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RECEIVED 20 August 2025

REVISED 30 October 2025

ACCEPTED 05 November 2025

PUBLISHED 17 November 2025

CITATION

Younas M, El-Dakhs DAS and Noor U (2025)
The impact of artificial intelligence-based
learning tools in academic innovation: a
review of Deep seek, GPT, and Gemini
(2020–2025).
Front. Educ. 10:1689205.
doi: 10.3389/feduc.2025.1689205

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The impact of artificial intelligence-based learning tools in academic innovation: a review of Deep seek, GPT, and Gemini (2020–2025)

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Artificial Intelligence-based Learning Tools (AI-LTs) are rapidly reshaping higher education by advancing the learning, teaching, and administrative processes. This paper offers a systematic review of peer-reviewed research, published between 2020 and 2025, by examining the roles, advantages, and challenges of the AI-LTs like ChatGPT, Deep Seek, Gemini, and Meta AI. Using a qualitative method, relevant studies were sourced from databases such as Scopus and Web of Science, by using strict criteria for the selection and extraction of data. The review highlights that the AI-LTs can significantly improve the personalized learning experiences, boost the engagement of students, and streamline the administrative operations. However, they also introduce ethical challenges like algorithmic bias and risks to data privacy. The study underscores the importance of responsible adoption of AI, advocating for the development of faculty algorithmic transparency and the robust collaboration of human-AI. Future research should prioritize empirical investigations to further validate the influence of the AI-LTs across diverse academic environments.

KEYWORDS

artificial intelligence-based learning tools, academic innovation, personalized learning, algorithmic transparency, higher education

1 Introduction

The stunning emergence of AI technology has dramatically transformed the traditional modes of teaching, learning, and research in international higher education (Al Zaidy, 2024). With these AI technologies, particularly GPT-based systems, developing and increasingly being utilized, the learning processes have become more adaptive, innovative, and learner-centered (Abulaiti, 2024). This user survey makes an effort to address the user need by: (1) assessing the effects of the AI-LTs and integrating adaptive learning systems on the performance of the students, (2) investigating the use of the AI-LTs by the faculty members for pedagogical practice enhancement and (3) critically examining the ethical and the social aspects of integrating the AI in the higher education. To support a thorough contextual understanding, In higher education, AI-based Learning Tools (AI-LTs) like the intelligent tutoring systems, automated grading, adaptive learning platforms, and analytics solutions have significantly changed the learning method, research, and administrative work of experts, students and faculty (Younas et al., 2025a; Afzaal et al., 2025).

The swift advancement of AI-driven educational technologies such as DeepSeek, GPT, and Gemini from 2020 to 2025 has significantly influenced academic innovation, transforming pedagogical methods and student interactions in higher education. This transformation is grounded in established educational paradigms, particularly Self-Determination Theory (Deci and Ryan, 1985) and digital literacy frameworks (Ng, 2012; Eshet-Alkalai and Soffer, 2012), providing a theoretical foundation for understanding how AI enhances autonomy, competence, and relatedness in learners while improving critical digital skills. From this perspective, AI systems operate as both cognitive enhancers and catalysts for motivation and self-directed learning. This review contextualizes the analysis of DeepSeek, GPT, and Gemini within wider discussions on human-machine collaboration and the changing epistemologies of digital education by synthesizing various frameworks. This theoretical framework clarifies the study's objective and underscores its contribution to our comprehension of the transformative impact of AI-driven tools on pedagogy and student autonomy in contemporary educational environments.

Additionally, situating AI-driven educational tools within contemporary pedagogical ideas highlights their ability to improve learner-centered and flexible teaching methods. According to Vygotsky's (1978) sociocultural theory and Siemens (2005) connectivism, AI platforms such as DeepSeek, GPT, and Gemini facilitate knowledge construction by providing personalized feedback, enabling collaborative problem-solving, and supporting learning in interconnected environments. These systems illustrate the principles of adaptive learning (Johnson et al., 2016) by employing data-driven insights to tailor training to individual needs, thus enhancing both engagement and performance. Furthermore, within digital literacy frameworks (Redecker and Punie, 2017; Spante et al., 2018; Younas et al., 2025b), the integration of AI underscores the importance of critical

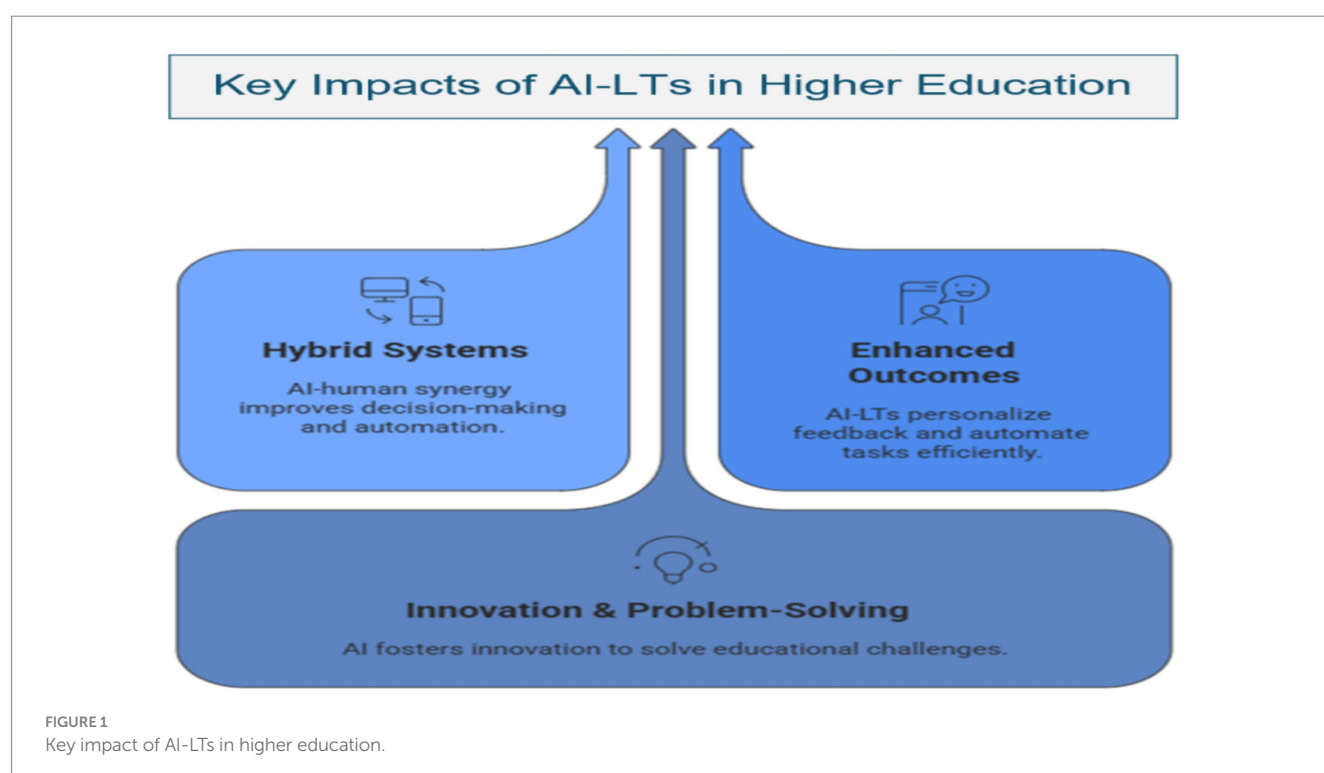
digital competence, ethical awareness, and algorithmic transparency in higher education. Thus, examining these tools within robust theoretical frameworks strengthens the conceptual basis of academic innovation research and underscores the significant educational implications of AI in fostering equitable, independent, and forward-looking learning environments.

1.1 Key impacts of the AI-LTs in higher education

Hybrid systems: The continuous human-AI integration results in the formation of hybrid systems that share the decision-making and routine tasks more between machines and humans. This collaboration can bring about the enhancement of automation to be more efficient, the obtaining deeper insights from data, and the process of being refreshed on a constant basis (Afzaal et al., 2024).

Enhanced outcomes: AI-LTs enable faster, more personalized feedback, comprehensive customization of learning, improved student engagement, and the automation of repetitive administrative tasks. This might also produce quicker responses from students, making the whole process of decision-making in educational institutions more efficient (Younas et al., 2025c). As depicted in Figure 1, the AI-Enhanced Personalized Learning Model shows how intelligent algorithms, learner profiling, and the real-time feedback mechanisms work in unison to deliver tailored academic support, thereby driving notable gains in student achievement and instructional efficiency (Tariq, 2025).

Innovation and problem-solving: Through AI's support in terms of creativity in teaching and learning, the industry's traditional problems of scaling up, allocating resources, and providing personalized assistance would be more easily dealt with and thus contributing to



the continuous pedagogical and organizational innovations in higher education (Al Zaidy, 2024; Alateyyat and Soltan, 2024).

1.2 Leading the practical applications reviewed

This review midpoints on three of the most straight and transformative AI-LT types are mentioned in Figure 2:

AI-based tutoring systems: Tools like chatbots and virtual tutors offer on-demand adaptive support, guiding students through complex concepts and providing personalized explanations (Varghese, 2024).

Adaptive learning platforms: These tailor content, pacing and the assessment to individual learners by using the real-time analytics to optimize the outcomes for the diverse groups (Mahrishi et al., 2024).

Faculty engagement tools: AI applications can support the educators by automating the course planning, content creation, grading, and individualized feedback. This can free the instructional time for the higher-order teaching activities (Sain et al., 2025).

1.3 Challenges and critical issues

Despite their promise, widespread adoption of the AI-LT raises several concerns which are highlighted in Figure 3:

Algorithmic bias and discrimination: Unchecked, AI models can continue or amplify the underlying social or cultural biases, impacting equity and fairness in the assessment and instructions (Rasul et al., 2023).

Data privacy and security: These tools can manage sensitive academic and personal information, providing robust privacy safeguards and security protocols that are essential to prevent data breaches or misuse.

Ethical dilemmas: Persistent ethical worries include transparency, explainability, consent, accountability, and the evolving nature of student-teacher roles (Bengueddach and Boudia, 2024).

