Research Article

THE APPLICATION OF ARTIFICIAL INTELLIGENCE FOR PERSONALIZED STUDENT LEARNING ACTIVITIES

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ABSTRACT

This study analyzes the role of AI in personalizing student learning activities, from core concepts and theoretical underpinnings to practical applications, while also clarifying influencing factors, challenges, and barriers and proposing solutions. A mixed-methods approach was employed, combining literature review and analysis with a survey of 594 students and in-depth interviews with 10 students and 5 instructors at Ho Chi Minh City University of Education. The findings suggest that AI has significant potential to enhance learning outcomes, foster student motivation, and increase student engagement. However, its effectiveness depends on factors such as data quality, system design, instructor competency, student involvement, and ethical considerations. Limitations include the non-representative survey sample and the need for further experimental research to confirm these results.

Keywords: adaptive learning systems; artificial intelligence; personalized learning; higher education

1. Introduction

Global higher education is facing increasing challenges in meeting the diverse learning needs of students. The context of large class sizes, coupled with traditional, "one-size-fits-all" teaching methods, often fails to effectively address the individual needs, abilities, and learning preferences of each student (Christensen et al., 2013). This model often results in some students being left behind, while others find themselves bored and unmotivated. The trend of personalized learning has emerged as a promising solution to this problem. The report by the Organisation for Economic Co-operation and Development (OECD, 2018) highlighted personalized learning as one of the key trends shaping the future of education. This report also pointed out that personalized learning is not merely about providing each student with a separate learning plan, but also requires changes in the way classes are organized, teaching methods, and the technology used. Personalized learning is the process

of "designing and implementing learning experiences tailored to the individual needs of the learner" (UNESCO, 2015, p.12). This may include adjusting the content, pace, teaching methods, assessment methods, and learning environment to suit each individual. Personalized learning enables students to learn in the way that best suits them, thereby enhancing motivation, improving knowledge acquisition, and promoting holistic development (Pane et al., 2017). The development of artificial intelligence (AI) has opened up unprecedented opportunities for personalized learning. AI, with its ability to process large data, recognize complex patterns, and automate tasks, offers immense potential for personalizing learning at scale and effectively. Holmes et al. (2019) argue that AI can "revolutionize education by providing each student with a personalized learning path, based on their needs, strengths, and weaknesses". This paper focuses on analyzing the role of AI in personalizing student learning, from concepts to specific applications, to enhance learning effectiveness and promote the holistic development of each individual.

2. Research methodology

2.1. Research methods

This study employs a mixed-methods approach, integrating a literature review, a quantitative survey, and qualitative in-depth interviews to investigate the application of AI in personalized learning. The research began with a synthesis of relevant literature to establish a theoretical framework. Following this, a quantitative survey was conducted using an online questionnaire distributed via Google Forms. The survey collected responses from 594 students at Ho Chi Minh City University of Education between December 15, 2024, and January 19, 2025, capturing their perceptions and evaluations of AI in personalized learning. It is acknowledged that this sample may have limitations regarding representativeness and potential self-selection bias, which future research should address through stratified random sampling. To complement the quantitative data, semi-structured in-depth interviews were conducted with a purposive sample of 10 students and 5 instructors experienced with AI-powered learning tools, exploring their subjective experiences and insights. Data analysis involves descriptive and inferential statistics for the survey data and thematic analysis (Braun & Clarke, 2006) for the interview data, providing a comprehensive understanding of the research problem.

2.2. Personalized learning

Personalized learning is a multifaceted concept with various definitions provided by reputable educational organizations and researchers. The Organisation for Economic Co-operation and Development (OECD, 2021) defines personalized learning as "a learner-centered approach in which the content and teaching methods are tailored to the individual learning needs of students" (p. 9). Personalized learning allows for adjustments to content, pacing, teaching methods, assessment tools, and the learning environment to suit each individual. Personalized learning enables students to learn in a manner that is most

appropriate for them, thereby enhancing motivation, improving knowledge acquisition, and promoting holistic development (Essa et al., 2023).

