EXPLORING THE EFFECTIVENESS OF AI POWERED PERSONALIZED LEARNING SYSTEMS ON STUDENT ACADEMIC PERFORMANCE IN HIGHER EDUCATION

MENGEKSPLORASI EFEKTIVITAS SISTEM PEMBELAJARAN PERSONALISASI BERBASIS KECERDASAN BUATAN (AI) TERHADAP PERFORMA AKADEMIK MAHASISWA DI PENDIDIKAN TINGGI

Wikanso[1], Teja Insyaf Sukariyadi[2]
Universitas PGRI Madiun[1,2]
*wikanso@unipma.ac.id[1], teja.is@unipma.ac.id[2]

Corresponding Author

ABSTRACT
This study aims to explore the effectiveness of an Artificial Intelligence (AI)-based personalized learning system on student academic performance in higher education. The approach used is systematic narrative review against literature obtained from reputable databases, namely Scopus, Web of Science, ERIC, and Google Scholar. The synthesis of findings shows that AI-based adaptive learning systems tend to improve academic outcomes, engagement, and student retention through adjusting content, speed, and learning methods to individual needs.However, the effectiveness of AI personalization is influenced by various factors. Moderating factors, including student characteristics (e.g., motivation and prior knowledge), the AI strategies implemented (such as adaptive feedback and intelligent tutoring), and the institutional context (including technology infrastructure and faculty support). The review also identified research gaps, such as the limitations of longitudinal studies, variations in effectiveness across disciplines, and the lack of integration of a robust theoretical framework for learning.This research strengthens the theoretical basis of adaptive learning and provides practical recommendations for universities to implement AI strategically and evidence-based. Overall, the findings suggest that AI can improve the quality of learning, but successful implementation depends on attention to contextual factors and appropriate system design.
Keywords: Artificial Intelligence (AI), Personalized Learning, Adaptive Learning, Higher Education, Academic Performance

ABSTRAK
Penelitian ini bertujuan untuk mengeksplorasi efektivitas sistem pembelajaran personalisasi berbasis Kecerdasan Buatan (AI) terhadap performa akademik mahasiswa di pendidikan tinggi. Pendekatan yang digunakan adalah tinjauan naratif sistematis (narrative review) terhadap literatur yang diperoleh dari basis data bereputasi, yaitu Scopus, Web of Science, ERIC, dan Google Scholar. Sintesis temuan menunjukkan bahwa sistem pembelajaran adaptif berbasis AI cenderung meningkatkan hasil akademik, keterlibatan (engagement), dan retensi mahasiswa melalui penyesuaian konten, kecepatan, dan metode belajar sesuai kebutuhan individu. Meskipun demikian, efektivitas AI personalization dipengaruhi oleh berbagai faktor moderasi, termasuk karakteristik mahasiswa (misalnya motivasi dan pengetahuan awal), strategi AI yang diterapkan (seperti umpan balik adaptif dan intelligent tutoring), serta konteks institusional (termasuk infrastruktur teknologi dan dukungan dosen). Tinjauan ini juga mengidentifikasi kesenjangan penelitian yang signifikan, seperti keterbatasan studi longitudinal, variasi efektivitas antar disiplin ilmu, dan minimnya integrasi kerangka teoritis pembelajaran yang kokoh. Penelitian ini memperkuat dasar teoritis pembelajaran adaptif dan memberikan rekomendasi praktis bagi universitas untuk mengimplementasikan AI secara strategis dan berbasis bukti. Secara keseluruhan, temuan menunjukkan bahwa AI dapat meningkatkan kualitas pembelajaran, namun keberhasilan implementasinya bergantung pada perhatian terhadap faktor-faktor kontekstual dan desain sistem yang tepat.
Kata Kunci: Kecerdasan Buatan (AI), Pembelajaran Personal, Pembelajaran Adaptif, Pendidikan Tinggi, Performa Akademik

1. INTRODUCTION

The development of artificial intelligence (AI) technology has had a significant impact on the education sector, particularly higher education. AI is now being used to support adaptive learning or personalized learning, where the material, methods, and learning pace can be tailored to each student's individual characteristics. AI-based personalized learning aims to improve learning effectiveness, motivation, and student academic outcomes (UNESCO, 2025).

