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Exploring the use of generative artificial intelligence by university students: a systematic literature review

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Abstract. *Problem statement*. Artificial intelligence (AI) has become a transformative force across various sectors, including education. The release of ChatGPT marked a pivotal shift in the educational landscape, accompanied by rapid proliferation of other generative AI (Gen-AI). Gen-AI tools have quickly become one of the most prevalent forms of AI in higher education. This research focus highlights a need for a comprehensive examination of Gen-AI's use. Addressing this gap is essential to developing a holistic understanding of Gen-AI's role in higher education, particularly from the student perspective. Given the rapid evolution of Gen-AI technology along with its rapidly growing and often uncontrolled adoption among students, a systematic literature review is necessary to synthesise current knowledge. *Methodology*. This study conducted a tertiary review utilising a systematic approach outlined in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, focusing on three key steps: search strategy and study selection, data analysis, and synthesis of findings. Data for this study was sourced from two databases: Google Scholar and Lens. These databases were chosen for their extensive coverage and accessibility, ensuring a comprehensive collection of relevant literature on AI use in higher education. The data was approached qualitatively: apriori and aposteriori codes were applied to the papers retrieved from Google Scholar. For a deeper analysis of the selected papers, we conducted a thematic analysis to identify recurring themes and patterns. *Results*. From the initial screening of 620 papers, 42 were selected for the final sample based on the predefined inclusion and exclusion criteria. The main uses of Gen-AI as identified in the analysed

papers are summarised in the table. *Conclusion*. The variance in how AI is used among students –depending on their competence levels – highlights an essential consideration for educators: AI can potentially widen the gap between more and less competent learners. This observation calls for a pedagogical balance where AI supports learning without diminishing the educational rigour necessary for critical thinking and problem-solving skills.

Key words: educational technology, generative artificial intelligence, higher education, systematic literature review, student engagement

Author's contribution. The authors contributed equally to this article.

Conflicts of interest. The authors declare that there is no conflict of interest.

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Изучение использования генеративного искусственного интеллекта студентами университетов: систематический обзор литературы

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Аннотация. *Постановка проблемы*. Искусственный интеллект (ИИ) меняет практики в различных областях деятельности, включая образование. Появление ChatGPT привело к заметным сдвигам в среде высшего образования, где стремительно распространяются различные инструменты генеративного ИИ. Использование студентами вузов этих инструментов изучено явно недостаточно. Устранение этого пробела имеет решающее значение для формирования целостного понимания роли генеративного ИИ в высшем образовании. Учитывая стремительное и зачастую неконтролируемое внедрение инструментов генеративного ИИ в студенческую среду, необходимо провести систематический обзор литературы для синтеза существующих знаний. *Методология*. В данном исследовании представлен систематический обзор литературы, основанный на принципах PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) и включавший три ключевых этапа: разработка стратегии поиска, отбор исследований, анализ данных и синтез результатов. Материалы для исследования собраны из двух баз данных: Google Scholar и Lens. Эти базы были выбраны за их полноту и доступность, что обеспечивало комплексный сбор соответствующей литературы по использованию ИИ в высшем образовании. Данные были проанализированы качественно: к статьям, полученным из Google

Scholar, были применены априори и апостериори коды. Для более глубокого анализа выбранных статей выявлялись повторяющиеся паттерны. *Результаты*. Из первоначального количества 620 статей на основе заранее определенных критериев были выбраны 42 статьи. Основные способы использования генеративного ИИ, выявленные в проанализированных статьях, обобщены и представлены в виде таблицы. *Заключение*. Обнаруженные различия в использовании студентами генеративного ИИ в зависимости от их уровня компетентности показывают, что инструменты генеративного ИИ потенциально могут увеличить разрыв между более и менее компетентными учащимися. Исходя из этого, необходимо соблюдать баланс, когда практики использования генеративного ИИ сопровождаются практиками формирования критического мышления.

Ключевые слова: образовательные технологии, генеративный искусственный интеллект, высшее образование, систематический обзор литературы, вовлечение студентов

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Problem statement. Artificial intelligence (AI) has become a transformative force across various sectors, including education [1]. While AI has influenced learning environments and instructional processes over several decades, its impact remained gradual until the launch of OpenAI's ChatGPT in 2022 [2; 3]. The release of ChatGPT marked a pivotal shift in the educational landscape, accompanied by rapid proliferation of other generative AI (Gen-AI) tools such as Perplexity.ai, BLOOM, ChatSonic, Claude, Bard, Whisper, and Jasper Chat. Collectively known as chatbots, these tools are built on large language models and process user input to provide interactive and contextually rich responses in both verbal and written forms [4]. Given their widespread adoption, Gen-AI tools have quickly become one of the most prevalent forms of AI in higher education, prompting a need to explore their implications on learning practices and outcomes.

Gen-AI has gained popularity among key university stakeholders, such as faculty and students. Faculty members utilise these tools for developing instructional materials and giving feedback [5], facilitating personalised learning experiences [6; 7], and streamlining administrative tasks [8]. Students, on the other hand, leverage Gen-AI for diverse academic purposes, including research [9], writing assistance [10; 11], coding [12], and problem-solving [13]. Concurrently, the body of research on students' use of Gen-AI significantly surpasses that on teachers' applications. According to the Lens database, there

are 2,305 papers focused on students, compared to 1,677 for faculty. Additionally, [2] report that 72 % of existing Gen-AI studies target student usage, while only 17 % concentrate on instructors. Despite this focus, existing literature reviews on AI intelligence demonstrate an underrepresentation of empirical studies focusing on university students' use of Gen-AI [14–16].

This research focus highlights a need for a comprehensive examination of Gen-AI's use. Addressing this gap is essential to developing a holistic understanding of Gen-AI's role in higher education, particularly from the student perspective. Given the rapid evolution of Gen-AI technology along with its rapidly growing and often uncontrolled adoption among students, a systematic literature review is necessary to synthesise current knowledge. The present review aims to (1) map the current applications of Gen-AI by university students, (2) assess the impact on their learning processes and academic performance, and (3) identify research gaps and propose directions for future investigation. By focusing on high-quality publications from Q1 and Q2 Scopus-indexed journals, this review seeks to provide an in-depth panorama of Gen-AI's integration into higher education.