Numerous studies have shown that personalized learning offers multiple benefits for students, including increased learning motivation, improved knowledge acquisition, development of self-directed learning skills, accommodation of diverse learning needs, and fostering holistic development. When students can learn in a way that best suits them, they feel more engaged and motivated to participate in the learning process (Essa et al., 2023). Personalized learning allows students to focus on the content they need most and learn at their own pace, thereby enhancing knowledge acquisition (Gocen & Aydemir, 2020). Personalized learning encourages students to be proactive in their learning, set their own goals, find their own resources, and self-assess their learning progress, thereby helping them develop self-directed learning skills. Personalized learning enables the accommodation of diverse learning needs of students, from high-achieving students to those who experience learning difficulties. Finally, personalized learning not only focuses on the development of knowledge, but also emphasizes the development of skills, attitudes, and values of students, thereby helping them achieve holistic development.

2.3. AI in Personalized Learning

The integration of Artificial Intelligence (AI) and personalized learning has fostered the development of numerous groundbreaking applications, significantly contributing to enhanced educational effectiveness and quality. Adaptive Learning Systems, for instance, utilize AI to monitor student learning progress, dynamically adjusting content, difficulty levels, and teaching methods. These systems are capable of analyzing diverse student learning data, such as scores, assignment completion times, and engagement with learning resources, to discern individual strengths, weaknesses, and preferred learning styles. Concurrently, personalized learning content recommendation systems leverage this data and student preferences to suggest relevant resources, including readings, videos, exercises, or online courses. AI-powered virtual learning assistants further augment this personalization by providing responses to student inquiries, offering guidance, aiding in problem-solving, and delivering tailored feedback. The application of AI extends to analyzing student data to identify specific learning challenges, facilitating the provision of targeted support and individualized guidance. Moreover, AI plays a crucial role in student assessment, with adaptive testing systems being a prime example (Tran, 2022). Research in Vietnam, particularly studies by Lê Thái Hưng and Nguyễn Thái Hà (2021), highlights the trend of leveraging technology for student assessment, demonstrating the potential for personalized learning. Their work outlines the application of information technology in assessment, encompassing online learning management systems (LMS) for classroom assessment, computerized adaptive testing (CAT) for adaptive assessment of learner abilities, and personalized learning ecosystems as comprehensive solutions. These applications align with

the broader global movement toward AI-driven personalized learning, although the Vietnamese context necessitates consideration of unique challenges and opportunities. Trần Thị Thu Hương (2022) further reinforces the importance of factors such as the digital environment in successfully implementing personalized learning.

However, the ethical implications of AI in personalized learning, notably algorithmic bias, require careful consideration. Ensuring fairness, transparency, and accountability in the use of AI to support student learning is paramount, necessitating diverse and representative training data, meticulously designed and tested algorithms, and robust data privacy and security measures. Continuous human oversight is essential to guarantee that AI is used responsibly and ethically, complementing, rather than supplanting, the crucial role of educators. The ongoing advancements in AI technology promise an expanding array of innovative applications, contributing even further to personalized learning and enhancing educational effectiveness for all learners.

2.4. Research results

2.4.1. Synthesis of research findings on the effectiveness of AI in personalized learning

A review of the literature indicates that AI is increasingly being applied in personalized learning and yielding promising results. Studies focus on evaluating the effectiveness of AI in improving learning outcomes, boosting motivation, and enhancing student engagement in personalized learning environments.

Effectiveness of AI in Personalized Learning:

A review of the literature reveals a growing trend of AI applications in personalized learning, accompanied by promising results. Studies in this area primarily focus on evaluating AI's effectiveness in three key areas: improving learning outcomes, boosting student motivation, and enhancing student engagement within personalized learning environments.

The effectiveness of AI in personalized learning is demonstrably multifaceted. Regarding improved learning outcomes, Essa et al. (2024) conducted a quantitative evaluation of an AI-based Adaptive Learning System in a general mathematics course. Their findings indicated that students utilizing the AI system achieved significantly higher test scores compared to those learning through traditional methods. This underscores AI's capacity to personalize learning pathways, providing tailored exercises and feedback that align with each student's individual level and progress, ultimately enhancing knowledge acquisition.

