Artificial Intelligence in Higher Education: a systematic review across academic disciplines

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Abstract

This systematic review examines how higher education students use artificial intelligence (AI) across academic disciplines, including its benefits and concerns. Following PRISMA guidelines, 100 Scopus-indexed studies were analyzed. Findings show disciplinary differences in AI adoption, with Linguistics and Language-related Studies and Medical and Health Sciences reporting the highest use. Benefits include personalized feedback, increased engagement, self-regulated learning, and improved

academic performance. However, concerns such as academic integrity risks, over-reliance on AI, ethical and privacy issues, uneven AI literacy, and limited pedagogical alignment persist. The review highlights the need for coherent frameworks, institutional policies, and discipline-specific AI training in higher education.

Keywords

Artificial Intelligence in education, Higher Education, Generative AI, AI literacy, pedagogical integration

Résumé

Cette revue systématique examine comment les étudiants de l'enseignement supérieur utilisent l'intelligence artificielle (IA) dans les disciplines académiques, y compris ses avantages et ses préoccupations. Conformément aux directives PRISMA, 100 études indexées à Scopus ont été analysées. Les résultats montrent des différences disciplinaires dans l'adoption de l'IA, les études linguistiques et linguistiques et les sciences médicales et de la santé ayant déclaré les plus grandes utilisations. Les avantages incluent un retour personnalisé, un engagement accru, un apprentissage autorégulé et une amélioration des performances scolaires. Toutefois, certaines préoccupations persistent, notamment les risques liés à l'intégrité académique, la dépendance excessive à l'égard de l'IA, les questions d'éthique et de confidentialité, les disparités dans la maîtrise de l'IA et l'adéquation pédagogique limitée. La revue met en lumière la nécessité de cadres cohérents, de politiques institutionnelles et de formations à l'IA spécifiques à chaque discipline dans l'enseignement supérieur.

Mots-clés

Intelligence artificielle dans l'éducation, enseignement supérieur, IA générative, alphabétisation en IA, intégration pédagogique

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Introduction

Recent systematic reviews on Artificial Intelligence (AI) in higher education outline a rapidly evolving yet heterogeneous research landscape organized around three core

axes: pedagogical integration, technological innovation, and ethical deployment. Despite this growing body of work, AI in higher education is still predominantly discussed through generalized or technocentric lenses, often overlooking the disciplinary contexts in which teaching and learning occur. Within this literature, disciplinary domains are frequently treated as homogeneous environments, despite substantial differences in epistemological traditions, pedagogical practices, assessment norms, and professional requirements across fields of study. The studies indicate that AI, particularly large language models (LLMs) such as ChatGPT, are primarily leveraged for personalized learning, automated assessment, enhanced feedback provision, and support of self-regulated learning (Gao et al., 2024; Lan & Zhou, 2025; Munaye et al., 2025). Concurrently, the literature underscores the importance of developing AI literacy, fostering human–machine collaboration, and employing AI as a tool for empowerment rather than a substitute for academic labor (Bond et al., 2024; Crompton & Burke, 2023).

In this framework, universities and organizations have begun to develop policies governing the integration and use of AI. At Clemson University (2024), the AI Use Policy prohibits the use of sensitive data in public AI tools and requires explicit statements in course syllabi regarding the terms of their use. Similarly, the University of California, Los Angeles (UCLA, 2024) stipulates that unapproved use of AI tools constitutes academic misconduct, while permitting supervised use for learning and reflective purposes. While such policies represent important steps toward responsible AI adoption, they are typically formulated as institution-wide frameworks and applied uniformly across disciplines. This uniformity risks overlooking discipline-specific pedagogical goals, epistemological assumptions, and forms of professional accountability. Despite this progress, the literature remains fragmented and largely technocentric, failing to adequately capture how AI applications differ meaningfully across disciplinary domains (Bond et al., 2024; Fadlelmula & Qadhi, 2025). As a result, existing syntheses provide limited guidance on how AI tools should be pedagogically aligned with the distinct educational logics of different fields. This gap highlights the need for targeted, discipline-sensitive investigations that align technological affordances with the pedagogical, epistemological, and ethical requirements of each field (Abdallah et al., 2025; Almasri, 2024).

Despite the extensive discourse surrounding the potential of AI, existing reviews identify several persistent research gaps. First, there is a lack of empirical evidence demonstrating measurable learning improvements through AI-based tools, as many studies remain theoretical or descriptive in nature (Bond et al., 2024; Crompton & Burke, 2023). Second, systematic theoretical grounding is largely absent: few studies explicitly draw upon established pedagogical theories, limiting the robustness and transferability of their findings (Lan & Zhou, 2025). This limitation is particularly consequential given that higher education encompasses diverse pedagogical orientations, ranging from clinical and laboratory-based instruction to interpretive, creative, and

practice-oriented learning environments. Third, concerns related to ethics, bias, and academic integrity persist, especially as LLMs may generate inaccurate, misleading, or non-original content (Bittle & El-Gayar, 2025; Munaye et al., 2025). Finally, the geographic and thematic distribution of research remains uneven, with technology- and language-related disciplines disproportionately represented, while arts-based, professional, and practice-oriented fields continue to be marginally examined (Almasri, 2024; Athanassopoulos et al., 2026; Fadlelmula & Qadhi, 2025). Collectively, these gaps suggest that current reviews fall short of offering a holistic and pedagogically grounded understanding of AI use across higher education.

From this perspective, a new systematic review examining AI practices, benefits, and challenges across disciplinary domains presents clear scientific and practical value. By adopting institutionally grounded disciplinary groupings and conducting a cross-disciplinary comparative synthesis, the present review addresses the identified thematic and methodological limitations. Specifically, it seeks to contribute to bridging pedagogical theory with technological practice by examining how AI tools are implemented, justified, and evaluated within distinct disciplinary contexts, and by proposing discipline-sensitive models for AI utilization (Almasri, 2024; Lan & Zhou, 2025). Furthermore, its findings can inform the development of institutional policies and ethical guidelines that move beyond one-size-fits-all approaches, thereby supporting more responsible, context-aware, and effective AI adoption in higher education (Grajek et al., 2024; UCLA, 2024). Ultimately, this review aims to foster the development of an interdisciplinary yet discipline-aware framework for AI literacy, enabling both students and educators to engage critically and creatively with AI across diverse fields of study (Abdallah et al., 2025; Bond et al., 2024; Lavidas et al., 2026).

In light of the above, the present systematic review aims to address this research and thematic gap by presenting, across institutionally and epistemologically distinct disciplinary domains, the practices, benefits, and challenges associated with integrating AI into higher education, with the overarching goal of shaping a coherent, pedagogically grounded, and ethically responsible framework for its use. Accordingly, the following research questions guide the review:

- RQ1. What AI tools and practices are employed across different disciplinary domains in higher education?
- RQ2. What educational benefits and learning-related outcomes are reported across these domains from the use of AI tools?
- RQ3. What challenges, risks, and ethical concerns emerge across disciplines in relation to the use of AI tools?

