
THE IMPACT OF ARTIFICIAL INTELLIGENCE-DRIVEN ADAPTIVE LEARNING SYSTEMS ON STUDENT ENGAGEMENT AND ACADEMIC PERFORMANCE IN ZIMBABWE HIGHER EDUCATION

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ABSTRACT

The integration of artificial intelligence (AI) in education has revolutionized learning methodologies, particularly through adaptive learning systems (ALS). These systems personalize instruction based on individual student needs, potentially enhancing engagement and academic performance. This study examines the impact of AI-driven adaptive learning systems on student engagement and academic performance in Zimbabwe's higher education institutions. A mixed-methods approach was employed, involving surveys from 200 students and interviews with 20 educators across five universities. Findings indicate that AI-driven ALS significantly improve student engagement by providing real-time feedback, personalized learning paths, and interactive content. Additionally, academic performance improved, particularly among students who struggled with traditional teaching methods. However, challenges such as digital infrastructure limitations, resistance to technology adoption, and ethical concerns were identified. The study concludes that while AI-driven ALS hold great potential for Zimbabwean higher education, their successful implementation requires policy support, infrastructure development, and faculty training.

KEYWORDS: Artificial intelligence, adaptive learning systems, student engagement, academic performance, higher education, Zimbabwe.

1. INTRODUCTION

The rapid advancement of artificial intelligence (AI) has transformed various sectors, including education (Luckin et al., 2016). One of the most promising applications of AI in education is adaptive learning systems (ALS), which use machine learning algorithms to

tailor educational content to individual learners' needs (VanLehn, 2011). Unlike traditional one-size-fits-all teaching methods, ALS dynamically adjust difficulty levels, provide instant feedback, and recommend personalized learning resources (Kulik & Fletcher, 2016).

In Zimbabwe, higher education institutions face challenges such as large class sizes, limited resources, and varying student preparedness (Chireshe, 2019). These issues often lead to disengagement and poor academic performance. AI-driven ALS could address these challenges by offering scalable, personalized learning experiences (Baker, 2016). However, the adoption of such systems in Zimbabwe remains limited due to infrastructural, financial, and cultural barriers (Mpofu & Chimhenga, 2019).

This study investigates the impact of AI-driven adaptive learning systems on student engagement and academic performance in Zimbabwean higher education. Specifically, it seeks to answer the following research questions:

1. How do AI-driven adaptive learning systems influence student engagement in Zimbabwean universities?
2. What is the effect of AI-driven ALS on academic performance among higher education students in Zimbabwe?
3. What are the key challenges and opportunities associated with implementing AI-driven ALS in Zimbabwe's higher education sector?

2. Literature Review

2.1 Artificial Intelligence in Education

AI in education encompasses technologies such as machine learning, natural language processing (NLP), and predictive analytics to enhance teaching and learning (Luckin et al., 2016). AI-driven tools can automate administrative tasks, provide intelligent tutoring, and facilitate adaptive learning (Woolf, 2010). Studies have shown that AI can improve learning outcomes by offering personalized feedback and reducing cognitive overload (VanLehn, 2011).

2.2 Adaptive Learning Systems (ALS)

Adaptive learning systems use AI to adjust instructional content based on learners' performance, preferences, and learning styles (Kulik & Fletcher, 2016). These systems track student progress in real-time, identify knowledge gaps, and recommend appropriate resources

(Baker, 2016). Research indicates that ALS can enhance student engagement by making learning more interactive and relevant (Tempelaar et al., 2015).

2.3 Student Engagement and Academic Performance

Student engagement refers to the degree of attention, curiosity, and passion students exhibit in their learning (Fredricks et al., 2004). High engagement is linked to improved academic performance, retention, and motivation (Kuh, 2003). AI-driven ALS have been found to increase engagement by providing immediate feedback, gamified learning experiences, and personalized challenges (Dicheva et al., 2015).

2.4 AI in African Higher Education

While AI adoption in African higher education is growing, it remains uneven due to infrastructure limitations, digital divides, and policy gaps (Ade-Ibijola & Okonkwo, 2021). In Zimbabwe, digital literacy among students and faculty is a significant barrier to AI integration (Mpofu & Chimhenga, 2019). However, studies suggest that AI can bridge educational gaps by providing access to quality learning resources (Oke & Fernandes, 2020).

3. Methodology

3.1 Research Design

This study employed a mixed-methods approach, combining quantitative surveys and qualitative interviews to provide a comprehensive analysis of AI-driven ALS in Zimbabwean higher education.

