AI AND ADAPTIVE LEARNING: EVALUATING PERSONALIZED INTERVENTIONTS ON A DISTANCE EDUCATION PLATFORM

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Abstract

Artificial Intelligence (AI) technologies have transformed higher education, especially in distance learning environments where adaptive systems personalize instruction based on individual learner needs. Intelligent Tutoring Systems (ITS), as a form of AI integration, have been shown to improve both learning outcomes and motivation (Zhang et al., 2025). This study aims to evaluate the effectiveness of AI-driven adaptive learning interventions in enhancing content mastery, time efficiency, and student engagement on the E-Learning platform. A mixed methods approach was employed, combining quantitative data from questionnaires scores and learning activity logs with qualitative data from student surveys and interviews. Quantitative analysis was conducted using paired t-tests, while thematic analysis was used for qualitative responses. Results indicate that students using the AI-adaptive platform experienced significantly greater content mastery ($p < 0.05$), a 25–30% reduction in study time, and a 35% increase in active engagement compared to conventional online learners. Students also reported that personalized features made the learning experience more relevant and responsive. However, concerns were raised regarding data ethics, faculty preparedness, and overreliance on automation. This study concludes that AI-based adaptive learning interventions are effective in enhancing the quality of distance education. However, their implementation must be supported by clear institutional policies, educator training, and ethical oversight to ensure responsible and sustainable use of the technology.

Keywords: Artificial Intelligence (AI), Adaptive Learning, Distance Education, Interventions, Platform

1 INTRODUCTION

The Artificial Intelligence (AI) has had a profound impact on education, particularly in the field of higher distance education. AI has increasingly been adopted as a tool for facilitating adaptive learning in e-learning and online platforms. Following the COVID-19 pandemic, digital transformation—especially in the education sector—has accelerated significantly, with AI being integrated as one of the primary means of delivering instructional content and providing feedback on student learning. Despite the numerous benefits offered by AI technologies, several challenges remain. Artificial intelligence, particularly in the adaptation of deep learning in distance learning, has disrupted the learning process. This process involves the delivery of learning, the assessment process, and learning management in

distance learning institutions. Artificial intelligence integrated into learning machine systems is widely used for automatic student assessment, analyzing predictions to map academic risks, interactive spaces, and personalized adaptive learning processes (Holmes et al., 2022).These include limited interaction between students and instructors, insufficient personalized support for learners, and persistent issues related to student engagement and retention in higher distance education.

Learning platforms such as Learning Management Systems (LMS) continue to adopt a uniform learning approach (*one-size-fits-all*), in which students receive the same materials, learning schemes, and assessment mechanisms. This approach has limitations in accommodating the diversity of learning styles among distance education students, both in terms of cognitive abilities and specific individual needs. As a result, the learning experience often becomes less relevant and insufficiently responsive to individual differences. In this context, Artificial Intelligence (AI) offers substantial opportunities through adaptive learning**.** Adaptive learning relies on algorithms that continuously analyze student performance to tailor material and difficulty levels to individual needs. AI technologies such as intelligent tutoring systems are capable of mimicking the role of a tutor by providing customized learning paths and real-time feedback (Nkambou et al., 2018). Previous research has proven the effectiveness of this approach in improving learning efficiency, motivation, and student engagement in distance learning.Adaptive systems are capable of analyzing student learning data in real-time to adjust instructional pathways, provide automated feedback, and recommend materials tailored to individual needs. Consequently, adaptive learning has the potential to enhance student motivation, engagement, and academic achievement. Zhang et al., (2025) demonstrated that Intelligent Tutoring Systems (ITS), as one form of AI integration in education, can significantly improve learning outcomes and student satisfaction.