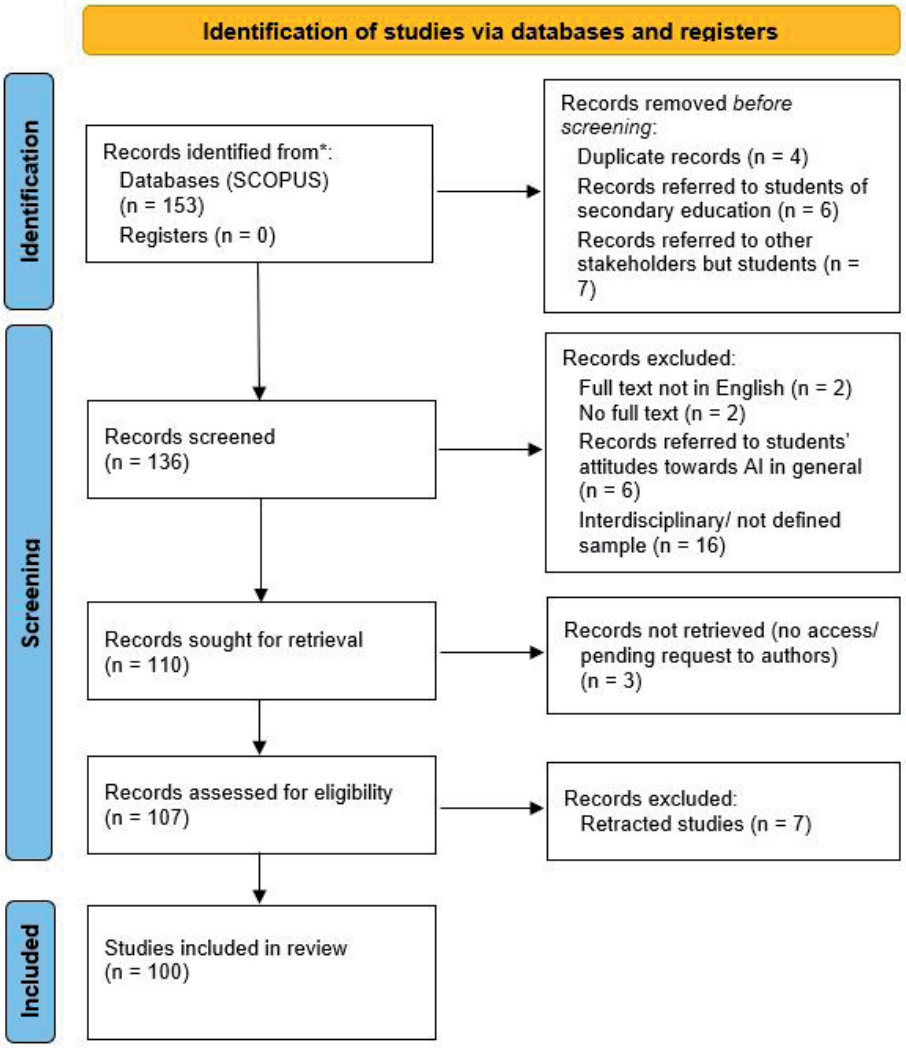
Methods

The methodology of this review is based on the criteria of a systematic review, which follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020) guidelines (http://www.prisma-statement.org). Research articles were retrieved from the trustworthy repository Scopus (https://www.scopus.com/sources.uri?zone=TopNavBar&origin=sbrowse (accessed on 16 November 2025) with the restriction of year 'since 2019'. The selection of 2019 as the starting point is grounded in both technological and contextual considerations. Specifically, this period marks a phase of rapid advancement in artificial intelligence and digital technologies, particularly in natural language processing, culminating in the widespread adoption of tools such as ChatGPT and other generative AI systems. These developments have significantly reshaped educational and research practices, rendering earlier studies less representative of the current technological landscape. Moreover, this timeframe coincides with the onset of the COVID-19 pandemic, which accelerated the integration of digital technologies and online learning environments worldwide. Consequently, focusing on studies published from 2019 onwards ensures that the review captures contemporary practices, methodological approaches, and user behaviors, thereby enhancing the relevance and applicability of its findings. The string query the authors crafted for the search was the following:

TITLE-ABS-KEY ("artificial intelligence" OR AI OR "machine learning" OR chatbot* OR "large language model*" OR "generative AI" OR ChatGPT) AND TITLE-ABS-KEY ("higher education" OR college* OR academic* OR tertiar* OR universit*) AND TITLE-ABS-KEY ("university students" OR "college students" OR student*) AND TITLE-ABS-KEY (perception* OR attitude* OR awareness OR acceptance OR adoption OR practice* OR usage OR engagement OR ethics OR concern*) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")).

Then, the retrieved studies, titles, and abstracts were checked for relevance to the subject and for duplicates. Therefore, articles whose sample consisted of other parts of higher education (i.e., educators, managers, parents, etc.) or did not analyze the data separately for students were omitted. The remained articles were then scrutinized, and articles without full text or with full text not in English were excluded, as well as those articles that referred to general attitudes of higher education students towards AI, without naming the tool and its usage, or if articles concerned K-12 education, or if the field of the students was not defined (e.g. interdisciplinary students, foreign students). The articles' methods and references were also checked to ensure their eligibility. Figure 1 presents the steps of the review process.

FIGURE 1



PRISMA reviewing process (https://www.prisma-statement.org/prisma-2020-flow-diagram)

After thorough screening, one hundred studies have been reviewed, using Excel sheets where the information of each study has been extracted and organized based on research questions. The grouping of the disciplines in this review follows the conventional classification adopted by higher education institutions, based on their disciplinary cohesion, as follows: Medical and Health Sciences (Medicine, Medical Imaging, Veterinary, Dentistry, Nursing, and Pharmacy); Natural Sciences (Mathematics, Physics, Chemistry,

Biology) / Computer Science and Engineering; Music; Physical Education and Sport Studies; Social Sciences (Teacher Education, Psychology, Literature, History, Art, Law, and Economics); and Linguistics, which focuses on the study of language(s) (e.g., English language, English as a foreign/additional language, other foreign language learning, and translation). Linguistics was examined as a distinct category in this review due to the disproportionately large number of studies identified in this domain, as well as the wide range of AI tools applied to language learning and processing (Ma et al., 2023). This distinction allows for a more accurate and meaningful analysis of AI applications within this field, while also reflecting its inherently interdisciplinary character (Koster, 2006; Ma et al., 2023).

Criteria of exclusion: Studies with only other stakeholders of higher education, such as educators, parents, managers, etc., were excluded, including those with mixed groups (i.e., not separately examined), such as faculty and students or parents and students. The inclusion and exclusion criteria are listed in Table I.

TABLE 1

Criteria for including or excluding Scopus-indexed articles in the review

Inclusion Criteria	Exclusion Criteria
Studies with samples of students (not mixed samples with other stakeholders of higher education)	Studies where the sample consisted only of faculty/ parents/managers or mixed groups of the former with students (where they were not separately examined)
Studies with samples of students from the same discipline (or from different disciplines if they were separately examined).	Studies with a student sample from mixed disciplines (not identified and separately examined)
Studies on students' perceptions after using AI tools for their studies.	Studies only measure students' general perceptions of AI
Studies on the benefits and challenges of AI tools after using them for learning a subject/ carrying out assignments/ during classes in higher education.	Studies about AI as a teaching subject (except if the teaching was performed with the use of AI tools)
	Studies about AI as the teaching subject (except if teaching was facilitated by AI tools)

After grouping the articles, twenty-two studies were in Medical and Health Sciences, seventeen in Natural / Computer Sciences and Engineering, five in Physical / Sport Education, five in Music, twenty-four in Linguistics/ study of language(s), and twenty-seven in Social Sciences.

A thematic analysis was employed to identify cross-study patterns. The coding of the selected studies was carried out using a predefined coding protocol, which included categories such as the type of AI tool, pedagogical approach, integration method, per-

ceived benefits, and challenges. Coding was conducted by two independent reviewers, and this process indicated strong agreement, about 82%. Reviewer disagreements were resolved through discussion; unresolved cases were resolved by a third reviewer.

Results

Each one of the fields is displayed in a different Table, where the AI tools experienced by students are presented in brief, as well as the way those tools were integrated in the course or individually employed by students to carry out their assignments.

From Table 2, we observe that in the field of health-related education and practice, artificial intelligence (AI), and in particular generative AI (GenAI), is increasingly integrated across educational and clinical contexts. Literature highlights significant benefits, including enhanced diagnostic accuracy, strengthened self-directed and reflective learning, greater student engagement, and the development of digital literacy skills. Implementation is carried out through diverse pedagogical approaches -ranging from gamified and immersive learning environments to self-guided curricula and AI-assisted evaluation-reflecting both innovation and experimentation. At the same time, recurring challenges emerge, such as limited technological readiness, the need for faculty training, ethical concerns (plagiarism, bias, patient safety), and the risk of over-reliance on AI-generated outputs. Variations in knowledge and preparedness across disciplines and geographic settings further underscore the need for structured curricula and standardized training frameworks. The findings highlight the transformative potential of AI in health sciences education, while emphasizing the importance of responsible integration, institutional support, and long-term evaluation.

Table 2

AI tools are integrated in Higher Education in the field of Medical and Health Sciences (i.e., Medicine, Medical Imaging, Veterinary, Dentistry, Nursing, and Pharmacy)

AI Tool	Pedagogical Approach / Use of Tool	Benefits / Positive Results	Challenges / Concerns	Scientific Field	Reference
ChatGPT	Used to generate reflective assignments in dental education, compared with student submissions	ChatGPT-generated analyses were similar to human researchers' work; potential to enhance dental education, reflective learning, and research.	ChatGPT-generated products misidentified as student work; risk of over-reliance on AI-generated analysis.	Dentistry	Brondani et al., 2024

TABLE 2

AI Assisted Diagnostic (AISD) software based on Volume Data Reconstruction (VDR) technique	Applied in practical medical imaging courses to enhance diagnostic interpretation and self-directed learning	Significantly improved image reading skills, computed tomography (CT) and magnetic resonance (MR) diagnostic scores, academic self-efficacy, and self-directed learning abilities; 3D thinking; overcame limitations of traditional teaching.	Self-directed learning strategies needed.	Clinical medicine/ Medical Imaging / Radiology	Wang et al., 2024
Various AI tools	Usage in nursing education/ curricula	Enhanced learning outcomes in nursing education; increased adoption of AI tools; recognition of AI's role in advancing curricula.	Barriers include technological readiness, faculty training, institutional support; lack of long-term impact studies.	Nursing	Jallad et al., 2024
AI scribes	Clinical utility in urology documentation	AI scribes improved documentation efficiency in urology; reduce clinician workload and burnout; may enhance patient-physician interaction.	Need for more research on long-term effects of AI scribes on patient outcomes; potential overreliance on technology.	Medicine/ Urology	Moryousef et al., 2025
Gamified learning + AI evaluation	Practice-based teaching of antimicrobial therapy with AI assessing of freeform answers	Gamified learning improved factual knowledge of antibiotic stewardship; reduced uncertainty in prescribing; AI supported evaluation of freeform answers; AI showed promise in educational assessment.	Concerns about reducing uncertainty in antibiotic prescription; reliance on AI to evaluate freeform answers requires validation.	Medicine / Infectious Diseases	Driesnack et al., 2024

