Utilizing Artificial Intelligence to Enhance Personalized Learning at Zambian Universities: A Case Study of NIPA

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Abstract—The integration of Artificial Intelligence (AI) in personalized learning offers significant potential to transform education in Zambian universities. Given the growing diversity of student populations and the challenges in traditional educational delivery, AI-driven adaptive learning systems present an innovative approach to customizing learning experiences to meet individual student needs. This study investigates the role of machine learning algorithms in analyzing student performance data to personalize course content, suggest relevant resources, and provide real-time feedback, thereby enabling individualized learning paths. Focusing on the National Institute of Public Administration (NIPA) as a case study, the research explores the impact of AI on student engagement, academic achievement, and retention in the context of Zambian higher education. The study also identifies challenges such as infrastructure limitations, concerns around data privacy, and the necessity for faculty training. The findings aim to offer valuable insights into the viability of AI-powered personalized learning systems in resource-limited environments, with practical recommendations for effectively integrating AI into university teaching practices to improve educational outcomes for both students and faculty.

Keywords—Artificial Intelligence (AI), Personalized Learning, Adaptive Learning Systems, Higher Education, Zambian Universities.

● INTRODUCTION

Artificial Intelligence (AI) is rapidly transforming global education by enabling personalized learning, automating administrative tasks, and offering data-driven insights to improve academic outcomes [1]. The global AI in education market is projected to grow from USD 3.7 billion in 2023 to USD 10.4 billion by 2028, underscoring its expanding role [2]. In higher education, AI tools such as adaptive learning systems, intelligent tutoring, and collaborative platforms are reshaping pedagogical practices [3, 4].

However, in sub-Saharan Africa, AI integration remains uneven due to infrastructural and policy challenges. Kenya has made strides in applying AI tools to enhance learning outcomes, with studies showing benefits in personalization and feedback despite limited access [5]. In contrast, Zambia lacks substantial research on AI-driven personalized learning, revealing a regional gap. Moreover, systematic reviews note that educators are often underrepresented in AI studies, raising concerns about alignment with institutional needs [6].

This study explores the adoption of AI for personalized learning at the National Institute of Public Administration (NIPA) in Zambia. By examining both opportunities and challenges, it contributes to discussions on equitable AI integration in resource-constrained contexts. Drawing from global guidelines [1] and regional insights [4], the study emphasizes localized strategies and includes perspectives from faculty and students, offering recommendations for policymakers to address digital divides, ethical concerns, and capacity gaps.

● *Background*

Artificial Intelligence (AI) is reshaping education by enabling personalized learning, which tailors content to individual learners' needs, preferences and pace through adaptive algorithms, data analytics and intelligent tutoring systems [7, 8]. Tools such as adaptive learning platforms adjust content difficulty

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and use predictive analytics to identify at-risk learners, enabling timely support [1, 9].

Globally, AI enhances engagement, improves academic outcomes, and streamlines teaching by automating tasks and detecting learning challenges early [10, 11]. In Sub-Saharan Africa, AI adoption shows promise. Countries like Kenya and South Africa have used AI tools to address high student-teacher ratios [5, 12], while Namibia's grassroots ICT revitalization projects demonstrate how innovation can empower disadvantaged schools [13] but barriers such as poor digital infrastructure, limited faculty training, and fragmented policies persist [11, 14]. Nigerian institutions report resistance to curricular change [15], while Ugandan institutions cite funding and ethical concerns [11]. These disparities emphasize the need for localized strategies aligned with regional realities [6].

Zambia's higher education sector reflects similar challenges, struggling with high student-to-teacher ratios, limited access to modern tools, and underdeveloped ICT infrastructure, especially in public institutions [16, 17]. Only 34% of Zambian universities have reliable internet connectivity, restricting access to online learning [18]. Faculty readiness remains low, with few institutions offering training in emerging technologies [19]. The National Institute of Public Administration (NIPA), a key institution for civil service training, exemplifies these issues with overcrowded classrooms and outdated teaching practices [18, 19].