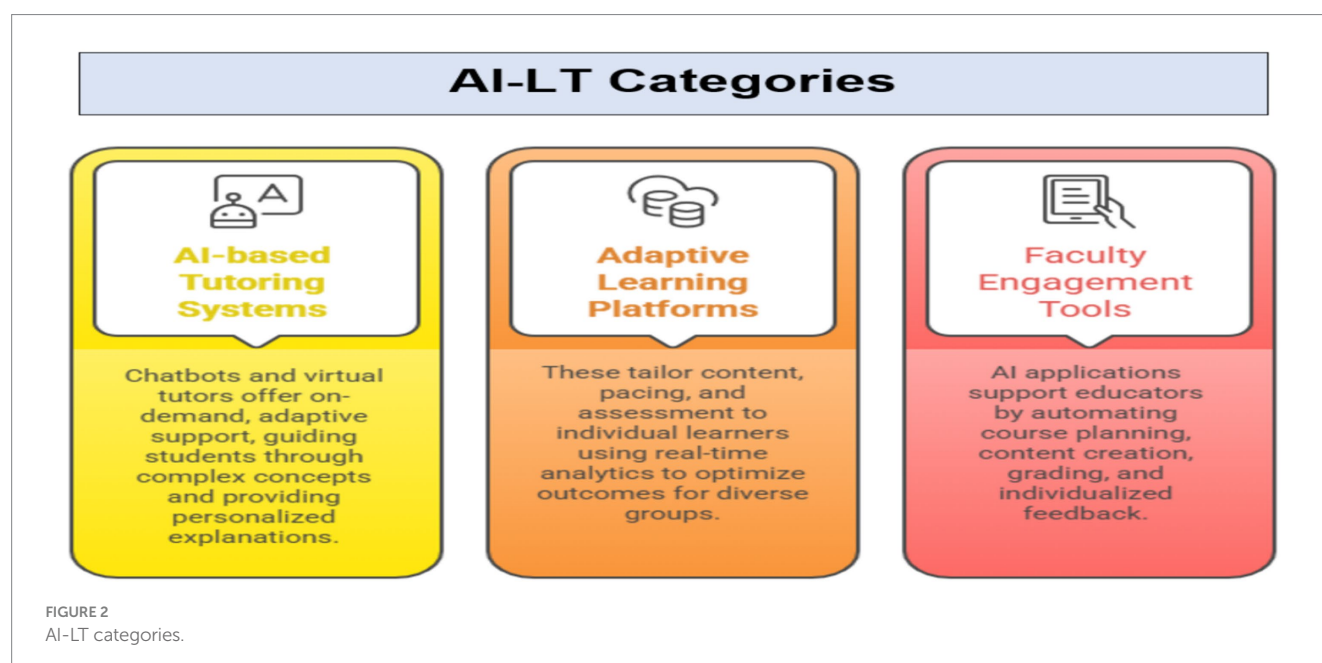
1.4 Prerequisites for impactful adoption

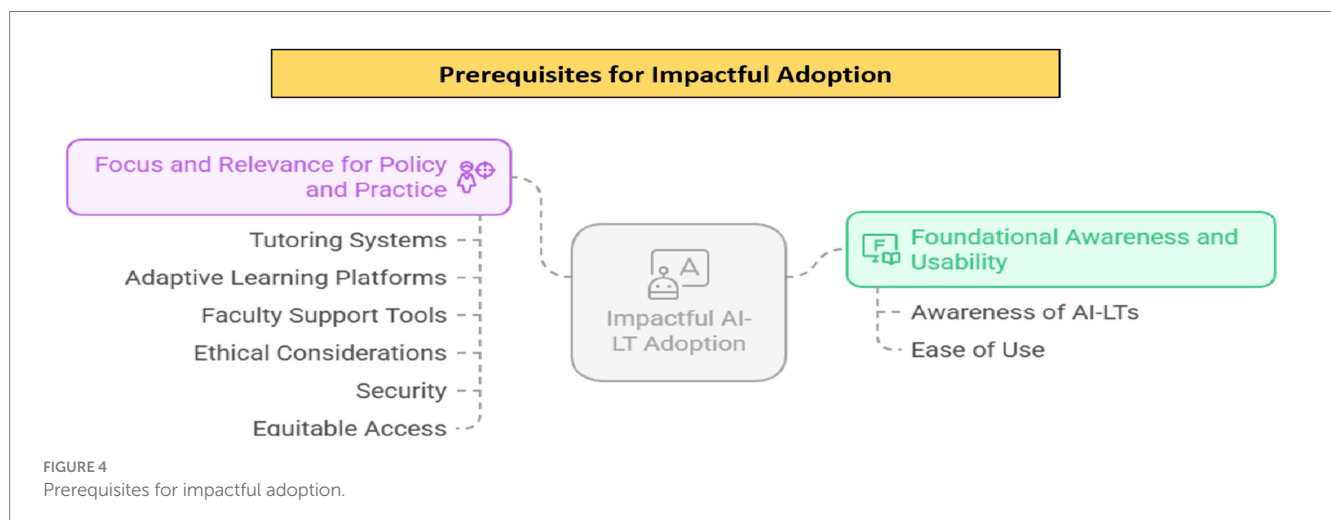
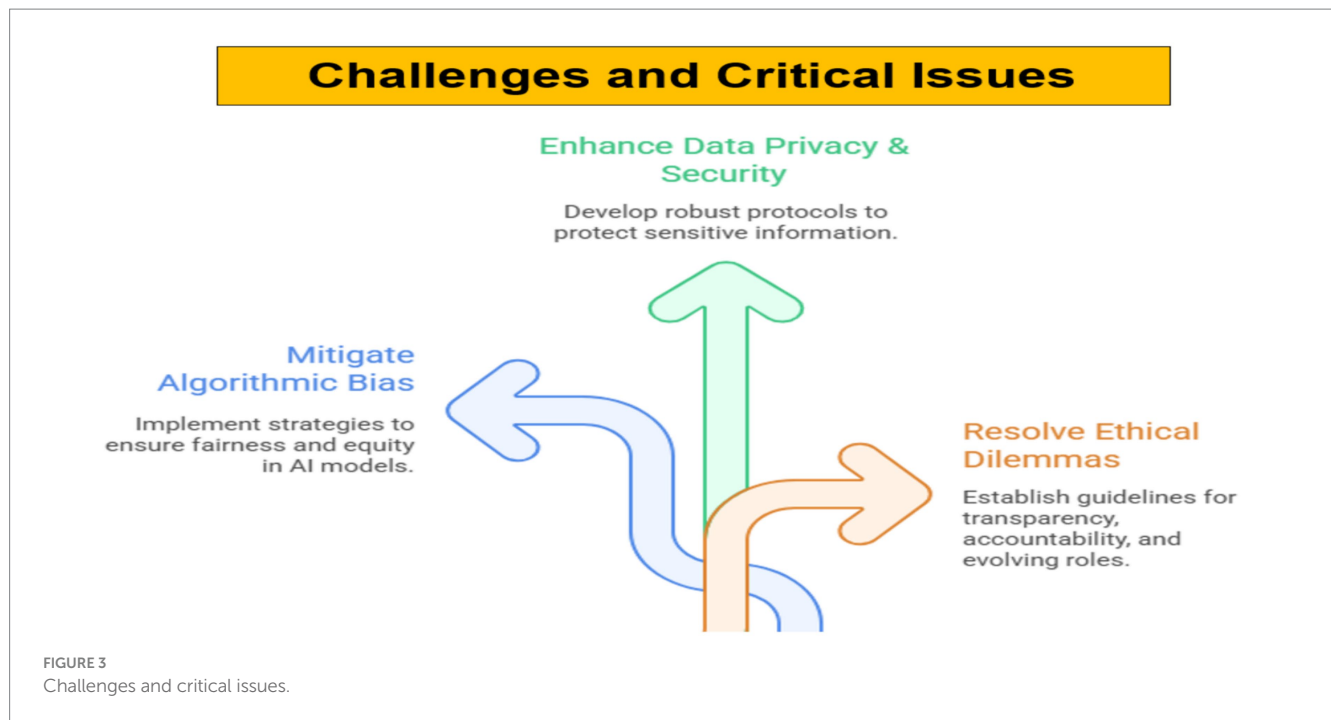
Foundational awareness and usability: The practical value of AI-LTs for educational stakeholders depends on clear awareness of available tools and their ease of use as mentioned in Figure 4. Broad and meaningful adoption is achievable only if faculty, students, and administrators understand how to integrate and benefit from these systems in daily academic practice (Aithal and Aithal, 2023).

Focus and relevance for policy and practice: While AI is transforming many aspects of education, this review mainly focuses on tutoring systems, adaptive platforms, and faculty tools as these are currently the most practical and influential AI-LT domains (Al Zaidy, 2024). Targeted insights and recommendations in these areas help educators and policymakers prioritize interventions and investments with the highest immediate impact for teaching and student success. AI-LTs are rapidly shifting the landscape of higher education, facilitating creative, adaptive, and efficient solutions, but these benefits are coupled with distinct challenges in ethics, security, and equitable access (Jin et al., 2025). A deep, practical understanding of leading tools and their responsible use is vital for leveraging AI's potential while safeguarding academic integrity and student welfare (Kelly and Sullivan, 2023).

2 Literature review

Scholars across fields such as computer science, ethics, psychology and education have explored many facets of AI-LT implementation in higher education (Abulaiti, 2024; Crompton and Burke, 2023). For example, I found that among the top 50 research studies on AI in higher education, the predominant themes include predicting students' academic performance, modeling student learning behaviors, and analyzing dropout and retention rates (Fahd et al., 2022; Siddiqui et al., 2025; Villegas-Ch et al., 2023).





Nevertheless, essential domains like communication skills, collaboration, self-efficacy, higher-order thinking, and the broader potential of AI remain under-researched in current literature (Shi, 2023). Moreover, AI's role in higher education is still in its early stages, indicating significant opportunities for further investigation and practical innovation (Aithal and Maiya, 2023; Dzogovic et al., 2024).

The assessment examines each tool across the critical dimensions as mentioned in Figure 5:

Learning personalization: The degree to which each tool can adapt to the individual learner's profiles and needs.

Student engagement: Interactive and dynamic features contribute to active learning.

Adaptive learning capabilities: Real-time adaptation based on the progress and comprehension of the student.

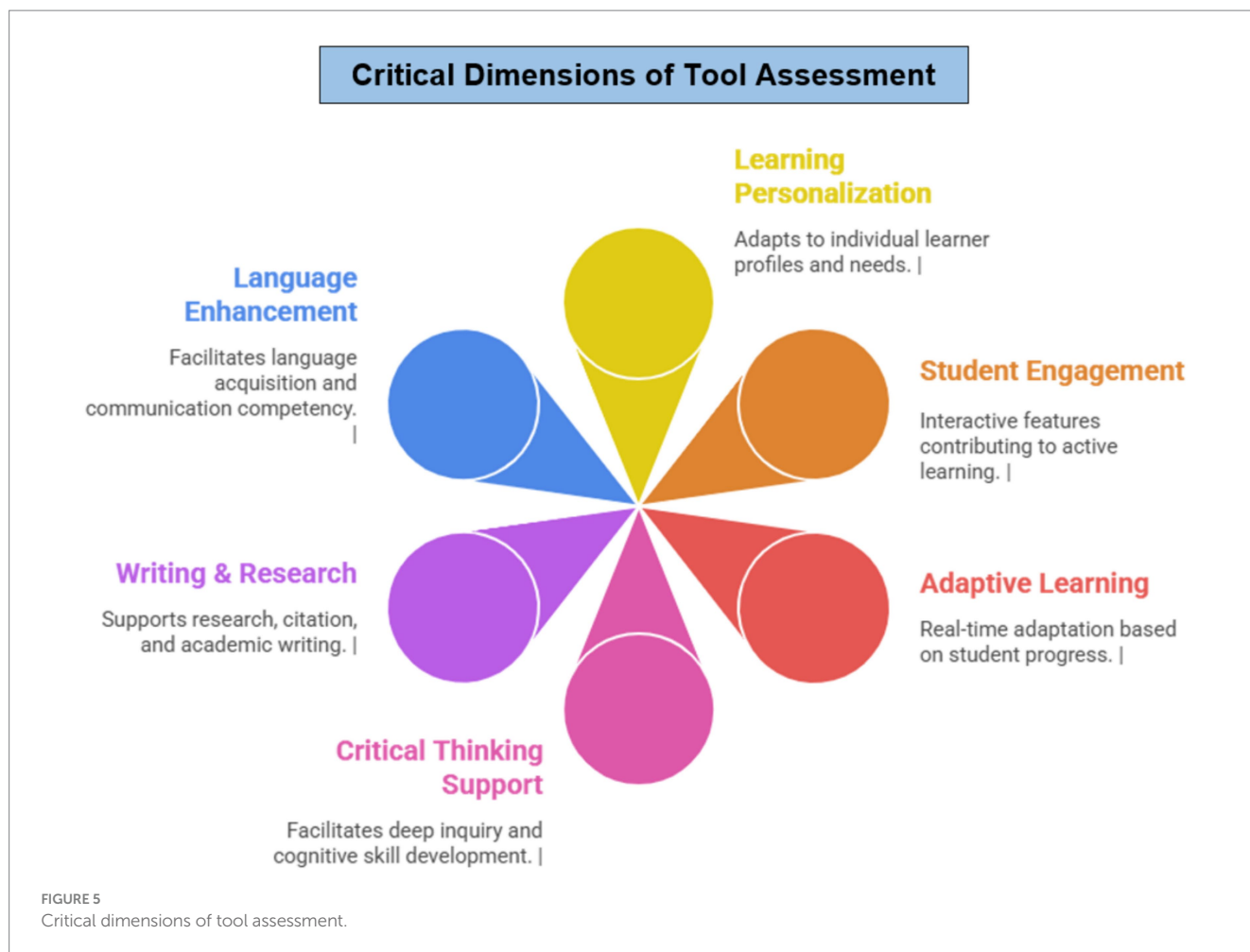
Support for critical thinking: Facilitation of the deep inquiry, reasoning and cognitive skill development.

