and students indicated that while AI-powered tools, such as intelligent tutoring systems, learning management systems with adaptive learning features, and data analytics dashboards, were available in several schools, their usage was inconsistent and largely dependent on teacher training and school leadership support. This aligns with the assertions of Holmes et al. (2019), who noted that while AI integration in education is advancing globally, its adoption varies significantly based on institutional readiness and digital competence. In the schools studied, AI was commonly used to automate routine tasks (e.g., grading quizzes, tracking performance), customize revision content based on student performance, and provide real-time feedback. However, in-depth implementation, such as fully adaptive learning paths or intelligent chatbots for individualized tutoring, was less prevalent. Teachers reported challenges, including limited professional training, lack of local content in AI systems, and budgetary constraints, which affected the depth of AI integration. These findings reflect earlier studies, such as Luckin, Holmes, Griffiths, and Forcier (2016), which emphasize that successful AI implementation requires more than access to technology; it demands systemic changes in pedagogy, infrastructure, and teacher capacity-building. While AI tools are present in many of Abuja's international schools, their potential to support fully personalized learning experiences remains underutilized, primarily due to contextual limitations.

The study also revealed that AI-powered PL tools have a positive impact on students' academic engagement and perceived learning outcomes. The majority of the student respondents agreed that AI-supported systems helped them learn at their own pace, improved their motivation through instant feedback, and provided more tailored

academic support than traditional instruction methods. These findings corroborate existing literature that highlights the benefits of AI-facilitated personalized learning. Pane et al. (2015) found that students in schools using PL approaches outperformed their peers in traditional settings in both mathematics and reading. Woolf (2010) emphasized that AI-driven instruction increases student autonomy and engagement by making learning more relevant and responsive. However, the study also revealed disparities in how students benefited from AI tools, often influenced by the extent of exposure, access to digital devices, and teacher competence in leveraging AI features. Students in more digitally advanced schools reported higher levels of satisfaction and improved academic performance, whereas those in less tech-integrated schools noted minimal difference from traditional methods. When effectively implemented, AI enhances cognitive and emotional engagement, fosters deeper understanding, and supports mastery learning. However, without consistent and equitable access, the benefits of AI-driven ML may remain unevenly distributed across schools.

Conclusion

This study examined the impact of AI technologies on personalized learning in international private secondary schools in Abuja, Nigeria. The findings demonstrated that while AI technologies are being introduced in these schools, their full potential for supporting ML remains unrealized. It is understood from the study that AI-powered ML tools influence students' engagement and academic outcomes appreciably. Therefore, when effectively deployed and appropriately utilized, the technologies can potentially support individualized instruction, facilitate differentiated learning, and contribute to improved academic performance. However, the inconsistency in usage across schools reveals the need for more strategic, system-wide approaches to integrate AI in education.

Recommendations

Regarding the study report, the following have been advocated:

1. There should be capacity building for teachers on AI integration. Educational stakeholders and school administrators, especially in international private schools, should invest in continuous professional development programs to equip teachers with the skills and operational competencies needed to effectively integrate AI tools into ML strategies. Training should focus on both the technical and pedagogical aspects of AI usage.
2. Strategic development of localized AI content and infrastructure support is required. In this situation, schools should collaborate with government and private tech companies and international partners to develop contextually relevant AI-powered educational platforms that align with local curricula. Schools should receive infrastructural support to ensure consistent access to the digital tools needed for personalized learning.

Ethics and Conflict of Interest:

The author declares no conflicts of interest, and the study article complies with the current ethical standards.

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