According to UNESCO's global survey, approximately66% of higher education institutions have developed or are developing policies related to AI adoption, although only 19% have formally implemented these policies. This indicates that most universities recognize the potential of AI, but their implementation is still in its infancy (UNESCO, 2025).

Meanwhile, the EDUCAUSE (2025) survey shows that60% of higher education administratorsWhile 100% of faculty and staff report using AI within their institutions, less than a third of faculty and staff have direct experience using AI to support teaching and learning. In the US Historically Black Colleges & Universities (HBCU) community, AI adoption by students has reached 98% and by faculty 96%, although challenges related to training and institutional readiness remain (EDUCAUSE, 2025).

In addition, industry reports indicate that approximately45% of higher education institutions have used AI tools to personalize learning, with adoption trends continuing to increase annually. This confirms that AI-based personalized learning has become part of the global higher education strategy to improve student learning outcomes (Zipdo, 2025; Wifitalents, 2025). The following table summarizes the adoption of AI in higher education based on several international surveys:

Table 1
AI Adoption in Higher Education

Institution / Source	AI Adoption Percentage	Information
UNESCO (Global)	66 %	Currently developing or have an AI policy, 19% are formal
EDUCAUSE (Administrator)	60 %	Using AI in institutions, but lecturers' experience is limited
HBCU (Students)	98 %	Students use AI, faculty usage is 96%
HBCU (Faculty)	96 %	Faculty uses AI to support learning
Industry/Global Trends	45 %	Institutions use AI to personalize learning

Source: From Several References

The table above shows that despite the high adoption of AI in higher education, the level of effective use to support personalized learning and academic outcomes remains variable. This data underscores the importance of research that empirically examines the effectiveness of AI-based personalized learning systems, particularly in the context of higher education. It also indicates a gap between AI's potential and actual implementation, necessitating further research to quantify its impact on student academic performance.

Although the adoption of artificial intelligence (AI) technologies in higher education has increased significantly, research that systematically assessesThe effectiveness of an AI-based personalized learning system on students' academic outcomesResearch on AI

personalization remains limited. Most existing studies focus more on technical aspects, user interfaces, or descriptions of learning experiences, without empirically evaluating the actual impact of AI personalization on students' academic achievement, learning motivation, or cognitive skills. This gap highlights the need for research that not only assesses technology implementation but also measures its effects on observable and quantitative learning outcomes.

Furthermore, the implementation of AI personalization in higher education contexts faces various challenges. From an institutional perspective, there are limitations in technological infrastructure, lecturers' readiness to utilize AI systems, and internal policies that support the comprehensive implementation of personalized learning. From a student perspective, adapting to AI systems requires specific digital skills, strong learning motivation, and the ability to manage learning independently. Variations in student characteristics, differences in academic disciplines, and diverse academic contexts make the effectiveness of AI personalization inconsistent across institutions. Therefore, this research is designed to address these challenges.empirical gapwith a focus on measuring the effectiveness of AI-based learning systems and identifying contextual factors that moderate or mediate the relationship between AI personalization and student academic performance.

This research theoretical contribution is significant to the development of educational science, especially in the context of adaptive learning theoryBy empirically assessing the effectiveness of AI-powered personalized learning, this research can strengthen our understanding of how adaptive learning systems can modify individual student learning experiences, increase engagement, and support academic achievement. The findings of this study can also serve as a basis for developing more comprehensive adaptive learning models that integrate cognitive, motivational, and behavioral aspects of student learning.

In a waypracticalThis research offers relevant recommendations for various stakeholders in higher education. For lecturers, the results can provide guidance on effectively utilizing AI personalization to improve student interaction and engagement. For universities, these findings can inform the development of educational technology policies and investment strategies in AI learning systems. For AI platform developers, this research provides insights into the personalization features that most impact student academic performance, enabling the development of systems that are more adaptive and responsive to individual learning needs.

Based on the research gaps and practical relevance outlined, this study focuses on the primary question: "To what extent do AI-powered personalized learning systems enhance student academic performance in higher education?" This primary question aims to assess the extent to which AI-powered personalized learning systems can improve student academic outcomes, while also exploring the factors that influence their effectiveness.