Writing and research assistance: Support for research, citation management, and academic writing.

Language and communication enhancement: Tools facilitating the acquisition of language and competency of communication competency (Pinzolit, 2023).

2.1 Assessment automation: AI-driven tools for grading, feedback, and analytics

Additionally, the analysis also evaluates how these platforms can assist the workflows of the faculty, address the key ethical challenges (including bias and model transparency), ensure robust data privacy and security, by shaping the evolving role of teaching. The final metrics consider the alignment of each tool with modern pedagogical models, offering a deep understanding of their practical utility and their



integration within the contemporary environment of higher education (Farooq et al., 2024; Noor et al., 2022). Recent innovations in education continuously recognize the transformative potential of AI for educational systems, with particular emphasis on enhancing efficiency and productivity across institutional processes (Saha and Mondal, 2024). The integration of the AI-LTs holds the promise not only to revolutionize the instructional methodologies, but also to streamline administration, management, recruitment of students and the pedagogical workflows in both international and remote learning contexts, thereby supporting sustainability and ongoing development within higher education (Alotaibi, 2024; Tzirides et al., 2024).

The shift from the conventional, instructor-centered methods toward the more machine-focused and knowledge-centered paradigms calls for a learner-centric emphasis addressing students' evolving educational needs and redefining the instructional role of AI-LTs within the academic ecosystem (Haleem et al., 2022; Pawar, 2023). Research has indicated that using AI-powered platforms, such as adaptive learning systems and smart tutoring technologies, contributes to noticeable improvement in academic performance, increased student motivation, and provision of very personalized learning experiences (Ou, 2024; Sari et al., 2024; Taşkın, 2025; Younas et al., 2024).

As reported by Kovari (2025), Przegalinska et al. (2025), AI-LTs have a beneficial effect on the development of learning outcomes, especially in the areas of skills training, group work, and the

establishment of more productive research-oriented environments. In addition, studies investigate how AI systems can be applied in online education to facilitate a large-scale, personalized interaction between learners and instructors, thus increasing access and supporting more dynamic, responsive instructional practices (Fitria, 2021; Tan et al., 2025). Importantly, findings from Dong et al. (2025) and Julius et al. (2023) show that AI tutoring systems can have a considerable positive impact on the academic performance of students in higher education.

Higher education is undergoing a transformation through AI that is basically affecting all dimensions: it is not only opening access and improving retention rates but also elevating the quality of learning and teaching, making assessment and feedback more efficient, while at the same time, cutting down on costs as well as paperwork. As these changes unfold, the strategic deployment of AI-LTs is poised to further advance educational effectiveness, institutional sustainability, and student-centered innovation in higher education (George and Wooden, 2023). The referenced study demonstrates a positive trend in adopting AI-based learning tools within educational settings, mainly due to their reputation as innovative methods for teaching and learning. This growing acceptance reflects the perception of AI technologies as cutting-edge solutions that can enhance instructional effectiveness and modernize learning environments (Liu and Yushchik, 2024; Meylani, 2024). Furthermore, as highlighted by the studies (Dubey and Mishra, 2024; Gligorea et al., 2023; Mariyono and Nur Alif Hd, 2025; Wang S. et al., 2024) Implementing AI teaching

systems can produce beneficial impacts, specifically in college students' environmental education. These systems foster more dynamic and engaging learning experiences, support the development of knowledge and awareness about environmental issues, and contribute to improved educational outcomes in this domain. Collectively, these findings underscore the value of integrating AI tools not only to advance general teaching practices but also to address specialized topics such as environmental education, thereby expanding their significance in higher education.

Table 1 illustrates the growing effect of the AI-based learning tools (AI-LTs) in a variety of areas of study. Despite these advancements, there is tremendous knowledge that still prevails regarding how the stakeholders, administrators, teachers, and learners perceive and utilize the AI tools, especially with respect to long-term institutional and academic impacts (Watermeyer et al., 2024).

Recent research, as documented in Tables, demonstrates that AI-based Learning Tools (AI-LTs) have had a profound as well as growing impact on higher education in recent years (Abulaiti, 2024; Aithal and Aithal, 2023; Al Zaidy, 2024; Alateyyat and Soltan, 2024; Jin et al., 2025; Rasul et al., 2023; Sain et al., 2025; Tariq, 2025; Varghese, 2024; Wang X. et al., 2024; Watermeyer et al., 2024; Younas et al., 2024; Younas et al., 2025b). These studies consistently show that AI-supported education can significantly enhance learning outcomes, primarily through improved learning processes, adaptive content delivery, and increased student engagement.

It further shows in detail and in comparison, the top AI-LTs shaping the higher education context. AI-based applications have

transformed the major sectors like education, business, industry, cybersecurity, and communication by introducing disruptive innovations that can reshape old traditional processes and practices.

Table 2 provides a comprehensive and comparative analysis of leading AI-LTs, including the Meta AI, ChatGPT, DeepSeek, Gemini and other emerging platforms actively deployed in the settings of higher education (ChatGPT-4o, 2024).

2.2 How do the AI-LTs affect the learning in higher education?

AI-LTs transform learning effects are mentioned in Figure 6 and explained in detail:

Boosting motivation and engagement: Studies (Al Zaidy, 2024; Kovari, 2025; Neji et al., 2023; Yaseen et al., 2025) show that interactive AI tools like chatbots significantly improve student motivation, engagement, and teamwork, especially in fields like engineering.

Enhancing learning outcomes: AI tutoring systems and virtual teaching assistants elevate academic performance, foster collaboration, and lead to higher student achievement (Mariyono and Nur Alif Hd, 2025; Xu, 2024).

Enabling immersive experiences: Emerging virtual and immersive learning environments (e.g., metaverse-based virtual labs) are shown to strengthen both cognitive and practical skills, as well as support vocational and technical education through VR applications (Damaševičius and Sidekerskiene, 2024).

TABLE 1 Impact of AI-based learning tools in higher education.

Dimension	DeepSeek (2023)	ChatGPT (2022-Present)	Meta AI (2023-Present)	Gemini AI (2023-Present)
Personalized learning	AI-driven contextual recommendations	Adaptive, real-time tutoring	Personalized content	Multimodal learning (text, image, code)
Student engagement	Interactive Q&A, research support	High engagement, dynamic discussions	Gamification, AI-driven feedback	Text, image, speech-based interaction
Adaptive learning	Context-aware recommendations	Dynamic, progress-based adaptation	Intelligent tutoring systems	Real-time AI for the personalized learning
Critical thinking	logical reasoning and Deep inquiry	Analytical, reasoning-rich discussions	AI-generated cognitive insights	Logical reasoning & Advanced analytics
Writing and research assistance	Academic summaries, literature synthesis	Structured writing with citations	AI-supported literature review	AI-enhanced multimodal writing
Language and communication	Multilingual, academic language support	Natural language processing for the communication	AI-driven speech synthesis and translation	Enhanced linguistic analysis
Assessment and feedback	AI-powered grading, explanations	Automated quiz generation, real-time feedback	Academic performance tracking	Personalized, multimodal assessment
Faculty assistance	AI-generated course materials, recommendations	Automated lesson planning, syllabus	Academic content, course suggestions	AI-enhanced content creation
Ethical concerns and bias	Bias in datasets, fairness challenges	Risk of misinformation and bias	Ethical fairness concerns	Evolving bias mitigation strategies
Data privacy and security	AI-driven data protection	Risk of data breaches & misuse	Secure encryption standards	Privacy protection mechanisms
Impact on teaching roles	Augments educators, not replaces	Supports blended/AI-assisted learning	Virtual teaching assistants	Complements, not replaces, educators
Support for teaching models	Research-powered learning	Effective for flipped classrooms	Optimized for blended/hybrid	Strong multimodal learning support

TABLE 2 Metrics for assessing learning outcomes in AI-based higher education.

Metric	Definition and relevance	AI's role in enhancement
Knowledge retention	Percentage of course content remembered over time	AI-driven spaced repetition, adaptive content delivery
Student performance	Grades, test results, and observable skill improvement	AI analytics identify strengths and weaknesses
Engagement rate	Participation in discussions, activities, and course work	AI monitors forums and class interactions
Personalized learning score	How well instruction is tailored to the individual	AI recommends custom content dynamically
Time to competency	Speed with which a learner achieves proficiency	AI accelerates learning with targeted interventions
Critical thinking score	Problem-solving, analysis, and reasoning skill measurement	AI presents challenge tasks to foster cognitive growth
Assessment accuracy	The objectivity and reliability of evaluation and feedback	AI reduces grader subjectivity and errors

Providing personalized support: AI enables adaptive learning paths, real-time feedback, and tailored interventions by swiftly analyzing vast student data including emotional and behavioral analytics which improves outcomes for diverse learners (Kabudi et al., 2021; Pawar, 2023; Tariq, 2025; Taşkın, 2025).

Automating and enhancing assessment: The automation of grading and the application of NLP and plagiarism detection enhance assessment validity, reliability, and efficiency, reducing faculty workload and offering faster feedback (Al-Zahrani and Alasmari, 2024; Gnanaprakasam and Lourdasamy, 2024).

2.3 What is the role of AI-LTs in higher education for students?

For students, AI-LTs roles are explained in Figure 7:

Personalize learning journeys: AI dynamically adapts the content, pacing, and instructional approach based on each student's needs and learning data, maximizing their engagement and supporting at-risk learners with targeted interventions (Kovari, 2025; Ou, 2024; Pawar, 2023; Yaseen et al., 2025).

Foster teamwork and communication: AI-powered chatbots and grouping algorithms facilitate better group collaboration and learning outcomes in online and blended environments (Sain et al., 2025).

Deliver immediate support: Virtual teaching assistants and chatbots are available 24/7 to answer questions, provide resources, and provide constructive, real-time feedback.

Enhance critical skills: Through intelligent analytics, AI systems support the development of higher-order skills, critical thinking, and

self-directed learning (Damaševičius and Sidekierskiene, 2024; Goyal et al., 2023).