This study positions NIPA as a strategic case study for exploring AI adoption in Zambia. By examining its capacity to implement adaptive learning systems [7], AI-powered collaborative frameworks [3], and addressing its institutional challenges, the research evaluates how AI can enhance personalized learning, boost engagement, and improve academic outcomes in Zambia's higher education sector [18, 19].

- *Problem Statement*

Despite global progress in AI-driven personalized learning, Zambian higher education remains dominated by traditional, one-size-fits-all teaching methods that fail to address diverse learner needs, especially in large, under-resourced classrooms [16, 17]. While countries such as Kenya and South Africa have begun integrating AI tools to improve engagement and equity [5, 12], Zambia lacks empirical studies and implementation frameworks, leaving institutions ill-prepared to adopt adaptive systems or utilize data-driven approaches [18, 19]. This gap reinforces inequities, as students in under-resourced universities face limited access to personalized academic support, contributing to poor performance, high dropout rates, and constrained innovation in teaching. Without targeted interventions, Zambia risks deepening the digital divide and producing graduates ill-equipped for an AI-driven workforce [1]. Addressing this challenge is critical to fostering more inclusive and effective educational environments. This study investigates how AI-powered personalized learning can be adapted to Zambia's specific context, using the National Institute of Public Administration (NIPA) as a case study. By examining NIPA's opportunities and constraints, the research aims to identify scalable strategies that enhance student engagement, promote equity, and improve learning outcomes in resource-constrained settings.

- *Research Objectives*

To assess the current state of personalized learning approaches and the extent of AI integration in higher education institutions in Zambia, with a specific focus on NIPA.

To investigate how AI-based adaptive learning technologies can help address key challenges such as high student-to-teacher ratios and limited academic support at NIPA.

To evaluate the effectiveness of AI-driven adaptive learning systems in enhancing student engagement, academic performance, and equity in learning outcomes at NIPA.

To investigate institutional, technical, and cultural barriers to AI adoption at NIPA by analyzing faculty perceptions, policy limitations, and infrastructural gaps.

To establish context-specific strategies for integrating AI into Zambia's higher education system, emphasizing scalability, equity, and faculty development, in alignment with national education policies.

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- *Research Questions*

How can AI-based adaptive learning technologies address challenges such as high student-to-teacher ratios and limited academic support at NIPA?

What is the current state of personalized learning approaches and the level of AI integration in Zambian higher education institutions, particularly at NIPA?

What extent do AI-driven adaptive learning systems improve student engagement, academic performance, and equity in learning outcomes at NIPA?

What institutional, technical, and cultural barriers hinder the adoption of AI technologies for personalized learning at NIPA?

What context-specific strategies can be proposed to integrate AI into Zambia's higher education system, in line with national education policies?

- LITERATURE REVIEW

AI in Education: Global Trends

Artificial Intelligence (AI) is transforming education through personalized learning, intelligent tutoring systems (ITS), adaptive platforms, and AI-based assessments. In high-resource settings, these tools enhance learners' engagement, track progress in real time, and support data-driven curriculum design [8, 20, 21]. Generative models like ChatGPT simulate one-on-one tutoring, while ITS are especially effective in STEM by identifying knowledge gaps and customizing instruction [7, 9]. Pedagogical innovations like AI-augmented flipped classrooms enhance engagement by automating content delivery and enabling collaborative, problem-based learning [3, 8]. However, global adoption is uneven due to concerns over data privacy, algorithmic bias, and the digital divide [1]. Inclusive policies are needed to ensure AI complements rather than replace human instruction.

African Context and Zambia's Challenges

Across Africa, AI integration in higher education is emerging but uneven. Kenya has piloted adaptive platforms and automated grading with positive results, though scalability is constrained by unreliable electricity and connectivity [5, 17]. Nigeria's reforms face resistance and limited faculty training [15, 22], while South Africa applies AI for collaborative learning and analytics, but rural access remains limited [12]. In Zambia, AI integration remains minimal. Universities face outdated ICT infrastructure, poor connectivity, and low funding [16, 17, 18, 23]. Although Mulungushi University piloted an AI-powered recommender system highlights potential but lacks scalability support and adoption is isolated [18]. Faculty readiness is another obstacle as most instructors have limited digital literacy and little institutional backing [11, 23]. Moreover, Zambia lacks a national policy framework for AI in education, leaving institutions reliant on fragmented donor-driven initiatives [19].