TABLE 2

AI educational module	Postgraduate AI module for radiographers using participatory action research; based on constructivist epistemology and relativist ontology	AI module for radiographers was meaningful and effective; promoted engagement; highlighted potential for blended, contextualized learning.	Barriers in module design, cost, and delivery; participants' varied backgrounds affecting engagement; need for blended, flexible learning.	Radiography / Medical Imaging	van de Venter et al., 2023
Web-based AI/ machine learning (ML) ML curriculum	Self-guided elective for medical students with technical and non-technical tracks	Virtual self-guided curriculum boosted AI/ML confidence (66% increase); encouraged innovation; students appreciated flexibility and project-based learning; broad appeal across specialties.	Some students wanted more technical guidance; Need to balance technical vs. nontechnical tracks.	Medicine	Abid et al., 2024
GenAI tools	Integration of AI tools in dental practice	AI in dentistry enhanced diagnostic accuracy, treatment planning, and patient management; potential to improve outcomes and efficiency.	Lack of training, resistance to change, data privacy concerns; need for collaboration and ethical guidelines.	Dentistry	Hamd et al., 2023
AIAVRT (AI + 3D animation + VR)	Integration of immersive computer graphics	Enhances understanding of complex concepts, improves engagement and knowledge retention; supports personalized learning.	No explicit concerns noted, but implied need for validation of immersive AI/VR methods in medical education.	Medical Education / Multimedia Technology	Kumar et al., 2022
GenAI tools	3-week workshop on AI fundamentals in radiology	Improved AI literacy and confidence; 89% improve in post-workshop.	Limited to foundational literacy; small participant group; not focused on technical depth.	Radiology	Hu et al., 2023

TABLE 2

ChatGPT, grammar checkers	n.d.	General enthusiasm and favorable attitudes toward AI; higher student knowledge; recognition of AI's potential despite fears.	Concerns over AI dehumanizing healthcare, physician redundancy, skill erosion, and patient harm; need for formal training emphasized.	Medicine	Oluwadiya et al., 2023
ChatGPT-3.5, ChatGPT-4, Google Bard, Bing Chat	Comparative evaluation of LLMs in evidence-based dentistry	ChatGPT-4 outperformed others; LLMs (esp. ChatGPT-4) showed promise in evidence-based dentistry; could assist practitioners if used critically.	All LLMs showed limitations like inaccuracy and outdated content; lack of source references in LLMs; and risks of harmful healthcare decisions without oversight. caution urged.	Dentistry	Giannakopoulos et al., 2023
SPARRO framework	Prompt design and human-AI interaction in healthcare education	SPARRO developed to guide prompt formulation and review; improved engagement with AI tools.	Challenges include AI hallucination, mistrust of AI outputs, and difficulties in prompt formulation.	Nursing / Healthcare Education	Olla et al., 2024
Generative AI	AI tools integrated into a writing-intensive nursing course	Enhanced writing skills and critical thinking; AI-supported feedback improved student engagement and outcomes; Fostered creativity and communication skills.	Need for adapting teaching methods responsibly; reliance on AI feedback could impact critical thinking.	Nursing	Chan, 2025
Generative AI (ChatGPT) Immersive virtual environment (AI-enhanced)	Used for anatomy and physiology instruction	Immersive VR environment boosted motivation, engagement, and learning in anatomy and physiology; Students rated it positively for usability and interactivity.	Design adjustments needed to meet user expectations	Medicine / Human Anatomy & Physiology	Maraza-Quispe, 2025

TABLE 2

GenAI tools	Employed for accurate diagnoses, health predictions, and improved treatment recommendations	85.4% viewed AI as positive for healthcare; highlighted need for formal training; support for integrating AI into curricula.	Limited AI knowledge in Saudi Arabia; need for mandatory AI courses; gap in understanding AI's role in diagnosis/ treatment.	Medicine	Alshanberi et al., 2024
GenAI tools	Exploring knowledge, attitudes, and practices (KAP) of pharmacy students	96% believed AI could enhance patient care; recognition of AI's role in pharmacy practice;	Moderate knowledge levels; job security and patient safety concerns; lack of AI training in pharmacy.	Pharmacy	Hasan et al., 2025
GenAI tools	Student AI readiness in Indonesia	Students generally perceived AI positively; recognized benefits for future practice; motivation for enhanced AI education.	Varying readiness and knowledge; gaps in AI education; need for targeted interventions in curricula. Concerns about job security and patient safety.	Medicine	Lugito et al., 2024
GenAI tools	Artificial Intelligence and Digitalization Training Program; AI tools in veterinary practice	53.5% of students saw AI as a tool to improve professional skills; majority did not fear replacement by robots; recognized the importance of staying updated.	Partial knowledge among veterinary students; ethical concerns (39% acknowledged issues); worries about job displacement.	Veterinary Medicine	Yerlikaya & Küçükaslan, 2024
Generative AI	Fundamentals of AI in nursing	AI seen as beneficial for nursing education; potential to enhance curricula; recognition of opportunities for responsible integration.	Risks of plagiarism and academic dishonesty with AI; Partial understanding; Need for responsible integration and educator preparedness.	Nursing	Schneidereith & Thibault, 2023

TABLE 2

Generative AI	AI employment for digitizing and pattern recognition	Importance of preparing future radiologists for an AI-enhanced practice environment.	Educational programs are beginning to incorporate AI training, but there is a lack of structured approach and standardized curricula across institutions.	Medicine (Diagnostic Radiology)	Santos et al., 2023
Generative AI	Integration of AI-powered language models, crafting effective prompts	Highlights AI-powered language models for student learning in physiology, as a supplemental resource	Responsibility needed in implementing AI tools in academic settings, ensuring they serve as supplemental resources rather than replacements for critical thinking and effort	Physiology	Favero, 2024

Seventeen studies on AI tools in Natural Sciences, Computer Sciences, and Engineering met the criteria of the review. They were mainly addressing programming, design, mathematics, and laboratory skills. As shown in Table 3, AI tools are used in Natural Sciences and Engineering by students in various ways to enhance learning, engagement, and problem-solving skills. These tools -ranging from ChatGPT and generative AI models to neural networks and educational chatbots-are applied to tasks such as personalized learning, error detection, automated assessment, and conceptual understanding in areas like programming, mathematics, and scientific computing. The reviewed studies report significant improvements in students' motivation, digital competence, and academic performance, indicating that AI technologies can effectively support self-directed and adaptive learning (Baba et al., 2024; Bravo & Cruz-Bohorquez, 2024; Domínguez et al., 2024). Nevertheless, several challenges emerge, including the risk of over-reliance on AI-generated feedback, reduced critical thinking, inaccuracies or "hallucinations" in responses, and ethical issues related to academic integrity and data privacy (Ahmed et al., 2024; Barrientos et al., 2024; Gill et al., 2024). Overall, the integration of AI in Natural Sciences and Engineering education demonstrates strong potential to transform traditional teaching practices; however, its effective adoption depends on thoughtful pedagogical design, ongoing instructor training, and the establishment of ethical and regulatory frameworks that ensure responsible and equitable use.

TABLE 3

AI tools in Natural / Computer Sciences and Engineering in Higher Education

AI Tool Used	Pedagogical Approach / Usage	Benefits / Positive Results	Challenges/ concerns	Scientific Field / Specialty	Reference
LSTM Neural Network + OpenAI API-powered Chat	Personalized learning via prediction of learning style transitions	Effective for aligning with UN SDGs (quality education, decent work, sustainability); OpenAI-powered chat supports personalizing learning	Limited technological resources in some institutions; need for reliable personalization; dependence on accurate LSTM predictions.	Engineering Education	Domínguez et al., 2024
ChatGPT	Error checking, debugging, conceptual understanding in coding	Enhanced error checking, debugging, conceptual understanding, code generation, and mathematical problem-solving in programming.	Declining code quality, reduced collaboration in pair programming, and over-reliance on ChatGPT; need to adapt learning objectives.	Scientific Computing / Programming in Mechanical Engineering	Groothuijsen et al., 2024
Student-created AI Chatbots	Enhancing digital competence and engagement through chatbot creation	High student satisfaction and engagement; successful integration of chatbot creation into mathematics	Transferability to other subjects not fully tested; reliance on brief training may limit depth of learning.	Mathematics Education (Geometry)	Moral-Sánchez et al., 2023
No specific AI tool (awareness survey)	Evaluation of AI awareness levels	High AI awareness; recognition of technology's role in enhancing learning experiences; Employment of Web 4.0 tools.	Insufficient understanding of concepts like "mind" and "intelligence"; concerns about job displacement and reduced communication in education.	Engineering Education	Dergunova et al., 2022
ChatGMP (a chatbot)	Automating repetitive tasks	Increases efficiency, engagement, and personalization; supports educational innovation	Risk of over-automation reducing deeper learning; need to balance chatbot use with critical thinking and complex teaching tasks.	Chemical Engineering	Caccavale et al., 2024