2.4 How do the AI-LTs impact the students, faculty, and researchers of higher education?

Impact of AI-based learning tools in higher education are documented in Figure 8 and explained in detail as well.

2.4.1 For students

Academic improvement: Data-driven personalization improves performance, retention, and motivation.

Increased equity: AI analytics can identify and support at-risk groups for more equitable outcomes though ethical safeguards must counterbalance new risks of bias and data privacy.

2.4.2 For faculty

Automated and efficient workflow: AI automates repetitive tasks (grading, content delivery, and feedback), freeing faculty for creative teaching and research (Farooq et al., 2024).

Innovative pedagogical models: AI enables flexible, student-centered teaching methodologies, supports professional development, and encourages positive perceptions toward technology (Mariyono and Nur Alif Hd, 2025; Younas and Dong, 2024).

Collaborative framework development: Adoption is enhanced by institutional support and continuous interdisciplinary collaboration among educators, legislators, and AI developers.

2.4.3 For researchers

Advanced analytics capabilities: Machine-learning methods help identify drivers of student success and dropout, enabling deeper research into learning, grouping, and pedagogical strategies (Fahd et al., 2022; Farooq et al., 2024; Villegas-Ch et al., 2023).

Interdisciplinary opportunities: AI-LTs foster new interdisciplinary explorations in ethics, education science, data science, and psychology, with growing attention to issues of bias, justice, and transparency (Meylani, 2024).

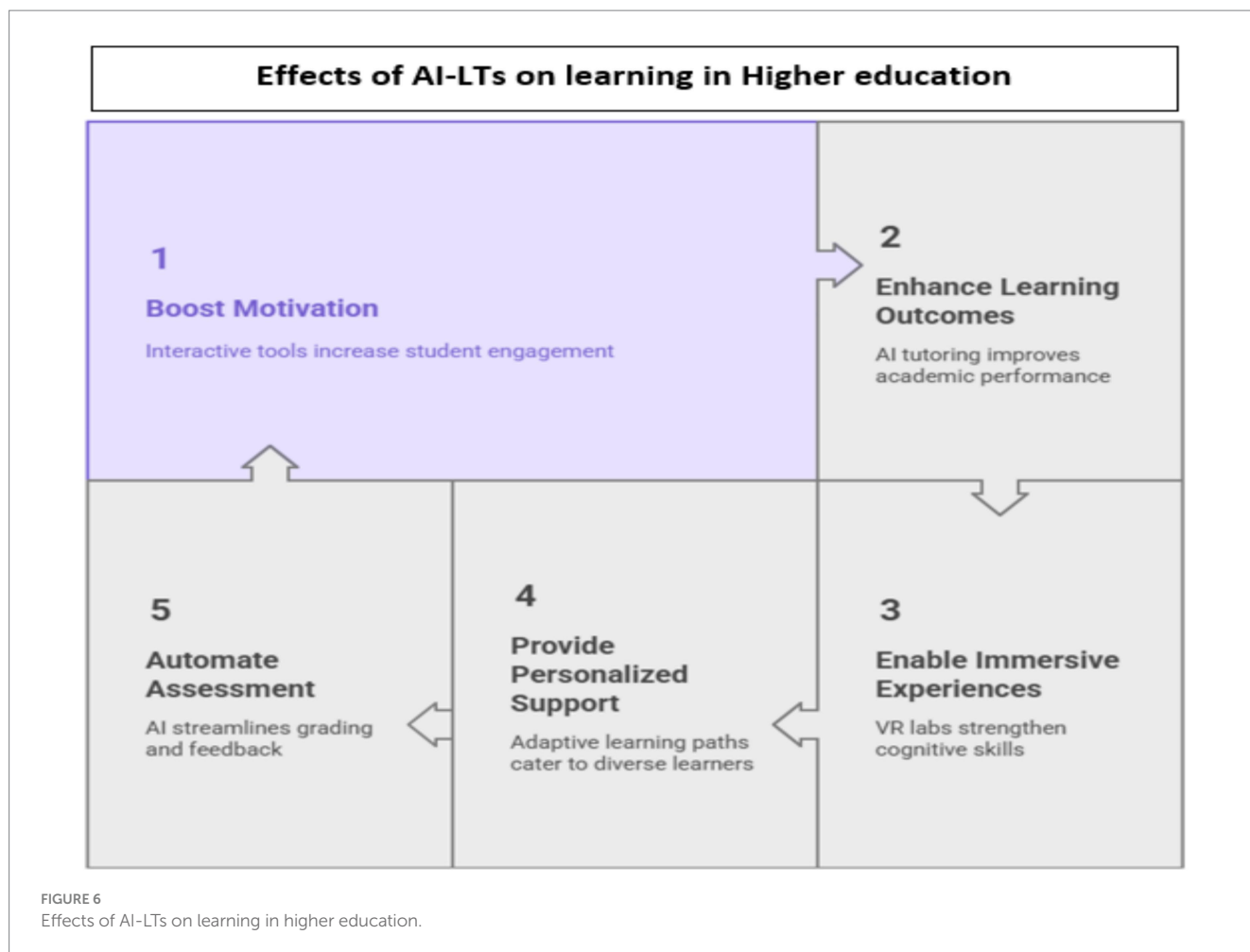
2.4.3.1 Additional insights

Systemic and ethical challenges: Studies identify systemic obstacles to AI adoption particularly in developing countries including cultural, technological, and institutional barriers to gamification and advanced AI tools.

Ethical deployment: Responsible implementation requires policies for transparency, student consent, faculty-AI collaboration, and robust data privacy protections, emphasizing fairness and inclusivity (Al-Zahrani and Alasmari, 2024; Al Zaidy, 2024).

Transforming social and institutional relationships: The integration of AI-LTs not only changes teaching and learning but redefines the relationships between students, instructors, and technological systems enhancing operational efficiency in administration, teaching, and learning domains.

AI-based learning tools are accelerating the evolution of higher education, fostering improved academic outcomes and engagement, supporting personalized instruction, enhancing administrative and faculty efficiency, and opening new pathways for research and



cross-disciplinary innovation while also demanding careful attention to ethics, equity, and institutional readiness.

3 Methodology overview

This review utilizes systematic literature review methodology to evaluate the existing body of research on the impacts, strengths, and challenges of AI-LTs in higher education. The review was carefully designed to ensure comprehensive coverage and minimize bias, aligning with best practices for evidence-based educational research. Figure 9 shows a complete overview of the methodology.

3.1 Guiding research questions

RQ1: What is the impact of AI-LTs on student learning outcomes?

RQ2: How do the faculty utilize AI-LTs for instructional enhancement?

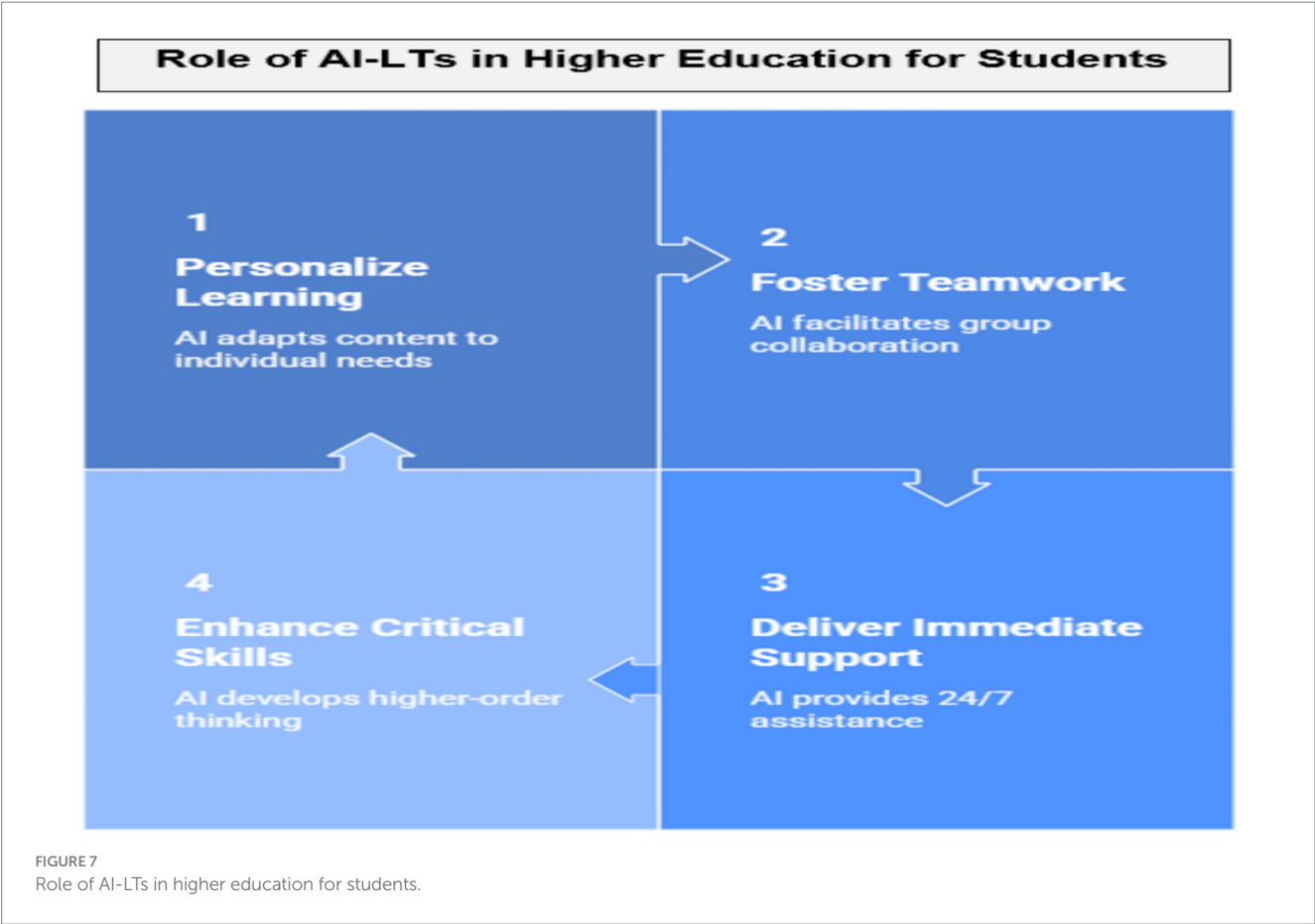
RQ3: What ethical and societal challenges arise from adopting AI in education?

3.2 Search strategy

3.2.1 Qualitative exploratory approach

The research adopts a qualitative design, focusing on thematic synthesis rather than quantitative meta-analysis. Electronic databases were rigorously searched for peer-reviewed articles published in English from January 2020 to June 2025. Given the diversity in study designs and reporting, improvement figures like “30–40% better outcomes” are reported as cited in individual studies and not calculated meta-analytically in this work.

In this paper in Table 3, the key scientific databases, in which IEEE Xplore, Springer, Web of Science and Google Scholar were used. The keywords used to conduct this study include the following ones: AI in education, ChatGPT in higher education, DeepSeek, AI based learning tools, adaptive learning. Following the search results, 45 related publications were chosen because of their dominant contribution over others. Although the paper examines all documents that have been conducted, it shows two areas of focus. It is important to note though that the general number of publications on the issue of AI application in education remains relatively low, but AI-based educational initiatives have become more significant in the industry. This paper suggests AI implementation, projects, concerns of benefits, and adoption issues in education.



