



Personalized Artificial Intelligence in Higher Education: A Systematic Literature Review on Learning Outcomes, Knowledge Accuracy, and Conceptual Understanding

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Abstract:

This systematic literature review investigates the integration of personalized Artificial Intelligence (AI) in higher education, specifically focusing on its impact on learning outcomes, knowledge accuracy, conceptual understanding, and associated risks. Following the PRISMA 2020 guidelines, a rigorous selection process from the Scopus database yielded 49 peer-reviewed empirical studies published between 2022 and 2026. The findings reveal that AI-supported personalized learning, ranging from Generative AI and Large Language Models (LLMs) to Intelligent Tutoring Systems (ITS) and advanced Machine Learning architectures, significantly enhances students' academic achievement, engagement, and self-regulated learning skills across various disciplines. However, the synthesis exposes a critical cognitive paradox: improved learning performance and speed do not automatically translate into deep conceptual understanding. Uncritical over-reliance on AI leads to passive cognitive offloading, diminished critical thinking, and vulnerability to AI hallucinations and factual inaccuracies. Furthermore, ethical and institutional challenges, including data privacy concerns, algorithmic bias, and academic integrity risks, present substantial implementation barriers. To maximize pedagogical benefits while mitigating these risks, this study underscores the necessity of a "Human-in-the-Loop" orchestration framework, where AI functions as an educational scaffold while human educators retain primary authority over critical reasoning and ethical technology adoption.

Keywords: Artificial Intelligence, Conceptual Understanding, Knowledge Accuracy, Learning Outcomes, Personalized Learning

Introduction

The use of artificial intelligence (AI) as a form of digital technology has brought about significant changes in the world of higher education (Syakhrani et al., 2026). The application of AI in higher education has become a critical issue aimed at improving the quality of learning, operational efficiency, and ease of access for students (Fatmadiwi et al., 2025). The emergence of generative AI, such as ChatGPT and Large

Language Models (LLMs), is increasingly transforming the way students and faculty members learn and teach at universities (Niyu et al., 2024). While AI was initially used primarily for administrative tasks, it has now expanded into direct support for learning activities as an materials, searching for information, and answering academic questions (Pratama et al., 2023). This technology offers the ability to process information and facilitate flexible dialogues for students (Mizan & Norman, 2024). These changes present an opportunity to make it easier for students to access academic assistance that is readily available, responsive, and fast.

Traditional teaching methods often employ a one-size-fits-all approach, where the process tends to rely solely on the same methods for all students (Kause et al., 2025), even though each student's abilities and learning pace differ (Syakhrani et al., 2026). Diversity in prior knowledge, interests, and learning styles means that a one-size-fits-all teaching approach is considered ineffective in meeting individual needs (Almujab, 2023). The emergence of AI technology offers an ideal solution for realizing personalized learning through AI systems capable of efficiently recognizing students' learning patterns and characteristics. Through AI-based personalized learning, the sequence of course material can be tailored so that students can learn at their own pace (Mukaromah et al., 2024). This easily adaptable material has been shown to improve students' retention, recall, and understanding of course content (Faizi et al., 2026).

Technically, learning within the AI system is facilitated by intelligent tutoring systems that operate by analyzing students' knowledge gaps and cognitive states (Niyazova et al., 2026). To map out a learning path tailored to each individual's needs, AI algorithms analyze user interaction data, task completion times, and error histories (Syakhrani et al., 2026). This system is capable of providing real-time feedback and offering additional recommendations while the learning process is underway (Faizi et al., 2026). By utilizing a mechanism of gradual support (educational scaffolding), students can solve complex problems in a structured manner (Supriyadi et al., 2026). At the same time, this approach, which is similar to educational scaffolding, encourages students to engage in self-explanation, a practice proven effective in identifying and correcting initial misconceptions (Makransky et al., 2024).

Personalized learning using AI has various positive effects on student learning outcomes, such as improved academic achievement, learning performance, and knowledge gain (Faizi et al., 2026). Research conducted by Ahmed et al. (2025) also found that the interactive support offered by AI has a positive influence on enhancing student engagement and motivation, both inside and outside the classroom. The ease of accessing information through AI also helps students manage their own learning paths (autonomy)

and develop problem-solving skills (Dewi, 2026). However, this ease does not always have positive implications. Research conducted by Thalib et al. (2026) indicates that cognitive and emotional over-reliance may occur as a result of this ease of access. There is concern that this excessive reliance could dull students' critical thinking skills and diminish their analytical abilities (Armalivia et al., 2026).

The accuracy of the information provided by AI itself cannot always be trusted absolutely. As initial evidence, research by Shoufan & Esmaeil (2026) explains that Large Language Model (LLM) AI often generates incorrect information, presents fictional data, and even provides false references—a phenomenon known as “AI hallucination.” Furthermore, the use of a structured, fluent, and overly confident style of language also misleads students (Dang & Nguyen, 2025; Shoufan & Esmaeil, 2026). Therefore, students are required to double-check AI-generated answers by comparing them with official sources (Armalivia et al., 2026) to ensure that incorrect information does not compromise the accuracy of their knowledge (Banjade et al., 2024).

These coexisting positive and negative aspects raise a reflective question that distinguishes this study from previous ones: Do students truly understand the concepts, or are they merely obtaining answers quickly? (Ataev, 2026; Hankeln, 2024). Students who frequently use AI often face a trade-off between processing speed and accuracy, where tasks are completed more quickly but deep thinking is eliminated (Ataev, 2026). Passively offloading cognitive tasks to AI allows students to quickly obtain answers without active mental processing, resulting in a very superficial understanding of the context (Hankeln, 2024; Lodge & Loble, 2026). Under these conditions, over-reliance acts as a mediator linking the problem of information inaccuracy to the erosion of students' conceptual understanding (Si et al., 2026; Thalib et al., 2026). It is this passive reliance that ultimately poses the greatest cognitive challenge and risk that must be addressed in the use of AI in higher education (Thalib et al., 2026).

Amid the proliferation of research on the integration of artificial intelligence in education, a literature review reveals a significant research gap (Syakhrani et al., 2026). The current scientific literature remains fragmented and focuses only partially on the topic, with some studies merely reviewing learning outcomes in general (Ahmed et al., 2025; Faizi et al., 2026), while others focus solely on personalized learning techniques (Pratama et al., 2023). On the other hand, several separate studies have examined the issues of knowledge accuracy (Dang & Nguyen, 2025; Shoufan & Esmaeil, 2026), whereas other studies have addressed conceptual understanding (Hankeln, 2024) or protected autonomy (Ataev, 2026; Thalib et al., 2026). To date, there has been no systematic literature review that fully integrates these four aspects into a single research framework at the university level (Fatmadiwi et al., 2025; Syakhrani et al., 2026). Therefore, a systematic study is needed to map the relationships between AI personalization,

learning outcomes, knowledge accuracy, conceptual understanding, and the associated risks (Syakhrani et al., 2026).

