

## AI-Based Adaptive Learning in Higher Education: Improving Student Engagement and Learning Outcomes

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### Abstract:

Artificial Intelligence (AI) based adaptive learning has great potential to improve student engagement and learning outcomes by personalizing the teaching-learning process. This study aims to analyze the implementation of AI-based adaptive learning in higher education and its impact on student engagement and learning outcomes. This study uses a qualitative approach with a case study method. The subjects of the study consisted of the Rector, Dekan, Head of the Study Program, Lecturers, IT Team, and students. Data collection techniques were done through observation, in-depth interviews, and documentation. Data analysis techniques used include data reduction, data presentation, and conclusion. The study results indicate that implementing AI-based adaptive learning in higher education provides significant benefits, such as the ability to adjust learning materials to the needs of individual students, increase learning motivation, and support students in understanding the material more deeply. AI is used to identify student learning patterns, provide real-time feedback, and recommend relevant learning resources. However, the challenges faced include the need for more technological literacy among students and lecturers, technical constraints in implementing AI systems, and ethical policies in using student data. This study significantly contributes to developing technology-based learning models in higher education. By highlighting the role of AI in creating more personalized learning experiences, this research encourages the strategic adoption of AI technology in education.

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## INTRODUCTION

It is essential to realize that AI-based adaptive learning focuses on the technical aspects of system management and increasing student engagement in the learning process. This is because AI technology can analyze individual student needs and provide materials that are appropriate to their abilities so that it can increase learning motivation (Zhang et al., 2024). Research conducted by (Al Shloul et al., 2024) proves



that students who use AI-based adaptive learning systems have higher levels of engagement and better learning outcomes than traditional learning methods. Thus, AI-based adaptive learning provides a solution that improves learning effectiveness and supports personalization and a more inclusive learning experience in higher education.

AI-based adaptive learning has become one of the critical innovations in higher education that improve student engagement and learning outcomes. Previous studies, such as those conducted by (Du Plooy et al., 2024), have shown that learning technologies designed to adapt the material and pace of learning to individual student needs can significantly improve motivation and learning outcomes. In addition, a study by (Naseer et al., 2024) revealed that implementing AI systems that consider student preferences and learning styles can create a more personalized learning experience, thereby increasing retention rates and academic success. Meanwhile, research by (Honig et al., 2024) examines the impact of AI integration in classroom management, which shows that this technology can provide real-time feedback and encourage student engagement in the learning process. In this context, AI systems also enable lecturers to monitor student progress more effectively so interventions can be carried out more quickly and precisely. (Fischer et al., 2024) highlights the importance of student and lecturer involvement in developing and evaluating AI-based learning systems to ensure that the technology is relevant to individual student needs while supporting the goals of higher education institutions. Thus, although many studies have demonstrated the positive impact of AI-based adaptive learning on student engagement and learning outcomes, further research is needed on how this strategy can be integrated with traditional pedagogical approaches and how the interaction between the two can address the ethical and technical challenges in implementing this technology in higher education settings.

This study aims to fill the gap in previous research that emphasizes traditional aspects such as teaching methods and standard curriculum in improving student engagement and learning outcomes. Most studies have yet to explore the role of AI-based adaptive learning in this context. Therefore, this study aims to analyze how AI-based adaptive learning can improve student engagement and learning outcomes through an integrated approach with the education quality evaluation system. This study proposes that a personalized AI-based learning system, supported by data analytics and digital competency development programs, can answer the challenges of changing learning needs in the technology era (Liu et al., 2024). The novelty of this study lies in the new approach that combines AI-based adaptive learning with education quality evaluation strategies to maximize student learning outcomes, which has yet to be widely explored in previous literature. This study is also relevant amid an era marked by technological disruption, where higher education institutions must respond with more adaptive pedagogical innovations. This approach is expected to significantly contribute to strengthening the relevance of higher education and providing evidence-based policy recommendations for the effective implementation of AI-based learning in higher education institutions.

This study argues that artificial intelligence (AI) based adaptive learning significantly enhances student engagement and learning outcomes in higher education.

AI technology enables learning systems to tailor teaching materials and methods to individual student needs, creating a more personalized and practical learning experience (Tian, 2024). The ability of adaptive learning to analyze real-time student learning behaviour data provides an opportunity to detect gaps in understanding and identify appropriate learning strategies (Obourdin et al., 2024). This approach can increase students' motivation, active engagement, and confidence in facing academic challenges. Thus, students understand the learning material better and are better prepared to apply that knowledge in the real world. This study confirms that integrating AI-based adaptive learning in higher education can strengthen student engagement, improve learning outcomes, and create a more meaningful and relevant educational experience.