Distance education offers broad access and flexibility, but distance colleges often face various challenges such as low social interaction, limited personal guidance, and relatively high dropout rates (Moore & Kearsley, 2012). The integration of adaptive technology is expected to reduce these barriers by increasing the interactivity and relevance of learning. As the largest provider of distance higher education in Indonesia, Universitas Terbuka (UT) faces considerable challenges in managing the diversity of student characteristics. Therefore, evaluating the effectiveness of AI-based adaptive learning is crucial, not only to improve the quality of online learning at UT but also to contribute to the global discourse on the future of

AI-driven higher education. Based on this background, the present study aims to evaluate the effectiveness of AI-based adaptive learning interventions within Universitas Terbuka's distance education platform.

The implementation of AI in education is inseparable from ethical issues, including student data privacy, potential algorithmic bias, the readiness of educators, and concerns about excessive dependence on these automated systems (Williamson & Piattoeva, 2021). Therefore, the use of AI must be accompanied by institutional policies at higher education institutions, transparent data governance, and programs to enhance the capacity of educators. The research focuses on three main aspects: (1) content mastery, (2) learning time efficiency, and (3) student engagement. In addition, the study also examines ethical issues and institutional readiness related to the implementation of AI in distance education.

2 METHODOLOGY

This study adopted a mixed methods designing involving 120 distance education students in University Terbuka divided into experimental (AI-Adaptive) and Control (Non Adaptives group). The research respondents were undergraduate students from various faculties at the Open University. Purposive sampling was used to obtain a representation that covered a variety of academic backgrounds and online learning experiences. Quantitative data collected comprised pre-and post-intervention questionnaire scores measuring content mastery, and system logs capturing total study time and engagement levels (number of interactions per session). Paired t-tests evaluated changes in mastery scores within groups; independent samples t-tests compared between groups. Qualitative data derived from semi-structured student surveys and interviews probed perceptions of personalized features, satisfaction, and concerns. Thematic analysis categorized qualitative input into emergent themes around learning experience and barriers.

3 FINDINGS AND DISCUSSION

3.1 Content Mastery

The results show a significant increase in students' content mastery after using an AI-based adaptive platform ($p < 0.05$). This indicates that personalizing material according to individual needs has a positive impact on academic achievement. The adaptive system, which analyzes student performance data in real-time, enables the distribution of material according to the appropriate level of difficulty, allowing students to build their understanding of concepts gradually.