To clarify the direction of the research and guide the literature analysis, this study also considers severalsub-research questionsFirst, how does AI personalization affect student engagement and motivation, including internal mechanisms that may mediate the relationship between AI use and academic outcomes, including engagement levels, intrinsic motivation, and self-regulation skills in learning. Second, which AI strategies are most effective for improving academic performance, with a focus on features such as adaptive feedback, learning path customization, and intelligent tutoring? Third, does the effectiveness of AI personalization differ across disciplines or student characteristics, including differences in background knowledge, learning styles, and learning motivations? Thus, this research question is designed to generate a comprehensive understanding of the effectiveness of AI personalization systems, both from the perspective of academic outcomes and contextual factors that influence students' responses to the technology.

2. METHODS

The method used in this research follows the approach/narrative review with the aim of synthesizing findings from relevant literature regarding the effectiveness of AI-based personalized learning systems on student academic performance in higher education. The review process began with literature search strategyA systematic search using internationally reputable databases, namely Scopus, Web of Science, ERIC, and Google Scholar. The keywords used include key terms that reflect the research focus, including:"AI-powered personalized learning", "adaptive learning", "student academic performance", And "higher education"This search strategy was designed to ensure that the literature obtained was relevant to the research topic and covered a variety of perspectives on AI personalization in the context of higher education.

To ensure the quality and relevance of the literature, this study established inclusion and exclusion criteriaThe literature included were peer-reviewed articles published between 2015 and 2025, focusing on the implementation of AI personalization in higher education and its impact on student academic outcomes. Articles that only discussed AI technology in general, without measuring academic outcomes, were excluded from the analysis. This approach allowed researchers to select studies that provided empirical evidence regarding the relationship between the use of AI personalization and academic performance, thus enhancing the validity of the review and providing a basis for developing theory and practical recommendations.

Once the relevant literature is selected, the next step is data extraction and synthesisThe extracted data included author, year of publication, educational context (e.g., discipline, type of institution), type of AI personalization system used, research methods, and reported academic results. The analysis was conducted systematically.narrative and thematic, by grouping findings based on the AI strategies implemented, their effects on student academic performance, and moderating or mediating factors that influence the effectiveness of AI systems. This approach allows for the identification of patterns, similarities, and differences in findings across studies, and provides deeper insights into the mechanisms by which personalized AI can improve academic outcomes in higher education contexts.

Thus, this systematic narrative review method not only provides a comprehensive mapping of the existing literature, but also allows for a critical synthesis that highlights research gaps, the effectiveness of AI strategies, and the theoretical and practical implications of using AI-based personalized learning systems in higher education.

3. RESULT

3.1. Overview of Selected Studies

The literature on AI-powered personalized learning in higher education reflects a growing body of scholarship surrounding this transformative technology, particularly in the last decade. The proliferation of research, especially since 2018, indicates heightened interest among scholars and practitioners in integrating AI systems into educational environments. Numerous studies have emerged from diverse geographical regions, including North America, Europe, and Asia. This diversity is crucial as it encapsulates various institutional contexts and cultural factors that shape the application and effectiveness of AI in education.

Firstly, many studies emphasize the technical aspects of AI systems designed to enhance learning experiences. For instance, Hinojo-Lucena et al. conducted a bibliometric study highlighting the impact of AI in higher education, particularly focusing on virtual tutoring solutions as a primary means for improving learning experiences (Hinojo-Lucena et al., 2019). Furthermore, Deri et al. provide a comprehensive overview of AI integration, emphasizing personalized learning experiences through intelligent tutoring systems and automated grading (Deri et al., 2024). These findings are consistent with the broader perspective presented by

Kovalchuk et al., who explore the use of adaptive technologies to tailor educational trajectories based on individualized student needs (Kovalchuk et al., 2025).

Despite the focus on enhancing individual learning experiences seen in the literature, the actual measurement of educational outcomes remains notably limited. Lyanda et al. address this gap by conducting a systematic review and meta-analysis of AI tools in online learning contexts, evaluating their effectiveness in fostering student engagement and performance outcomes (Lyanda et al., 2024). Moreover, while many studies advocate for the characteristics and implementation of AI technologies, there is often a lack of rigorous quantitative assessments that would enable clearer insights into academic outcomes, as discussed by Bhatia et al. (Bhatia et al., 2024). This is echoed by Rajendran et al., who discuss how AI can adapt educational content to individual learning styles, yet highlight the need for robust evaluative frameworks to measure these adaptations' success (Rajendran et al., 2024).