TABLE 3

Various AI tools	Quiz creation, student assessment, performance prediction	Enhance science education through better learning environments; multiple pedagogical benefits.	Challenges with implementation in science education, including integration strategies and teacher preparedness.	Science Education	Almasri, 2024
Generative AI	Exploration of academic integrity issues	Supports learning and research; provides advanced tools that enhance educational experiences.	Risks to academic integrity through plagiarism or misuse; need for policies and responsible use guidelines.	Science and Mathematics in Higher Education	Barrientos et al., 2024
AI Chatbots	Supporting motivation, self-directed learning, feedback	Significant positive impact on engineering learning outcomes (knowledge acquisition, motivation, self-directed learning, and goal-directed practice); facilitating the organization and connection of prior knowledge; promoting self-directed learning, allowing students to practice and apply their acquired skills; positive classroom environments.	Errors within AI-generated code / mathematical operations; Implementation in more specialized contexts (e.g., Electronics) presupposes students to critically evaluate the precision of the offered information. Answers often surpassing their understanding; Instructors must balance AI support with critical pedagogy.	Engineering Education	Bravo & Cruz-Bohorquez, 2024
Gamified AI Educational Robot (GAIER)	GAFCC model-based gamification for safety training	Improved learning achievement, motivation, problem-solving, and reduced cognitive load.	Risk of superficial engagement if gamification outweighs deep learning; limited testing beyond laboratory safety courses.	Laboratory Safety / Engineering Education	Yang et al., 2023

TABLE 3

Generative AI Tools + 4PADAFE Matrix	Personalized content, massive MOOC development	Personalized learning and engagement; scalable design and improved teaching-learning processes.	Potential over-dependence on generative AI; need for robust instructional design to prevent shallow engagement.	General Education / Teacher Training	Ruiz-Rojas et al., 2023
AI-powered Mobile Platform (Langchain, Pinecone, LLM model)	Personalized mobile learning	Enhanced understanding, academic performance and engagement.	Requirement for continuous innovation; possible digital divide for students without access to mobile AI platforms.	Higher Education (Polytechnic Engineering)	Baba et al., 2024
ChatGPT	Acting as Teaching Assistant in Programming	Effectively explained core programming concepts; supplemented teaching; supported students' understanding of introductory coding.	Weaknesses in handling complex student confusion; limited ability to personalize responses; cannot replace human instruction.	Introductory Programming in Higher Education	Ahmed et al., 2024
ChatGPT	Supplementary tool (drafting, grammar)	Supported drafting, outlining, and grammar correction; eased academic tasks similar to calculators; useful as a supplementary tool.	Inaccuracies in AI outputs; danger of over-reliance; risks of hindering genuine learning if students do not verify outputs.	Engineering Instruction	Simelane & Kittur, 2024
AI + ChatGPT-4O	Emotionally intelligent teaching model	Enhance student performance, personalized feedback and dynamic learning; improved academic and behavioral standards.	Complexity of integrating emotional data; possible instructor bias despite AI support; reliance on accurate EI interpretation.	Architectural Education	Zahra et al., 2025

TABLE 3

AI Teaching Assistants	Personalized guidance in design projects	Improved understanding of complex concepts, boosted engagement, collaboration, and personalized feedback.	Risk of excessive reliance on AI feedback; possible reduction in student independence in engineering design tasks.	Solar Energy Engineering Design	Sung et al., 2024
ChatGPT	Instructional content creation, online educator	Transformative tool, provided coherent replies across disciplines, acted as an online educator, supported innovation.	ChatGPT prone to inaccuracies ("hallucinations"); plagiarism risks; need for updated regulations and evaluation frameworks.	General Education (Engineering Students)	Gill et al., 2024
Various AI Tools (incl. virtual assistants)	Enhancing academic performance, personalized learning	Broad usage (95.6%) of virtual assistants; improved academic outcomes, personalized learning, engagement.	Risks include over-reliance on AI, diminished critical thinking, data privacy concerns, and potential academic dishonesty.	General University Education (Engineering Students)	Vieriu & Petrea, 2025

As presented in Table 4, AI tools are increasingly utilized in Physical Education to enhance teaching effectiveness and personalize student learning, focusing on teaching automation and individual health/performance tracking. Technologies such as emotion recognition systems, bigdata platforms, and AI-based evaluation models enable real-time feedback, individualized training, and more accurate assessment of teaching practices (Cao et al., 2022; Cheng & Wang, 2021; Tian, 2024). These applications contribute to improved engagement, performance, and instructional quality. However, challenges remain, including over-reliance on automated evaluation, data privacy concerns, and limited teacher preparedness to integrate AI tools effectively. Researchers further emphasize the need for ethical frameworks and professional development to ensure responsible implementation (Killian et al., 2023). The results indicate that AI adoption in Physical Education shows strong potential to advance personalized and data-driven learning, though its success depends on balancing technological efficiency with pedagogical and ethical considerations.

TABLE 4

AI tools used in the field of Physical/ Sport Education in Higher Education

AI Tool Used	Pedagogical Approach / Use of AI	Benefits / Positive Results	Challenges/ concerns	Academic Field / Specialization	References
AI technology (with emotion recognition and visual analysis)	Evaluation enhancement of inverted (flipped) classroom; real-time feedback and observation of teaching behaviors	AI improves evaluation efficiency, accuracy; supports real-time feedback, enables personalized growth for students	Over-reliance on automated systems, which may reduce the role of professional judgment in teaching evaluation.	College Sport education	Cheng & Wang, 2021
AI-based big data technology (smart service platform)	Diagnosis and improvement of classroom effectiveness; analysis of online vs. traditional teaching needs	Smart service platform improves physical education reliability, identifies and solves problems in real-time, raises practice density to 57.5%	Systemic challenges stem from outdated curricula and teacher adaptation difficulties; Necessity to be adjusted to the physical fitness of the students	Physical Education	Cao et al., 2022
AI-based Physical Education (AIPE), Natural Language Processing (NLP), AI-driven training systems	Individualized training, performance analysis, health tracking, teaching automation	AIPE systems enhance learning and health tracking; provide individualized training, and immediate feedback; improve student learning experiences;	Challenges like technological reliability and privacy concerns.	Physical Education	Tian, 2024
AI based multi-feature fuzzy evaluation model	Objective and systematic evaluation of physical education teaching methods	Fuzzy model offers nuanced evaluation, helps improve strategies, enhances engagement and performance	Practical challenges: availability of resources and compatibility; their interpretation needs careful calibration for educational settings	Physical Education Methodology	Li et al., 2024
ChatGPT and large language models	Facilitation of informed, solution-focused decisions	Opportunities of AI chatbots to enrich physical education; addresses digital equity - promotes equitable practices.	Call for field-specific consensus statements to guide the ethical use, ensuring the societal good.	Academic Field / Specialization	Killian et al., 2023

AI tools have been employed in Music studies mainly in applications such as personalized lessons and feedback (Table 5). AI and related technologies, such as Augmented Reality (AR), Virtual Reality (VR), and deep learning systems exhibit increasing integration into music and art education to enhance creativity and personalized learning. Studies indicate that these tools significantly improve students' technical skills, engagement, and creative expression through adaptive feedback, interactive environments, and individualized learning paths (Cui, 2022; Wei et al., 2022; Zhang, 2024). Despite these benefits, challenges include potential over-reliance on digital tools, reduced teacher–student interaction, ethical concerns regarding creative ownership, and the need for continuous technological updates and educator training. Table 4 underlines that the integration of AI in music and art education shows strong potential for fostering creativity and personalization, provided that human guidance and ethical oversight remain central to the learning process.

TABLE 5

AI tools used in Higher Education for Music studies

AI Tool Used	Pedagogical Approach / Use of AI	Key Findings	Challenges / Concerns	Academic Field / Specialization	References
Augmented Reality (AR) mobile applications (Flowkey, Simply Piano, Skoove, AR Pianist, Music Everywhere)	AR-enhanced online piano course for beginners	Significant improvement in musical terminology (89%), sheet music reading (83%), technical and performance skills (90%).	Reliance on AR may reduce traditional teacher–student interaction.	Piano Education / Music Pedagogy	Cui, 2022
Music Education and Teaching based on AI (MET-AI), machine learning, NLP, data analytics	Personalized learning, feedback systems, adaptive environments in music teaching	AI improves personalized learning, engagement	Requires continuous updates; educators must adapt to technological advancements.	College Music Education	Wei et al., 2022
Rough set–neural network model, hierarchical evaluation model	Service quality assessment for online music education platforms	Validated model effectively evaluates platform services considering the subjective student feedback	Evaluation depends heavily on subjective student feedback; models may overlook nuanced experiences.	Online Music Learning Platforms / Educational Technology	Yang & Liu, 2022

TABLE 5

AI and Virtual Reality (VR) technologies	Interactive audio-visual curriculum integrating VR and AI	High recognition accuracy of music signals; VR+AI enhances interactive learning experiences.	Implementation of VR+AI demands high technological infrastructure and resources.	Music Signal Recognition / Educational Innovation	Yan & Xia, 2023
Community discovery algorithm, AGNES clustering, improved CNN	Smart music learning model with personalized learning paths	Smart learning models provided personalized learning paths; strong correlation with academic performance.	Risks of over-reliance on digital tools; ethical concerns and digital divide issues. Complexity of algorithms may limit teacher adoption; requires data literacy training.	Higher Education / Smart Music Learning	Zhang, 2024

AI tools are widely used in English language education to enhance writing, speaking, and overall language proficiency (Table 6). Applications such as ChatGPT, Automated Writing Evaluation (AWE) systems, machine translation tools, and multimedia platforms provide personalized feedback, improve grammatical accuracy, and promote learner engagement and motivation (Alghannam, 2024; He, 2024; Tai & Chen, 2024). These technologies have shown particular effectiveness in developing writing quality, fluency, and confidence among English as a Foreign Language (EFL) learners. However, challenges persist, including over-reliance on AI-generated feedback, issues of data privacy, limited critical thinking, and variability in feedback accuracy (Cheng, 2024; Chung & Jeong, 2024). As Table 6 demonstrates, the integration of AI in language learning presents significant pedagogical benefits but requires careful implementation and teacher oversight to ensure meaningful and ethical outcomes.