The literature identifies various uses of Gen-AI that can be classified into more complex dimensions. Thus, [10] begin the discussion by dividing Gen-AI tools into "mindless" functions, such as summarising and paraphrasing, and "mindful" functions, which can generate entire texts. The former is more popular among students. Building on this, [17] categorise Gen-AI applications based on the role of chatbots, viewing them as tools for language or idea generation or as writing partners. Also, [18] offer another classification based on how students interact with Gen-AI: one group makes no changes to AI-generated content, thereby learning little, while another group modifies the content according to their abilities. This idea is expanded by [11], who observe that "competent" writers use Gen-AI as a supplementary tool, whereas less competent writers rely more heavily on AI-generated text. [19] and [20] further explore the debate over whether to alter or directly copy Gen-AI feedback. [19] contrast the simple copy-paste approach with an iterative process of engaging with Gen-AI feedback, echoing [18] earlier findings. [19] also introduce two dimensions for classifying AI use: "content and component uses" and "structured adaptivity" versus "unstructured streamline". [20] focuses on text-production patterns, classifying students into those who frequently modify Gen-AI feedback, those who explore Gen-AI resources, and those who prefer ready-made texts with citations. [21] also address the issue of editing AI-generated drafts, emphasising that interactivity is a part of a broader classification of Gen-AI applications. They divide Gen-AI usage into stages: "brainstorming and outlining", "writing and revision", and "feedback and evaluation", aligning with the three main stages of the writing process: pre-writing, writing, and post-writing. Interestingly, [19] offer a similar classification based on writing stages and further differentiate between "hidden" and "predominant" Gen-AI uses, particularly in writing tasks. [22] identify similar Gen-AI uses and introduce a "metadimension" of seeking inspiration in

interacting with AI, previously described as "overcoming writer's block" by [17]. [23] expand these ideas by specifying Gen-AI uses at each writing process stage. Finally, while [24] discuss AI's application in language practice, some patterns overlap with writing applications. In addition to speaking practice and personalised feedback, Gen-AI is used for grammar correction and finding appropriate words.

While a substantial body of research has investigated the role of AI in administrative and instructional applications within higher education, studies specifically focusing on student engagement with Gen-AI tools are comparatively limited. Existing literature highlights Gen-AI's capability to augment collaborative learning environments. For instance, [25] and [26] discuss Gen-AI potential to facilitate online collaborative debates and enhance writing processes through automated feedback mechanisms and question generation. [15] emphasise that AI-driven chatbots have proven effective in fostering group discussions and aiding students in articulating their perspectives more confidently. Further explorations in the literature reveal that AI tools not only support collaboration but also contribute significantly to skill development across various domains. For example, studies have documented the efficacy of chatbots in language learning contexts, where they enhance performance, critical thinking, empathy, communication skills, and overall student satisfaction [16; 15]. Moreover, Gen-AI applications extend to providing personalised academic assistance, where systems recommend resources and offer scaffolding tailored to individual learning needs [8; 26; 27]. Thus, previous literature reviews have broadly addressed the use of Gen-AI in higher education, yet detailed explorations of how university students utilise it in their studies still remain absent.

To identify articles for inclusion in a literature review, various databases are utilised, which may vary depending on the research scope and objectives. For instance, [28] focused on one specific journal relevant to their topic. In contrast, [29] examined several leading journals on distance education, while [30] expanded their search to encompass journals in the broader field of higher education. In cases where the research scope is more extensive, all articles on selected topics from specific databases may be included. For example, [25] addressed three international databases: EBSCO Education Source, Web of Science, and Scopus. Similarly, [31] sourced articles from multiple electronic databases including Emerald, SpringerLink Journal, ScienceDirect Journal, SAGE, Taylor & Francis Online, and Wiley Online Library. [32] and [8] employed an even broader array of resources, including the Educational Database (ProQuest), Education Research Complete (EBSCOhost), ERIC (ProQuest), Scopus, Web of Science (Core Collection), and ProQuest Central.

Similarly, the time frame for literature analysis is closely tied to the scope of the study. For example, when reviewing a single journal on a narrowly defined topic, as in the study by [28], the time frame may span several decades, from 1980 to 2014. In contrast, studies encompassing a few journals, such as [29], typically restrict the review period to a few years, in this case from 2014 to 2019.

When a single topic is investigated across a few databases, the time frame is generally constrained to a decade or less; for instance, [33] analysed literature from 2007 to 2016 using databases like ERIC, Web of Science, Scopus, and PsycINFO. However, when multiple databases are employed to explore a single topic, as in [32], the time frame might be limited to just a few years.

Generally, the reviewed studies adhere to the basic methodology and its variations as outlined by [34], which require a reviewer to establish a clear protocol for handling papers. This includes setting exclusion/inclusion criteria and following three primary stages of the review process: searching for papers, selecting them based on set criteria, and synthesising the findings. Concurrently, the tripartite approach advocated by [35] delineates the stages of a literature review such as description (a summary of the review content), synthesis (categorization of the reviewed research), and critique (evaluating the strengths and weaknesses of the literature). Furthermore, some studies utilise a critical literature review methodology aimed at identifying the most significant items in a field to produce a conceptual contribution [36]. This method includes a linguistically based approach where the underlying conceptualizations and assumptions are scrutinised, particularly the meanings of words [30]. The approaches to article analysis before synthesis vary across studies. For instance, [28] employ content analysis to examine the conceptual structure of text-based information and identify the most prevalent and recurring themes [37]. Some studies combine analytical methods like text mining and social network analysis [2], while others integrate content analysis [38] with thematic analysis [39; 32]. Another combination involves deductive analysis [40], where selected studies are categorised into pre-existing codes, and a constant comparative method used to inductively compare studies and create sub-themes that fit into larger themes on the topic [31]. The use of mixed methodologies is justified by the need to triangulate data, thereby enhancing the reliability and validity of research findings [41]. A popular method to report systematic review findings is preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, which include describing inclusion/exclusion criteria, defining a search strategy, screening and selecting articles, describing relevant studies, and analysing and synthesising the findings [31; 33]. While the PRISMA guidelines are widely adopted for systematic reviews, alternative methodologies such as DARE[1] and AMSTAR 2 [42] are also employed, providing diverse frameworks for conducting reviews with varying focuses and criteria, as exemplified by [16].