Theoretical Framework

This study draws on Adaptive Learning Theory and Constructivism. Adaptive learning emphasizes tailoring instruction to individual needs, abilities and progress, mirrored by AI tools like ITS and generative models that adjust content based on real-time performance data [7, 9, 21]. Constructivism emphasizes active, experience-based knowledge construction, which aligns with AI-augmented flipped classrooms that automate foundational content delivery and create space for collaborative problem-solving [8]. However, in Zambia, infrastructural limitations, cultural resistance to student-centered methods, and the absence of localized models in institutions such as NIPA continue to hinder the effective adoption of these frameworks [10, 14].

D. Barriers to AI Adoption

Key barriers to AI adoption in Zambia's higher education include infrastructural and connectivity challenges, faculty readiness, and gaps in policy and funding. Outdated ICT systems, unreliable power supply, and limited bandwidth continue to hinder effective deployment, as seen in Mulungushi University's recommender system, which was undermined by poor connectivity [18, 24]. Additionally, more than 80% of educators report minimal exposure to AI, contributing to skepticism and resistance to its integration in teaching and learning [11, 15, 23]. Ethical issues around digital learning, similar to those raised in earlier electronic

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notes distribution studies in Namibia [25], also shape faculty perceptions. The absence of a national AI strategy further exacerbates these challenges, with institutions relying on fragmented, donor-driven initiatives that lack sustainability and often widen rural–urban disparities [1, 23]. Regional collaborations such as the Ubuntunet Alliance have shown potential to reduce brain drain and strengthen research capacity across Africa [26]. Without targeted investment in digital literacy, robust infrastructure, and coherent policy alignment, the adoption of AI risks deepening educational inequalities between urban and rural institutions.

- *Research Gap*

Although global and regional research on AI in education is expanding, Zambian higher education remains critically understudied, particularly regarding AI-driven personalized learning. While countries like Kenya, Nigeria, and South Africa have explored adaptive systems and AI-enhanced pedagogies [5, 12, 22], Zambia lacks empirical studies on how AI personalization can address local challenges such as high student-teacher ratios, resource disparities, and infrastructural constraints [16, 23].Existing Zambian research tends to focus on ICT infrastructure gaps [18], digitalization efforts [23], or policy-level discussions [19], with limited attention to scalable AI solutions for personalized instruction. Moreover, there is a notable absence of studies capturing educator and student perspectives on AI adoption, a gap emphasized by Zawacki-Richter et al. [6]. While [1] calls for equitable AI frameworks in low-resource settings, Zambia's unique socio-cultural and economic context marked by donor-dependent ICT initiatives and rural-urban divides [24] remains largely unaddressed.

Additionally, there is scarce evidence evaluating the effectiveness, scalability, and ethical implications of personalized AI tools within Zambian universities. This lack of localized, evidence-based strategies impedes informed decision-making and leaves institutions like NIPA ill-equipped to adapt global AI models to local realities, potentially deepening educational inequities. This study seeks to fill this gap by examining the opportunities and challenges of implementing learner-centered AI tools in Zambia's higher education system, using NIPA as a case study to inform scalable, context-sensitive solutions.

- METHODOLOGY

Research Design

A mixed-methods case study was conducted at the National Institute of Public Administration (NIPA) to investigate the impact of AI-driven personalized learning on student engagement, outcomes, and institutional readiness in a resource-constrained context.

Participants

Purposive sampling targeted 110 students enrolled in digital learning programs and 20 faculty members involved in teaching, curriculum, or technology decisions. The target sample included approximately 110 students and 20 faculty members.

Data Collection Instruments

Two structured online questionnaires (Google Forms) were developed. Students' questionnaire entailed AI exposure, perceptions, challenges, and suggestions while faculty questionnaire entailed Awareness, technology use, and views on AI integration.