Furthermore, AI has shown the potential to enhance learning motivation. Gevorgyan (2024) explored the impact of AI chatbots on student motivation through a qualitative study. The research revealed that AI chatbots, by providing 24/7 learning support and instant, personalized feedback, can significantly motivate students to engage in self-study and participate more actively in the learning process. However, Gevorgyan (2024) also cautioned

that careful design of AI chatbots is crucial to avoid fostering over-reliance on technology and diminishing valuable human interaction.

In terms of student engagement, Zawacki-Richter et al. (2019) conducted a synthesis of studies on AI applications in education. They highlighted that AI tools, such as virtual assistants, chatbots, and virtual reality/augmented reality (VR/AR) systems, can transform classrooms into more interactive and engaging spaces. These tools enable students to participate in diverse learning activities, immerse themselves in simulated learning environments, and receive immediate feedback, consequently increasing their focus, interest, and overall engagement.

In summary, existing research provides compelling evidence of the positive impacts of AI in personalizing learning, demonstrating its potential to improve learning outcomes, boost student motivation, and enhance student engagement. However, it's important to acknowledge that the effectiveness of AI is contingent upon several factors, including the quality of data used to train AI systems, the design of the AI system itself, the capacity of instructors to effectively integrate AI into their teaching, and the active participation of students in the learning process.

Factors Influencing the Effectiveness of AI in Personalized Learning:

While research highlights the positive impacts of AI in personalizing learning, its effectiveness is not absolute and depends on several interacting factors. The literature identifies key elements that significantly influence the success of AI-driven personalized learning initiatives.

A primary factor is data quality. AI systems require high-quality, complete, and diverse datasets for accurate predictions and decisions (Ifenthaler & Schumacher, 2022). Inaccurate, incomplete, or biased input data can lead to skewed results, undermining personalization efforts. For example, an adaptive learning system trained on data from a homogenous group of students may not effectively support learners with differing proficiency levels.

Another critical factor is AI system design. Systems must be scientifically designed, aligning with learning objectives, the educational context, and learner characteristics (Teng et al., 2023). Effective design ensures that AI can interact meaningfully with students, provide appropriate learning content, track progress, and deliver timely, accurate, and personalized feedback.

Instructor capacity also plays a vital role. Educators need the knowledge and skills to use AI effectively, understand its advantages and limitations, integrate it into teaching methods, and evaluate its impact (Holmes et al., 2019). Active instructor involvement in the design and implementation of AI systems is crucial to ensure they meet student needs and align with the specific teaching context.

Furthermore, student engagement is a key determinant of success in personalized learning (Zawacki-Richter et al., 2019). Students must actively interact with the AI system,

providing information about their needs, preferences, and learning styles, and offering feedback on the system's effectiveness.

Finally, the broader educational culture and policy environment must encourage and support AI applications in personalized learning (UNESCO, 2023). Clear policies are needed regarding the collection, use, and security of student learning data, alongside ethical guidelines for AI implementation in education.

To empirically identify and validate these influencing factors, the present study employed Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to reduce a large set of variables into fewer latent factors. CFA, as explained by Kline (2016), tests the theoretical structure of factors identified through EFA. The combined application of EFA and CFA provides empirical evidence on the key factors, enabling informed recommendations for solutions and policies to promote effective AI implementation in education. The results are presented below.

Table 1. Factors and Items Influencing the Effectiveness of AI in Personalized Learning

Factor	Item Code	Item	Reference source
1. Data Quality (CLDL)	**CLDL1**	The data used to train the AI system is accurate and reliable.	Ifenthaler & Schumacher, 2022
	CLDL2	The input data of the AI system is diverse, fully representing the characteristics of learners.	Siemens & Baker, 2012
	CLDL3	The AI system's training data is regularly updated to ensure its relevance.	Ifenthaler & Schumacher, 2022
	CLDL4	The data used for personalized learning is free from bias towards any group of learners.	Ravizza et al., 2024
	CLDL5	Data collection and processing comply with regulations on security and privacy.	Ravizza et al., 2024
2. AI System Design (TKHT)	**TKHT1**	The AI system is designed in accordance with the specific learning objectives of the course/program.	Essa et al., 2023
	TKHT2	The AI system's interface is user-friendly, easy to use, and accessible to learners.	Teng et al., 2023
	TKHT3	The AI system provides personalized learning content that is appropriate for each learner's level and needs.	Essa et al., 2023
	TKHT4	The AI system is capable of tracking learner progress and providing timely feedback.	Gevorgyan, 2024
	TKHT5	The AI system allows learners to interact and collaborate with each other during the learning process.	Teng et al., 2023
3. Instructor Capacity (NLGV)	**NLGV1**	Instructors have sufficient knowledge and skills to use the AI system in their teaching.	Holmes et al., 2019