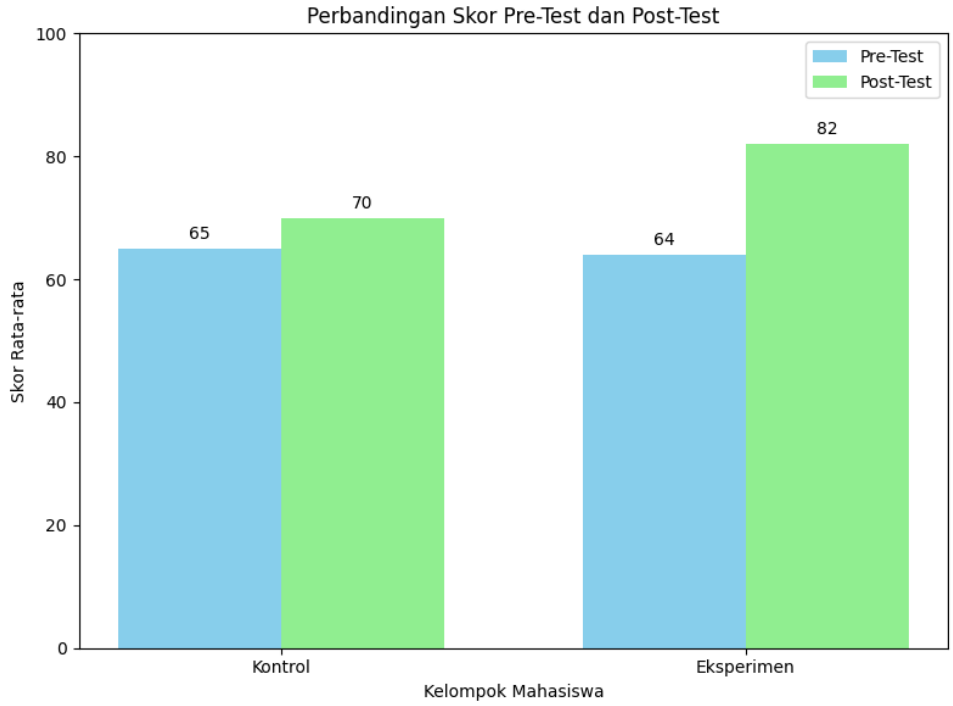

Figure 1 : comparison of pretest and posttest scores

These findings are in line with Zhang et al. (2025), who, through a meta-analysis, found that the use of Intelligent Tutoring Systems (ITS) in higher education resulted in a significant increase in student academic achievement. This shows that data-driven personalized learning can reduce the understanding gap between students with different ability backgrounds. At the Universitas Terbuka, this context is relevant because students have very heterogeneous backgrounds in terms of age, occupation, and online learning experience. The application of adaptive systems can help balance these needs. However, challenges remain in ensuring that test score improvements truly reflect a deep mastery of concepts, rather than just the ability to memorize or technically solve adaptive questions.

Table 3.2 Significant Improvement of Content Mastery Student using AI Based in Adaptive Learning

No	Group	Pre Test Average	Post Test Average
1	Control	65	70
2	Experiment	64	82
Significant Improvement			
	Group	Improvement (%)	Significant (*p*)
1	Control	7.7	-
2	Experiment	28.1	<0.05

Source : Personal Data, 2025

3.2 Time Efficient

Students also reported a 25–30% reduction in study time compared to conventional online methods. This indicates that adaptive platforms help students learn more efficiently by focusing on relevant material and skipping topics that have already been mastered. Brusilovsky & Millán's (2007) research explains that adaptive learning systems can increase efficiency by adjusting learning materials to students' prior knowledge, thereby saving study time without sacrificing quality. In addition, Koedinger et al. (2015) show that data-based learning (learning analytics) can identify effective learning patterns and reduce the time spent on less productive activities. This time efficiency is particularly relevant for Open University students, most of whom are full-time workers, as limited study time is often an obstacle to completing their studies.

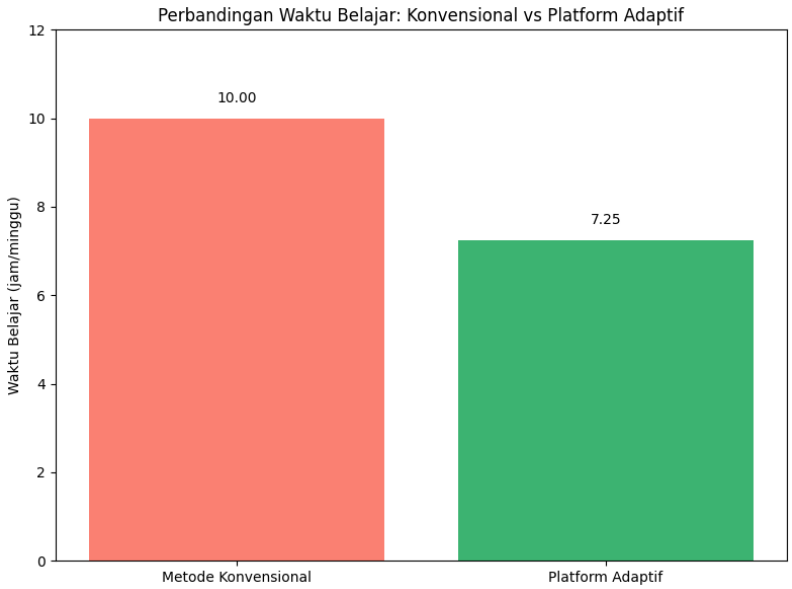

Figure 2 : comparison of Time Efficient

3.3 Student Engagement

Student engagement increased by 35% after using the adaptive system. This increase was demonstrated through login frequency, forum participation, and interaction with the material. According to Self-Determination Theory (Deci & Ryan, 2000), learning engagement increases when students feel that their needs for autonomy, competence, and relatedness are met. Adaptive learning supports this by providing a more personalized learning experience, real-time feedback, and challenges that match students' abilities. Research by Wang, Vogel, & Ran (2011) shows that integrating adaptive elements into online learning can increase

students' intrinsic motivation and participation. Similarly, Baker & Siemens (2014) emphasize that the use of learning analytics in adaptive platforms can significantly increase engagement and interactivity in online learning.