[1] *Data Collection Procedure*

Surveys were shared via mailing lists, WhatsApp groups, and notice boards. Participation was voluntary, with informed consent, anonymity, and confidentiality assured.

[2] *Data Analysis*

Quantitative data were analyzed in Excel using descriptive statistics, while qualitative responses were thematically coded to identify challenges, barriers, and recommendations. To enrich the analysis, identity attribute mining and fuzzy inference models [27] were considered as methodological inspirations for handling complex, multi-variable educational data.

- FINDINGS

The results in this section reflect responses from NIPA students and faculty, analyzed through descriptive

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statistics for closed-ended items and thematic analysis for open-ended ones. Combining both perspectives, the findings reveal current practices, challenges, and opportunities for adopting AI-driven personalized learning in Zambia's higher education.

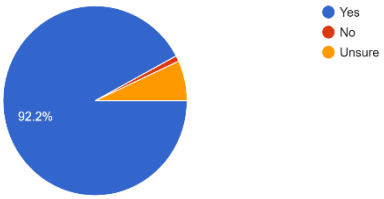

Figure 1. Students' openness to AI

Figure 1 shows students' openness to using AI-driven tools for learning. A vast majority (92.2%) indicated they would be willing to adopt AI to enhance their learning experience, while 6.9% were unsure and only a very small fraction opposed the idea. These results suggest that students at NIPA demonstrate strong readiness and a positive attitude toward AI integration, highlighting a favorable environment for introducing personalized AI-based learning systems.

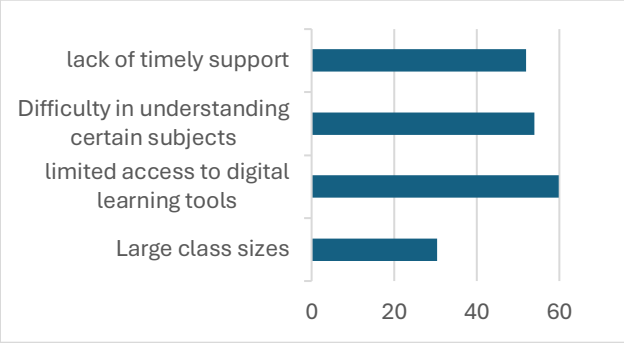

Figure 2. Student Learning Challenges

The figure above illustrates the learning challenges students currently face at NIPA. The most frequently reported barriers were limited access to digital learning tools (59.8%), difficulty in understanding certain subjects (53.9%), and lack of timely academic support (52%). In contrast, large class sizes were mentioned by 30.4% of students. These findings highlight that while structural issues such as class sizes remain relevant, students perceive digital access and insufficient academic support as the most pressing obstacles to effective learning.

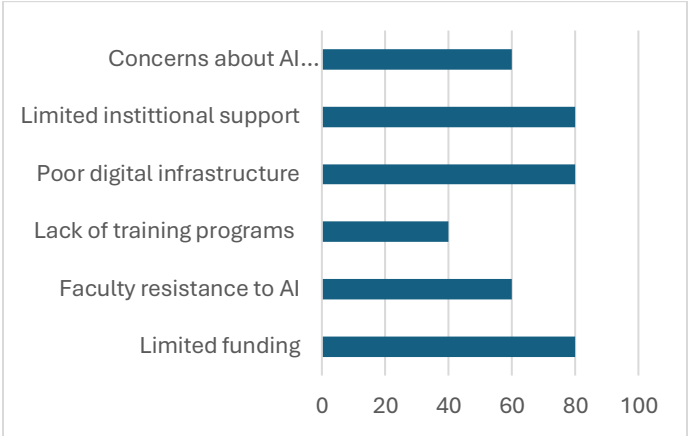

Figure 3.Faculty Barriers to AI Adoption

The diagram presents faculty perspectives on the barriers to AI adoption at NIPA. The most significant obstacles identified were limited funding (80%), poor digital infrastructure (80%), and limited institutional support (80%), reflecting systemic constraints that hinder large-scale integration of AI in teaching. Additionally, faculty resistance to AI (60%) and concerns about its effectiveness in education (60%) highlight cultural and pedagogical hesitations. A smaller proportion (40%) cited the lack of training programs as a barrier. These results indicate that while resource limitations remain the most critical challenge, successful AI adoption will also require addressing faculty readiness and institutional attitudes.