This study conducted a systematic literature review (SLR) to map the use of AI for personalized learning, synthesize the resulting learning outcomes, identify evidence related to knowledge accuracy and conceptual understanding, and map the risks and challenges of using AI in higher education (Banjade et al., 2024; Murria et al., 2026a; Syakhrani et al., 2026). Based on these objectives, this systematic literature review was designed to answer four main research questions (RQs), namely: How is AI used to support personalized learning in higher education? (RQ1); What are the learning outcomes associated with AI-supported personalized learning? (RQ2); How does AI-enabled personalized learning relate to students' conceptual understanding and knowledge accuracy? (RQ3); and What challenges and risks are associated with the use of AI for personalized learning in higher education? (RQ4).

Literature Review

AI in Higher Education

Artificial Intelligence is transforming higher education in various ways. Artificial Intelligence has the ability to adapt to students' specific needs, such as content requirements, learning pace, and learning styles (Gulbanbegim et al., 2026). Furthermore, generative AI is widely used by students in academic assignments and research (Murria et al., 2026b; Şenyüz et al., 2025) and helps them independently understand difficult concepts (Sabir et al., 2025). Additionally, AI plays a role in supporting faculty members by automating administrative tasks such as grading, creating exams, and analyzing teaching quality, thereby allowing faculty to focus more on in-depth mentoring (Aydeniz, 2025; Olaitan & Ajao, 2025). AI also improves accessibility for students with disabilities (Bakari et al., 2025), overcomes language barriers through real-time translation (Thao et al., 2025), and supports distance learning in remote areas (Rahman et al., 2026).

Personalized Learning Supported by AI

AI-Supported Personalized Learning reflects a shift in teaching toward a student-centered approach (Risdianto et al., 2026). Personalized learning itself encompasses broader pedagogical goals in creating learning experiences that are more relevant, meaningful, and aligned with students' needs (Hernández-Herrera et al., 2026; Khuong An & Thuy An Ngo, 2025; Xiong & Huang, 2026). The presence of AI will support the creation of personalized learning because AI systems are capable of collecting and generating

data on interactions with students, thereby building a personalized learning environment based on users' emotions, cognitive aspects, and behavioral tendencies (Risdianto et al., 2026). AI-Supported Personalized Learning also promotes the creation of learning support for students, such as by providing recommendations for instructional materials and learning pathways tailored to individual levels of understanding and preferences (Xiong & Huang, 2026), offering questions and exercises based on students' abilities (Rahman et al., 2026), acting as a tutor to facilitate learning in real time (Sajja, Sermet, Fodale, et al., 2026), and monitoring learning progress and providing interventions if there is a decline in student learning performance (Kabashkin, 2025).

Learning Outcomes

Learning outcomes are the results students achieve through their engagement in the learning process, which describe their capacity or ability in terms of knowledge, skills, and values after completing a learning experience (Olaitan & Ajao, 2025). The knowledge dimension of learning outcomes may include mastery of subject matter, the ability to process information, memory, and conceptual understanding. The skills dimension can be observed in problem-solving abilities, critical thinking, and critical reasoning (Khuong An & Thuy An Ngo, 2025). The values and responsibility dimension can include the development of attitudes, ethics, and levels of independence or academic responsibility (Kabashkin, 2025). Learning outcomes serve as the primary benchmark for assessing the extent to which a learning experience or the integration of technology—such as AI—successfully enhances students' competencies and learning experiences (Raxmatov et al., 2026).

Knowledge Accuracy

"Knowledge Accuracy" in the context of AI application in higher education refers to the truthfulness, conceptual accuracy, and relevance of the content and answers generated by AI systems (Khuong An & Thuy An Ngo, 2025). However, in this context, various factors influence the quality of information generated by AI, such as inaccuracies in AI responses (Bakari et al., 2025), as well as the phenomenon of "AI hallucination," which leads to errors, misdirection, and the fabrication of academic references that do not actually exist (Şenyüz et al., 2025). The causes of this inaccuracy include AI's reliance on unverified open-internet data and limited access to paid scientific journals or data (Ullah et al., 2025). Furthermore, current AI systems do not yet fully understand social and emotional contexts or situational backgrounds as deeply as humans do (Aydemir & Kır, 2025; Bakari et al., 2025). Human involvement is required to review AI-generated answers before they are used (Hernández-Herrera et al., 2026) therefore, students

are expected to possess domain knowledge and the skills to cross-check every AI output against credible academic sources before using it (Nandhlal & Kabanda, 2026).

Conceptual Knowledge

Conceptual Understanding, or Conceptual Knowledge, is a learner's ability to understand the deep relationships among basic elements, classifications, and theories within a discipline and to organize that knowledge into a coherent understanding (Zhou et al., 2026). The main characteristics of Conceptual Understanding are: (1) a focus on interpretable understanding, possessing meaningful insights, and being able to explain the relationships between ideas rather than merely memorizing them (Yan et al., 2025), (2) learners with strong Conceptual Understanding are able to connect various different concepts and apply them in real-world situations (Khuong An & Thuy An Ngo, 2025), (3) Conceptual Understanding bridges higher-order thinking skills such as analyzing, evaluating, and creating innovative solutions or ideas (Makransky et al., 2024).

Challenges and Risks of AI in Learning

Artificial Intelligence in the learning process offers convenience but also presents challenges and risks from academic, cognitive, ethical, and institutional governance perspectives (Gulbanbegim et al., 2026; Krvavica et al., 2025; Ofem et al., 2026; Şenyüz et al., 2025). The ease of using AI fuels academic dishonesty, such as the unauthorized use of AI in exams or assignments, and threatens the originality of work (Voicu et al., 2026). Furthermore, reliance on AI in learning leads to a decline in critical thinking and problem-solving skills due to the instant answers generated by AI (Şenyüz et al., 2025); this ease creates "fluency bias" and "cognitive laziness," where students feel they have mastered the material simply because AI can present it fluently, even though students have not generated those answers cognitively or in depth (Aydeniz, 2025). AI also has the potential to generate incorrect information or hallucinations, and students who lack adequate foundational knowledge are vulnerable to accepting AI-generated answers without verifying them (Hilliger et al., 2026). Excessive use of AI can also reduce interaction between instructors and students, thereby eroding emotional support, empathy, and character guidance, elements that technology cannot replicate (Krvavica et al., 2025). This occurs because AI tends to support self-directed learning but is less effective in fostering social skills, group dynamics, and conflict resolution among students (Lee, 2026; Munawwarah et al., 2025; Voicu et al., 2026). AI also creates gaps in institutional governance due to the lack of clear guidelines and policies defining the limits of AI use, which

can lead to the misuse of AI in the tasks and assessments conducted by faculty members (Ofem et al., 2026).