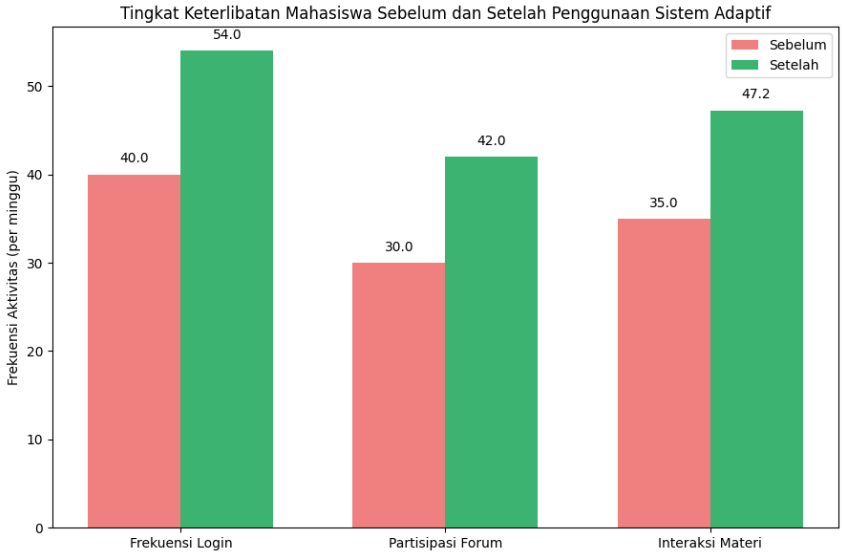

Figure 3 : comparison of Time Efficient

3.4 Study Qualitative

Qualitative findings from interviews and student perception surveys reveal that AI-based adaptive learning systems are considered capable of providing a more relevant, interactive learning experience that is tailored to everyone's needs. Most respondents stated that personalization features, such as additional material recommendations and automatic feedback, were very helpful in understanding topics that they found difficult. Students felt that learning paths tailored to their abilities reduced cognitive load while increasing intrinsic motivation to study independently.

Table 3.4 Qualitative Findings Themes

Themes	Description
Relevance & Interactivity	Students found learning more relevant, interactive, and aligned with individual needs.
Personalization Features	Features such as material recommendations and automated feedback were appreciated.
Concerns: Data Privacy	Concerns regarding security and confidentiality of personal data.
Concerns: Faculty Readiness	Concerns about lecturers' preparedness to guide adaptive learning.
Concerns: Human Interaction	Concerns about reduced human interaction due to reliance on AI.

In addition, adaptive systems were considered capable of fostering a sense of ownership over the learning process. Students were more engaged because they could see their learning

progress in real time, receive instant feedback, and obtain more structured learning directions. This is in line with the findings of Wang, Vogel, & Ran (2011), which show that the integration of adaptive elements in e-learning can increase learning motivation through increased autonomy and a sense of control over the learning process.

However, students also highlighted a number of concerns that need to be addressed by educational institutions. First, the issue of security and confidentiality of personal data is a major concern. Some respondents expressed doubts about how their interaction data—such as learning history, test performance, and online activity patterns—would be used, stored, and processed by the system. This concern is in line with literature that emphasizes the risks of "datafication" in education, namely the transformation of learning activities into data that can be monitored and evaluated (Williamson & Piattoeva, 2021).