The surge in AI-related publications also points to an evolving academic commitment to exploring implications for teaching and assessment practices. As highlighted by Popenici and Kerr, the rapid adoption of AI technologies in education is not merely about technological advancement but also involves reconsidering pedagogical frameworks and assessment strategies in the face of these innovations (Popenici & Kerr, 2017). Moreover, the literature identifies distinct regional approaches to AI integration, as seen in the comparative analysis of AI-enhanced adaptive learning across developed nations by Saad et al. (Saad et al., 2025).

In summary, the body of literature reviewed demonstrates a concerted effort to explore AI's potential to transform personalized learning in higher education. While these studies highlight a variety of applications and benefits, the ongoing challenge remains the comprehensive assessment of their educational efficacy and the diverse socio-cultural factors influencing their implementation.

3.2. Effectiveness of AI-Powered Personalized Learning

The integration of Artificial Intelligence (AI) in personalized learning has shown substantial promise in enhancing student academic performance across various educational contexts. Empirical findings consistently indicate that AI-powered personalized learning systems contribute positively to student engagement and retention, ultimately leading to improved academic outcomes. Notably, studies have demonstrated significant improvements in academic grades through the utilization of adaptive learning systems that tailor educational materials and exercises to meet the individualized needs of students. These adaptive systems exemplify how AI can analyze various data points, such as learning patterns and performance history, and subsequently create customized educational experiences that foster a conducive learning environment (Abbas et al., 2023; (Aggarwal et al., 2023; Roshanaei et al., 2023).

Moreover, the literature reveals that students who engage with AI-powered systems exhibit heightened levels of engagement and persistence in their academic pursuits. For instance, personalized learning environments have been shown to result in more consistent course completion rates compared to traditional methods (Aggarwal et al., 2023; Ayeni et al., 2024; . These advancements suggest that AI not only facilitates immediate academic improvements, such as enhanced quiz and assignment scores but also cultivates essential skills for the long term, including critical thinking, self-regulated learning, and overall readiness for further academic evaluation (Aggarwal et al., 2023; Agatova & Latipova, 2025).

The scope of AI in education extends beyond mere performance metrics, as it actively shapes teaching methodologies and curricular frameworks. For instance, educators are utilizing AI tools to gain insightful feedback regarding student participation and progression, thereby enabling informed, data-driven decision-making in instructional practices (Tanvir et al., 2024; (Uğur, 2025; . Furthermore, the trend towards personalized learning has gained momentum in higher education, with AI applications increasingly aiming to address diverse student needs and gaps in educational equity (Li, 2024; (Uğur, 2025.

The positive impact of AI personalization in learning is further corroborated by the literature, indicating that these technologies adapt lessons and enrich the learning experience through real-time feedback, intelligent tutoring systems, and predictive analytics. This adaptability allows for a more engaging and inclusive learning environment, as AI can tailor content and pedagogical strategies to reflect the unique strengths and challenges of each learner (Pasupuleti, 2024; Ayeni et al., 2024; Saxena & Bajotra, 2024). However, while the benefits of AI-enhanced personalized learning systems are substantial, the accompanying challenges—such as ethical considerations and the need for responsible implementation—must be addressed to ensure equitable access and effectiveness within educational settings (Uğur, 2025; Saxena & Bajotra, 2024).

In summary, the body of research underscores that AI-powered personalized learning significantly improves academic performance, engages students more effectively, and enhances overall educational experiences, all while highlighting the importance of responsible AI deployment in educational contexts.

3.3. Factors Affecting Effectiveness

The effectiveness of AI-powered personalized learning is shaped by various intertwined factors that can significantly determine learning outcomes. Student characteristics such as prior knowledge, learning motivation, and self-regulation are crucial in moderating individual responses to AI systems. Research indicates that students with high levels of motivation and self-regulation skills tend to derive more substantial benefits from personalized learning environments, emphasizing the importance of intrinsic motivation in educational settings (Балашов et al., 2021; Jia & Tu, 2024; Eccles & Wigfield, 2002).