## **RESEARCH METHOD**

This research method focuses on applying artificial intelligence (AI)-based adaptive learning to improve student engagement and learning outcomes in higher education, with a personalization approach as the core of development. The steps implemented, such as the use of AI algorithms to analyze individual learning needs, the development of materials that are by students' learning styles, and the integration of adaptive technology in the learning process, are expected to provide a positive contribution to a more effective and meaningful learning experience. The application of AI-based adaptive learning not only focuses on the technological aspect but also includes a systemic approach that considers the goals of higher education and the needs of the digital era. In higher education, which is increasingly oriented towards relevant and inclusive learning outcomes, examining how personalization through AI can improve student engagement in the learning process and overall academic outcomes is essential. The paradigm shift from traditional learning methods to a flexible, student-centred, technology-based approach is expected to create a more interactive, responsive educational ecosystem oriented towards long-term competency development. Thus, the integration of AI-based adaptive learning can encourage the achievement of higher learning outcomes, as well as build higher education institutions that are more innovative and ready to face global challenges in the future.

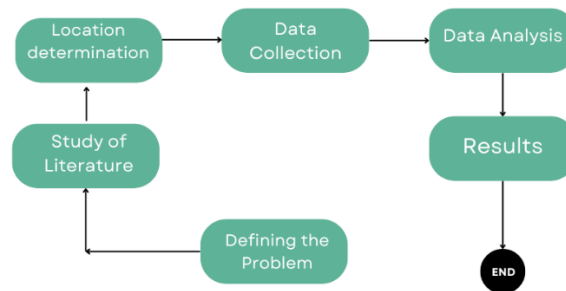
The researcher used a qualitative approach with a case study type to study AI-based adaptive learning in higher education to improve student engagement and learning outcomes. The case study was chosen because it provides an in-depth, contextual, and holistic understanding of how adaptive AI technology can contribute to optimizing the learning process, especially in the context of higher education. This study allows for a deeper exploration of the factors that influence the effectiveness of AI-based adaptive learning, such as student learning preferences, technical challenges, and the influence of external and internal factors on engagement and learning outcomes. In addition, with an educational innovation perspective, this study also seeks to explore how adaptive AI technology can be aligned with humanistic pedagogical principles to strengthen student engagement and improve learning outcomes. In this study, the researcher aims to understand the perspectives of individuals directly involved in this dynamic, such as students, lecturers, and AI technology developers, who

can provide subjective insights regarding the experience and meaning of the adaptive learning process that impacts student academic success.

This study's primary focus is to uncover the role of AI-based adaptive learning in improving student engagement and learning outcomes in higher education. The researcher explored sources of information from individuals and parties who have a deep understanding of how AI-based adaptive learning is applied in the context of higher education. The data collected in this study are divided into two main categories: first, data on efforts made to implement AI-based adaptive learning, which includes the development of technology-based curricula, training for lecturers in using AI in the teaching process, and evaluation of learning systems that enable personalization of student learning experiences; and second, data on the implications of these efforts on improving student engagement and learning outcomes, as seen from the increase in student interaction in learning, understanding of the material, and academic evaluation results. The primary data sources in this research include the Rector, Dean, Head of Study Program, Lecturers, IT Team, and students. This approach ensures that the data collected provides an overview and an in-depth analysis of how AI-based adaptive learning can improve student engagement and learning outcomes, as well as its implications for creating more effective and responsive learning environments in higher education.

The data collected in this study were analyzed using Miles and Huberman's data analysis techniques, which include data condensation, data display, and verification by research (Köhler, 2024). Researchers systematically managed, analyzed, and verified data to ensure the accuracy and reliability of findings regarding the application of AI-based adaptive learning in improving student engagement and learning outcomes in higher education. Data management was carried out through interviews, observations, and documentation, which were then condensed and grouped based on central themes such as AI technology, adaptive learning, student engagement, and learning outcomes. Data analysis used matrices and graphs to visualize critical findings, while verification was carried out by triangulating sources and member checking to ensure the consistency and validity of the findings. With this approach, researchers can ensure that conclusions on the relationship between AI-based adaptive learning and student engagement and learning outcomes are measured accurately and reliably and provide in-depth insights into how AI technology can improve the quality of learning in higher education.