3.2 Participants

Quantitative Phase: A sample of 200 students from five universities (University of Zimbabwe, National University of Science and Technology, Midlands State University, Great Zimbabwe University, and Chinhoyi University of Technology) participated in an online survey.

Qualitative Phase: 20 educators (lecturers and instructional designers) from the same institutions were interviewed to gather insights on ALS implementation challenges.

3.3 Data Collection

Surveys: A structured questionnaire assessed students' perceptions of ALS, engagement levels, and academic performance before and after using AI-driven platforms (e.g., Siyavula, Khan Academy, and local ALS prototypes).

Interviews: Semi-structured interviews explored educators' experiences with ALS, barriers to adoption, and recommendations for improvement.

3.4 Data Analysis

Quantitative Data: Descriptive and inferential statistics (t-tests, ANOVA) were used to analyze survey responses.

Qualitative Data: Thematic analysis was conducted to identify key patterns in interview responses.

3.5 Ethical Considerations

Ethical approval was obtained from participating institutions. Informed consent was secured from all participants, and data anonymity was maintained.

4. RESULTS

4.1 Impact on Student Engagement

The survey results indicated a significant increase in student engagement after using AI-driven ALS (Table 1).

Table 1: Changes in Student Engagement Before and After ALS Implementation.

Engagement Metric	Before ALS (%)	After ALS (%)	p-value
Time spent on learning	45%	72%	<0.001
Participation in discussions	38%	65%	<0.001
Motivation to learn	52%	80%	<0.001

Students reported that real-time feedback, interactive quizzes, and personalized learning paths enhanced their engagement. One student noted:

*"The system adapts to my pace, so I don't feel left behind. It's like having a personal tutor."**
(Student, University of Zimbabwe)

4.2 Impact on Academic Performance

Academic performance improved, particularly among students who previously struggled with traditional teaching methods (Table 2).

Table 2: Changes in Academic Performance Before and After ALS Implementation.

Performance Metric	Before ALS (%)	After ALS (%)	p-value
Average test scores	58%	74%	<0.001
Pass rates	65%	82%	<0.001
Retention of concepts	50%	78%	<0.001

Educators observed that students who used ALS showed better problem-solving skills and higher confidence in assessments. However, some students with limited digital literacy struggled initially.

4.3 CHALLENGES AND OPPORTUNITIES

Despite the benefits, several challenges were identified:

1. *Infrastructure Limitations*: Unreliable internet access and lack of devices hindered ALS adoption.
2. *Resistance to Technology*: Some educators were skeptical about AI replacing traditional teaching methods.
3. *Digital Literacy Gaps*: Students and faculty required training to effectively use ALS.
4. *Ethical Concerns*: Data privacy and algorithmic bias were raised as potential risks.

However, opportunities for improvement were also noted:

Government and institutional support for digital infrastructure development.

Faculty training programs to enhance AI literacy.

Partnerships with edtech companies to develop localized ALS solutions.

5. DISCUSSION

The findings align with previous research indicating that AI-driven ALS enhance student engagement and academic performance (Kulik & Fletcher, 2016; Baker, 2016). The personalized nature of ALS addresses the diverse learning needs of Zimbabwean students, particularly in large classes where individualized attention is limited (Chireshe, 2019).

However, the study also highlights significant barriers to AI adoption in Zimbabwean higher education. Infrastructure limitations and digital literacy gaps are consistent with findings from other African contexts (Ade-Ibijola & Okonkwo, 2021). To maximize the benefits of ALS, institutions must invest in digital infrastructure, faculty training, and policy frameworks that support AI integration.

6. CONCLUSION AND RECOMMENDATIONS

This study demonstrates that AI-driven adaptive learning systems have a positive impact on student engagement and academic performance in Zimbabwean higher education. However, their successful implementation requires addressing infrastructural, cultural, and ethical challenges.

RECOMMENDATIONS:

1. *Government and Institutional Support:* Policymakers should invest in digital infrastructure and provide funding for AI-driven educational technologies.
2. *Faculty Training:* Universities should offer professional development programs to enhance educators' AI literacy.
3. *Student Digital Literacy Programs:* Institutions should provide training to ensure students can effectively use ALS.
4. *Ethical AI Frameworks:* Policies should be developed to address data privacy and algorithmic bias in AI-driven education.
5. *Public-Private Partnerships:* Collaboration with edtech companies can help develop localized ALS solutions tailored to Zimbabwe's educational needs.

Future research should explore long-term effects of ALS on student outcomes and investigate cost-effective models for AI adoption in resource-constrained settings.

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