Research Methodology

This study was conducted using a qualitative Systematic Literature Review (SLR) approach, which is a structured and reproducible research procedure for identifying, reviewing, presenting, and synthesizing collected research findings without introducing researcher bias (Aurilia et al., 2025; Azarian et al., 2023). The execution of this study began with the planning, implementation, and reporting stages (Batool et al., 2025). In carrying out the literature selection and screening process, PRISMA 2020 (Preferred Reporting Items for Systematic Literature Review) establishes standard guidelines aimed at ensuring the transparency and accountability of the document selection process (Tugwell & Tovey, 2021).

The literature search was conducted using the Scopus database with the following query: (TITLE-ABS-KEY(("artificial intelligence" OR "generative AI" OR "generative artificial intelligence" OR "ChatGPT" OR "Large Language Model") AND ("personalized learning" OR "personalized learning" OR "adaptive learning" OR "individual learning") AND ("higher education" OR "college students" OR "university students"))) AND PUBYEAR > 2021 AND PUBYEAR < 2027), with a search cutoff date of September 17, 2026. Specific phrases and synonyms were also included for the target terms to capture a broader scope of the literature while maintaining a focus on AI-based personalized learning in higher education. The search results were processed using the web-based tool Rayyan (Ouzzani et al., 2016).

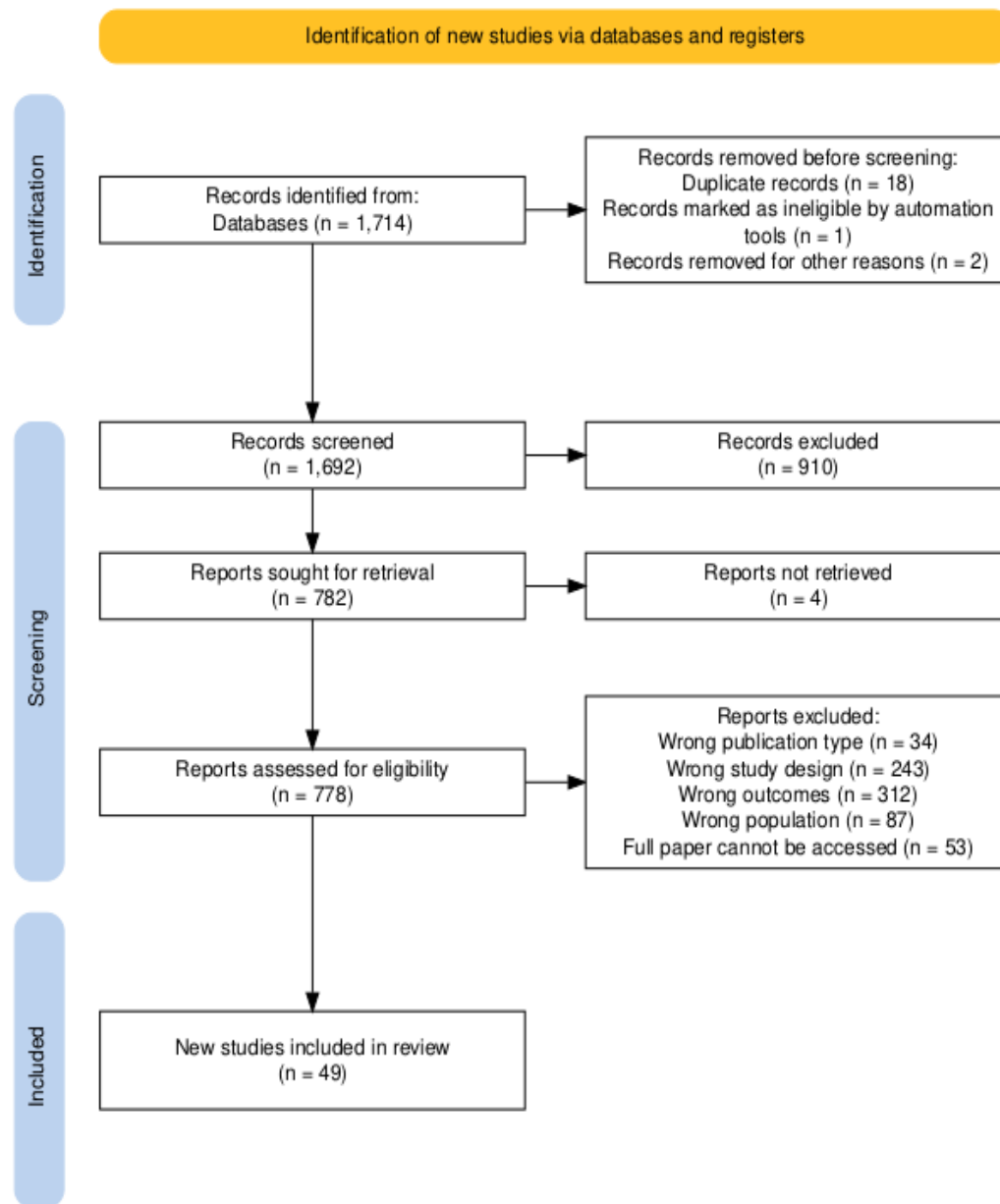


Figure 1. PRISMA
(Source: Processed Data, 2026)

The search using the Scopus database yielded 1,714 articles as the initial dataset. During the identification stage, 40 articles were identified as duplicates and were removed (records removed before screening) 20 articles, of which 18 were found to have a similarity level of 70–80% and 2 were duplicates. During the screening stage, criteria were established to streamline the literature selection process. The selection criteria were defined as inclusion and exclusion criteria (Azarian et al., 2023). Inclusion criteria were established for journal publications investigating topics relevant to the study—namely, AI

integration, personalized learning, and higher education—as well as empirical studies or systematic reviews presenting findings that address research questions (RQ) 1–4 (Batool et al., 2025), and articles published in English. Exclusion criteria were established for articles not focused on the higher education context (elementary school, junior high school, senior high school, and vocational high school); non-journal literature (book chapters, books, short surveys, and conference papers); and articles that do not provide the full text. Additionally, the PICO (Population, Intervention, Comparison, Outcome) framework was applied to highlight key elements in the titles and abstracts of the articles (Ouzzani et al., 2016). At the initial stage of full-text screening, 49 journal articles were identified that could be further analyzed to address the previously defined research questions (RQ).