In systematic literature reviews, researchers employ a variety of tools to enhance their analysis and presentation of findings. For instance, Leximancer is utilised in [28] to generate concept maps from the titles and abstracts of selected papers, facilitating a visual exploration of key themes and concepts. Similarly, [29] apply Leximancer for text mining purposes, extracting and analysing textual data to identify patterns and relationships. For the analysis of social networks

[1] *Database of Abstracts of Reviews of Effects (DARE): Quality-assessed reviews*. The University of York Centre for Reviews and Dissemination (UK). https://www.ncbi.nlm.nih.gov/books/NBK285222/ (accessed: 19.09.2024)

within the literature, tools such as Gephi and NodeXL are used by [29] to visualise and interpret the connections among authors, concepts, and publications. Furthermore, EPPI Reviewer 4.0 serves as a comprehensive platform for managing and analysing literature. This software is employed in studies like [25] and [16] to streamline the process of retrieving, reviewing, and coding papers, ensuring systematic data handling and enhanced accuracy in the synthesis of research findings.

What exactly is analysed in found papers also varies. For instance, [28] focus solely on titles and abstracts to determine the relevance of articles to their study questions. [29] extend their analysis to reference lists, which can uncover additional relevant studies and extend the scope of their review. Meanwhile, in qualitative analyses such as the one conducted by [32], only those parts of articles that directly address the research questions are examined, allowing for a focused exploration of the topic at hand.

Methodology. This study conducted a tertiary review utilising a systematic approach outlined in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, focusing on three key steps: search strategy and study selection, data analysis, and synthesis of findings. Data for this study was sourced from two databases: Google Scholar and Lens. The first one was employed to search for papers to analyse via qualitative analysis, the second – to perform a quantitative part. Google Scholar, a widely accessible and extensively used academic search engine, offers a broad spectrum of scholarly literature from various sources. Lens is a comprehensive scholarly database that aggregates global research across multiple disciplines, providing a robust platform for accessing a wide variety of scientific publications. These databases were chosen for their extensive coverage and accessibility, ensuring a comprehensive collection of relevant literature on AI use in higher education.

Search string:

“artificial intelligence” OR “machine intelligence” OR “intelligent support” OR “intelligent virtual reality” OR “chat bot” OR “machine learning” OR “automated tutor” OR “personal tutor*” OR “intelligent agent*” OR “expert system” OR “neural network” OR “natural language processing” OR “smart technologies” OR “intelligent technologies” AND “higher education” OR “tertiary” OR “college*” OR “undergrad*” OR “graduate” OR “postgrad*” AND “learn*” OR student* AND “use/application”*

The following inclusion and exclusion criteria were applied to select papers from Google Scholar database.

Inclusion criteria:

- Source of publication: Articles indexed on Google Scholar.
- Publication date: Studies published from January 2023 onward.
- Language: Studies must be published in English.
- Journal ranking: Only articles from journals ranked in the first or second quartile (Q1–Q2) according to relevant journal ranking metrics by Scopus.

- Type of paper: empirical study.
- Gen-AI is used by: students.

Exclusion criteria:

- Educational setting: Studies that do not focus on higher education contexts.
- Relevance: Articles not addressing AI in higher education.
- Data type: Excludes studies that do not present empirical data.
- Peer review status: Excludes articles that are not peer-reviewed.

The data was approached qualitatively: apriori and aposteriori codes were applied to the papers retrieved from Google Scholar. Mostly, the abstracts were analysed, but if the information was not sufficient, the results and discussion sections of the papers were addressed. Further to this, generic codes were used to extract basic factual information, such as the journal name and the authors' countries. For a deeper analysis of the selected papers, we conducted a thematic analysis to identify recurring themes and patterns, as described by [39]. We employed a priori codes, derived from existing literature reviews on Gen-AI, to systematically categorise and analyse the data.

Thematic apriori codes:

– ways of using Gen-AI [8];
– impact of using Gen-AI [16; 26];
– Gen-AI as collaboration facilitator [15; 25].

This approach ensures that the coding process is grounded in established research, facilitating the comparison and synthesis of new findings with previous studies. Additionally, a posteriori codes that emerged during the analysis process were integrated to capture new themes and insights not previously identified in the literature.

Thematic a posteriori codes:

– Gen-AI adoption;
– Gen-AI perception;
– Gen-AI literacy;
– preparation for Gen-AI use;
– Gen-AI implementation;
– Gen-AI performance in assignments;
– skills required for collaboration with Gen-AI;
– role of Gen-AI in collaboration;
– alternative perspectives on AI and collaboration.

Results and discussion. From the initial screening of 620 papers, 42 were selected for the final sample based on the predefined inclusion and exclusion criteria. The distribution of the selected papers across different years is as follows: 7 papers were published in 2022, 24 – in 2023, and 11 – in 2024. Among these, 6 were authored by a single individual, while 40 were collaboratively written with co-authors. In terms of publication quality, 27 papers were published in Q1 journals, and the remaining 15 in Q2 journals. A total of 27 journals were identified as sources of the included studies. The distribution of journals indicates

a concentration of publications in specific outlets. *The International Journal of Educational Technology in Higher Education* emerged as the most frequently cited journal, with six articles, underscoring its pivotal role in disseminating research on AI application. This was followed by *Computers and Education: Artificial Intelligence* and *Education and Information Technologies*, each contributing significantly to the literature with four and three articles, respectively. *Scientific Reports*, *Frontiers in Psychology*, *Cogent Education*, *Humanities and Social Sciences Communications* and *Education Sciences* demonstrated repeated engagement in this research area with two articles published in each.

The review identified a significant variance in the geographic distribution of authors contributing to the field. The United Arab Emirates (UAE) led with the highest number of authors, totalling 50. Following the UAE, the United Kingdom contributed 15 authors. China and the United States also showed considerable involvement, with 14 authors each. Other notable contributions came from Jordan and Australia, each with 8 authors. Indonesia, Lebanon, and Egypt contributed 6 authors each, demonstrating their ongoing commitment to the research area. The analysis also pointed out contributions from a range of other countries, with varying levels of involvement, including Saudi Arabia, Thailand, Poland, and Germany with 5 authors each. Several countries, such as Switzerland, Morocco, Israel, Malaysia, and Tunisia, each contributed one author. This diversity in authorship from countries across different continents emphasises the global relevance and interdisciplinary nature of the topic.

To report findings based on a priori and a posteriori code that address the research questions posed in the methodology, a narrative summary of findings organised around key themes or factors will be employed, along with a narrative synthesis of the data as suggested by [43].

Research question 1. How do university students use Gen-AI in their studies?