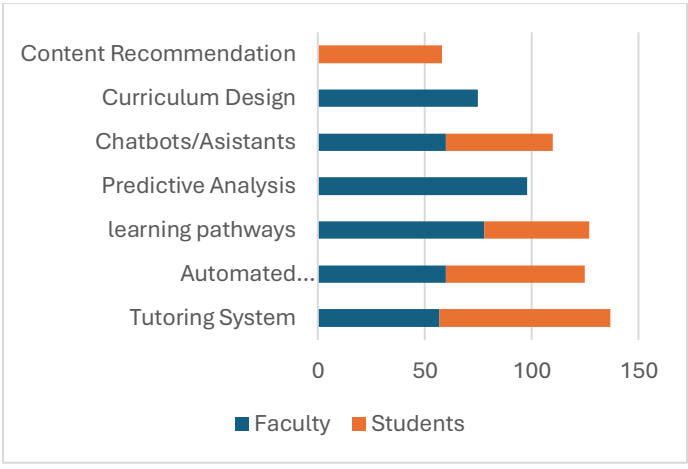

Figure 4. Desired AI Features (students + Faculty).

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Figure 4 illustrates the desired AI features as indicated by both students and faculty. While there is strong alignment on the importance of tutoring systems (78.4% students; 60% faculty) and automated feedback/grading (61.8% students; 60% faculty), differences also emerge. Faculty placed the highest priority on predictive analytics for student performance (98%) and curriculum design (80%), whereas students highlighted personalized content recommendations (58.8%) and adaptive learning pathways (51%). These results suggest that while both groups see value in AI for personalization and efficiency, faculty tend to emphasize institutional-level applications, while students focus more on learner-centered support.

Faculty familiarity with AI-driven personalized learning: Most faculty reported moderate knowledge, with 60% indicating they were somewhat familiar and 40% stating they were very familiar. This suggests a general awareness of AI concepts but highlights the need for deeper, practical understanding.

Student perceptions of current e-learning effectiveness: Students expressed mixed views regarding the effectiveness of existing e-learning platforms. Only 6.1% rated them as very effective and 15.3% as effective, while 26.5% found them ineffective and 9.2% very ineffective. A significant proportion (42.9%) remained neutral, indicating limited satisfaction and room for improvement.

Faculty's willingness to participate in AI training programs: All faculty expressed openness to professional development in AI-powered teaching, though their preferred formats varied. 60% preferred formal workshops and training, 20% favored online self-paced learning, and another 20% indicated willingness only if aligned with institutional requirements.

CONCLUSION AND RECOMMENDATIONS

This study highlights the potential of Artificial Intelligence (AI) to enhance personalized learning in Zambian higher education, particularly at NIPA. Students show strong receptiveness to AI tools, and faculty demonstrate openness to training, creating opportunities for innovation. However, challenges such as limited infrastructure, funding constraints, and institutional readiness must be addressed. AI-driven adaptive learning can help mitigate high student-teacher ratios and improve academic support, but successful integration requires context-sensitive strategies, faculty development, and alignment with national educational policies.

- *Recommendations*

1. Infrastructure: Invest in reliable internet, modern ICT tools, and stable power.
2. Faculty Training: Provide continuous AI-focused professional development.
3. Policy Support: Develop a national AI framework and integrate strategies into university plans.
4. Pilot AI Tools: Start small, refine using feedback, then scale up.
5. Equity & Inclusion**:** Ensure access for rural and under-resourced students.
6. Partnerships & Funding**:** Collaborate with private sectors, NGOs, and international organizations.
7. Monitor & Evaluate: Track AI impact to guide improvements.

AI adoption in Zambia's higher education is achievable with barrier removal and faculty readiness, enabling personalized, equitable, and future-ready learning at institutions like NIPA.

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