Results and Discussions

Publication Trends

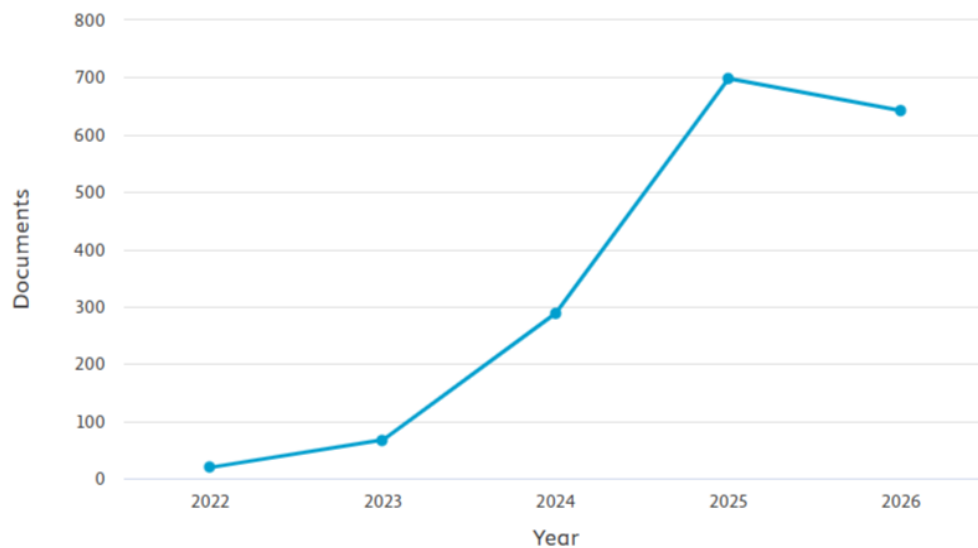


Figure 2. Publication Trend Graph
(Source: Processed Data, 2026)

Based on the dataset compiled through Scopus, the publication trend related to personalized Artificial Intelligence (AI) in higher education experienced a significant increase during the observation period. In 2022, the number of relevant publications totaled only 19 articles, and began to rise gradually in 2023 with 67 articles. A significant increase occurred in 2024 with 288 articles published, reaching a 58.7% increase with 698 publications in 2025. This sharp surge indicates that the integration of AI—

particularly the emergence of generative AI models—has sparked academic interest in exploring its effectiveness in higher education. In contrast to previous years, 2026 shows a 7.8% decrease, or precisely 643 journal articles. This is not without reason; since the dataset was collected on September 17, 2026, this year’s data does not yet fully cover a complete period. This condition is referred to as an “artificial decline” resulting from the collection of current-year data (right-censored data), meaning that 2026 cannot yet reflect the actual annual volume of journal publications (Seo & Lee, 2025).

Table 1. Top 5 Most Cited Articles

Cited by	Author & Year	Title
2098	C. K. Y. Chan & Hu (2023)	Students’ voices on generative AI: perceptions, benefits, and challenges in higher education
604	Abulibdeh et al., (2024)	Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions
590	Rasul et al. (2023)	The role of ChatGPT in higher education: Benefits, challenges, and future research directions
573	C. K. Y. Chan & Lee (2023)	The AI generation gap: Are Gen Z students more interested in adopting generative AI such as ChatGPT in teaching and learning than their Gen X and millennial generation teachers?
483	Wei (2023)	Artificial intelligence in language instruction: impact on English learning achievement, L2 motivation, and self-regulated learning

Source: Processed Data, 2026

In addition to the number of publications each year during the observation period, an analysis was also conducted on articles with the highest number of citations to identify works that have made significant contributions to establishing the scientific foundation and direction of development in this field. Based on Table 1, the study conducted by C. K. Y. Chan & Hu (2023) ranked highest as the most cited, with a total of 2,908 citations. This was followed by the work of Abulibdeh et al., (2024), which received 604 citations. This study explores the integration of AI and education for sustainable development in the industry 4.0 era and delves deeply into the ethical dimensions, opportunities, and challenges of such integration. In third place, with 590 citations Rasul et al. (2023), is a study examining the role of ChatGPT in higher education. Not to be outdone, with 573 citations, is the study by C. K. Y. Chan & Lee (2023), which examines the gap in AI adoption between Generation Z students and Generation X and Millennial

educators, as well as Wei (2023), with 483 citations, who investigates the impact of AI-assisted instruction on student learning outcomes, motivation, and students' learning autonomy.

Mapping the trend of increasing publications over the years for the most-cited articles reveals a measurable research pattern: from early 2022 through 2023, research tended to focus on the basic introduction, adoption, and potential of AI, as seen in the studies by C. K. Y. Chan & Lee (2023), Rasul et al. (2023), and Wei (2023). By the time the publication surge phase began, the research focus shifted toward a clearer and more mature direction by analyzing comprehensive impacts that encompass ethical dimensions, ongoing challenges, and priorities regarding user understanding and perceptions—as evidenced by the high number of citations in the article by Chan & Hu.