Gen-AI adoption (n=9)[2]

Theories and models

In measuring the adoption and acceptance of Gen-AI tools among university students, researchers commonly apply specific theories and models. The identified theories include Diffusion of Innovations Theory [44], Constructivism Learning Theory [45], Self-Determination Theory [46], Situated Expectancy-Value Theory (SEVT) [47], the Unified Theory of Acceptance and Use of Technology (UTAUT) [46], and UTAUT2 [48; 49]. The primary model identified is the Technology Acceptance Model (TAM), which forms the basis for UTAUT and UTAUT2 [46; 50]. Additionally, financial considerations [51] and academic major [52] were found to influence Gen-AI adoption.

Factors and variables

Student willingness to adopt Gen-AI is directly influenced by variables such as technological expertise and ease of doing business [44], as well as perceived ease of use and social influence [46]. Other significant factors include facilitating

[2] Hereinafter “n” is a number of papers.

conditions [48], the benefits of using Gen-AI, supportive environments [47], user-friendliness [50], habit, performance expectancy, and hedonic motivation [49]. Key motivations for using ChatGPT are also its quick response time and ease of use, enhancing educational efficiency and task management [45]. Additionally, students with external funding are more likely to use Gen-AI than those who pay for it themselves [51]. Gen-AI is more readily accepted in engineering than in business, while the arts had lower adoption due to the tool's text-centric nature [52]. Conversely, perceived usefulness, autonomy, and trust do not significantly affect Gen-AI acceptance [46], along with effort expectancy [48]. Although perceived usefulness did not directly impact adoption intention, it had an indirect effect through personalization (positive) and interactivity (negative) [50].

Ways of using Gen-AI (n=6)

Gen-AI is widely applied in academic settings, facilitating a variety of tasks including coding [53; 54], administrative duties [53], and problem-solving [54]. Additional uses encompass clarifying subject concepts [54] and answering questions [53; 54]. Notably, the most common application of Gen-AI is in writing-related activities. Thus, during the pre-writing phase, Gen-AI assists in brainstorming [21], generating ideas [51; 53], conducting preliminary literature searches [54], outlining [21], and creating initial drafts [51]. It also supports literature studies [54] and data analysis [53]. In the while-writing phase, Gen-AI aids in the composition process itself [21; 54], enhancing language, style, and writing techniques [51], and performing translations [54]. Post-writing, Gen-AI is utilised for revisions, feedback, and evaluation [21]. The table below summarises the main uses of Gen-AI as identified in the analysed papers.

Overview of Gen-AI applications identified in selected papers

Gen-AI use	Barrett, Pack, 2023 [21]	Chan, Hu, 2023 [53]	Dakakni, Safa, 2023 [51]	Von Garrel, Mayer, 2023 [54]
Brainstorming	▲	▲	▲	
Outlining	▲			
Writing technique	▲		▲	▲
Language			▲	
Translation				▲
Style			▲	
Creating drafts			▲	
Revising drafts				
Feedback	▲			
Evaluation	▲			
Answering questions		▲		▲
Clarifying concepts				▲

Окончание табл.

Gen-AI use	Barrett, Pack, 2023 [21]	Chan, Hu, 2023 [53]	Dakakni, Safa, 2023 [51]	Von Garrel, Mayer, 2023 [54]
Research aid		▲		▲
Data analysis/coding		▲		▲
Multimedia creation/ design		▲		▲
Administrative tasks		▲		
Solving problems				▲

Source: compiled by Anna E. Korchak, Yevgeny D. Patarakin, Jamie Costley.

There are also papers related to Gen-AI use by students that do not describe its particular applications. For instance, [55] discovered that students who mastered prompt engineering could enhance their learning by generating more accurate and valuable responses from AI systems. Similarly, [56] observed that students' confidence in using Gen-AI grew with increased experience, encompassing ethical considerations as well.

Gen-AI perception (n=10)

Positive

Students generally hold positive attitudes towards Gen-AI, appreciating its ability to ease university transition anxieties [57; 58], enhance language, style, and writing techniques [51], and provide unique insights and personalised real-time feedback [53; 59; 60]. It is valued for its assistance in understanding fundamental concepts and performing routine tasks, thus freeing up time for higher-level activities [59; 61]. Its 24/7 availability and the provision of virtual learning environments also stand out as beneficial features [59–61].

Negative

Despite these positives, students sometimes find it difficult to initiate conversations with AI, and technical issues can lead to mixed feelings [57]. There is a noted distrust of Gen-AI, particularly regarding its capability in assessments and the need for human oversight in grading processes [51]. Concerns about Gen-AI's lack of emotional intelligence, empathy, and in-depth subject understanding further contribute to negative perceptions [53; 62]. Moreover, students feel that Gen-AI cannot replace personal interactions with educators [61; 63].

What affects perception

Factors influencing these perceptions include user-friendliness of Gen-AI, its social impact, perceived benefits, behavioural and cognitive effects, and minimal perceived risks [58]. The quality of Gen-AI's output and social influence significantly impact its acceptance [64]. As students become more familiar with Gen-AI, their usage tends to increase, and their perception of Gen-AI shifts from viewing it as a "cheating tool" to recognizing it as a valuable, albeit supervised, educational resource [51; 63].

Research question 2. What outcomes are reported from students' use of Gen-AI?

Impact of using Gen-AI (n=9)

Positive impact of using Gen-AI

The positive effects of using Gen-AI, as identified in the analysed papers, are categorised into three main areas: academic performance and cognitive development, skills development and professional preparation, and self-directed learning. A detailed breakdown of the outcomes for each category follows. In the realm of academic performance and cognitive development, outcomes include increased motivation [65] and enhanced academic experiences [52]. Studies also highlight a rise in cognitive achievement [66] and academic performance [62] as a result of using Gen-AI. Additionally, there are significant improvements in the use of cognitive and metacognitive learning strategies [65], along with enhanced comprehension and creativity [52]. The outcomes related to skill development include improved problem-solving abilities, which prepare students for professional roles [67]. Furthermore, critical thinking is enhanced when students are tasked with critically evaluating Gen-AI-produced content [55]. Additionally, using Gen-AI has shown potential in enhancing language skills [45]. In terms of self-directed learning, Gen-AI is reported to facilitate task completion [54], boost self-confidence [45], and assist in managing behaviour during self-study [68].

Negative impact of using Gen-AI

While Gen-AI offers numerous benefits, it also presents several challenges. According to [45], reliance on Gen-AI can lead to an over-reliance that may diminish students' critical and problem-solving skills, posing significant risks to academic integrity. Additionally, [68] highlight that Gen-AI may not effectively maintain student motivation or increase their drive to learn, limiting its efficacy as a comprehensive educational tool.