	NLGV2	Instructors understand the advantages and limitations of applying AI in personalized learning.	Gocen & Aydemir, 2020
	NLGV3	Instructors know how to effectively integrate the AI system into their teaching methods.	Holmes et al., 2019
	NLGV4	Instructors can evaluate the effectiveness of the AI system in supporting personalized learning.	Kuleto et al., 2021
	NLGV5	Instructors are involved in the design and implementation process of the AI system.	Kuleto et al., 2021
4. Student Engagement (TGTV)	TGTV1	Students actively use the AI system to support their learning process.	Zawacki-Richter et al., 2019
	TGTV2	Students provide complete and accurate information about their needs, preferences, and learning styles to the AI system.	Pane et al., 2017
	TGTV3	Students actively interact with the AI system and other learners during the learning process.	Zawacki-Richter et al., 2019
	TGTV4	Students regularly provide feedback on the effectiveness of the AI system.	Pane et al., 2017
	TGTV5	Students feel comfortable and confident using the AI system.	Zawacki-Richter et al., 2019
5. Educational Culture and Policy (VHCS)	VHCS1	The school/educational institution has a clear policy on the application of AI in personalized learning.	UNESCO, 2023
	VHCS2	The school/educational institution provides sufficient resources (e.g., funding, facilities, training) to support the application of AI.	OECD, 2021
	VHCS3	The school/educational institution encourages instructors and students to use AI in teaching and learning.	UNESCO, 2023
	VHCS4	There are clear regulations on the collection, use, and security of student learning data.	OECD, 2018
	VHCS5	The school/educational institution has ethical guidelines for the application of AI in education.	UNESCO, 2023

Table 2 presents the results of the Exploratory Factor Analysis (EFA) using the Varimax rotation, including information on factor loadings, mean values (MV), and standard deviations (SD) for each item (observed variable). The results show that all factor loadings are high, exceeding the threshold of 0.5 and most are above 0.8. According to Hair et al. (2010), factor loadings of 0.5 or higher are considered practically significant, indicating a strong correlation between the items and the factor they represent. This confirms that the selected items are capable of effectively measuring the latent constructs (factors) in the

research model. The high concentration of these factor loadings also suggests the unidimensionality of each group of items, meaning that each group of items primarily measures a single factor.

Table 2. Results of EFA with Varimax Rotation

Item	Factor Loading	ĐTB	ĐLC
CLDL1	.879	3.98	.684
CLDL2	.897	3.99	.648
CLDL3	.869	3.98	.631
CLDL4	.870	3.99	.663
CLDL5	.851	3.98	.662
TKHT1	.872	3.99	.620
TKHT2	.854	3.97	.640
TKHT3	.869	3.99	.653
TKHT4	.871	4.00	.634
TKHT5	.895	4.01	.643
NLGV1	.859	4.03	.622
NLGV2	.860	4.00	.657
NLGV3	.925	3.99	.641
NLGV4	.871	4.00	.647
NLGV5	.866	3.99	.643
TGTV1	.881	3.99	.657
TGTV2	.850	4.02	.653
TGTV3	.852	4.00	.652
TGTV4	.842	3.99	.617
TGTV5	.880	3.97	.650
VHCS1	.866	3.98	.661
VHCS2	.862	4.01	.658
VHCS3	.905	4.01	.656
VHCS4	.884	4.03	.676
VHCS5	.854	3.99	.652