## RESEARCH METHODS



**Figure 1.** Research Method

## RESULT AND DISCUSSION

This study focuses on three main aspects of implementing AI-based adaptive learning in higher education: increasing student engagement through learning personalization, improving student learning outcomes through data-driven learning, and improving student learning independence. The results of this study reveal how the implementation of AI-based learning technology supported by a data-driven approach can strengthen the relationship between students and learning materials, create an educational environment that supports the diversity of individual learning needs through personalized recommendations, and increase the effectiveness of the learning process. The discussion of these results will outline the positive impacts of these three aspects on increasing student engagement and learning outcomes, strengthening students' adaptability to academic challenges, and optimizing learning strategies at the higher education institution level.

### **Increasing Student Engagement through Personalized Learning**

Increasing student engagement through personalized learning is a critical factor in improving the quality of higher education, especially in the context of quality control. Students must be able to experience learning that suits their styles and needs, which can help students be more active and motivated in the learning process (Saifi et al., 2024). Through personalized learning, students can develop skills that are more relevant to the development of the world of work and future challenges, while increasing satisfaction and academic performance (Pimdee et al., 2024). Thus, personalized learning is a supporting element in creating a more inclusive and quality learning experience.

The following are research results that show increased student engagement through personalized learning at Universitas Nurul Jadid, Probolinggo:

**Table 1.** Interview Result Data

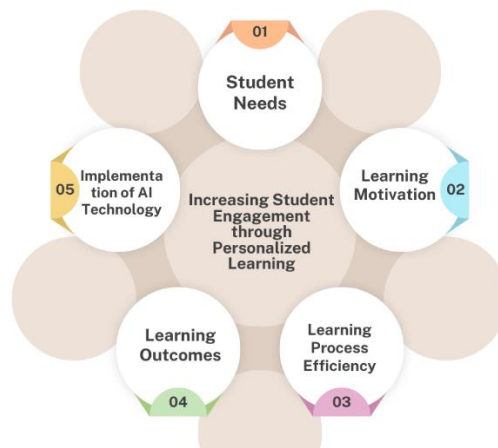
*Increasing Student Engagement through Personalized Learning*

Informant	Code	Statement
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Rektor	Student Needs	"Students have diverse learning needs, and personalization helps us meet individual needs through recommendations for specific materials or assignments."
Student	Motivation to learn	"With the AI-based adaptive system, I feel more motivated because the material presented is according to my level of understanding."
IT Team	Efficiency of Learning Process	"AI is able to identify areas of student weakness, so that lecturers can immediately pay attention to aspects that require intervention."
head of the study program	Learning outcomes	"Data shows that adaptive approaches improve student learning outcomes, especially in subjects that require deep conceptual understanding."
Lecturer	Implementation of AI Technology	"The key to successful adaptive learning is valid data and algorithms that continuously learn from student patterns in real-time."

The interview highlighted the significant impact of personalized learning through AI in improving educational outcomes. According to lecturers, customized learning helps meet the diverse learning needs of students by providing tailored recommendations for materials or assignments. Students feel more motivated because the adaptive system presents materials that are appropriate to their understanding. The IT team emphasized the efficiency of AI in identifying areas that require additional support, allowing lecturers to focus on aspects that need more attention. Data shows that this adaptive approach improves student learning outcomes, especially in subjects that require deep conceptual understanding. For lecturers, the success of adaptive learning relies heavily on accurate data and algorithms that continually evolve based on real-time student patterns.

Integrating AI into education provides a learning experience tailored to students' needs, making it more engaging and efficient. Lecturers report that AI-based recommendations allow for the unique needs of each student, which can increase motivation and create a more personalized learning environment. From an IT perspective, AI helps streamline the learning process by identifying student weaknesses so lecturers can intervene effectively. The result is improved student performance, especially in subjects that require deep understanding. The effectiveness of AI-based adaptive learning systems relies heavily on high-quality data and continuous refinement of algorithms based on real-time student patterns.