Research question 3. What is the role of Gen-AI in collaboration aspects of the study process?

Although the collaborative aspects of Gen-AI are seldom investigated independently, they frequently intersect with various research domains. This intersection explains why the number of papers categorised under this code exceeds those under other codes – collaboration is present across many subjects in this study.

Skills required for collaboration with Gen-AI (n=4)

Collaboration competencies are categorised as a crucial component of the Gen-AI capabilities within higher education institutes [69]. Critical aspects necessary for successful Gen-AI-student collaboration include "learner identity", "learner activeness", and "learner position" [56]. Effective collaboration with Gen-AI also requires a high level of AI literacy, prompt engineering, and critical thinking skills to navigate challenges like AI bias and misinformation [55]. Features like logical argumentation, explainability, and scientific rigour essential when utilising Gen-AI tools [54].

Role of Gen-AI in collaboration (n=5)

Some students view Gen-AI as a 'top student', providing tutor-like support, as noted by [53]. Meanwhile, its capabilities in offering feedback and supporting various dimensions of self-regulated learning – cognitive, metacognitive, and behavioural – lead others to see it as a learning partner [68; 70]. Additionally, Gen-AI serves as an 'agent-to-support' in experiential learning, enhancing the collaborative design of learning experiences between students and educators [71]. However, [64] emphasises that Gen-AI cannot replicate the nuanced role of educators in managing complex learning processes and interpersonal interactions.

Gen-AI as collaboration facilitator (n=13)

Gen-AI enhances learning by promoting a collaborative approach in education, stimulating communication and engagement among students [57; 61]. This is facilitated by Gen-AI's ability to mimic human-like interactions [44]. Additionally, it offers varied perspectives and insights, thereby fostering creativity and interdisciplinary connections in group activities [53]. AI-supported platforms such as intelligent tutoring systems and adaptive learning environments not only identify individual weaknesses but also customise group exercises to improve collective learning outcomes [59]. AI-driven systems are crucial in processing complex data streams in real-time, enhancing collaborative learning through more personalised and inclusive educational experiences [60; 69]. Gen-AI tools and applications like ChatGPT facilitate dynamic environments ideal for collaborative tasks such as decision-making and peer feedback [55; 71]. However, concerns remain regarding Gen-AI's impact on collaboration. For instance, there is a risk that Gen-AI could reduce the role of peer learning and direct human interactions [53; 70]. Additionally, there are concerns about students potentially misusing Gen-AI tools such as ChatGPT to generate content for group assignments, which could circumvent the intended collaborative learning process [72].

Alternative perspectives on Gen-AI and collaboration (n=2)

The research by [73] advocates for the use of non-AI bots, which are collaboratively programmed by educators to support specific educational functions without mimicking human intelligence. Additionally, a study by [12] measures 'cooperativity' – a component of computational thinking skills – and found that the use of ChatGPT significantly improved cooperativity scores. This suggests that while ChatGPT primarily aids individual problem-solving, it can also enhance collaborative skills by helping students effectively deconstruct and communicate programming challenges.

Codes not related to research questions directly

How Gen-AI is implemented (n=2)

The literature highlights two crucial considerations for implementing Gen-AI tools: students' learning needs and the overall context. [58] identify context factors such as the user's country, age, type of university, and recent academic

achievements. Concurrently, [73] emphasise the importance of community feedback, including that of students, in the deployment of Gen-AI tools like an Onboarding Bot that assesses student knowledge before courses, a Tutorial Bot that aids in tutorial preparation, a Grouping Bot that helps form student groups, and a Collaboration Bot that facilitates group discussions.

How Gen-AI performs in assignments (n=5)

ChatGPT generally performs well in generic tasks and subjects, yet struggles with more specific ones. [74] observed that ChatGPT's performance across various courses often matches that of students, but its use is hard to detect due to tools frequently misclassifying human-written responses as AI-generated, along with the ease of modifying AI-generated text to evade detection. Specifically, [70] noted that in business administration undergraduate courses, instructors rated ChatGPT's responses as high-quality, often equalling or surpassing the top student scores in clarity, coherence, and critical engagement, without any plagiarism issues. Conversely, [75] reported that while ChatGPT effectively identified concepts in general chemistry exam questions, it fell below the class average in problem-solving success. It performed better in questions requiring general knowledge compared to those demanding specific skills. [71] found that Gen-AI tools, particularly ChatGPT 3.5, aligned effectively with scholarly literature when addressing complex educational concepts, offering dynamic scenarios that personalised learning and linked to real-world applications. However, [76] highlighted that in medical radiation science, ChatGPT's performance in undergraduate course exams was generally below average, struggling significantly with specific subjects, although it fared better in foundation courses.

The incorporation of Gen-AI within higher education settings has demonstrated transformative outcomes, enhancing both pedagogical methods and student learning achievements. This systematic review compiles and analyses data from various studies, focusing on Gen-AI's impact in enriching educational experiences, particularly from the standpoint of university students. We explored Gen-AI's use in activities such as writing, coding, and problem-solving. The application of Gen-AI ranges from basic support, like grammar correction, to advanced cognitive functions, including algorithm development and the creation of original content. Findings highlight the multifaceted role of Gen-AI as both a facilitator and a transformative force in higher education, illustrating its ability to foster more personalised, engaging, and efficient learning environments.

The use of Gen-AI, as discussed by [19] and [20], often complements traditional learning methods by providing students with instant feedback and access to information, thereby supporting self-regulated learning and cognitive development. This integration of Gen-AI in educational settings aligns with findings from [12], who reported improved cooperativity skills among students, suggesting that Gen-AI can significantly enhance collaborative skills essential for the modern educational landscape. Despite the potential for Gen-AI to diminish peer-to-peer interaction, as noted by [53] and [70], the technology also

offers new avenues for collaboration. The ability of Gen-AI to simulate human-like interactions and provide diverse perspectives fosters an environment where collaborative tasks can thrive, enhancing the design of learning experiences and facilitating more effective group work. This is particularly relevant in settings where interdisciplinary approaches are valued, and where the synthesis of various information streams can enhance learning outcomes.