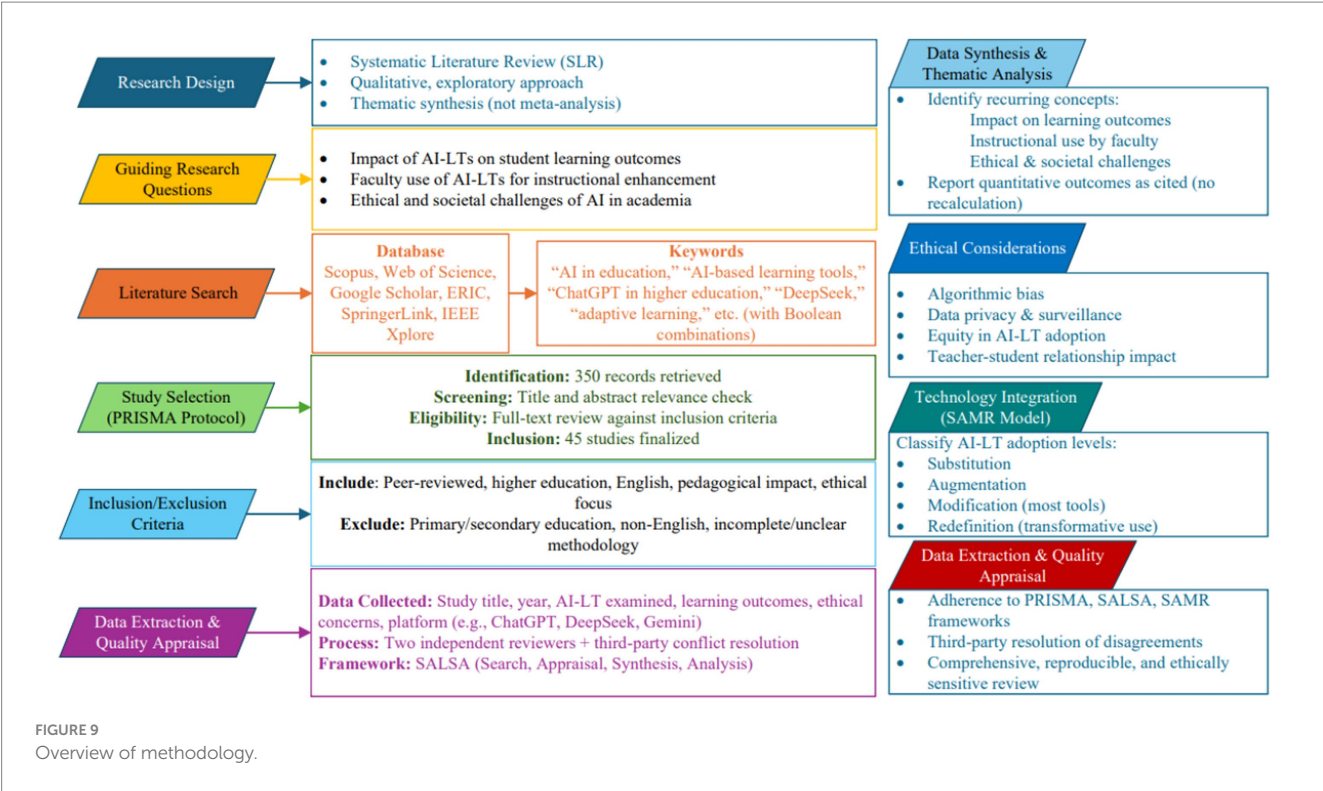


TABLE 3 Search keywords.

Searching by query string	Searching by keywords
AI in education," "ChatGPT in higher education," "DeepSeek," "AI-based learning tools," "adaptive learning,"	1. Application of AI in education 2. AI-based educational projects 3. Benefits of AI technology in education 4. AI adoption challenges in education

TABLE 4 Searches in databases.

Electronic database	Query strings
Scopus	Paper title, keywords, abstract
IEEE explore	Paper title, keywords, abstract
Web of science	Paper title, keywords
Springer link	Paper title, keywords
Google scholar	Paper title, keywords

3.3 Databases searched

Major academic databases for this study include. In Table 4, the key scientific databases, in which IEEE Xplore, Springer, Web of Science and Google Scholar were used. The keywords used to conduct this study include the following ones: AI in education, ChatGPT in higher education, DeepSeek, AI based learning tools, adaptive learning.

3.4 Inclusion and exclusion criteria

The inclusion and exclusion phase entails the determination of the relevant publications to answer the research questions. To this end, an inclusion and exclusion list has been created as presented in Table 5.

Filtered on the titles and abstracts to remove the duplicate articles and selected the ones that are in direct relation to our research, were concerned with blockchain applications, projects, benefits, and challenges of its adoption in education. Nevertheless, some of the articles did not give us an opportunity to completely

TABLE 5 Inclusion and exclusion of articles.

Criteria for exclusion	Criteria for inclusion
Studies were published before 2019.	Studies published from 2020 to 2025 (the last 6 years) are used for this review.
Non-English studies	The full text is available in open online.
Editorial comments	Journal, Conference, and Workshop publications.
Studies that do not present the AI application project's benefits and challenges in education.	Studies that present AI, benefits, and challenges in education.

access their contents and we disqualified them. In the search selection process of this study 350 out of 500 articles were excluded and 45 articles that were included in the relevant publication were researched.

The final sample comprised 45 studies, which were chosen by their methodological quality and the relevance to the research questions; this relatively small number was predetermined by the

low amount of high-quality and peer-reviewed empirical studies about AI-based learning tools over the given period of time and ensured a specific and credible synthesis of emerging evidence.

3.5 Screening process and data extraction

3.5.1 PRISMA protocol

The review followed PRISMA guidelines, employing four stages as shown in [Figure 10](#).

Subsequently, the analysis of the data was conducted, including the AI application, the projects, and the benefits, as well as the adoption challenges that are discussed in the 45 primary articles. Following such analysis, articles were selected. These themes have been picked up considering nine items displayed in the table.

3.6 Structured data extraction

The information was retrieved through the chosen sources, which mostly addressed AI applications and projects, their benefits, and challenges in the adoption in education. These aspects were the basis of the extracted data, which was obtained in the form of the significant shortlisted articles (see [Table 6](#)).

3.7 Methodological assessment framework

The SALSA framework (Search, Appraisal, Synthesis, and Analysis) was used to ensure rigor:

- *Search*: Robust strategy using defined keywords.
- *Appraisal*: Assessing clarity, relevance, and potential bias.
- *Synthesis*: Thematic categorization to identify patterns.

- *Analysis*: Drawing conclusions linked to the three core research objectives.

3.8 Data synthesis and thematic analysis

3.8.1 Thematic organization

Recurring concepts and themes (e.g., impact on outcomes, instructional use, and ethical challenges) were synthesized across studies.

3.8.2 Reporting of results

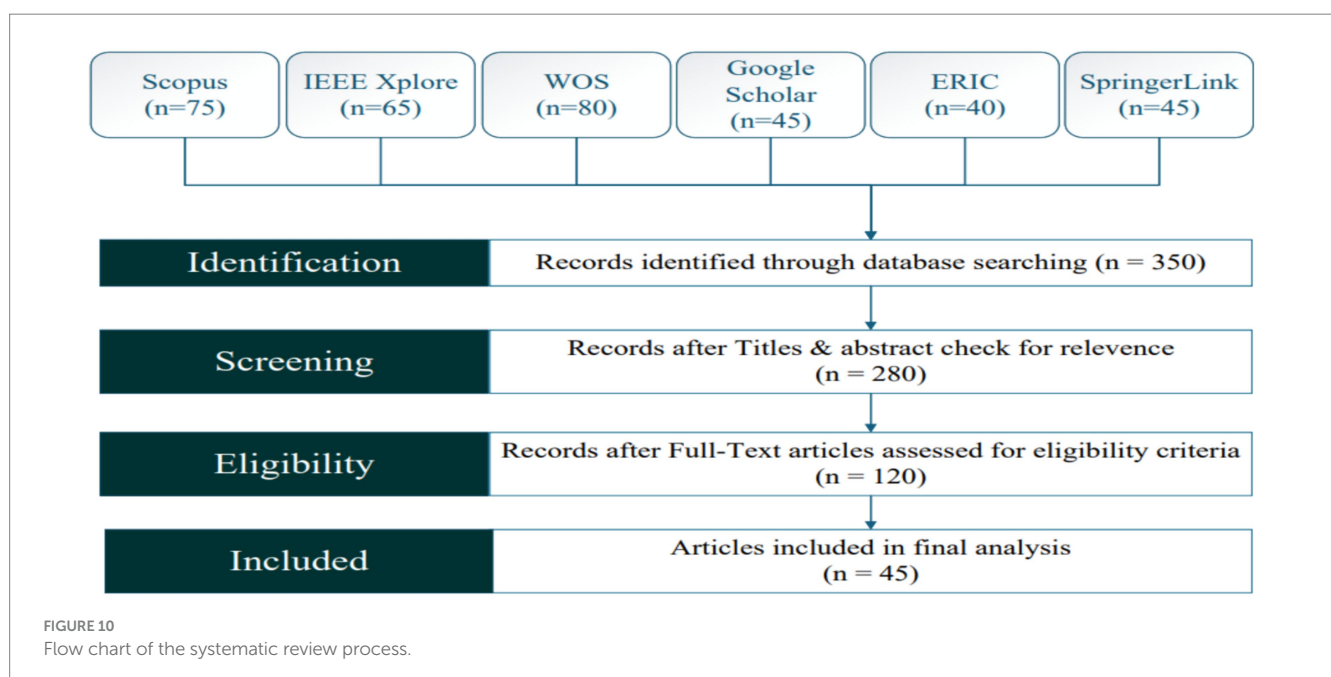
Quantitative impacts (e.g., % improvement) are reported as cited in original studies, not aggregated or recalculated for this review.

3.9 Ethical considerations

Key concerns such as algorithmic bias, data privacy, surveillance, and equity—were systematically addressed. The review also discusses how AI-LTs may transform teacher and student dynamics,

TABLE 6 Data extraction.

Data item	Explanation
Title	Title of the paper
Type	Conference /Journal/ Workshop.
Date	Years of publication
Language	English papers
Application	AI potential applications in education
Projects	Blockchain projects in education.
Benefits	Benefits of AI Technology in Education
Adoption challenges	Challenges of Implementing AI in Education



recommending ongoing professional development to help educators and learners adapt responsibly.

3.10 SAMR model application

3.10.1 Technology integration assessment (SAMR)

The SAMR model (Substitution, Augmentation, Modification, and Redefinition) was adopted to classify the depth and impact of AI-LTs in higher education. Most AI-LTs reviewed fall within the 'Modification' and 'Redefinition' levels, fundamentally reshaping instructional practices and learner experiences.

3.11 Rigor and transparency

Transparency in methods and adherence to systematic protocols ensure that the review is comprehensive, reproducible, and balanced, providing both technical robustness and ethical sensitivity.

Disagreements in article selection or data extraction were resolved by consensus or third-party arbitration, further strengthening the reliability of the review process.

This systematic qualitative review integrates rigorous, transparent processes (PRISMA, SALSA, SAMR) to synthesize recent evidence on AI-LTs in higher education, highlighting both their transformative potential and the ethical, societal, and institutional challenges that future research must continue to address.