Co-occurrence Analysis

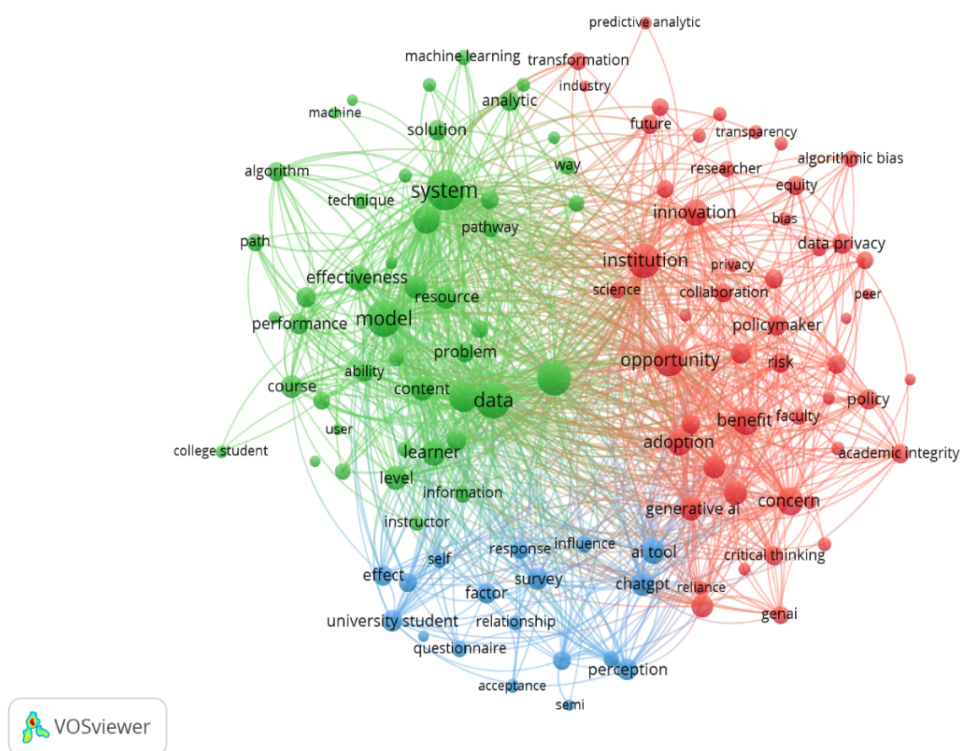


Figure 3. Network Visualization

The results of the co-occurrence analysis using VOSviewer were obtained from bibliographic data in the Scopus database. A minimum occurrence threshold of 50 was set to filter out keywords with low frequency, allowing the analysis to focus on keywords that appear frequently and are strongly associated with the literature. Based on these results, three main clusters were identified that appear most frequently and are strongly linked in the literature. Based on these results, three main clusters were identified that describe the themes and research directions related to the use of AI in higher education.

The green cluster, dominated by keywords such as “system,” “model,” “data,” “learner,” “machine learning,” “performance,” and “effectiveness,” indicates that AI research conducted at universities tends to focus on the development of data-driven systems and models that support adaptive and personalized learning processes. The association of these keywords with “learner” and “performance” suggests a focus on utilizing student data to tailor learning while evaluating its validity. Returning to the initial context of personalized learning, this cluster aligns with studies on how AI algorithms recommend personalized learning tailored to users’ needs and their potential to drive learning outcomes.

The red cluster encompasses domains representing institutional, ethical, and governance aspects of AI implementation in higher education, with key terms including innovation, institution, adoption, policy maker, data privacy, transparency, and academic integrity. This cluster shows that the adoption of AI is accompanied by concerns regarding privacy, algorithmic bias, transparency, academic integrity, and institutional policies. These issues are highly relevant to personalized learning because AI personalization generally relies on student data and algorithmic decision-making.

The blue cluster focuses on students’ experiences with and feedback on AI technology. Keywords such as “university student,” “perception,” “acceptance,” “effect,” and “influence” indicate a substantial research focus on students’ perceptions, acceptance, and interactions with AI. This cluster complements the technological perspective of the green cluster by emphasizing the user perspective. However, positive perceptions or acceptance of AI must be distinguished from objectively measured learning outcomes and conceptual understanding.

Overall, the three identified clusters indicate that AI research in higher education encompasses interconnected dimensions of technology, pedagogy, student-centeredness, institutional aspects, and ethics. The green cluster emphasizes the technological and learning dimensions; the blue cluster examines student acceptance and interaction; while the red cluster addresses institutional adoption and ethical governance. This structure provides reinforcement and a foundation for research on AI-personalized learning, where the implementation of technology must also prioritize learning outcomes, accuracy, conceptual understanding, and the student experience. Challenges in AI adoption also need to be explored to prevent the use of AI for irresponsible purposes.

Keyword Distribution Analysis

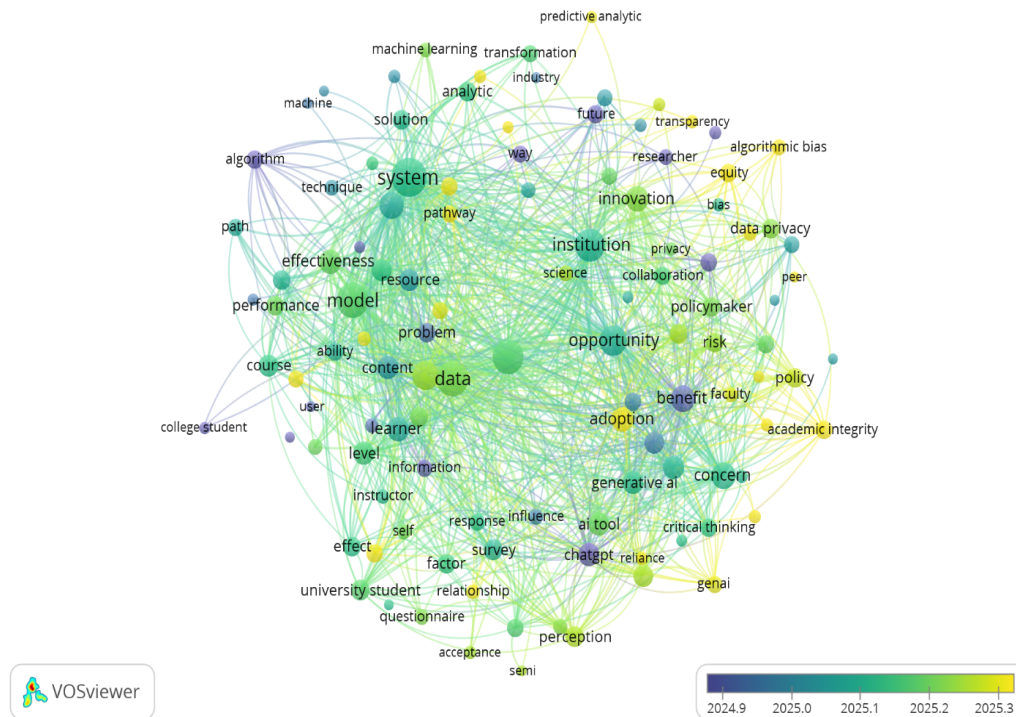


Figure 4. Overlay Visualization

Based on the overlay visualization shown in Figure 4, there has been a shift in focus from technical aspects toward issues related to learning, usage, challenges, and AI governance in the evolution of research themes regarding AI in personalized learning in higher education. This shift in focus can be seen through keywords such as “algorithm,” “machine,” “path,” “technique,” “college student,” “future,” and “way,” which appear in the blue color spectrum, indicating that in the earlier period of the dataset, research was largely related to technical approaches and system implementation.