TABLE 6

AI tools in Linguistics/ study of language(s) in Higher Education*

AI Tool Used	Pedagogical Approach / AI Use	Benefits / Positive Results	Challenges / Concerns	Field / Specialization	References
ChatGPT, Kahoot, QuillBot, Grammarly, TWEE, QUIZIZZ, CONKER, Copilot, Quizlet, Edpuzzle, Poe AI, Mindmeister, Liveworksheet	Appreciative Inquiry model in English Language Teaching (ELT) lesson design	Positive impact on student teachers' professional development	Plagiarism, lack of resource information (ChatGPT); no limitation for Edpuzzle and Poe AI; (Limited/ no) free access for the rest.	ELT	Al-Nofaie, & Alwerthan, 2024
ChatGPT	AI-provided feedback on English as a foreign language (EFL) writing	Useful accuracy-oriented feedback on writing, improving organization and language issues.	AI feedback lacked consistency, credibility, and communicative/ affective depth; required teacher oversight.	EFL Writing	Alghannam, 2024
Writerly & Google Docs - Integrative automated writing evaluation (AWE) tools	AWE programs in academic writing	Significant improvement in writing quality and engagement.	Limited to writing-focused AWE; may lack personalization beyond writing skills.	Academic Writing Instruction	Wale, 2024
Multimedia AI Technology	Multimedia teaching platform	Improved performance in multiple language skills especially comprehension; 30% increase in educational efficiency	Traditional teaching models mismatched with new multimedia needs.	English language	Dou, 2021
AI-assisted presentation training platform	Oral presentation training without teacher intervention	Increased student receptivity and opportunities for oral practice.	AI scoring weakly correlated with human assessment, particularly in fluency and accuracy.	English as an additional language (EAL)	Chen et al., 2023

TABLE 6

ChatGPT	Grammar and writing assistance	Improved efficiency in grammar and writing	Concerns about over-reliance, reduced critical thinking, authenticity, data privacy, and integrity.	ELT Pre-service teachers	Chung & Jeong, 2024
Machine translation (MT) and GenAI tools	Self-regulated academic writing support	Improves writing skills when used with self-regulation; sociocultural dynamics matter	Dependence on self-regulation; sociocultural factors may hinder tool effectiveness.	Academic EFL Writing	Wang, 2024b
Fliki AI Videos	Personalized visual/audio EFL instruction	Enhanced comprehension of linguistic and pedagogical concepts, personalized learning and engagement.	Limitation: need for supplementary activities and optimal video design features.	EFL Pre-service teachers	Cabrera-Solano et al., 2024
AI-integrated Microsoft Teams	Blended English for Specific Purposes (ESP) learning	AI-integrated blended learning facilitated ESP learning effectively.	Social aspects (interaction the most challenging) and lack of teacher support (challenges, especially for advanced students).	ESP course (English for Economics)	Taylor, 2024
Machine Translation (MT)	MT strategy instruction & flipped learning	Reduced student anxiety; promoted MT use; motivated students in translation courses.	Student dependency on MT, anxiety, and ineffective traditional assessments.	College Translation Teaching	Li et al., 2023
Computer Simulation in Educational Communication (CSIEC) chatbot	AI-assisted mobile applications	Human-likeness and social presence improve motivation, eagerness, and confidence.	Technical and classroom management challenges may hinder chatbot effectiveness for students.	EFL	Ebadi & Amini, 2024
AI-powered Smart Classroom	Intelligent classroom model with real-time feedback	Enhanced language proficiency and cultural literacy; interactive learning	Concerns over access, cultural appropriateness, overreliance on technology, and ethical issues.	English Language & Literature	Zhang et al., 2023

TABLE 6

Backpropagation Neural Network (BPNN) for English reading level detecting	Production Oriented Approach (POA) -based reading instruction with AI evaluation	Significantly improves reading skills especially reading; higher exam participation and performance	Limitation: small amount of data used in POA model creation, leads to certain errors.	English Reading	Wang & Yan, 2022
AI-generated pedagogical agents	Virtual teachers in language learning videos	Embodiment factors affect tech acceptance, perceived ease of use and engagement in learning videos.	Worries about technical issues with virtual teachers and classroom management.	Language Learning Technology Acceptance	Lin & Yu, 2024
Technology-Enhanced Project-Based Language Learning (TePBLL) framework with AI block	Telecollaborative course (between Universities in USA and Spain)	Personalize and enhance the efficiency of language learning; hands-on training critical for AI pedagogical utilization	Concerns about overuse, ethical issues, and impacts on critical thinking.	Pre-service teacher language education	Uwosomah & Dooly, 2025
Generative AI chatbots	Speaking skills via chatbot interaction	Improved fluency, confidence and motivation; paired practice was valuable	Need for careful integration and guidance for AI chatbot use.	Elementary EFL Speaking	Tai & Chen, 2024
ChatGPT	Case study in grammar, writing, vocabulary	Enhances learning of grammar, writing, vocabulary; boosts motivation		Foreign language education	Karataş et al., 2024
ChatGPT	ChatGPT in supporting student English language learning	Enhanced engagement; provided useful feedback;	Faculty noted challenges in implementation of ChatGPT despite positive perceptions.	EFL	Mohamed, 2024
ChatGPT	AI-generated writing feedback	ChatGPT convenient for improving English writing skills.	Critical of feedback quality (i.e., vague and ambiguous).	Tertiary English Writing	Cheng, 2024

TABLE 6

AI writing bots (Essay GPT, essai.ai, Jenni AI, Paperpal, SciSummary, EditPad, Wordtune Parafrasist, Smodin, etc.)	Taxonomy of AI tools for writing instruction	Benefits for progress in writing, supported by a taxonomy framework	Teachers skeptical of AI writing tools; drawbacks alongside benefits.	Foreign language writing instruction	García Laborda et al., 2024
Automated Writing Evaluation (AWE)	AWE feedback alongside traditional instruction (teacher feedback)	AWE enhances student motivation, enjoyment-buoyancy, writing success	Some students lacked guidance on initiating writing tasks despite AWE support.	EFL Writing	He, 2024
AI-driven Chatbots	Academic engagement intervention	Higher motivation, engagement and participation; Provided effective learning support	Implementation challenges despite high engagement levels.	EFL	Wang & Xue, 2024
Poe Application corrective feedback (CF)	Intervention with AI (Poe Application) CF/ teacher CF/ no CF in EFL	AI CF reduced writing anxiety, improved fluency and accuracy more than teacher CF	None significant, though AI feedback must be optimized to align with pedagogical goals.	EFL Writing	Wang, 2024a
Otter.ai AI Meeting Assistants (AIMAs)	Real-time transcription during lectures	Increases engagement and expected grades	Perceived decline in instructor enthusiasm and communication	English	Kwok et al., 2024

**(i.e., English language; English as a foreign (or additional) language; other foreign language)*

AI technologies are increasingly employed across Social Sciences to enhance engagement, personalization, and pedagogical innovation (Table 7). Tools such as ChatGPT, generative AI systems, augmented and virtual reality applications, and intelligent tutoring platforms are used to support writing, reflective learning, and critical thinking (Del

Moral-Pérez et al., 2024, Hezam & Alkhateeb, 2024; Lavidas et al., 2024). AI-supported systems like DL-ALS and generative AI also promote artistic innovation and higher self-efficacy (Chiu et al., 2022; Creely & Blannin, 2025). Studies highlight notable benefits, including improved academic performance, motivation, and creativity, as well as greater student-centered interaction. However, recurring challenges involve over-reliance on AI systems, ethical and privacy concerns, reduced human interaction, and the need for systematic teacher training and integration frameworks (Fernández-Barrero et al., 2024; Hesse & Helm, 2024). Table 7 demonstrates that AI's incorporation within Social Sciences exhibits considerable potential for enriching educational practices, though sustainable implementation requires balancing technological innovation with ethical responsibility and pedagogical depth.