4 Results

This review systematically examined the evolving landscape and challenges presented by AI-LTs like DeepSeek, GPT-4, and Gemini in higher education. Findings are organized according to the sequence of the guiding research questions.

4.1 AI-LTs and student learning outcomes

The adoption of AI-LTs in higher education has accelerated markedly in recent years. Modern AI platforms adaptive learning systems, intelligent tutoring systems, and analytics-enabled educational tools demonstrate strong effectiveness in enhancing learning outcomes, personalizing instruction, and boosting student engagement. Studies (Abulaiti, 2024; Aithal and Aithal, 2023; Aithal and Maiya, 2023; Al-Zahrani and Alasmari, 2024; Al Zaidy, 2024) highlighted how the top 50 AI-related works in the field predominantly forecast student achievement, retention, and dropouts often overlook aspects such as collaboration, communication, and higher-order thinking. This discloses a research gap in discovering the full educational potential of AI-LTs.

AI children's learning systems that are powered by AI use real-time data analytics to change the curriculum according to the student's needs and provide the students with individualized feedback and support throughout their learning process. The personalization of learning is very advantageous for the students who have different requirements or are at risk of being left behind. Studies indicate that tutoring by AI promotes academic performance, builds up one's self-esteem, and gives

the power of learning at one's own pace, thus allowing the students to move ahead according to their capacities (Adewale et al., 2024).

AI-LTs have made large-scale personalization possible, which in turn allows teachers to take on larger classes while giving a similar amount of personal attention. The AI has driven the knowledge-centered methods to create learning environments that are dynamic, interactive, and students are the ones who are actively exploring and understanding deeply (Mariyono and Nur Alif Hd, 2025; Singh et al., 2024).

4.2 AI-LTs and institutional and administrative transformation

Outside the classroom, AI-LTs initiative systemic variations within higher education institutes. Studies found AI tools crucial for enhancing administrative efficiency and sustainability—automating enrollment, scheduling, and student support, and generating actionable insights for resource management (Deep, 2024). Data-driven institutional decision-making strengthens sustainability, quality assurance, and alignment with global standards (Gaftandzhieva et al., 2023).

AI-powered analytics enable real-time monitoring of student progress, emotional well-being, and group dynamics, fostering a more responsive and supportive learning environment. Tailored interventions based on predictive analytics improve retention rates and empower at-risk learners. AI-based grouping methods consistently outperform traditional random or instructor-assigned methods, resulting in more engaged, productive, and communicative student teams. These insights reinforce the value of AI in facilitating meaningful collaboration and optimal learning outcomes in both physical and virtual settings (Zheng et al., 2024).

4.3 AI-LTs in teaching, assessment, and faculty roles

AI-based tools substantially lighten instructor workload by automating grading, analyzing feedback, and informing adaptive teaching strategies. Natural language processing (NLP) systems accurately grade written work, reducing human bias and ensuring uniform evaluation.

Professional development benefits such as AI-LTs provide analytics on pedagogy and student interaction, enabling faculty to diversify teaching strategies and free up time for innovative methodologies like flipped or blended classrooms. Successful integration, however, hinges on comprehensive training for educators and close collaboration among institutional stakeholders (Soni, 2025).

AI's impact extends to institutional functions optimizing management, administration, and recruitment. AI-driven analytics help identify at-risk students, automate assessment, and support data-driven policy decisions, streamlining operations and supporting sustainable institutional growth (Kotler et al., 2023).

4.4 Ethical, social, and pedagogical challenges

Despite transformative potential, AI-LTs raise significant ethical and societal concerns. Algorithmic bias, privacy risks, and surveillance

are recurring issues. The lack of transparency and potential for dehumanizing education call for comprehensive ethical frameworks, emphasizing accountability, inclusivity, and alignment with human-centered educational values. Moreover, these technologies are reshaping job roles in education, demanding workforce reskilling and prompting reevaluation of curricula. Policies and retraining are essential to mitigate negative workforce impacts and foster creative, interdisciplinary opportunities (Thelma et al., 2024; Mariyono and Nur Alif Hd, 2025). The importance of developing AI and digital literacy for educators and non-experts is vital. Ethical deployment depends on transparency, ongoing professional development, and robust interdisciplinary research to increase system reliability and trust (see Table 7).

4.5 Limitations

This review relies solely on secondary data from peer-reviewed articles, without primary empirical evidence. The lack of firsthand data may limit the originality and practical validation of conclusions. The sample size is restricted, potentially affecting generalizability, and findings are predominantly based on self-reported measures, which could introduce bias. Perspectives from AI developers and industry were not directly included. The overview of the limitations is shown in Figure 11.

Implications and Future Directions are documented in Figure 12 and explained in detail.

Expand research scope: Future studies should include empirical data (surveys, interviews, case studies) and seek input from AI developers, industry, and diverse institutional contexts.

Broaden stakeholder perspectives: Understanding the needs of all stakeholders including students, educators, administrators, developers, and policymakers will foster more holistic, effective deployment.

Prioritize ethical frameworks: Sustained attention to bias, privacy, accountability, and the human-AI relationship is essential for responsible AI-LT adoption.

Invest in professional development and literacy: Training programs will prepare educators and students for ethical, effective AI integration.

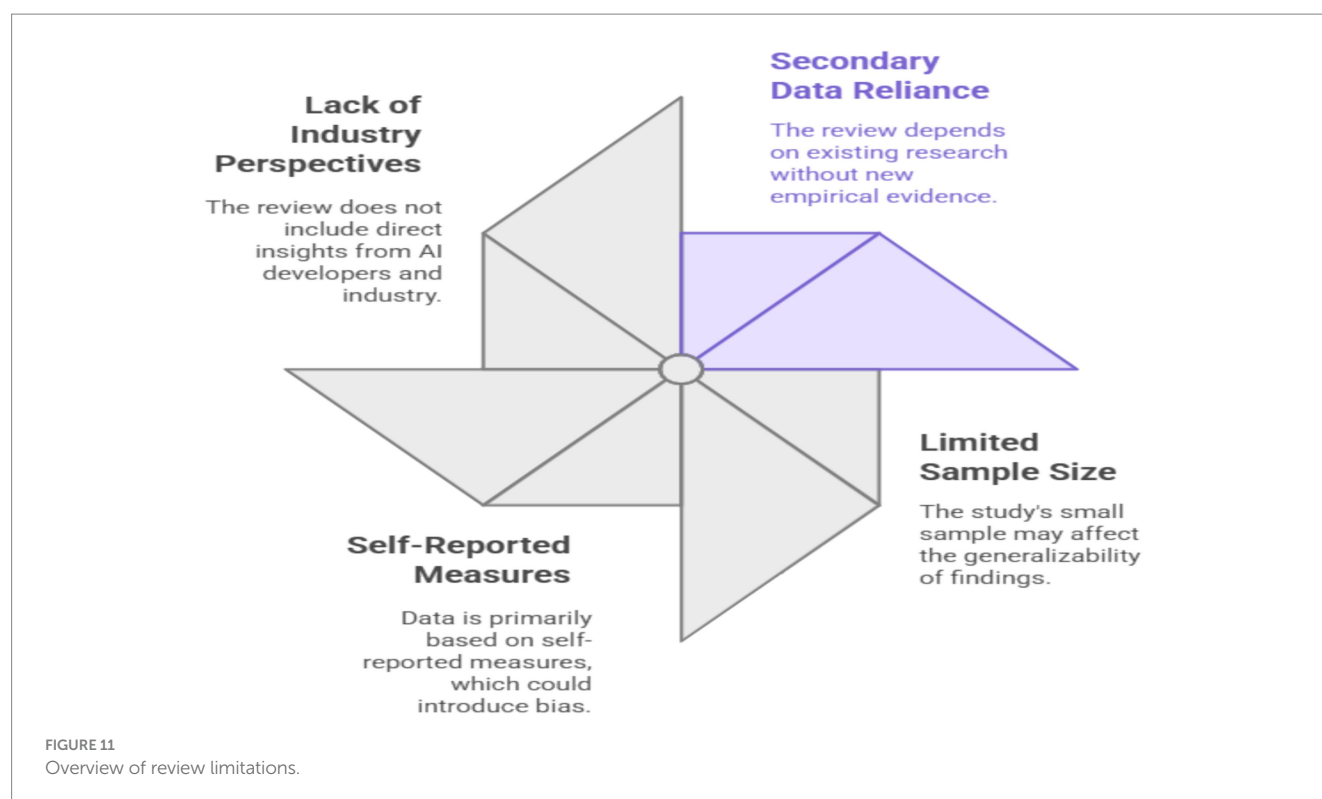
5 Discussion

The results of this study highlight the transformative potential of the AI-based learning tools (AI-LTs) in reshaping pedagogical practices, enhancing the engagement of the learner, and supporting the critical as well as the emotional development in higher education. By the integration of AI tools like ChatGPT and other generative platforms, students can report greater personalization in their learning experiences, which further fosters the increased intrinsic motivation and encourages deep levels of active learning. The data suggest that the students who interact regularly with these AI-LTs show stronger tendencies toward the independent exploration of knowledge, self-directed learning, and metacognitive engagement. This aligns with the principles of Self-Determination Theory (SDT), which emphasizes autonomy and competence as critical to intrinsic motivation. Furthermore, the positive relations also observed between the usage of AI-LT and the development of critical thinking, which highlights

TABLE 7 Summary table of key insights.

Focus area	Key findings
Student outcomes	AI tutoring improves achievement, engagement, and retention, personalized learning fosters deeper understanding (Adewale et al., 2024; Al Zaidy, 2024; Deep, 2024; Dong et al., 2025).
Group collaboration	AI grouping supports communicative, equitable teamwork (Al-Zahrani and Alasmari, 2024; Mariyono and Nur Alif Hd, 2025; Przegalinska et al., 2025).
Assessment automatization	NLP tools ensure speed and accuracy; AI automates grading, plagiarism detection.
Institutional admin and analytics	AI streamlines management enables evidence-based intervention and resource optimization (Al Zaidy, 2024; Farooq et al., 2024; Haleem et al., 2022; Jin et al., 2025).
Faculty professional development	AI supports teaching diversification and skill enhancement (Farooq et al., 2024; Mariyono and Nur Alif Hd, 2025; Meylani, 2024; Shi, 2023; Tan et al., 2025; Yaseen et al., 2025).
Ethical and social concerns	Issues: bias, data privacy, transparency, workforce impact (Al-Zahrani and Alasmari, 2024; Al Zaidy, 2024; Thelma et al., 2024; Kovari, 2025; Sain et al., 2025).
Need for collaboration and training	Multi stake holder collaboration and teacher training are crucial for meaningful AI integration (Al Zaidy, 2024; Farooq et al., 2024; Mariyono and Nur Alif Hd, 2025).

the role of these tools in enabling learners to synthesize information, assumptions for questions, and approach problems with analytical accuracy. However, the study also discloses many essential nuances. While AI tools support the learning needs of the individual and offer instant feedback the concerns arise regarding the over-dependence on this AI-generated content, which may hinder creativity or reduce opportunities for collaborative discourse if it is not integrated carefully. Renovation of emotional learning is comparatively un-explored dimension that acted as a key outcome, the students representing that these AI tools can produce a safe and modified environment that can help in confidence-building and decrease anxiety around learning duties. Also, this emotional appointment depends meaningfully on how the teachers present and support these types of tools. Ethical consciousness and digital knowledge have also been raised as reasonable factors that can inspire how the students can interact with these AI-LTs. In the absence of passable guidance, a student might try AI tools frequently for using these and this will help to accept AI tools without going deep investigation checking during conducting research. This situation underscores the need for



educational organizations to deliver constant support; teachers training should be done frequently and teaching students the notion of digital responsibility. Apart from that, the influence of AI-enabled knowledge is not equal to every student; some classes might gain more advantages based on their experiences and learning situations. Challenges in technology obtainability, language skills in the academic fields can impact on how students use these AI tools. Therefore, the need for an AI-driven learning situation that is comprehensive and cultural awareness is highlighted. To sum up, this research strengthens the potential of these AI-LTs to facilitate as the breakthrough for novelty in educational setting and understating the human direction, ethical responsibility, and academic intent as key issues in the answerable usage of technology.