During the middle period, the dominant visualizations for green keywords—such as “system,” “model,” “data,” “learner,” “performance,” and “effectiveness”—indicated that research focus was shifting toward the application of these concepts in learning systems and interactions with learners. Meanwhile, “performance” and “effectiveness” reflected a focus on the impact of system use on learning processes and outcomes. At this stage, keywords such as “perception,” “adoption,” “institution,” and “generative AI” also indicate that the focus of research is increasingly expanding to user experience and the implementation of AI in higher education settings.

Meanwhile, several keywords with a green-yellow to bright yellow spectrum indicate themes that have emerged more recently. Keywords such as algorithmic bias, data privacy, academic integrity, policy, critical thinking, and gen AI reflect a growing focus in research on the consequences of AI use, including

bias, data protection, academic integrity, policy, and students' ability to evaluate information provided by AI. Therefore, the overlay visualization shows that the trajectory of the literature's development has shifted from the technical aspects of AI toward the integration of AI into learning, then increasingly focused on the quality of interactions and learning outcomes, and has begun to address ethical issues, risks, and the management of AI adoption.

RQ 1: AI Use for Personalized Learning

To answer the question of how artificial intelligence (AI) is used to support personalized learning in higher education, the results of the literature synthesis indicate a paradigm shift from an approach that was initially oriented toward conventional and uniform (one-size-fits-all) methods toward a new ecosystem of student-centered learning (Khuong An & Thuy An Ngo, 2025). The integration of AI in higher education does not happen overnight. Certain aspects must be carefully considered, such as behavioral data, cognitive profiles, and students' real-time comprehension levels, in order to tailor course material, learning pace, and provide two-way feedback (Ala et al., 2025). In addition to facilitating self-regulated learning, this personalized approach also functions as scaffolding—providing step-by-step support—that guides students in unraveling complex concepts at their own pace (Coban et al., 2025).

Based on a comprehensive analysis of 49 selected articles, the application of AI technology in personalized learning at the higher education level can be categorized into four main typologies, namely: Generative AI & Large Language Models (ChatGPT/Custom GPT/LLM), Adaptive Learning Platforms & Intelligent Tutoring Systems (ITS), AI-Based Gamification & Mobile Learning Platforms, and Machine Learning and Reinforcement Learning Architectures. A detailed breakdown of the distribution of AI types used is presented in the following table:

Table 2. Literature Distribution on the Use of Generative AI and Large Language Model

Types of AI Used	Author
ChatGPT (Open AI)	(Ala et al., 2025; Brainnita Oktarina et al., 2024; Chiang et al., 2026; Coban et al., 2025; Fan & Liu, 2026; Gouia-Zarrad & Gunn, 2024; Huo & Siau, 2024; Mabanta, 2026; Olaitan & Ajao, 2025a; Singh & Singh, 2026; Tran & Truong, 2026; Xu et al., 2024)
Custom GPT /RAG-based GPT (<i>Retrieval-Augmented Generation</i>)	(Chun et al., 2025; Cruz-Ángeles et al., 2026; Hernández-Herrera et al., 2026; Sabouni et al., 2025; Sajja, Sermet, Chi, et al., 2026; Sajja, Sermet, Fodale, et al., 2026)

Types of AI Used				Author
Multimodal	GenAI	&	LLM	(Baba et al., 2024; Baradziej & Kochanska, 2026; Barra et al., 2026; Flores et al., 2026; Gold et al., 2026; Hasan & Mehnaz, 2026; Ilieva et al., 2023; Mukherjee & Singh, 2025; Wang & Zhi, 2026; Yan et al., 2025)
Conversational	Agents	(GPT-40,		
		LLaMA, Gemini, Claude, Nectir AI		
		Spark, VizChat, AIQUIZ)		

Source: Processed Scopus dataset

Generative AI and Large Language Models (LLMs) are used as everyday virtual tutors (Derbas et al., 2026), automatic question/quiz generators, providers of real-time feedback (Ilieva et al., 2023), and creators of personalized explanatory materials (Flores et al., 2026) based on individual students' needs..

Table 3. Literature Distribution on the Use of ITS and Adaptive Learning Platforms

Type of AI Used	Author
Intelligent Tutoring Systems (ITS) & Integrated Adaptive Learning Platforms (Knewton Alta, Stanford AI, Adaptemy, ASSISTments)	(Al-Zahrani & Alasmari, 2024a; Chadha, 2024; Derbas et al., 2026; Kalra et al., 2026; Karoglou et al., 2025; Khuong An & Thuy An Ngo, 2025; Lee, 2026; Wei, 2023)
Rule-Based AI & Scaffolding Real-Time Analytics	(Lim et al., 2024)
Platform Analytics Learning & Automated Content Recommendations	(Jantassova et al., 2026; Rakhmetov et al., 2026)

Source: Processed Scopus dataset

Adaptive learning platforms and Intelligent Tutoring Systems (ITS) are used to customize flexible learning pathways (Khuong An & Thuy An Ngo, 2025) present material according to learning pace (Chadha, 2024; Kalra et al., 2026), and provide scaffolding and diagnostic analysis (Lim et al., 2024).

Table 4. Literature Distribution on the Use of AI Gamification and Mobile Learning Platforms

Type of AI Used	Author
AI-Driven Gamification (Canvas AI, Moodle AI, Kahoot! AI, Quizlet AI)	(Beleya et al., 2026; Y. K. Chan et al., 2026; Naseer et al., 2025)
AI-Based Mobile Learning Platforms (Tech Learn-AI, Campus Mobile)	(Baba et al., 2024; Siasiev et al., 2026)

Source: Processed Scopus dataset

AI-based gamification and mobile learning (Mobile AI Platforms) are used to adjust difficulty levels and points in real time (Baba et al., 2024; Siasiev et al., 2026) based on individual performance and support self-directed mobile learning (Siasiev et al., 2026).