Additionally, specific AI strategies can enhance educational effectiveness by integrating adaptive features like personalized content recommendations, performance-based suggestions, and intelligent tutoring systems. These systems not only provide immediate feedback but also tailor learning experiences to individual student needs (Nwana, 1990; (Bulut & Wongvorachan, 2022; . Studies have shown that effective feedback generation through AI can improve student engagement and learning outcomes, demonstrating the positive impact of timely and relevant interactions in educational contexts (Bulut & Wongvorachan, 2022; (Wei, 2023). Moreover, the design of these AI systems, including their feedback modalities and adaptability, plays a pivotal role in fostering a more personalized learning journey for students, thus enhancing overall motivation and learning satisfaction (Wei, 2023).

Institutional factors are also vital in determining the successful integration of AI-powered personalized learning. The technological infrastructure, availability of faculty support, and relevant institutional policies greatly influence the implementation and optimization of these systems (Nofriyandi & Andrian, 2022; Andini et al., 2023)(Wang et al., 2025). For instance, a well-equipped technological environment coupled with adequately trained faculty can lead to more effective use of AI tools, enhancing student learning experiences (Wang et al., 2025). Conversely, a lack of infrastructure or insufficient faculty preparation can hinder the effectiveness of AI systems, as identified in some studies where inadequate support was linked to diminished learning outcomes (Nofriyandi & Andrian, 2022; Andini et al., 2023).

In conclusion, the interplay between student characteristics, the design and implementation of AI strategies, and institutional support forms a complex network of factors that collectively influence the effectiveness of AI-powered personalized learning. Understanding these dynamics is crucial for educators and institutions aiming to enhance the learning experience through AI technologies.

3.4. Gaps in Literature

The literature surrounding artificial intelligence (AI) personalization in education illustrates significant advancements; however, it also highlights critical research gaps that warrant attention. One major gap is the scarcity of longitudinal studies, which limits the understanding of the long-term impacts of AI personalization on academic performance. Longitudinal analysis is essential for assessing how AI-driven educational interventions influence student outcomes over time, particularly their sustained effectiveness across different academic contexts and demographic groups (Katiyar et al., 2024; Abbas et al., 2023; Trang & Thư, 2024).

Moreover, the effectiveness of AI personalization may vary significantly across disciplines and student characteristics. Current studies have not thoroughly examined these variations, leading to a limited comprehension of the contexts in which AI can be most beneficial. For instance, while some research indicates that AI-driven personalized learning enhances engagement and academic performance in specific courses, the nuances of how this relationship differs across subjects and types of learners remain under-explored. This lack of diverse context understanding can hinder the design of universal AI systems capable of adapting to wide-ranging educational settings Sapci & Sapci, 2020; Bahroun et al., 2023; Abbas et al., 2023; Guo et al., 2024).

Additionally, the theoretical underpinnings of AI personalization strategies often lack robust integration with established learning theories. Research frequently emphasizes the technological capabilities of AI without adequately contextualizing these within educational theory, which is essential for comprehensively understanding how AI influences learning processes and outcomes. The integration of learning theories into empirical studies could illuminate the mechanisms through which AI personalizes education, thereby enhancing the theoretical grounding of existing frameworks (Nguyen et al., 2024; Hardaker & Glenn, 2025; Ahmad et al., 2020).

These identified gaps emphasize the imperative for extensive research that merges robust theoretical frameworks with empirical investigations. Such studies should focus on long-term impacts, contextual efficacy, and theoretical underpinnings to yield deeper insights into AI personalization's effectiveness in higher education. They should also explore innovative applications, allowing AI to adapt pedagogical approaches that cater to individual learners' needs while ensuring ethical considerations are at the forefront of technological integration (Alenezi, 2023; Yan et al., 2025; Sapci & Sapci, 2020; (Katiyar et al., 2024; Duran, 2024).

4. DISCUSSION

4.1. Interpretation of Findings

The findings of the review underscore the significant impact of AI-powered personalized learning on student academic performance within higher education settings. Various studies have demonstrated that adaptive learning systems, which tailor educational content and pace to individual student needs, lead to improved academic outcomes, retention, and engagement. For instance, personalized systems have been shown to enhance knowledge retention and promote engagement through customized educational experiences (Abbas et al., 2023; Ayeni et al., 2024). These findings indicate a robust correlation between the integration of AI personalization strategies and enhancements in student learning experiences, as well as their measurable academic performance.