The influence of the AI-created learning tools (AI-LTs) in educational institutions is not seen as a mere improvement in teaching effectiveness but a total setback in the teaching attitude and the control exercised by the institution. AI tools like ChatGPT, DeepSeek, Gemini, and Meta AI are not only appealing students more in the learning process and rationalization the organizational activities, but they are also making us to reconsideration our definition of knowledge by turning the AI into a cognitive partner as an alternative of instrument (Younas and Dong, 2024; Sain et al., 2025). This collaboration fosters autonomy, competence, and self-directed learning following the Self-Determination Theory; but on the other hand, it raises new ethical issues such as those of genuineness, authorship, and dependance on algorithmic feedback (Al Zaidy, 2024; Kelly and Sullivan, 2023). The research shows that adaptive and data-driven personalization can make students more engaged and help develop their critical thinking; however, it might worsen inequalities when digital literacy and access are not evenly shared among the population (Farooq et al., 2024; Jin et al., 2025). The institutional adoption of AI-LTs stances challenges the old-style views of

academic truthfulness and pedagogical specialist, which require teachers to take automatic, ethically informed situations that bring together human decision and algorithmic advice (Bengueddach and Boudia, 2024; Watermeyer et al., 2024). Therefore, the AI-driven alteration of higher education should be treated critically as a dialectical process that, on the one hand, empowers and, on the other, weakens the traditional academic constructions, requiring constant ethical supervision, inclusive design, and theoretical basis to guarantee human-centered novelty.

The inquiry regarding the ethical issues associated with AI-based Learning Tools (AI-LTs) specifies that these tools are the main cause of conversation related to the problems of accountability, transparency, and academic justice, which are outside the boundaries of data confidentiality and algorithmic unfairness. Though the technologies assist in efficiency as well as personalization, they still bring about the problems of making the surveillance typical, worsening the existing inequalities, and treating it hard to tell the difference between real learning and machine-generated answers (Al-Zahrani and Alasmari, 2024; Kelly and Sullivan, 2023). The moral issue involves the opposition of the innovation factor to the accountability factor, or the determined direction of AI to us, being positioned on the side of human judgment in the education process and assessment only (Watermeyer et al., 2024). Furthermore, digital literacy and access discrepancies create more ethical problems that require the establishment of a framework in institutions to help achieve the goals of inclusion, informed consent, and fairness in the deployment of algorithms (Jin et al., 2025; Sain et al., 2025). Therefore, technology should be regarded as the driver of an ethical dialog that should continue hand-in-hand with its process of being made and applied, and ethics are not to be viewed as a limitation but rather as the cornerstone of both the acceptance of non-discriminatory and sustainable AI in higher education and the process of coming up with such standards.

Implications and Future Directions



FIGURE 12
Implications and future directions.

The worldwide conversations about ethics have led to the conclusion that the different challenges presented by AI-enabled learning systems (AI-LTs) are never the same in all parts of the world. To be more specific, the challenges possess the same root stemming from areas' cultural, economic, and institutional differences. East-west discrepancies as to, e.g., infrastructure, data management, and digital literacy vary among regions thus causing quite a lot of individuals to get cut off from or to be subjected to bias or to remain without fair access to the AI-inspired educational opportunities (Jin et al., 2025; Al-Zahrani and Alasmari, 2024). Global ethics and institutional transparency may ensure the highest of the regions' academic integrity, developed universities still must be confronting the most ethical issues.

6 Conclusion

This systematic review has shown that AI Learning Tools (AI-LTs), of which ChatGPT, DeepSeek, Gemini, and Meta AI are a part, are, on the one hand, supplementary technologies and, on

the other, the driving force of academic innovation. Their acceptance in between 2020 to 2025 has discovered the potential to modify and individualize knowledge paths, to engage the students in depth, and also ease the process of the institution, thus reorganization the higher education system management. Though, these novelties bring along ethical worries: fairness in algorithms, data safety, and directness in AI shaping. The future growth of AI-LTs in the academic world sphere trusts heavily on the dependability of answerable integration, the willingness of the staff, the intelligibility of the governance agendas, as well as the constant human-AI relationship are the factors that underscore the integration of AI knowledges in education. The Research efforts motivation must deal with the procedures established for the usage of AI technologies which drive necessitate the picture of framework-specific and experiential inquiries through academic discussions. Likewise, higher education determination able to take benefit of AI not as a disruptive control but as a companion in revolution that shapes reasonable, advanced, and wide-ranging learning environments.

Author contributions

MY: Methodology, Writing – original draft. DE-D: Methodology, Supervision, Writing – review & editing. UN: Data curation, Formal analysis, Methodology, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported APC part by Prince Sultan University under the Language and Communication Research Laboratory (Grant RL-CH-2019/9/1).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Abulaiti, M. (2024). “Higher education in the era of AI” in Developments and future trends in transnational higher education leadership. eds. G. R. Morris and S. Kozuch (Hershey, PA: IGI Global Scientific Publishing), 244–265.
- Adeyale, M. D., Azeta, A., Abayomi-Alli, A., and Sambo-Magaji, A. (2024). Impact of artificial intelligence adoption on students’ academic performance in open and distance learning: a systematic literature review. *Heliyon* 10:e40025. doi: 10.1016/j.heliyon.2024.e40025
- Afzaal, M., Brashi, A., Younas, M., and El-Dakhs, D. A. S. (2025). ChatGPT and intrinsic motivation in higher education: a TAM-based study. *Front. Educ.* 10:1674141. doi: 10.3389/feduc.2025.1674141
- Afzaal, M., Shanshan, X., Dong, Y., and Younas, M. (2024). Mapping artificial intelligence integration in education a decade of innovation and impact 2013–2023-a bibliometric analysis. *IEEE Access* 12:313. doi: 10.1109/ACCESS.2024.3443313
- Aithal, P., and Aithal, S. (2023). Application of ChatGPT in higher education and research—a futuristic analysis. *Int. J. Appl. Eng. Manag. Lett.* 7, 168–194. doi: 10.2139/ssrn.4674364
- Aithal, P. S., and Maiya, A. K. (2023). Innovations in higher education industry—shaping the future. *Int. J. Case Stud. Bus. IT Educ.* 7, 283–311. doi: 10.2139/ssrn.4770797
- Al Zaidy, A. (2024). The impact of generative AI on student engagement and ethics in higher education. *J. Inf. Technol. Cybersecur. Artif. Intell.* 1, 30–38. doi: 10.70715/jitcai.2024.v1.i1.004
- Alateyyat, S., and Soltan, M. (2024). Utilizing artificial intelligence in higher education: a systematic review. In Proceedings of the 2024 ASU international conference in emerging Technologies for Sustainability and Intelligent Systems (ICETSYS), (pp. 371–374). IEEE.
- Alotaibi, N. (2024). The impact of AI and LMS integration on the future of higher education: opportunities, challenges, and strategies for transformation. *Sustainability* 16:10357. doi: 10.3390/su162310357
- Al-Zahrani, A. M., and Alasmari, T. M. (2024). Exploring the impact of artificial intelligence on higher education: the dynamics of ethical, social, and educational implications. *Humanit. Soc. Sci. Commun.* 11:912. doi: 10.1057/s41599-024-03432-4
- Bengueddach, A., and Boudia, C. (2024). *ChatGPT in higher education: advantages, limitations, and perspectives*. Aleph. Available online at: <https://aleph.edinum.org/11215>.
- ChatGPT-4o (2024). ChatGPT-4 and Google Gemini are compared with students: a study in higher education. *Int. J. Technol. Educ. Sci.* 8, 627–644. doi: 10.46328/ijtes.585
- Crompton, H., and Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *Int. J. Educ. Technol. High. Educ.* 20:22. doi: 10.1186/s41239-023-00392-8
- Damaševičius, R., and Sidekierskiene, T. (2024). Virtual worlds for learning in metaverse: a narrative review. *Sustainability* 16:2032. doi: 10.3390/su16052032
- Deci, E. L., and Ryan, R. M. (1985). The general causality orientations scale: self-determination in personality. *J. Res. Pers.* 19, 109–134. doi: 10.1016/0092-6566(85)90023-6
- Deep, S. (2024). Optimizing administrative efficiency and student engagement in education: the impact of AI. *Int. J. Curr. Sci. Res. Rev.* 7:12. doi: 10.47191/ijcsrr/V7-i10-34
- Dong, L., Tang, X., and Wang, X. (2025). Examining the effect of artificial intelligence in relation to students’ academic achievement: a meta-analysis. *Comput. Educ. Artif. Intell.* 8:100400. doi: 10.1016/j.caeai.2025.100400
- Dubey, S., and Mishra, S. (2024). Revolutionizing education: the impact of AI-enhanced teaching strategies. *Int. J. Res. Appl. Sci. Eng. Technol.* 12:127. doi: 10.22214/ijraset.2024.64127
- Dzogovic, S., Zdravkovska-Adamova, B., and Serpil, H. (2024). From theory to practice: a holistic study of the application of artificial intelligence methods and techniques in higher education and science. *Human Res. Rehabil.* 14:406. doi: 10.21554/hrr.092406
- Eshet-Alkalai, Y., and Soffer, O. (2012). Guest editorial—navigating in the digital era: digital literacy: socio-cultural and educational aspects. *Educ. Technol. Soc.* 15, 1–2.
- Fahd, K., Venkatraman, S., Miah, S. J., and Ahmed, K. (2022). Application of machine learning in higher education to assess student academic performance, at-risk, and attrition: a meta-analysis of literature. *Educ. Inf. Technol.* 27, 3743–3775. doi: 10.1007/s10639-021-10741-7
- Farooq, U., Malik, S. A., and Syed, A. S. (2024). Revolutionizing higher education: the transformative impact of artificial intelligence on teaching, learning, and career preparation. *ShodhKosh* 5, 789–794. doi: 10.29121/shodhkos.v5.i3.2024.3239
- Fitria, T. N. (2021). *Artificial intelligence (AI) in education: using AI tools for teaching and learning process*. Prosiding Seminar Nasional & Call for paper STIE AAS, Surakarta, pp. 134–147.
- Gaftandzhieva, S., Hussain, S., Hilcenko, S., Doneva, R., and Boykova, K. (2023). Data-driven decision making in higher education institutions: state-of-play. *Int. J. Adv. Comput. Sci. Appl.* 14:642. doi: 10.14569/IJACSA.2023.0140642
- George, B., and Wooden, O. (2023). Managing the strategic transformation of higher education through artificial intelligence. *Adm. Sci.* 13:196. doi: 10.3390/admsci13090196
- Gligorea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., and Tudorache, P. (2023). Adaptive learning using artificial intelligence in e-learning: a literature review. *Educ. Sci.* 13:1216. doi: 10.3390/educsci13121216
- Gnanaprakasam, J., and Lourdasamy, R. (2024). The role of AI in automating grading: enhancing feedback and efficiency. London: IntechOpen.
- Goyal, P., Minz, N., and Sha, A. (2023). “Chatbots and virtual assistants in education: enhancing student support and engagement” in Education Unleashed: AI Era. ed. P. Goyal (Lucknow: Book Rivers), 89–107.
- Haleem, A., Javaid, M., Qadri, M. A., and Suman, R. (2022). Understanding the role of digital technologies in education: a review. *Sustain. Oper. Comput.* 3, 275–285. doi: 10.1016/j.susoc.2022.05.004
- Jin, Y., Yan, L., Echeverria, V., Gašević, D., and Martinez-Maldonado, R. (2025). Generative AI in higher education: a global perspective of institutional adoption policies and guidelines. *Comput. Educ. Artif. Intell.* 8:100348. doi: 10.1016/j.caeai.2024.100348
- Johnson, L., Becker, S. A., Cummins, M., Estrada, V., Freeman, A., and Hall, C. (2016). NMC horizon report: 2016 higher education edition. Austin, TX: The New Media Consortium, 1–50.