TABLE 7

AI tools in Social Sciences in Higher Education

AI Tool Used	Use of AI	Benefits	Challenges/ Concerns	Academic Field / Specialty	References
Graph Convolutional Network (GCN) psychological civics teaching model with Bidirectional Gated Recurrent Unit (Bi-GRU)	Sentiment analysis of teacher-student dialogues in civics and psychology education	Improved emotional classification and ideological guidance in higher education	Need to preserve ideological content; AI should serve pedagogy, not dominate it.	Psychology and Civics Education	Han & Gong, 2022
Large Language Models (LLM), ChatGPT, CoPilot, Stable Diffusion, DALL-E, Midjourney, DeepBrain AI, Sora	Acceptance study of AI by students based on Unified Theory of Acceptance and Use of Technology (UTAUT2)	Performance, habit, and enjoyment predicted AI use intentions; behavior intention, habit and facilitation affect actual use	Over-reliance on applications due to habit formation and enthusiastic adoption; thoughtful integration of AI needed	Humanities and Social Sciences, Economics	Lavidas et al., 2024
ChatGPT	Virtual tutor for digital natives	Provides personalized learning, enhances engagement for digital natives	Dependency and overreliance concerns, ethical issues (cheating, plagiarism), training needs	Social and Political Sciences	Margono et al., 2024

TABLE 7

Machine Teacher, Smart Tutoring App, Chatbot	Value co-creation via AI roles	Co-creation with machine teachers and smart tutoring apps valued	Chatbots linked to value co-destruction; negatively seen by users	Value creation	Robayo-Pinzon et al., 2023
ChatGPT	Evaluation of AI-generated journalistic writing; AI as writing assistant	AI assisted in journalistic writing, supporting the generation of simple and informative texts.	Concerns about originality, depth, and ethical implications of AI-generated journalistic texts.	Journalism Education	Fernández-Barrero et al., 2024
Machine Teacher (AI Teaching Assistant)	Online support in distance learning	Efficient and available teaching assistants for online education	Lack of emotional support, reduced human interaction	Communication	Kim et al., 2020
GenAI writing tools	Needs assessment for AI writing training in teacher education	AI writing tools revealed diverse training needs and emphasized integration into teacher education.	Lack of AI writing training; heterogeneity in needs creates challenges for program design.	Pre-service teacher -Writing instruction	Hesse & Helm, 2024
Augmented Reality (AR) + AI	Game-based teacher training using film	Boosts transmedia skills, creativity, collaboration	Subjectivity in creative approaches, challenges in AR/AI integration	Early-Childhood -Education Teacher Training	Del Moral-Pérez et al., 2024
ChatGPT, Lensa AI, and Canva Magic Write + Social Media (Twitter)	Critical reflection and student-centered design	Social media + AI fosters engagement and student-centered design	Student hesitance, safety/privacy concerns, complex ethical issues	Teachers/ Educational designers	Parra & Chatterjee, 2024

TABLE 7

GenAI tools in literature education	AI in teaching short stories	AI improved comprehension; supported short story learning by providing personalized, engaging experiences	Concerns over quality of AI-generated content; need for training and ethical guidelines.	Literature Education	Hezam & Alkhateeb, 2024
AI-Powered Personalized Learning Tools (within Moodle)	Intervention using AI tools within the Moodle platform vs. traditional instruction	Significant gains in academic performance, motivation, critical thinking and engagement	Integration challenges and inclusivity issues in scaling AI across diverse learning contexts.	Educational Technology	Eltahir & Babiker, 2024
ChatGPT + Web 2.0 Tools	Creation of digital comic stories for sustainability education	Improved sustainability awareness and knowledge	Issues of productivity, originality, and ethics in sustainable development education.	Education for Sustainable Development	Kayaalp et al., 2024
AI vs Human Feedback Providers	Feedback in argumentative writing	social cues (e.g., provider, language) should be considered when designing feedback processes.	Non-significant impact on motivation/ self-efficacy, over-trust in AI feedback	Argumentative writing	Ruwe & Mayweg-Paus, 2023
AI + jQuery	Web-based multimedia equipment management	Centralized control and efficient management of multimedia teaching resources	Technical integration challenges; dependency on systems	Educational Technology	Su et al., 2021
ChatGPT	Online higher education	Opportunities for potential quality improvements and effectiveness of online education	Identified 10 challenges (infrastructure, pedagogy, training), 8 threats (data security, privacy risks)	Education technology	Aldawsari & Almohish, 2024

TABLE 7

GenAI + Podcasting	Re-embracing orality in digital education	Podcasting fosters engagement, creativity, inclusivity	Requires thoughtful integration, risk of neglecting traditional methods	Digital Education	Lee & Lui, 2024
ChatGPT	Real-time feedback, personalized assistance	Real-time feedback, personalized assistance, enhanced learning experiences	Risk of stifling creativity, uniformity in writing; overreliance halting deep understanding	Academic writing	Alhajji, 2024
Text-based GenAI tools Large Language Models (LLMs)	6-phase pedagogical model for self-regulated learning of academic writing using text-based generative AI tools.	Enhances critical thinking, self-regulated learning, guides the writing process	Misuse risks academic integrity, need for structured guidance	Academic writing	Kong et al., 2024
GenAI	Personalized feedback	Reduces workload, enhances personalized feedback	Risks in over-automation, need for careful integration with human instruction	Automated feedback	Lee & Moore, 2024
ChatGPT	Survey of GenAI across writing stages	Provides writing support across brainstorming, outlining, revising, and feedback stages	Lack of preparedness in institutions, calls for guidelines; minor teacher-student disagreements	Academic writing	Barrett & Pack, 2023
AI-Supported Scaffolding Automatic Analysis of Cohesion (AISS-TAACO tool	Argumentation scaffolding with Natural Language Processing (NLP); tracking revisions in student written arguments	Strengthens academic argumentation, stronger and cohesive claims	Small-scale study, limited scope, potential overreliance on AI scaffolding	Graduate-level writing course	Kim et al., 2022

TABLE 7

AI-powered tutoring systems	Adaptive/personalized tutoring	Provides continuous guidance, personalized tutoring and enhances satisfaction	Cultural differences (Hungary vs. Spain) in AI expectations, reliance on AI tutors instead of human instructors	Social sciences and humanities	Hajeer et al., 2024
Chatbots	AI student assistants for learning support	Enhances engagement and success; supports inclusive learning	Challenges in ensuring accurate chatbot responses	Conversational learning	Chen et al., 2023
GenAI, AI-based practice simulations, legal research software	Balanced AI adoption in legal education	Potential benefits for legal education; ethical and sustainability challenges; Calls for guidelines	Risks of bias, fairness, sustainability, and lack of ethical frameworks in legal education.	Legal education	Balan, 2024
Deep Learning-Based Art Learning System (DL-ALS), ResNet50 model	AI-supported system to classify artworks and improve appreciation and painting	DL-ALS improved achievement, self-efficacy, satisfaction; outperformed traditional methods	High reliance on AI systems could reduce human creativity; risk of students over-depending on automated feedback.	Art Appreciation & Painting Education	Chiu et al., 2022
GenAI	Human-AI creative partnerships	Enhanced creativity, collaboration and innovation in education	Ethical concerns, need for guidelines for responsible AI use	Computer-generated artistic content	Creely & Blannin, 2025
ChatGPT-3	Creativity support via generative tools	Improves creative thinking (flexibility, fluency, elaboration, originality)	Potential negative impacts on creativity, confidence, potential overreliance	Creativity course	Habib et al., 2024

Discussion

Utilizing AI tools in Medical and Health Sciences

Across the field of Medical and Health Sciences, Artificial Intelligence is used in various educational contexts through tools such as generative language models (e.g., ChatGPT), diagnostic systems (AISD), AI scribes, virtual environments with VR, and ML-based educational modules. Their applications include the production of reflective assignments, training in diagnostic interpretation (Wang & Xue, 2024), documentation improvement (Moryousef et al., 2025), writing support (Chan, 2025), and the development of AI literacy through flexible courses (Abid et al., 2024). These uses support personalized learning and active engagement, with an emphasis on the complementary function of AI (Brondani et al., 2024; Favero, 2024).

The reviewed studies identify multiple benefits of integrating artificial intelligence (AI) into medical and health education. AI was shown to enhance factual knowledge, diagnostic accuracy, reflective learning, and confidence in clinical decision-making (Brondani et al., 2024; Driesnack et al., 2024; Hamd et al., 2023; Hu et al., 2023; Wang et al., 2024). It also supported learner engagement, self-directed learning, and motivation across fields such as radiography, nursing, and medical imaging (Abid et al., 2024; Brondani et al., 2024; Chan, 2025; Maraza-Quispe, 2025; van de Venter et al., 2023). Gamification, VR, and 3D simulations further improved knowledge retention and comprehension of complex concepts by creating immersive learning environments (Driesnack et al., 2024; Kumar et al., 2022; Maraza-Quispe, 2025). In clinical practice, AI scribes and diagnostic tools reduced workload, improved documentation, and supported patient management (Giannakopoulos et al., 2023; Hamd et al., 2023; Moryousef et al., 2025). AI also fostered innovation and creativity through project-based learning and design thinking (Chan, 2025; Hu et al., 2023; Lugito et al., 2024), while AI-driven decision-support tools strengthened evidence-based practice during clinical rotations (Abid et al., 2024; Olla et al., 2024). Students reported generally positive experiences with GenAI tools like ChatGPT, noting the value of prompt design and the comparability of AI-generated analyses to human work (Brondani et al., 2024; Favero, 2024; Giannakopoulos et al., 2023; Olla et al., 2024). Overall, the findings highlight AI's considerable potential to enhance medical education and contribute to more efficient, high-quality healthcare.