Table 3. CFA Results

Index	Result	Acceptable Level
Chi-square/Degree of freedom	1.114	< 5
GFI	0.963	> 0.9
CFI	0.998	> 0.9
TLI	0.997	> 0.9
RMSEA	0.014	< 0.08
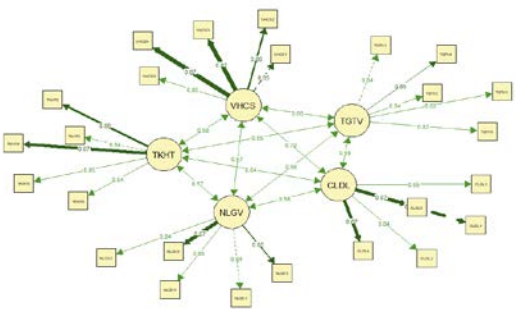
The EFA with Varimax rotation, as presented in Table 2, reveals a robust factor structure with high factor loadings (all above 0.5, most exceeding 0.8), indicating strong correlations between items and their respective factors, thus confirming the scale's ability to

effectively measure the latent constructs (Hair et al., 2010). Mean values (MV) for the items, ranging from 3.97 to 4.03 on a 5-point Likert scale, demonstrate a high level of agreement among respondents regarding the importance of these factors in influencing AI's effectiveness in personalized learning, particularly "Instructor Capacity" (NLGV) and "Educational Culture and Policy" (VHCS), which have the highest mean scores. These findings align with previous research emphasizing the roles of system design (Essa et al., 2023), instructor capacity (Holmes et al, 2019), and student engagement (Zawacki-Richter et al., 2019). The relatively small standard deviations (SD), ranging from 0.617 to 0.684, suggest a consensus among respondents on the importance of these factors. Overall, the EFA results indicate good reliability and validity of the scale, with items grouped logically, reflecting the proposed theoretical factors.

2.4.2. Analysis of challenges and barriers in the application of AI in personalized learning

The application of AI in personalized learning, while promising, faces significant challenges and barriers. These encompass data issues, technological infrastructure limitations, instructor capacity gaps, student perceptions, and ethical considerations.

Data quality is a critical concern. AI systems require high-quality, complete, and diverse data to function effectively and personalize learning pathways (Ifenthaler & Schumacher, 2022). However, collecting, processing, and analyzing student learning data from various sources (LMS, assignments, tests, online activities) is complex, often involving inconsistent, noisy, and error-prone raw data that requires extensive cleaning and standardization. As one interviewed instructor noted, "We have so much data from different platforms, but it's often in different formats, making it difficult to combine and use for AI" (PV-03).

Technological infrastructure poses another substantial barrier, particularly in developing countries. Deploying AI systems requires robust and stable infrastructure, including high-speed internet, data processing servers, and specialized software. A lack of investment in this area can significantly hinder AI implementation in education. A student participant highlighted this challenge, saying, "Sometimes the internet connection in our school is very slow, so it's difficult to use the AI learning tools" (PV-07).

Instructor capacity is crucial for successful AI integration. Educators need the knowledge and skills to effectively utilize AI, understand its principles and limitations, and integrate it into their teaching methods (Holmes et al., 2019). However, many instructors lack confidence and training in this area. One instructor shared, "I'm interested in using AI in my class, but I don't know where to start. I need training and support" (PV-01).

Student perceptions also significantly impact AI adoption. Concerns about privacy, data security, and potential algorithmic bias can hinder student engagement. As one student expressed, "I'm worried that the AI system might collect my personal information and use it without my permission" (PV-05). Addressing these concerns through education, communication, and transparent data security measures is vital for fostering trust and encouraging student participation.

Ethical considerations are paramount. The risk of algorithmic bias, where AI systems

trained on biased data perpetuate inequalities, is a serious concern (UNESCO, 2023). Over-reliance on technology, potentially diminishing the teacher's role, is another ethical challenge. A university administrator stressed: "We have to think about how to use this AI tool for good, not to replace the human interaction between teacher and student completely" (PV-09).

In conclusion, realizing the full potential of AI in personalized learning requires a concerted effort to address these challenges. Policymakers, universities, instructors, and students must collaborate to ensure high-quality data, adequate infrastructure, instructor training, student awareness, and ethical AI implementation. As a researcher emphasized, "It's not just about the technology itself. It's about how we use it responsibly and ethically to improve education for everyone" (PV-12).