Conclusion. The variance in how AI is used among students – depending on their competence levels – highlights an essential consideration for educators: AI can potentially widen the gap between more and less competent learners. More competent students tend to use AI to augment their capabilities, whereas less competent learners may rely heavily on AI, risking inadequate engagement with learning materials. This observation calls for a pedagogical balance where AI supports learning without diminishing the educational rigour necessary for critical thinking and problem-solving skills. A significant concern arising from this review relates to the challenges AI poses to academic integrity and skill development. As AI tools become more capable, especially in generating sophisticated texts and solutions, educational institutions face the dual challenge of leveraging these tools for learning while ensuring they do not facilitate academic dishonesty or hinder skill acquisition. This issue is particularly pertinent in writing tasks, where the line between assistance and cheating can become blurred.

While this review provides a comprehensive overview of the current state of AI use in higher education, the fast-evolving nature of AI technologies means that continuous updates to this body of research are necessary. Additionally, the review is limited to articles from Q1 and Q2 journals, which may omit valuable insights from lower-tier publications or grey literature such as conference proceedings, pre-prints and similar. Future research may explore the longitudinal impacts of AI on student learning outcomes and skill development. Studies could investigate how different disciplines adapt AI tools to their specific needs and the long-term effects on students' academic and professional trajectories. Furthermore, qualitative studies focusing on students' perceptions and experiences with AI could provide deeper insights into the contextual factors influencing AI adoption in higher education.

References

[1] Zawacki-Richter O, Bai JYH, Lee K, Slagter van Tryon PJ, Prinsloo P. New advances in artificial intelligence applications in higher education? *International Journal of Educational Technology in Higher Education*. 2024;21:32. https://doi.org/10.1186/s41239-024-00464-3

[2] Bozkurt A, Sharma RC. Challenging the status quo and exploring the new boundaries in the age of algorithms: Reimagining the role of generative AI in distance education and online learning. *Asian Journal of Distance Education*. 2023;18(1):i–viii. https://doi.org/10.5281/zenodo.7755273

[3] Rudolph J, Tan Sh, Tan S. War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. The new AI gold rush and its impact on higher education. *Journal of Applied Learning and Teaching*. 2023;6(1). https://doi.org/10.37074/jalt.2023.6.1.23

[4] Huang G, Liang X. Generative AI research of education from 2013 to 2023. In: *Proceedings of the 6th International Conference on Computer Science and Technologies in Education, 19–21 April 2024, Xi'an, China*. IEEE Publ.; 2024. p. 125–130. https://doi.org/10.1109/CSTE62025.2024.00030

[5] Baidoo-anu D, Ansah LO. Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*. 2023;7(1):52–62. https://doi.org/10.61969/jai.1337500

[6] Dogru T, Line N, Hanks L, Acikgoz F, Abbott JA, Bakir S, et al. The implications of generative artificial intelligence in academic research and higher education in tourism and hospitality. *Tourism Economics*. 2024;30(5):1083–1094. https://doi.org/10.1177/13548166231204065

[7] Nikolopoulou K. Generative artificial intelligence in higher education: Exploring ways of harnessing pedagogical practices with the assistance of ChatGPT. *International Journal of Changes in Education*. 2024;1(2):103–111. https://doi.org/10.47852/bonviewIJCE42022489

[8] Crompton H, Burke D. Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*. 2023;20:22. https://doi.org/10.1186/s41239-023-00392-8

[9] Bantugan BS, Li X, Liu L, Liu Y, Wang X, Yang M, Zhang X. The adoption of artificial intelligence of selected international Chinese educators enrolled as graduate students in the College of Education of St. Paul University Manila. *International Journal of Research and Scientific Innovation*. 2024;11(2):133–146. https://doi.org/10.51244/IJRSI.2024.1102011

[10] Delcker J, Heil J, Ifenthaler D, Seufert S, Spirgi L. First-year students AI-competence as a predictor for intended and de facto use of AI-tools for supporting learning processes in higher education. *International Journal of Educational Technology in Higher Education*. 2024;21:18. https://doi.org/10.1186/s41239-024-00452-7

[11] Woo DJ, Susanto H, Yeung CH, Guo K, Fung AKY. Exploring AI-generated text in student writing: How does AI help? *ArXiv* [Preprint] 2023. https://arxiv.org/pdf/2304.02478 (accessed: 05.12.2024)

[12] Yilmaz R, Yilmaz FGK. The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. *Computers and Education: Artificial Intelligence*. 2023;4:100147. https://doi.org/10.1016/j.caeai.2023.100147

[13] Daher W, Diab H, Rayan A. Artificial intelligence generative tools and conceptual knowledge in problem solving in chemistry. *Information*. 2023;14(7):409. https://doi.org/10.3390/info14070409

[14] Chen X, Zou D, Xie H, Cheng G, Liu C. Two decades of artificial intelligence in education: contributors, collaborations, research topics, challenges, and future directions. *Educational Technology & Society*. 2022;25(1):28–47. https://www.jstor.org/stable/10.2307/48647028

[15] Deng X, Yu Z. A meta-analysis and systematic review of the effect of chatbot technology use in sustainable education. *Sustainability*. 2023;15(4):2940. https://doi.org/10.3390/su15042940

[16] Bond M, Khosravi H, De Laat M, Bergdahl N, Negrea V, Oxley E, et al. A meta systematic review of artificial intelligence in higher education: a call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*. 2024;21:4. https://doi.org/10.1186/s41239-023-00436-z

[17] Ippolito D, Yuan A, Coenen A, Burnam S. Creative writing with an AI-powered writing assistant: Perspectives from professional writers. *ArXiv* [Preprint] 2022. https://arxiv.org/pdf/2211.05030 (accessed: 19.09.2024)

[18] Malinka K, Peresíni M, Firc A, Hujnák O, Janus F. On the educational impact of ChatGPT: Is artificial intelligence ready to obtain a university degree? In: *Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education, 7–12 July 2023, Turku, Finland*. Vol. 1. New York: Association for Computing Machinery; 2023. p. 47–53. https://doi.org/10.1145/3587102.3588827

[19] Nguyen A, Hong Y, Dang B, Huang X. Human-AI collaboration patterns in AI-assisted academic writing. *Studies in Higher Education*. 2024;49(5):847–864. https://doi.org/10.1080/03075079.2024.2323593

[20] Liu J, Li S. Toward artificial intelligence-human paired programming: A review of the educational applications and research on artificial intelligence code-generation tools. *Journal of Educational Computing Research*. 2024;62(5). https://doi.org/10.1177/07356331241240460

[21] Barrett A, Pack A. Not quite eye to A.I.: student and teacher perspectives on the use of generative artificial intelligence in the writing process. *International Journal of Educational Technology in Higher Education*. 2023;20:59. https://doi.org/10.1186/s41239-023-00427-0