**Figure 2.** *Increasing Student Engagement through Personalized Learning*

Figure 2. AI-based adaptive learning in higher education offers a more personalized approach to addressing student needs, increasing learning motivation, and supporting the efficiency of the learning process. By using AI technology, the learning system can adjust teaching materials and methods according to each student's level of understanding and learning style, thus meeting individual needs more precisely (Ezzaim et al., 2024). This approach can also increase student learning motivation because they feel more cared for and given materials relevant to their abilities (Baharun & Hasanah, 2023). In addition, the efficiency of the learning process increases because AI can provide real-time feedback, allowing students to understand the material faster and avoid repeating mistakes (Han et al., 2024). Ultimately, this technology-driven personalization of learning can improve student learning outcomes by providing a more effective, engaging, and developmentally appropriate learning experience.

### **Improving Student Learning Outcomes through Data-Based Learning**

Improving student learning outcomes is one of the main goals in higher education, especially by utilizing data-based learning that allows for a more targeted and measurable learning approach. Data-based learning provides an opportunity to analyze students' needs, abilities, and developments in depth so that more relevant and effective learning strategies can be designed according to individual profiles (Salem Abdullah Bajaber, 2024). In this way, students get materials that suit their needs and can develop optimal learning abilities through evidence-based interventions. Analytical technology and decision support systems are essential for the ongoing data-based learning process (Soori et al., 2024). In addition, quality control through systematic monitoring and evaluation is needed to ensure that this approach positively impacts student learning outcomes and remains relevant to the demands of the ever-evolving world of education. Therefore, data-based learning and quality control are essential synergies in creating a more productive learning environment in higher education (Agus R et al., 2024).

The results of an interview conducted at Nurul Jadid University with a lecturer who has implemented data-based learning and AI. He stated, "*With AI technology, we can understand students' learning patterns in depth, such as when they tend to be active, where they have difficulties, and interests interesting to them. This allows us to provide more relevant learning recommendations.*" He said student engagement has increased by 30% since this data-based learning system was implemented. He also noted that students

feel more personally supported, increasing their motivation to learn. A student of the Informatics Engineering study program who uses an AI-based adaptive learning system. He said, "At first, I was skeptical about this technology, but after a few weeks, I felt that this system helped me understand difficult materials. When I had difficulty with a particular topic, AI immediately recommended additional videos or interactive simulations that suited my needs." The student emphasized that he felt more confident in preparing for the exam because the materials provided were to his level of understanding.

The above interview highlights the lecturer's perspective on how AI is used to enhance the personalization and effectiveness of learning, resulting in increased student engagement. This is in line with the second interview, where students directly experienced the benefits of this approach, especially regarding access to relevant and personalized materials. The connection between the interviews illustrates that the success of implementing data-driven learning in higher education depends on the technology itself and students' acceptance of its benefits. The alignment between lecturer data analysis and student experiences suggests that AI-based adaptive learning can be a solution to improve learning outcomes more inclusively and efficiently.

Therefore, implementing AI-based adaptive learning can increase student engagement and learning outcomes through a personalized and needs-based approach. In addition, the success of this program requires collaboration between educational institutions, lecturers, and students to maximize the potential of technology. Through this strategy, higher education can utilize data-based learning to create a more adaptive and relevant learning experience. By implementing AI-based adaptive learning, educational institutions can adjust teaching materials and methods according to each student's speed and learning style, thereby increasing understanding and retention of the material. Collaboration between technology, teachers, and students also opens up opportunities to optimize the evaluation process and provide more timely and targeted feedback, supporting the development of student competencies more effectively.



**Figure 3.** Improvement in student learning outcomes

Figure 3. Improving student learning outcomes through data-driven learning can be achieved by optimizing student engagement, personalizing learning, evaluating learning outcomes, and collaboration. Student engagement is monitored through participation data, which helps improve understanding of the material. Personalizing learning allows the material to be tailored to individual needs, maximizing learning



effectiveness. Learning outcomes can be evaluated through data analysis from assessments and assignments, allowing for corrective actions to improve student understanding. Collaboration is also strengthened through digital platforms that support interaction between students, lecturers, and technology, enriching the learning experience. By integrating these factors, data-driven learning can significantly improve student learning outcomes.