Generative AI statement

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- Julius, F., Morgan, A., Ayoox, S., and Hoover, R. (2023). *Evaluating the Impact of AI Tutors on Student Performance in Online Learning Platforms* Author.
- Kabudi, T., Pappas, I., and Olsen, D. H. (2021). AI-enabled adaptive learning systems: a systematic mapping of the literature. *Comput. Educ. Artif. Intell.* 2:100017. doi: 10.1016/j.caeai.2021.100017
- Kelly, A., and Sullivan, M. (2023). ChatGPT in higher education: considerations for academic integrity and student learning. *J. Appl. Learn. Teach.* 2023:17. doi: 10.37074/jalt.2023.6.1.17
- Kotler, P., Mary, N., Steve, C., and Andrewson, S. (2023). *AI-powered grading systems: automating assessment and enhancing instructor productivity* author.
- Kovari, A. (2025). A systematic review of AI-powered collaborative learning in higher education: trends and outcomes from the last decade. *Soc. Sci. Humanit. Open* 11:101335. doi: 10.1016/j.ssaho.2025.101335
- Liu, Z., and Yushchik, E. (2024). Exploring the prospects of using artificial intelligence in education. *Cogent Educ.* 11:464. doi: 10.1080/2331186X.2024.2353464
- Mahrishi, M., Abbas, A., Radovanovic, D., and Hosseini, S. (2024). Emerging dynamics of ChatGPT in academia: a scoping review. *J. Univ. Teach. Learn. Pract.* 21:13. doi: 10.53761/b182ws13
- Mariyono, D., and Nur Alif Hd, A. (2025). AI's role in transforming learning environments: a review of collaborative approaches and innovations. *Qual. Educ. All* 2, 265–288. doi: 10.1108/qa-08-2024-0071
- Meylani, R. (2024). Artificial intelligence in the education of teachers: a qualitative synthesis of the cutting-edge research literature. *J. Comput. Educ. Res.* 12, 600–637. doi: 10.18009/jcer.1477709
- Neji, W., Boughattas, N., and Ziadi, F. (2023). Exploring new AI-based technologies to enhance students' motivation. *Issues Inf. Sci. Inf. Technol.* 20, 095–110. doi: 10.28945/5149
- Ng, W. (2012). Can we teach digital natives digital literacy? *Comput. Educ.* 59, 1065–1078. doi: 10.1016/j.compedu.2012.04.016
- Noor, U., Younas, M., Saleh Aldayel, H., Menhas, R., and Qingyu, X. (2022). Learning behavior, digital platforms for learning and its impact on university student's motivations and knowledge development. *Front. Psychol.* 13:933974. doi: 10.3389/fpsyg.2022.933974
- Ou, S. (2024). Transforming education: the evolving role of artificial intelligence in the students academic performance. *Int. J. Educ. Humanit.* 13, 163–173. doi: 10.54097/cclx7r95
- Pawar, P. (2023). "AI-enhanced education: personalized learning and educational technology" in *Fusion of Knowledge* (Lunawada: Red'shine Publication pvt. Ltd).
- Pinzolit, R. (2023). AI in academia: an overview of selected tools and their areas of application. *MAP Educ. Hum.* 4, 37–50. doi: 10.53880/2744-2373.2023.4.37
- Przegalinska, A., Triantoro, T., Kovbasiuk, A., Ciechanowski, L., Freeman, R. B., and Sowa, K. (2025). Collaborative AI in the workplace: enhancing organizational performance through resource-based and task-technology fit perspectives. *Int. J. Inf. Manag.* 81:102853. doi: 10.1016/j.ijinfomgt.2024.102853
- Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W. J., et al. (2023). The role of ChatGPT in higher education: benefits, challenges, and future research directions. *J. Appl. Learn. Teach.* 6, 41–56. doi: 10.37074/jalt.2023.6.1.29
- Redecker, C., and Punie, Y. (2017). *Digital competence of educators*.
- Saha, A., and Mondal, C. (2024). Artificial intelligence in education revolutionizing learning and teaching. Lunawada: Red Shine, 88.
- Sain, Z., Baharun, H., Chanda, T., Lawal, U. S., Habibu, M., and Sain, S. (2025). ChatGPT in higher education: exploring usage patterns, benefits, and ethical implications. *SSR J Eng Technol.* 2, 1–7. doi: 10.5281/zenodo.14639848
- Sari, H., Tumanggor, B., and Efron, D. (2024). Improving educational outcomes through adaptive learning systems using AI. *Int. Trans. Artif. Intell.* 3, 21–31. doi: 10.33050/italic.v3i1.647
- Shi, L. (2023). *Exploring the emerging roles of artificial intelligence in teaching practices and its relationships with teachers*. University of Georgia.
- Siddiqui, M., Hussain, S. A., Saleemi, H., and Fatmi, K. (2025). The intersection of AI educational psychology and learning analytics predicting student dropout risk through behavioural indicators. *Crit. Rev. Soc. Sci. Stud.* 3, 104–120. doi: 10.59075/k2zgws84
- Siemens, G. (2005). Connectivism: learning as network-creation. *ASTD Learn. News* 10, 1–28.
- Singh, A., Saxena, S., and Saxena, R. (2024). The future of learning: AI-driven personalized education. *Asian J. Curr. Res.* 9, 207–226. doi: 10.56557/ajocr/2024/v9i49018
- Soni, M. (2025). AI-powered teaching assistants: enhancing educator efficiency with NLP-based automated feedback systems. *Int. J. Sci. Res. Arch.* 14, 9–18. doi: 10.30574/ijrsra.2025.14.3.0603
- Spante, M., Hashemi, S. S., Lundin, M., and Algers, A. (2018). Digital competence and digital literacy in higher education research: systematic review of concept use. *Cogent Educ.* 5:1519143. doi: 10.1080/2331186X.2018.1519143
- Tan, X., Cheng, G., and Ling, M. H. (2025). Artificial intelligence in teaching and teacher professional development: a systematic review. *Comput. Educ. Artif. Intell.* 8:100355. doi: 10.1016/j.caeai.2024.100355
- Tariq, M. U. (2025). "AI-driven personalized learning-enhancing student engagement and outcomes" in *AI and learning analytics in distance learning*. ed. M. U. Tariq (Hershey, PA: IGI Global Scientific Publishing), 151–178.
- Taşkın, M. (2025). Artificial intelligence in personalized education: enhancing learning outcomes through adaptive technologies and data-driven insights. *Hum. Comput. Interact.* 8:173. doi: 10.62802/ygye0506
- Thelma, C. C., Sain, Z. H., Shogbesan, Y. O., Phiri, E. V., and Akpan, W. M. (2024). Ethical implications of AI and machine learning in education: a systematic analysis. *Int. J. Instr. Technol.* 3, 1–13. doi: 10.33650/ijit.v3i1.9364
- Tzirides, A. O., Zapata, G., Kastania, N. P., Saini, A. K., Castro, V., Ismael, S. A., et al. (2024). Combining human and artificial intelligence for enhanced AI literacy in higher education. *Comput. Educ. Open* 6:100184. doi: 10.1016/j.cao.2024.100184
- Varghese, D. (2024). *Transforming education with ai: embracing CHATGPT and addressing challenges for the future*, pp. 91–100.
- Villegas-Ch, W., Govea, J., and Revelo-Tapia, S. (2023). Improving student retention in institutions of higher education through machine learning: a sustainable approach. *Sustainability* 15:14512. doi: 10.3390/su151914512
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*, vol. 86. Cambridge, MA: Harvard University Press.
- Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., and Du, Z. (2024). Artificial intelligence in education: a systematic literature review. *Expert Syst. Appl.* 252:124167. doi: 10.1016/j.eswa.2024.124167
- Wang, X., Younas, M., Jiang, Y., Imran, M., and Almusharraf, N. (2024). Transforming education through blockchain: a systematic review of applications, projects, and challenges. *IEEE Access* 1:1. doi: 10.1109/ACCESS.2024.3519350
- Watermeyer, R., Phipps, L., Lanclos, D., and Knight, C. (2024). Generative AI and the automating of academia. *Postdigit. Sci. Educ.* 6, 446–466. doi: 10.1007/s42438-023-00440-6
- Xu, Z. (2024). AI in education: enhancing learning experiences and student outcomes. *Appl. Comput. Eng.* 51, 104–111. doi: 10.54254/2755-2721/51/20241187
- Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimh, H., Ali, A., and Sharabati, A.-A. A. (2025). The impact of adaptive learning technologies, personalized feedback, and interactive AI tools on student engagement: the moderating role of digital literacy. *Sustainability* 17:1133. doi: 10.3390/su17031133
- Younas, M., and Dong, Y. (2024). The impact of using animated movies in learning English language vocabulary: an empirical study of Lahore, Pakistan. *SAGE Open* 14:398. doi: 10.1177/21582440241258398
- Younas, M., Dong, Y., Zhao, G., Menhas, R., Luan, L., and Noor, U. (2024). Unveiling digital transformation and teaching prowess in English education during COVID-19 with structural equation modelling. *Eur. J. Educ.* 60:e12818. doi: 10.1111/ejed.12818
- Younas, M., El-Dakhs, D., and Jiang, Y. (2025b). A comprehensive systematic review of AI-driven approaches to self-directed learning. *IEEE Access* 1:1. doi: 10.1109/ACCESS.2025.3546319
- Younas, M., Ismayil, I., El-Dakhs, D. A. S., and Anwar, B. (2025c). Exploring the impact of artificial intelligence in advancing smart learning in education: a meta-analysis with statistical evidence. *Open Praxis* 17, 594–610. doi: 10.55982/openpraxis.17.3.842
- Younas, M., Ismayil, I., El-Dakhs, D. A. S., Anwar, B., and Noor, U. (2025a). Evaluating the effectiveness of digital scenario-based English teaching at the university level using the artificial intelligence generated content. *Front. Educ.* 10:1670892. doi: 10.3389/feduc.2025.1670892
- Zheng, L., Fan, Y., Gao, L., Huang, Z., Chen, B., and Miao Lang, L. (2024). Using AI-empowered assessments and personalized recommendations to promote online collaborative learning performance. *J. Res. Technol. Educ.* 57, 1–27. doi: 10.1080/15391523.2024.2304066