Table 5. Literature Distribution on the Use of Advanced Machine, Deep and Reinforcement Learning

Type of AI Used	Author
Deep Learning (CNN & RNN) for Personalized Learning	Naseer et al., 2024
Multi-Agent Architecture & Reinforcement Learning (Q-learning / ELA Tutor)	(López-Goyez et al., 2026)
Adaptive Cognitive Intervention Architecture (ACIA: Explainable AI / XGBoost, LightGBM, GMM, Q-learning)	(Valentín Melgarejo et al., 2026)
Model Hybrid PLP (BERT Semantic Matching, Bayesian Knowledge Tracing - BKT, Item Response Theory - IRT)	(Risdianto et al., 2026)

Source: Processed Scopus dataset

Advanced Machine Learning, Deep Learning, and Reinforcement Learning architectures are used in modeling complex learning pathways (Naseer et al., 2024; Risdianto et al., 2026), grouping students based on their metacognitive abilities (Valentín Melgarejo et al., 2026), and enabling automatic and flexible decision-making (López-Goyez et al., 2026).

RQ 2: Learning Outcomes Associated with AI-Supported Personalized Learning

The integration of AI into personalized learning has been shown to have a positive impact on students' cognitive learning outcomes and academic achievement (Kalra et al., 2026; Risdianto et al., 2026). This is evidenced by the implementation of personalized learning pathways and adaptive systems capable of improving test scores, learning experiences, academic performance, and measurable knowledge (Naseer et al., 2024). In addition to the positive impacts observed post-implementation, AI platforms based on deep learning and Large Language Models (LLMs) also offer other benefits, such as the ability to assess individual comprehension levels and deliver content tailored to users' learning paces (Cruz-Ángeles et al., 2026). Furthermore, the use of AI assistants based on Retrieval-Augmented Generation (RAG) and Intelligent Tutoring Systems (ITS) is said to be capable of narrowing the achievement gap among students by improving the performance of groups that are falling behind (Cruz-Ángeles et al., 2026), thereby fostering an inclusive learning environment (Chadha, 2024).

Student engagement in the behavioral, cognitive, and affective dimensions has also increased as a result of AI-based personalization in the learning process (Beleya et al., 2026; Olaitan & Ajao, 2025; Singh & Singh, 2026). With the provision of context-relevant materials, two-way feedback, and flexible gamification, students have shown increased interest in learning and active participation (Beleya et al., 2026; Olaitan & Ajao, 2025; Singh & Singh, 2026). Furthermore, the freedom and flexibility of “judgment-free feedback” in providing instant feedback also have a positive impact on reducing learning anxiety and boosting students’ self-confidence when facing complex material (Hasan & Mehnaz, 2026; Wei, 2023).

Another significant impact of AI personalization in learning is the enhancement of students’ self-regulated learning (SRL) skills and learning autonomy (Ala et al., 2025; Y. K. Chan et al., 2026; Lee, 2026). The availability of real-time scaffolding, automated quizzes, and AI-generated metacognitive prompts makes it easier for students to set learning goals, monitor their progress independently, and evaluate their understanding (Barra et al., 2026; Chun et al., 2025; Lim et al., 2024). Time management and study habits can also be organized in a more structured manner without relying on instructor presence. More broadly speaking, AI-driven personalization serves as a cognitive companion and facilitator of metacognitive reflection, training students to become independent and lifelong learners.

Table 6. Classification of Scientific Discipline

No	Field of Study	Author	Number
1	Language and Literacy Education (EFL/ <i>Language Learning</i>)	(Brainnita Oktarina et al., 2024; Chiang et al., 2026; Fan & Liu, 2026; Hasan & Mehnaz, 2026; Jantassova et al., 2026; Wang & Zhi, 2026; Wei, 2023)	7
2	<i>Engineering, Computer Science & IT</i>	(Atta et al., 2025; Barra et al., 2026; Cruz-Ángeles et al., 2026; Karoglou et al., 2025; López-Goyez et al., 2026; Naseer et al., 2024; Sajja, Sermet, Fodale, et al., 2026; Siasiev et al., 2026)	8
3	<i>STEM/Natural Sciences & Mathematics</i>	(Coban et al., 2025; Gouia-Zarrad & Gunn, 2024)	2
4	<i>Health Sciences & Nursing</i>	(Chun et al., 2025; Sajja, Sermet, Fodale, et al., 2026)	2
5	<i>Economics, Business & Accounting</i>	(Gold et al., 2026; Huo & Siau, 2024; Khuong An & Thuy An Ngo, 2025)	3

No	Field of Study	Author	Number
6	<i>Social Sciences & Psychology</i>	(Lim et al., 2024; López-Rodríguez et al., 2025; Singh & Singh, 2026; Valentín Melgarejo et al., 2026)	4
7	<i>Inclusive Education & Special Needs</i>	(Y. K. Chan et al., 2026)	1
8	<i>General Higher Education & Online Learning</i>	(Ala et al., 2025; Al-Zahrani & Alasmari, 2024b; Baba et al., 2024; Baradziej & Kochanska, 2026; Beleya et al., 2026; Chadha, 2024; Derbas et al., 2026; Flores et al., 2026; Hernández-Herrera et al., 2026; Ilieva et al., 2023; Kalra et al., 2026; Lee, 2026; Mabanta, 2026; Mukherjee & Singh, 2025; Naseer et al., 2025; Olaitan & Ajao, 2025; Rakhmetov et al., 2026; Risdianto et al., 2026; Sabouni et al., 2025; Tran & Truong, 2026; Xu et al., 2024; Yan et al., 2025)	22

Source: Processed Scopus dataset

Based on Table 6, Multidisciplinary/General Higher Education dominates the distribution of AI-based personalized learning implementation in higher education (44%), followed by Engineering & Computer Science (16%), and Language Learning/EFL (14%).

RQ 3: Knowledge Accuration and Conceptual Understanding

The diversity of academic disciplines in higher education means that standards for measuring Knowledge accuracy varies from one discipline to another. In the disciplines of engineering, computer science, exact sciences, and health sciences, the definition of knowledge accuracy centers on factual correctness, mathematical precision, and the exclusion of AI hallucinations—a state in which AI provides information that is highly coherent and syntactically perfect but factually incorrect (Cruz-Ángeles et al., 2026). Still within the field of engineering, in C# programming, AI facilitates two-way, step-by-step guidance in code debugging, algorithm analysis, and program structure design as a form of support for students' conceptual understanding (Atta et al., 2025; Barra et al., 2026; Cruz-Ángeles et al., 2026). Meanwhile, research in the fields of exact sciences and mathematics in higher education has found that AI's flexible visualizations and scaffolded instructions help students break down highly abstract problems—such as calculus and quantum cryptography—into simpler, more understandable concepts (Y. K. Chan et al., 2026; Coban et al., 2025; Gouia-Zarrad & Gunn, 2024). In the field of health sciences and

nursing, AI-driven personalization in learning is utilized in AI textbooks and flashcards based on Bloom's Taxonomy, which facilitate mastery of basic clinical concepts; however, the role of human instructors remains essential for honing complex clinical reasoning (Chun et al., 2025; Sajja, Sermet, Fodale, et al., 2026).