Key concerns relate to educational barriers, including insufficient faculty training, low AI literacy, and curricula that do not adequately address technological competencies (Alshanberi et al., 2024; Jallad et al., 2024; Lugito et al., 2024; van de Venter et al., 2023). Issues in pedagogical design also emerged, such as the need for blended learning formats, technical support, and validated AI-driven tools, including automated feedback and VR systems (Abid et al., 2024; Driesnack et al., 2024; Kumar et al., 2022; Maraza-Quispe, 2025; van de Venter et al., 2023; Wang et al., 2024). Ethical and professional

worries, ranging from resistance to change and fears of dehumanized care to risks of academic dishonesty and job insecurity, were frequently reported (Giannakopoulos et al., 2023; Hamd et al., 2023; Hasan et al., 2025; Schneidereith & Thibault, 2023; Yerlikaya & Küçükaslan, 2024). Technical limitations, such as inaccuracies, outdated information, lack of source references, and potential for harmful recommendations, were also highlighted (Brondani et al., 2024; Chan, 2025; Maraza-Quispe, 2025; Olla et al., 2024). Finally, literature stresses the need for regulatory and institutional frameworks, including clear guidelines and curriculum reforms, to ensure responsible and effective AI adoption (Alshanberi et al., 2024; Hamd et al., 2023; Hasan et al., 2024; Olla et al., 2024; Oluwadiya et al., 2023) and evidence-based training programs (Sharma et al., 2025). Collectively, these concerns show that realizing AI's benefits requires thoughtful pedagogy, ethical oversight, and strong institutional support.

Utilizing AI tools in Natural / Computer Sciences and Engineering

In Natural and Computational Sciences and Engineering, tools such as ChatGPT, genetic models, educational chatbots, AI-powered platforms (such as Langchain and Pinecone), and gamified robotic educational systems are used. Uses include explaining programming concepts (Ahmed et al., 2024), debugging and writing support (Groothuijsen et al., 2024; Simelane & Kittur, 2024), creating quizzes and predicting performance (Almasri, 2024), personalized learning through emotionally intelligent or mobile environments (Baba et al., 2024; Zahra et al., 2025), and the enhancement of self-regulated learning and critical thinking through digital assistants (Bravo & Cruz-Bohorquez, 2024). These tools are integrated into both basic and specialized courses, contributing to the understanding of complex concepts, the active engagement of students, and the development of digital skills.

The reviewed studies highlight key benefits of artificial intelligence (AI) in Natural/Computer Sciences and Engineering education. AI supports personalized and adaptive learning through chatbots and intelligent platforms that boost engagement, comprehension, and performance (Baba et al., 2024; Bravo & Cruz-Bohorquez, 2024; Domínguez et al., 2024; Sung et al., 2024; Vieriu & Petrea, 2025). Efficiency is enhanced as AI automates routine tasks, easing cognitive load and enabling instructors to focus on higher-order teaching (Almasri, 2024; Caccavale et al., 2024; Yang et al., 2023). Gamification, chatbot development, and immersive tools increase motivation, collaboration, and digital skills (Moral-Sánchez et al., 2023; Sung et al., 2024), while generative AI such as ChatGPT assists with content creation, debugging, and academic support (Ahmed et al., 2024; Gill et al., 2024; Groothuijsen et al., 2024; Simelane & Kittur, 2024). Integration with emotional intelligence frameworks and structured instructional models further promotes innovation and student-centered learning (Ruiz-Rojas et al., 2023; Zahra et al., 2025). Overall, these developments demonstrate AI's capacity to strengthen academic

performance, support lifelong learning, and prepare students for digitally driven futures (Dergunova et al., 2022; Domínguez et al., 2024; Vieriu & Petrea, 2025).

Despite these benefits, the studies also identify persistent challenges. Over-reliance on AI may weaken critical thinking, collaboration, and independent problem-solving, and gamification may overshadow deep learning (Bravo & Cruz-Bohorquez, 2024; Caccavale et al., 2024; Groothuijsen et al., 2024; Sung et al., 2024; Vieriu & Petrea, 2025; Yang et al., 2023). Technical and pedagogical issues arise when tools like ChatGPT produce inaccurate outputs or fail to handle complex queries (Ahmed et al., 2024; Gill et al., 2024; Simelane & Kittur, 2024). Academic integrity concerns, including plagiarism and inappropriate use of generative AI, are widely noted (Barrientos et al., 2024; Gill et al., 2024; Vieriu & Petrea, 2025). Systemic challenges include gaps in AI literacy, ethical concerns about job displacement, and reduced human interaction when AI substitutes for instructors (Almasri, 2024; Dergunova et al., 2022; Vieriu & Petrea, 2025). Unequal access to technology, the need for ongoing innovation, and demands for strong instructional design also constrain implementation (AlAfnan et al., 2024; Domínguez et al., 2024; Michels, 2024). Additionally, emotional intelligence models and gamification raise questions about validity and instructor bias (Yang et al., 2023; Zahra et al., 2025). Together, these concerns stress the need for ethical oversight and balanced pedagogy to prevent AI from deepening inequalities or promoting shallow learning.

Utilizing AI tools in Physical/ Sport Education

In the field of Physical Education, AI tools such as emotion recognition and visual analysis systems (Cheng & Wang, 2021), big data-based smart service platforms (Cao et al., 2022), educational systems with AIPE and NLP (Tian, 2024), multi-criteria evaluation models with fuzzy logic (Li et al., 2024), and language models such as ChatGPT (Killian et al., 2023) are utilized. Their uses include enhancing assessment in flipped classrooms, analyzing teaching effectiveness, providing personalized training, and monitoring student health, as well as facilitating decision-making through digital assistants.

The integration of AI in higher education physical education has produced several notable benefits. AI-supported inverted classrooms improve evaluation efficiency, reduce assessment time, and deliver real-time feedback that supports learning (Cheng & Wang, 2021). Big data platforms diagnose classroom issues and increase practice density, fostering engagement and reliability (Cao et al., 2022). AI systems also enable personalized, data-informed instruction through individualized training, health monitoring, and automated performance analysis (Tian, 2024). Fuzzy evaluation models enhance systematic, less subjective feedback (Li et al., 2024), while LLMs such as ChatGPT support reflection, decision-making, and new forms of knowledge dissemination (Killian et al., 2023). Overall, AI promotes innovation through real-time analytics and evidence-based

feedback, strengthening student-centered learning and improving educational quality (Cheng & Wang, 2021; Killian et al., 2023; Tian, 2024).

Despite these advantages, key challenges remain. Over-reliance on automated evaluations may reduce teachers' critical judgment (Cheng & Wang, 2021), while big data platforms raise privacy concerns requiring strict governance (Cao et al., 2022). Technical errors and system malfunctions can disrupt instruction, and teachers often need substantial training for effective adoption (Cao et al., 2022; Tian, 2024). Fuzzy models still require careful interpretation to avoid misapplication (Li et al., 2024), and LLMs introduce risks of inequitable access, biased outputs, and overdependence on automated guidance (Killian et al., 2023). Broader ethical issues include data protection, digital inequities, and uneven institutional capacity (Cao et al., 2022; Killian et al., 2023). These concerns underscore the need for robust oversight, faculty development, and ethical frameworks to ensure AI complements rather than compromises physical education pedagogy (Cao et al., 2022; Killian et al., 2023; Li et al., 2024; Tian, 2024).

Utilizing AI tools in Music

In music education, IT tools such as augmented reality (AR) applications (e.g., Flowkey, Skoove), machine learning and neural network models, VR environments with music signal recognition, and intelligent personalized learning systems (Cui, 2022; Wei et al., 2022; Yan & Xia, 2023; Zhang, 2024) are used. Uses include interactive instrument learning with AR, providing immediate feedback and personalized learning paths, evaluating the quality of educational platforms, and improving music signal recognition through VR+AI.

AI-driven technologies such as augmented reality (AR), deep learning, and virtual reality (VR) significantly enhance music and art education by enabling personalized and engaging learning. AR tools like Flowkey, Simply Piano, and AR Pianist have improved music literacy and technical skills for most learners (Cui, 2022). AI-supported systems, including MET-AI frameworks, VR-based courses, and smart learning models, offer adaptive pathways, real-time feedback, and more accurate evaluations of online platforms (Wei et al., 2022; Yan & Xia, 2023; Yang & Liu, 2022; Zhang, 2024). VR combined with AI also improves interactive learning through reliable music-signal recognition (Yan & Xia, 2023).

Despite these gains, notable challenges remain. Data privacy, limited algorithmic transparency, and the high cost of AR/VR infrastructure restrict implementation, especially in under-resourced contexts (Yan & Xia, 2023; Yang & Liu, 2022). Rapid technological change requires continual adaptation, and reliance on automated feedback may lead to student dependency (Zhang, 2024). These issues highlight the importance of responsible governance and educator training to ensure effective and ethical use of AI in creative education.

Utilizing AI tools in Linguistics/ study of language(s)

In the field of linguistics and language teaching, a wide range of Artificial Intelligence tools are used, such as ChatGPT, AWE (Automated Writing Evaluation) tools, translation systems, chatbots, multimedia platforms, and virtual assistants such as Otter.ai. Uses include feedback on written expression (Alghannam, 2024; He, 2024), personalized learning support (Cabrera-Solano et al., 2024), oral speech practice through dialogic practices (Tai & Chen, 2024), enhancing language fluency and comprehension using multimedia (Dou, 2021), and linking university programs with AI-supported projects (Uwosomah & Dooly, 2025). At the same time, tools such as AI chatbots and applications such as Poe or Wordtune are used for corrective feedback and paraphrasing, enhancing student autonomy and engagement in learning (García Laborda et al., 2024; Wang, 2024a).