Table 3.4.1 *Table 3.4 Qualitative Findings Aspect*

Category	Aspect	Description
Benefit	Relevance and personalization of learning	The adaptive system adjusts learning materials according to individual student needs.
Benefit	Student motivation and engagement	Increased motivation and participation through instant feedback.
Benefit	Sense of ownership over the learning process	Students become more active as they can monitor their learning progress in real-time.
Challenge	Data security and privacy	Students expressed concerns regarding the storage, use, and confidentiality of their data.
Challenge	Lecturer readiness to support AI	Lecturers still need to adapt to effectively support AI-based learning.
Challenge	Decline in human interaction	Risk of reduced social interaction between students and lecturers.

Second, students highlighted the readiness of lecturers in assisting with the use of adaptive systems. Several respondents stated that although AI systems help in delivering material, support from lecturers is still needed to provide more in-depth explanations, guide critical discussions, and provide personal motivation. This shows that the successful implementation of AI depends not only on technology but also on the readiness of human resources to utilize it optimally. Third, there are concerns about the potential decline in the quality of human interaction. Students revealed that over-reliance on adaptive systems can reduce opportunities for direct discussion with lecturers and fellow students. In fact, social interaction is an important aspect of building academic communities and improving collaborative skills. This is consistent with Moore & Kearsley (2012), who emphasize the importance of interaction in maintaining engagement and preventing isolation in distance education. Overall, these qualitative findings reveal ambivalence: on the one hand, AI-based adaptive systems are

considered effective in increasing the relevance and interactivity of learning; on the other hand, ethical, pedagogical, and social challenges must be anticipated. Therefore, the implementation of AI in distance education must consider both technical and humanistic aspects to ensure that the student learning experience remains balanced between technological sophistication and human interaction.

4 CONCLUSION AND RECOMMENDATIONS

This study concludes that artificial intelligence (AI)-based adaptive learning interventions have been proven to contribute significantly to improving the quality of distance learning, particularly at the Open University. The results of the analysis show three main achievements, namely: first, a significant increase in students' mastery of content, as demonstrated by improved test scores after the implementation of the adaptive system. Second, learning time efficiency increased with the personalization of learning paths, allowing students to focus their cognitive energy on relevant topics. Third, student engagement in online learning activities was also significantly encouraged, as shown by increased participation in forums, login frequency, and interaction with learning materials.

However, this effectiveness is not automatic and sustainable without institutional support and a holistic approach. The implementation of AI-based adaptive systems requires clear policies from universities regarding student data protection, ethical governance, and transparency of the algorithms used. This is important to build student trust and prevent the risk of data misuse. On the other hand, the success of adaptive systems is also greatly influenced by the readiness of lecturers. Therefore, developing lecturer capacity through intensive training and digital literacy programs is key to ensuring that AI is optimally utilized as a learning tool, rather than merely a technical tool.

In addition, the integration of AI in distance learning needs to be balanced. AI should be positioned as a support, not a replacement, for the role of humans in education. The presence of lecturer-student interaction remains crucial, especially to support the affective and social dimensions, as well as the development of critical thinking skills that cannot be fully replaced by automated systems. Thus, a hybrid approach that combines AI with conventional pedagogical interaction is considered more effective in the long term.

Based on the findings of this study, several recommendations can be made. First, further research needs to examine the long-term impact of AI-based adaptive learning on student retention and learning outcomes. This is important to determine the extent to which positive

effects can be sustained after several semesters or years. Second, a more in-depth study needs to be conducted on the contribution of AI in developing higher-level skills such as critical thinking, problem solving, and collaboration, which are essential competencies in the 21st century. Third, further exploration of the technology access gap is needed so that the application of AI does not widen the digital divide among students, especially those from remote areas with limited internet infrastructure.

By considering policy aspects, lecturer readiness, and equal access, the implementation of AI-based adaptive learning is expected to not only provide short-term benefits in the form of improved academic achievement, but also support the long-term mission of inclusive, sustainable, and equitable distance education.

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