### **The Effectiveness of Adaptive Learning in Improving Student Learning Independence**

The effectiveness of adaptive learning is critical in improving students' learning independence, especially in facing technological developments and the changing needs of higher education. Adaptive learning allows students to learn with a more personal approach tailored to their abilities and learning styles, thus facilitating the development of their potential to the maximum (Conde & Rodríguez-Sedano, 2024). With this approach, students can gain a more relevant and practical learning experience, improving their ability to manage the learning process independently (Hasanah et al., 2024). In the context of quality control, a continuous evaluation system plays a vital role in assessing the extent to which adaptive learning can support students' learning independence and ensuring that the quality of learning is maintained and relevant to future educational needs (Lai et al., 2023). Therefore, adaptive learning and quality control are two elements that support each other in creating a more effective and quality learning experience for students.

The results of interviews with the head of the dean at Nurul Jadid University show the importance of using adaptive learning based on artificial intelligence (AI) in supporting student learning independence. He says, "*Adaptive learning allows students to learn at a pace and style that suits their needs, which is critical in this digital age.*" He explained that the ability to customize teaching materials and methods through AI technology allows students to be more involved and feel motivated in the learning process. This is in line with the opinions of several lecturers who stated, "*AI enables a more personalized and flexible learning approach, helping students develop greater learning independence.*"

In addition, the Head of the Study Program added that "*Student engagement increases when they feel that the learning material is relevant to their needs and level of understanding.*" When adaptive materials are applied, students attend lectures and play an active role in exploring knowledge according to their rhythm and capabilities. The Head of the Study Program noted that since implementing the adaptive learning system, many students have shown increased learning motivation and independence in managing academic tasks. This view is supported by the results of observations during the Covid-19 pandemic, where the application of technology in teaching is increasingly relevant to creating a practical and independent learning experience.

On the other hand, the Chancellor said that to strengthen the effectiveness of adaptive learning, Nurul Jadid University has collaborated with international institutions to research and develop educational technology. This collaboration program includes studies and benchmarking to countries such as Malaysia and Singapore that have previously implemented AI technology in education. "*By expanding our international*

*network, we hope to adopt best practices in applying AI in higher education while providing opportunities for lecturers and students to engage in collaborative research."* This is expected to improve the quality and involvement in technology-based learning so that students are better prepared to learn independently and oriented towards better results.

The results of interviews with various parties at Nurul Jadid University emphasized the importance of adaptive learning based on artificial intelligence (AI) in encouraging students' learning independence. The Dean's Chairperson highlighted that this approach allows students to learn at the pace and style they need, which is relevant in the digital era. Other lecturers added that student engagement increases when learning materials are tailored to their needs and level of understanding. This adaptive technology has been shown to improve students' motivation and ability to manage academic tasks independently, especially after the experience during the Covid-19 pandemic, which emphasized the importance of technology in creating effective and flexible learning.

Nurul Jadid University is also actively strengthening adaptive learning initiatives through international collaborations with institutions from Malaysia and Singapore, countries that have advanced in the application of AI in education. This collaboration includes joint research and benchmarking of best practices to develop educational technology. Through this step, the university hopes to increase the involvement of lecturers and students in global research while ensuring the optimal adoption of AI. This approach is believed to improve the quality of education, prepare students to learn more independently, and produce better academic achievements.

## **CONCLUSION**

Research on AI-based adaptive learning in higher education discusses how AI technology can improve student engagement and learning outcomes. Adaptive learning that integrates AI enables a more personalized learning experience tailored to each student's needs. The findings in this study indicate that students involved in adaptive learning systems tend to be more motivated and better understand the learning material. Adapting learning to individual student abilities is essential in improving the effectiveness of the learning process and academic outcomes. These findings are very relevant to higher education institutions' efforts to optimize the quality of education by utilizing technological advances.

The importance of these findings lies in their application to higher education practices and policies. By implementing AI-based adaptive learning, higher education institutions can create more inclusive learning experiences that are responsive to students' academic needs. Policies supporting AI integration into learning can accelerate the personalization process, allowing students to learn in a way and at a pace that suits their potential. These AI-based learning management practices can significantly increase student engagement, which in turn also contributes to improved learning outcomes. This study opens up space for further research on how AI can support diversity and inclusivity in higher education.

This article's contribution to knowledge is to provide new insights into how AI-based adaptive learning can impact student engagement and learning outcomes in higher education contexts. This research enriches the existing literature on AI integration in education and offers practical solutions to enhance students' learning experiences. Implications for further research include a deeper exploration of the influence of other factors, such as motivation, social support, and higher education policies, in maximizing the potential of AI-based adaptive learning. This could lead to more holistic and data-driven learning models, supporting more effective and efficient teaching quality and education management.

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