AI integration in Linguistics and language education has shown substantial benefits, particularly in enhancing engagement, academic performance, and personalized learning. Tools such as ChatGPT, Kahoot, QuillBot, Grammarly, Quizizz, Copilot, and other AI-supported platforms strengthen student-teacher professional development and improve reading skills, writing accuracy, coherence, and motivation through automated writing evaluation and AI-assisted feedback (He, 2024; Wale, 2024; Wang & Yan, 2022). AI writing bots also accelerate progress in student writing (García Laborda et al., 2024). Generative AI tools and chatbots provide instant feedback, support vocabulary growth, and improve fluency and confidence in conversational practice (Alghannam, 2024; Tai & Chen, 2024; Wang & Xue, 2024). Multimedia technologies and smart classrooms create interactive environments that increase cultural literacy, proficiency, and motivation (Dou, 2021; Zhang et al., 2023). AI-powered resources such as Fliki videos and meeting assistants further promote comprehension and self-directed learning (Cabrera-Solano et al., 2024; Kwok et al., 2024) while machine translation tools reduce anxiety and encourage enrollment in translation courses (Ebadi & Amini, 2024; Wang, 2024b). Overall, AI fosters adaptive, personalized support and improves learning outcomes across diverse linguistic contexts (Al-Nofaie & Alwerthan, 2024; Cheng, 2024; Chung & Jeong, 2024; Karataş et al., 2024).

Despite these benefits, challenges persist. Over-reliance on AI may weaken critical thinking, authenticity, and communicative competence (Chung & Jeong, 2024; Karataş et al., 2024; Uwosomah & Dooly, 2025). Feedback from generative AI is often inconsistent or superficial, requiring human oversight (Alghannam, 2024; Cheng, 2024). Ethical issues, data privacy, academic integrity, and cultural suitability remain significant (Chung & Jeong, 2024; Mohamed, 2024), as do technical limitations such as inaccuracies, bias, and difficulty assessing nuanced linguistic features (Chen et al., 2023; Lin & Yu, 2024). Teachers frequently feel unprepared to integrate AI effectively (Tai & Chen, 2024), and unequal access to technology creates equity concerns (Taylor, 2024; Zhang et al., 2023).

Reduced human interaction adds further complexity (Kwok et al., 2024; Li et al., 2023). These challenges highlight the need for professional training, ethical guidelines, and structured implementation to support responsible AI use in Linguistics and language education (García Laborda et al., 2024; Taylor, 2024).

Utilizing AI tools in Social Sciences

In the field of Social Sciences in higher education, a variety of Artificial Intelligence tools are used to support teaching, learning, and creativity. Large language models and genetic algorithms (such as ChatGPT, CoPilot, DALL-E, Midjourney) for personalized guidance, writing, and multimedia content creation, improving student engagement and creative thinking (Habib et al., 2024; Margono et al., 2024). At the same time, chatbots and 'Machine Teachers' enhance engagement in distance learning by providing support and immediate feedback (Chen et al., 2023; Kim et al., 2020). The use of automatic assessment systems, such as AISS-TAACO, is also important for improving academic writing and argumentation (Kim et al., 2022), while AI tools are integrated into platforms such as Moodle (Eltahir & Babiker, 2024).

AI shows significant transformative potential across Linguistics/language studies, legal education, and the social sciences. In civics and psychology, AI-enhanced sentiment analysis strengthens emotional classification and supports instructional guidance (Han & Gong, 2022). AI tools also increase perceived performance, enjoyment, and sustained use among students (Lavidas et al., 2024). More broadly, generative models, chatbots, and intelligent tutoring systems provide personalized learning, boost engagement, and improve academic performance while fostering self-regulated learning, critical thinking, and creativity (Chen et al., 2023; Del Moral-Pérez et al., 2024; Hajeer et al., 2024; Kim et al., 2022; Kong et al., 2024; Margono et al., 2024; Robayo-Pinzon et al., 2023). Automated feedback offers timely, individualized support (Lee & Moore, 2024), and AI promotes inclusivity by addressing diverse learning needs (Chen et al., 2023). Field-specific benefits include improved civic learning through sentiment analysis (Han & Gong, 2022), enhanced journalism writing (Fernández-Barrero et al., 2024), personalized tools for literature study (Hezam & Alkhateeb, 2024), and strengthened artistic skills through deep learning models such as DL-ALS (Chiu et al., 2022). Generative AI further expands creative thinking and collaboration in the arts (Creely & Blannin, 2025; Habib et al., 2024). Overall, AI modernizes instruction, making learning more adaptive, interactive, and efficient.

Despite these advantages, notable challenges persist. Academic integrity concerns, including plagiarism, loss of originality, and over-reliance on AI, are prominent (Alhajji, 2024; Fernández-Barrero et al., 2024; Kong et al., 2024; Ruwe & Mayweg-Paus, 2023; Su et al., 2021). Excessive dependence on AI may hinder creativity and deep learning (Lee & Lui, 2024), while AI-generated content can lack trustworthiness and emotional support

(Hezam & Alkhateeb, 2024; Kim et al., 2020). Implementation is further constrained by limited teacher training - difficulty in integrating AI across diverse learning contexts, weak institutional readiness, and infrastructural barriers (Aldawsari & Almohish, 2024; Eltahir & Babiker, 2024; Hesse & Helm, 2024). Issues of data privacy, security, and algorithmic bias are especially salient in legal and online education (Aldawsari & Almohish, 2024; Balan, 2024). The absence of clear ethical guidelines for AI use in creative work raises risks of reduced authenticity and academic dishonesty (Creely & Blannin, 2025; Habib et al., 2024). Research, therefore, calls for strong ethical frameworks, comprehensive educator training, and balanced pedagogical strategies to ensure responsible and sustainable AI integration (Barrett & Pack, 2023; Parra & Chatterjee, 2024; Ruwe & Mayweg-Paus, 2023).

Conclusions

Synthesizing the findings, it becomes clear that AI is both an opportunity and a challenge in contemporary higher education. In general, language studies (generative AI, MT, and AWE tools) followed by medical and health studies (generative AI tools as well as sophisticated AI applications for imaging-pattern recognition-treatment prediction with Immersive VR, 3D animation etc.) are the fields of higher education in which AI tools are most usually employed either integrated in courses or during individual study and task completion. Although Medical and Health Sciences presented advanced tools, the field of Natural/ Computer Sciences and Engineering was focused mainly on ChatGPT usage (to explain core programming or other complex concepts). The Music field instead exhibited sophisticated AI applications (based on complex machine learning algorithms, AR and VR).

The review deduces that AI tools in student study foster engagement and motivation, provide useful real-time feedback, and enable adaptive learning, which aligns with modern educational goals across disciplines. Furthermore, the integration of AI tools into courses enhances personalized learning, engagement, and efficiency across disciplines, equipping students with advanced learning opportunities and preparing them for future professional contexts, arming them with confidence. On the other hand, it raises concerns related to academic integrity, ethical use, and over-reliance, as well as institutional and pedagogical readiness. A balanced approach in higher education that leverages AI's affordances while preserving the essential role of human educators is essential. This requires ethical safeguards such as thorough frameworks, institutional preparedness, and targeted training of all stakeholders to foster responsible use. This review identified a clear lack of established pedagogical practices in the integration of AI tools in classes, along with AI illiteracy to both students and educators. Therefore, it is recommended that education and instructional designers incorporate AI-related coursework into the

foundation year of university programs, tailored to the specific requirements of each academic field rather than embedded solely within individual syllabi. The primary aim is to equip students with the necessary skills and ethical awareness for responsible AI use. Then, in the ensuing years, students would be prepared to attend AI training programs customized to fit the particular needs of their field. Additionally, the establishment of a formal academic policy regulating the use of AI tools is essential to ensure ethical implementation and prevent academic misconduct. Ultimately, the development of an internationally shared academic framework on AI use is strongly advocated. AI should function as a facilitator rather than a substitute for human teaching and should be integrated within pedagogical strategies that ensure education remains technologically innovative while firmly grounded in equity, creativity, and critical thinking.

Limitations

This review has some inherent limitations. First, the distribution of studies across academic disciplines was uneven, with certain fields, such as social sciences and linguistics, being more heavily represented than others. In addition, studies involving mixed or interdisciplinary student samples were excluded if discipline-specific data could not be separated, which limited broader comparative insights. Only research articles indexed in the Scopus database were considered, which may have excluded relevant studies from other reputable sources. Another important limitation is the absence of a formal bias appraisal process. Furthermore, the review was restricted to journal publications, meaning that recent developments shared at academic conferences or included in grey literature were not taken into account. Future reviews should aim to include a more balanced set of disciplines, consider the inclusion of disaggregated data from interdisciplinary studies, employ formal critical appraisal tools, and broaden source criteria beyond Scopus-indexed journals to reflect the rapidly evolving nature of the field.

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