[22] Li Z, Wang C, Bonk C. Exploring the utility of ChatGPT for self-directed online language learning. *Online Learning*. 2024;28(3):157–180. https://doi.org/10.24059/olj.v28i3.4497

[23] Wang C, Li Z, Bonk C. Understanding self-directed learning in AI-assisted writing: A mixed methods study of postsecondary learners. *Computers and Education: Artificial Intelligence*. 2024;6:100247. https://doi.org/10.1016/j.caeai.2024.100247

[24] Belda-Medina J, Kokošková V. Integrating chatbots in education: Insights from the Chatbot-Human Interaction Satisfaction Model (CHISM). *International Journal of Educational Technology in Higher Education*. 2023;20:62. https://doi.org/10.1186/s41239-023-00432-3

[25] Zawacki-Richter O, Marín VI, Bond M, Gouverneur F. Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*. 2019;16:39. https://doi.org/10.1186/s41239-019-0171-0

[26] Chen X, Zou D, Xie H, Cheng G, Liu C. Two decades of artificial intelligence in education. *Educational Technology & Society*. 2022;25(1):28–47. https://www.jstor.org/stable/10.2307/48647028

[27] Zhai X, Chu X, Chai ChS, Jong MSY, Istenic A, Spector M et al. A Review of artificial intelligence (AI) in education from 2010 to 2020. *Complexity*. 2021;1. https://doi.org/10.1155/2021/8812542

[28] Zawacki-Richter O, Naidu S. Mapping research trends from 35 years of publications in *Distance Education*. *Distance Education*. 2016;37(3):245–269. https://doi.org/10.1080/01587919.2016.1185079

[29] Bozkurt A, Zawacki-Richter O. Trends and patterns in distance education (2014–2019): A synthesis of scholarly publications and a visualisation of the intellectual landscape. *The International Review of Research in Open and Distributed Learning*. 2021;22(2):19–45. https://doi.org/10.19173/irrodl.v22i2.5381

[30] Bearman M, Ryan J, Ajjawi R. Discourses of artificial intelligence in higher education: A critical literature review. *Higher Education*. 2023;86:369–385. https://doi.org/10.1007/s10734-022-00937-2

[31] Bizami NA, Tasir Z, Na Kew SN. Innovative pedagogical principles and technological tools capabilities for immersive blended learning: A systematic literature review.

Education and Information Technologies. 2023;28:1373–1425. https://doi.org/10.1007/s10639-022-11243-w

[32] Koh JHL, Daniel BK. Shifting online during COVID-19: A systematic review of teaching and learning strategies and their outcomes. *International Journal of Educational Technology in Higher Education*. 2022;19:56. https://doi.org/10.1186/s41239-022-00361-7

[33] Bond M, Buntins K, Bedenlier S, Zawacki-Richter O, Kerres M. Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*. 2020;17:2. https://doi.org/10.1186/s41239-019-0176-8

[34] Gough D, Oliver S, Thomas J. *An introduction to systematic reviews*. 2nd ed. London: Sage Publ.; 2017.

[35] Daniel BK, Harland T. *Higher education research methodology: A step-by-step guide to the research process*. London: Routledge; 2017.

[36] Grant MJ, Booth A. A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*. 2009;26(2):91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x

[37] Krippendorff K. *Content analysis: An introduction to its methodology*. Thousand Oaks, California: Sage Publ.; 2018.

[38] Weber RPh. *Basic content analysis*. 2nd ed. Newbury Park, California: Sage Publ.; 1990.

[39] Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77–101. https://doi.org/10.1191/1478088706qp063oa

[40] Nowell LS, Norris JM, White DE, Moules NJ. Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*. 2017;16. https://doi.org/10.1177/1609406917733847

[41] Thurmond VA. The point of triangulation. *Journal of Nursing Scholarship*. 2001;33(3):253–258. https://doi.org/10.1111/j.1547-5069.2001.00253.x

[42] Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. Amstar 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*. 2017;358:j4008. https://doi.org/10.1136/bmj.j4008

[43] Popay J, Roberts H, Sowden A, Petticrew M, Arai L, Rodgers M, et al. *Guidance on the conduct of narrative synthesis in systematic reviews: A product of the ESRC methods programme. Version 1*. Lancaster University; 2006. https://doi.org/10.13140/2.1.1018.4643

[44] Alhumaid K, Naqbi S, Elsori D, Mansoori M. The adoption of artificial intelligence applications in education. *International Journal of Data and Network Science*. 2023;7:457–466. https://doi.org/10.5267/j.ijdns.2022.8.013

[45] Hasanein AM, Sobaih AEE. Drivers and consequences of ChatGPT use in higher education: Key stakeholder perspectives. *European Journal of Investigation in Health, Psychology and Education*. 2023;13(11):2599–2614. https://doi.org/10.3390/ejihpe13110181

[46] Bilquise G, Ibrahim S, Salhieh SM. Investigating student acceptance of an academic advising chatbot in higher education institutions. *Education and Information Technologies*. 2024;29:6357–6382. https://doi.org/10.1007/s10639-023-12076-x

[47] Wang F, King RB, Chai ChS, Zhou Y. University students' intentions to learn artificial intelligence: the roles of supportive environments and expectancy–value beliefs. *International Journal of Educational Technology in Higher Education*. 2023;20:51. https://doi.org/10.1186/s41239-023-00417-2

[48] Habibi A, Muhaimin M, Danibao BK, Wibowo YG, Wahyuni S, Octavia A. ChatGPT in higher education learning: Acceptance and use. *Computers and Education: Artificial Intelligence*. 2023;5:100190. https://doi.org/10.1016/j.caeai.2023.100190

[49] Strzelecki A. Students' acceptance of ChatGPT in higher education: An extended unified theory of acceptance and use of technology. *Innovative Higher Education*. 2024;49:223–245. https://doi.org/10.1007/s10755-023-09686-1

[50] Raffaghelli JE, Rodríguez ME, Guerrero-Roldán A-E, Bañeres D. Applying the UTAUT model to explain the students' acceptance of an early warning system in Higher Education. *Computers & Education*. 2022;182:104468. https://doi.org/10.1016/j.compedu.2022.104468

[51] Dakakni D, Safa N. Artificial intelligence in the L2 classroom: Implications and challenges on ethics and equity in higher education: A 21st century Pandora's box. *Computers and Education: Artificial Intelligence*. 2023;5:100179. https://doi.org/10.1016/j.caeai.2023.100179