In English as a Foreign Language (EFL) and literacy learning contexts, knowledge accuracy is achieved through real-time corrections of grammar and vocabulary; it has been demonstrated that personalization refines students' academic writing skills and reduces learning anxiety (Chiang et al., 2026; Hasan & Mehnaz, 2026; Wei, 2023), whereas conceptual understanding is achieved when AI acts as an adaptive, two-way dialogue partner that adjusts to the complexity of the text according to each user's individual capabilities (zone of proximal development). In contrast, in the social sciences, humanities, and psychology, the accuracy of knowledge poses a challenge due to the high frequency of inaccurate AI outputs, thereby compelling students to cultivate critical thinking through knowledge-based evaluation when interpreting theories (Fan & Liu, 2026; López-Rodríguez et al., 2025). In the fields of economics, business, and accounting, AI provides support by linking conceptual understanding through the synthesis of knowledge across disciplines and offering critical feedback in connecting financial theory with sustainable reasoning (Gold et al., 2026; Huo & Siau, 2024)).

In the field of inclusive education, the accuracy of knowledge and conceptual understanding is enhanced through the use of AI as a tool for text-to-visual conversion, real-time translation, and the creation of instant terminology repositories that make it easier for students with special needs to understand complex science material (Y. K. Chan et al., 2026). In the context of general multidisciplinary higher education, flexible learning platforms utilize behavioral analysis and Bayesian Knowledge Tracing to detect knowledge gaps and automatically adjust task difficulty levels (Baba et al., 2024; Khuong An & Thuy An Ngo, 2025; Naseer et al., 2025; Risdianto et al., 2026). Nevertheless, the literature consistently reports a cognitive paradox: the accuracy of test scores as a measure of learning does not always align with the depth of conceptual understanding if AI is used only in passive ways or merely to mimic outputs without metacognitive processes (Ala et al., 2025; Baradziej & Kochanska, 2026; Fan & Liu, 2026). Therefore, the achievement of conceptual understanding across all academic disciplines fundamentally depends on instructional design that positions AI as a scaffold for building independent reasoning, rather than as a tool that replaces students' cognitive thinking processes.

RQ 4: Challenges and Risks

Although AI-based personalization holds transformative potential for improving learning outcomes, it consequently raises a number of challenges and risks that could potentially affect the success

of its implementation at the university level (Baradziej & Kochanska, 2026; Derbas et al., 2026; Olaitan & Ajao, 2025). The risks that have received the most attention are cognitive over-reliance and a decline in critical thinking skills (Ala et al., 2025; Chun et al., 2025). Instant access to answers threatens to reduce the learning process—which involves deep meaning-making—to mere practical outcomes that erode students’ independent reasoning (Fan & Liu, 2026; Kalra et al., 2026). These challenges are exacerbated by the phenomenon of AI hallucinations and compromised academic integrity resulting from exposure to fictitious information presented in convincing language or instances of plagiarism lacking any scientific basis.

Technical and ethical considerations, as well as threats to data privacy, security, and digital surveillance, may arise from the collection of user (student) behavioral data for the purpose of AI personalization (Chun et al., 2025; Hernández-Herrera et al., 2026; Kalra et al., 2026). Furthermore, limited data for training AI risks reinforcing algorithmic bias and cultural discrimination that marginalizes certain groups, thereby widening the digital divide between universities with abundant resources and those that are underresourced and geographically isolated (Ala et al., 2025; Baba et al., 2024; Hasan & Mehnaz, 2026; Kalra et al., 2026). The absence of consistent policy guidelines at the institutional level often creates a policy-practice gap, which prevents educators (faculty) and students from determining the ethical boundaries of AI use (Baradziej & Kochanska, 2026; Huo & Siau, 2024).

To prevent these risks, Hernández-Herrera et al. (2026) recommends a holistic governance approach based on the “Human-in-the-Loop” orchestration principle. Higher education institutions are not recommended to completely replace human instructors with AI, but rather to position AI as a supportive tool (scaffold) while allowing educators (in this case, faculty members) to retain primary control (Ala et al., 2025; Baradziej & Kochanska, 2026; Hernández-Herrera et al., 2026). At the institutional level, preventive strategies may include: 1) establishing well-developed ethical guidelines for AI use (Chadha, 2024; Derbas et al., 2026), 2) implementing privacy policies that utilize data minimization or session-only memory to protect student data (Baradziej & Kochanska, 2026), 3) digital and AI literacy training for faculty and students (Chiang et al., 2026; Khuong An & Thuy An Ngo, 2025), and 4) the use of process-based assessment methods to ensure the authenticity of students’ thought processes (Hernández-Herrera et al., 2026).

Conclusion

This article examines the use of AI to support personalized learning in higher education and analyzes its impact on learning outcomes, knowledge accuracy, conceptual understanding, and associated

risks. Using a Systematic Literature Review (SLR) approach guided by PRISMA 2020, 1,714 articles were identified within the search period from 2022 to 2026, sourced from Scopus. After the screening process, 49 articles met the inclusion criteria. The analysis results indicate that the use of AI (ranging from Generative AI and Intelligent Tutoring Systems to advanced Machine Learning) has shifted the direction of teaching toward a more student-centered approach (student-centered learning). This integration progressively enhances students' academic achievement, engagement, and self-regulated learning across various disciplines. However, the literature synthesis highlights a cognitive paradox: while test scores may improve and the speed of completing assignments may increase, these outcomes do not necessarily reflect conceptual understanding. Passive reliance on technology and the phenomenon of AI "hallucinations" risk undermining students' critical thinking skills and may even lead to misguided understanding if technology use is not accompanied by independent fact-checking.

The success of AI-based personalized learning depends on instructional design that positions AI as a cognitive scaffold and the implementation of "Human-in-the-Loop" management, ensuring that educators retain the primary role in guiding critical reasoning to maintain academic integrity, hone reasoning skills, and ensure the ethical use of technology.

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