The application of AI in personalized learning holds immense potential to enhance both the effectiveness and quality of education. AI's ability to process and analyze vast amounts of data from student learning activities enables the creation of personalized learning experiences at scale, efficiently, and effectively. AI systems can automatically adjust content, pacing, and teaching methods to suit individual student needs, freeing educators from repetitive tasks and allowing them to focus on core pedagogical activities such as supporting, guiding, and inspiring students (Holmes et al., 2019).

However, alongside this potential, AI presents limitations and challenges that require careful consideration. The risk of algorithmic bias, potentially leading to educational inequalities, is a significant concern. Over-reliance on technology could also inadvertently hinder the development of critical thinking and independent problem-solving skills in students. Furthermore, the use of AI in education raises ethical issues related to privacy, data security, and accountability (UNESCO, 2023).

In the context of AI-powered personalized learning, the role of instructors is not replaced but rather transformed and enhanced. Instructors become guides, mentors, and inspirers for students, playing a crucial role in designing and implementing AI systems. They ensure that AI is used effectively and appropriately within the educational context (Holmes et al., 2019). This shift necessitates that instructors receive training and upskilling in technology application and pedagogical methods, specifically in the areas of AI and personalized learning.

To effectively apply AI in personalized learning, a multi-stakeholder approach is essential. This involves developing clear policy frameworks and strategies, from the national to the school level, that focus on promoting innovation, training human resources, ensuring fairness, and addressing ethical concerns (UNESCO, 2023). Substantial investment in technological infrastructure is also crucial, including internet connectivity, hardware, and AI software, to ensure the effective deployment of AI systems (Kuleto et al., 2021). In-depth training and professional development programs on AI and personalized learning are needed to equip instructors with the confidence and skills to effectively apply AI in their teaching (Holmes et al., 2019). Finally, strengthening international cooperation in the field of AI and education is essential, fostering the sharing of experiences, exchange of knowledge, and

collaboration to develop AI solutions that are appropriate for diverse contexts (UNESCO, 2023).

In conclusion, the integration of AI into personalized learning is an undeniable trend in modern education. By proactively addressing the challenges and strategically harnessing AI's potential, we can create a more effective, engaging, and equitable learning environment for all students.

3.   Conclusion

In summary, AI plays a crucial role in promoting personalized learning, offering immense potential for enhancing the effectiveness and quality of education. However, for AI to truly be effective, it is necessary to continue researching and developing AI applications that are appropriate for the educational context, paying particular attention to addressing issues related to data, technological infrastructure, instructor capacity, student perceptions, and ethical considerations. Future research directions should focus on developing AI systems with high self-learning and adaptive capabilities while integrating cultural, social, and psychological factors into the design and implementation of AI in education.

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ỨNG DỤNG TRÍ TUỆ NHÂN TẠO CÁ NHÂN HÓA
HOẠT ĐỘNG HỌC TẬP CỦA SINH VIÊN

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TÓM TẮT

Nghiên cứu này phân tích vai trò của AI trong việc cá nhân hóa hoạt động học tập của sinh viên, từ các khái niệm cốt lõi, cơ sở lí thuyết đến các ứng dụng thực tiễn, đồng thời làm rõ các yếu tố ảnh hưởng, thách thức, rào cản và đề xuất giải pháp. Nghiên cứu sử dụng phương pháp hỗn hợp, tổng hợp và phân tích tài liệu với khảo sát trên 594 sinh viên và phỏng vấn sâu 10 sinh viên, 5 giảng viên tại Trường Đại học Sư phạm Thành phố Hồ Chí Minh. Kết quả nghiên cứu cho thấy AI có tiềm năng đáng kể trong việc cải thiện kết quả học tập, thúc đẩy động lực và tăng cường sự tham gia của sinh viên. Tuy nhiên, hiệu quả của AI phụ thuộc vào nhiều yếu tố như chất lượng dữ liệu, thiết kế hệ thống AI, năng lực của giảng viên, sự tham gia của sinh viên và các vấn đề đạo đức. Hạn chế của nghiên cứu là mẫu khảo sát chưa thực sự đại diện cho toàn bộ sinh viên và cần có thêm các nghiên cứu thực nghiệm để kiểm chứng các kết quả.

Từ khóa: cá nhân hóa học tập; giáo dục đại học; hệ thống học tập thích ứng; trí tuệ nhân tạo