[52] Grájeda A, Burgos J, Córdova P, Sanjinés A. Assessing student-perceived impact of using artificial intelligence tools: Construction of a synthetic index of application in higher education. *Cogent Education*. 2024;11(1):2287917. https://doi.org/10.1080/2331186X.2023.2287917

[53] Chan CKY, Hu W. Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*. 2023;20:43. https://doi.org/10.1186/s41239-023-00411-8

[54] Von Garrel J, Mayer J. Artificial Intelligence in studies – use of ChatGPT and AI-based tools among students in Germany. *Humanities & Social Sciences Communications*. 2023;10:799. https://doi.org/10.1057/s41599-023-02304-7

[55] Walter Y. Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*. 2024;21:15. https://doi.org/10.1186/s41239-024-00448-3

[56] Kelly A, Sullivan M, Strampel K. Generative artificial intelligence: University student awareness, experience, and confidence in use across disciplines. *Journal of University Teaching and Learning Practice*. 2023;20(6). https://doi.org/10.53761/1.20.6.12

[57] Abbas N, Whitfield J, Atwell E, Bowman H, Pickard T, Walker A. Online chat and chatbots to enhance mature student engagement in higher education. *International Journal of Lifelong Education*. 2022;41(3):308–326. https://doi.org/10.1080/02601370.2022.2066213

[58] Abdaljaleel M, Barakat M, Alsanafi M, Salim NA, Abazid H, Malaeb D, et al. A multinational study on the factors influencing university students' attitudes and usage of ChatGPT. *Scientific Reports*. 2024;14:1983. https://doi.org/10.1038/s41598-024-52549-8

[59] İçen M. The future of education utilizing artificial intelligence in Turkey. *Humanities and Social Sciences Communications*. 2022;9:268. https://doi.org/10.1057/s41599-022-01284-4

[60] Tapalova O, Zhiyenbayeva N. Artificial intelligence in education: AIEd for personalised learning pathways. *Electronic Journal of e-Learning*. 2022;20(5):639–653. https://doi.org/10.34190/ejel.20.5.2597

[61] Limna P, Kraiwanit T, Jangjarat K, Klayklung P, Chocksathaporn P. The use of ChatGPT in the digital era: Perspectives on chatbot implementation. *Journal of Applied Learning and Teaching*. 2023;6(1):64–74. https://doi.org/10.37074/jalt.2023.6.1.32

[62] Essel HB, Vlachopoulos D, Tachie-Menson A, Johnson EE, Baah PK. The impact of a virtual teaching assistant (chatbot) on students' learning in Ghanaian higher education. *International Journal of Educational Technology in Higher Education*. 2022;19:57. https://doi.org/10.1186/s41239-022-00362-6

[63] Tossell CC, Tenhundfeld NL, Momen A, Cooley K, de Visser EJ. Student perceptions of ChatGPT use in a college essay assignment: Implications for learning, grading, and trust in artificial intelligence. *IEEE Transactions on Learning Technologies*. 2024;17:1069–1081. https://doi.org/10.1109/TLT.2024.3355015

[64] Boubker O. From chatting to self-educating: Can AI tools boost student learning outcomes? *Expert Systems with Applications*. 2024;238(A):121820. https://doi.org/10.1016/j.eswa.2023.121820

[65] Al-Abdullatif AM, Al-Dokhny AA, Drwish AM. Implementing the Bashayer chatbot in Saudi higher education: measuring the influence on students' motivation and learning strategies. *Frontiers in Psychology*. 2023;14:1129070. https://doi.org/10.3389/fpsyg.2023.1129070

[66] Jaboob M, Hazaimeh M, Al-Ansi AM. Integration of generative AI techniques and applications in student behavior and cognitive achievement in Arab higher education. *International Journal of Human–Computer Interaction*. 2024;41(1):353–366. https://doi.org/10.1080/10447318.2023.2300016

[67] González LA, Neyem A, Contreras-McKay I, Molina D. Improving learning experiences in software engineering capstone courses using artificial intelligence virtual assistants. *Computer Applications in Engineering Education*. 2022;30(5):1370–1389. https://doi.org/10.1002/cae.22526

[68] Jin S-H, Im K, Yoo M, Roll I, Seo K. Supporting students' self-regulated learning in online learning using artificial intelligence applications. *International Journal of Educational Technology in Higher Education*. 2023;20:37. https://doi.org/10.1186/s41239-023-00406-5

[69] Wang S, Sun Z, Chen Y. Effects of higher education institutes' artificial intelligence capability on students' self-efficacy, creativity and learning performance. *Education and Information Technologies*. 2023;28:4919–4939. https://doi.org/10.1007/s10639-022-11338-4

[70] Chaudhry IS, Sarwary SAM, El Refae GA, Chabchoub H. Time to revisit existing student's performance evaluation approach in higher education sector in a new era of ChatGPT – A case study. *Cogent Education*. 2023;10(1):2210461. https://doi.org/10.1080/2331186X.2023.2210461

[71] Salinas-Navarro DE, Vilalta-Perdomo E, Michel-Villarreal R, Montesinos L. Using generative artificial intelligence tools to explain and enhance experiential learning for authentic assessment. *Education Sciences*. 2024;14(1):83. https://doi.org/10.3390/educsci14010083

[72] Michel-Villarreal R, Vilalta-Perdomo E, Salinas-Navarro DE, Thierry-Aguilera R, Gerardou FS. Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*. 2023;13(9):856. https://doi.org/10.3390/educsci13090856

[73] Breines MR, Gallagher M. A return to Teacherbot: rethinking the development of educational technology at the University of Edinburgh. *Teaching in Higher Education*. 2023;28(3):517–531. https://doi.org/10.1080/13562517.2020.1825373

[74] Ibrahim H, Liu F, Asim R, Battu B, Benabderrahmane S, Alhafni B, et al. Perception, performance, and detectability of conversational artificial intelligence across 32 university courses. *Scientific Reports*. 2023;13:12187. https://doi.org/10.1038/s41598-023-38964-3

[75] Clark TM. Investigating the use of an artificial intelligence chatbot with general chemistry exam questions. *Journal of Chemical Education*. 2023;100(5):1905–1916. https://doi.org/10.1021/acs.jchemed.3c00027

[76] Currie G, Singh C, Nelson T, Nabasenja C, Al-Hayek Y, Spuur K. ChatGPT in medical imaging higher education. *Radiography*. 2023;29(4):792–799. https://doi.org/10.1016/j.radi.2023.05.011

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