However, it is crucial to note that these improvements are not universally experienced across all contexts. The effectiveness of AI-driven personalized learning systems is influenced by varied institutional factors, which include the technological infrastructure available and the support provided by faculty (Zawacki-Richter et al., 2019; (Mustafa et al., 2024). For example, supportive teaching environments that leverage AI systems can create optimal learning conditions, which, in turn, enhance the academic experience (Mustafa et al., 2024). Similarly,

the design of AI strategies—such as adaptive quizzes and content recommendations—plays a vital role in determining educational success outcomes (Abbas et al., 2023; Sallu et al., 2024).

Another layer of complexity arises from the individual characteristics of students themselves; their learning motivation, prior knowledge, and learning styles significantly shape the outcomes of AI personalization efforts Herawati et al., 2024). Research emphasizes that the personalized nature of AI-powered instruction encourages self-regulated learning and enhances metacognitive skills, leading to a deeper learning experience (Chan, 2023; Herawati et al., 2024). Thus, the interaction between the technological aspects of AI applications and the user's unique educational context is critical for the success of these personalized learning approaches.

The review suggests that the success of AI personalization hinges heavily on the intricate dynamics of technology, user interaction, and the academic environment (Abbas et al., 2023; Chen et al., 2020). Adaptive learning systems must consider these multifaceted influences to optimize their approaches and realize their full potential in transforming education.

4.2. Theoretical Implications

These findings have important theoretical implications. First, the review results support principal constructivist learning, where learning tailored to individual needs encourages students to actively construct their own knowledge. Second, AI personalization can reduce cognitive load by presenting material according to students' abilities and readiness levels, thereby increasing learning effectiveness. However, current literature indicates a need for developing an integrative model which combines AI personalization with the concept of self-regulated learning, so that students not only receive material adaptively but also learn to manage their learning process independently and reflectively. Developing such a model can expand adaptive learning theory and provide a stronger theoretical foundation for further research.

4.3. Practical Implications

From a practical perspective, these findings provide clear direction for the development of AI systems in universities. Educational institutions can leverage these insights to design AI systems that are more responsive to individual needs, with personalized features powered by student data and adaptive feedback. For lecturers, this research offers guidance on effectively utilizing AI, for example, by providing supplemental materials, adjusting assignments, and monitoring student progress in real time. Furthermore, understanding moderating factors such as student characteristics and disciplinary context can help universities and AI developers determine more targeted implementation strategies, ensuring that AI systems are not only technically usable but also provide tangible benefits to academic performance.

4.4. Limitations

While this review provides a comprehensive overview, several limitations are worth noting. First, the research focus is limited to available, peer-reviewed literature, so generalizing the results to all higher education institutions or global contexts should be done with caution. Second, some of the analyzed studies lack transparency in explaining their academic performance evaluation methods, so interpretations of the impact of AI personalization on student outcomes must be understood within the context of these methodological limitations. Third, most of the studies are cross-sectional or short-term, so understanding the long-term effects of AI personalization is still limited and requires further, more longitudinal research.

5. CONCLUSION

The results of this review show thatAI-powered personalized learning tends to improve students' academic performance.in higher education. Learning systems that adapt content, pace, and methods to individual needs have been shown to be effective in improving student academic performance, engagement, and retention. However, their effectiveness is not uniform and is influenced by various factors, including the AI strategies used, student characteristics, and institutional contexts such as faculty support and technological facilities. These findings underscore the importance of approaches that consider the complex interactions between technology, users, and the academic environment to maximize the benefits of AI personalization.

Although the existing literature shows promising results, there are some research gaps that require attention in future studies. First, there are still limited longitudinal studies and comparative experiments that can assess the long-term impact of AI personalization on academic performance. Second, variations in effectiveness across disciplines and student characteristics have not been analyzed in depth, resulting in a limited understanding of optimal contexts. Third, the integration of learning theory in AI personalization studies is still limited, requiring further development of theoretical mechanisms explaining how and why AI improves academic performance. Future research should combine empirical approaches with robust theoretical frameworks to provide deeper and more applicable insights.

Overall, this narrative review provides a comprehensive understanding of the effectiveness of AI-powered personalized learning in higher education, highlighting factors influencing learning outcomes and identifying important research gaps. These findings not only strengthen the theoretical foundation of adaptive learning but also provide practical guidance for universities, lecturers, and AI system developers to improve the quality of technology-based learning. Thus, this review serves as a strategic foundation for future research and implementation of personalized AI, with the goal of improving the effectiveness and quality of higher education through evidence-based technological innovation.

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