Impact of generative artificial intelligence on critical thinking in higher education: A systematic review of empirical studies (2021-2026)

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Abstract: This study analyses the impact of Generative Artificial Intelligence (GAI) on critical thinking in higher education through a bibliometric and systematic review of 12 empirical studies published between 2021 and 2026. Following PRISMA 2020 guidelines. The findings reveal an ambivalent impact: while GAI can support analysis, evaluation, and inference when integrated into active methodologies with student self-regulation, its uncritical use risks promoting superficial learning. Algorithmic literacy and process-centered task design are identified as essential variables for positive cognitive outcomes. Additionally, the research notes current limitations in the field, including a scarcity of longitudinal studies and the heterogeneity of assessment instruments. In conclusion, the study advocates for the development of educational models that integrate GAI through critical and ethical perspectives to foster autonomous thinking in university students.

Keyword: Generative Artificial Intelligence (GAI)

Introduction

Generative artificial intelligence (GAI) emerged abruptly in contemporary society, especially since the appearance of models such as ChatGPT in 2022, particularly within higher education (Selwyn, 2022). These technologies, based on large-scale language models, have transformed the ways in which information is produced and accessed, as well as cognitive and pedagogical processes in higher education.

This phenomenon presents an ambiguous scenario. On one hand, GAI promises to improve learning efficiency, facilitate personalized education and expand access to knowledge (Salazar et al., 2024). On the other, its rapid integration into the academic sphere generates uncertainty regarding its impact on fundamental competences such as critical thinking, and it is essential to examine these concerns in order to distinguish between real risks and unfounded perceptions (García-Peña et al., 2020). This concern is intensified in a context characterized by information overload, the proliferation of automatically generated content and a still limited level of algorithmic literacy among students (UNESCO, 2023).

Critical thinking is also regarded as one of the key competences in higher education, as it is essential for making informed decisions, solving complex problems and constructing knowledge autonomously. From a classical perspective, Facione (1990) defines it as a reflective, self-regulated and purposeful process of judgement that enables a person to decide, in a reasoned manner, what to believe or do. Along similar lines, critical thinking is understood as a rational and independent process that allows an individual to determine their own beliefs or actions (De-Juanas, 2013). These conceptualizations align with the higher levels of Bloom's revised taxonomy, which are regarded as fundamental for in-depth learning in university contexts (Anderson & Krathwohl, 2001; Standish & Thoilliez, 2018). This situation calls for a restructuring of the educational

model that prioritizes the development of critical thinking and assigns new meaning to the purpose of learning (Ribera et al., 2024).

Within higher education, the relationship between GAI and critical thinking may be understood as a complex pedagogical dialectic. The implementation of GAI-based resources therefore has the potential to enrich critical thinking by creating interactive educational environments that motivate students to engage directly in their own learning (Baidoo-Anu & Owusu Anash, 2023). In such cases, tools such as generative models can enhance flexibility and adaptability in the university classroom (Garcés & Bastías, 2024; Yusuf et al., 2024). On the other hand, the immediate availability of information generated through GAI risks discouraging students' ability to develop their own conclusions (Eke, 2023). Accordingly, the real challenge for contemporary higher education is to incorporate GAI through an ethical and conscious praxis, ensuring that technological progress strengthens academic integrity rather than compromising it (González & Medina, 2023). According to Muñoz Martínez et al. (2025), the determining factor in the development of analytical thinking lies not in the technological tool itself, but in the educational strategy built around it. In this regard, Juárez-Cádiz (2026) argues that the integration of generative AI should not be limited to the automation of tasks but should evolve towards an Edu-communicative approach that promotes critical thinking through active supervision of the algorithm.

Consequently, it is essential to analyze rigorously the impact of the pedagogical integration of GAI on critical thinking among university students. To this end, the present study is based on a systematic literature review, carried out through an exhaustive search of the high-impact databases Scopus and Web of Science (WoS), in order to examine recent empirical evidence and contribute to a deeper understanding of how these emerging technologies are redefining teaching and learning processes and the development of critical thinking in higher education.

Objectives

On this basis, the study is structured around the following research question: How does the pedagogical integration of generative artificial intelligence tools influence the development of critical thinking among university students?

More specifically, the study pursues the following objectives:

- O1. Identify the main generative AI tools and the pedagogical approaches used for their integration into higher education.
- O2. Analyze the methodological approaches and forms of critical thinking assessment used in the empirical studies reviewed.
- O3. Examine the available empirical evidence on the influence of generative artificial intelligence on the development of critical thinking among university students.
- O4. Explore differences in results according to the disciplinary context and methodological design of the studies analyzed.
- O5. Identify and synthesize the most effective pedagogical practices for integrating generative artificial intelligence into the development of critical thinking.

Materials and methods

The present study was conducted through a systematic literature review designed to analyze current scientific production under a rigorous, transparent and replicable

protocol. The study follows the guidelines of the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021), thereby ensuring the quality of the process of document identification and selection (see Figure 1).

To ensure the robustness of the analysis, the five methodological stages proposed by Velt et al. (2020) were followed: (1) definition of strategic objectives and research questions; (2) bibliographic prospecting in high-impact databases; (3) rigorous selection according to validity and quality criteria; (4) comparison and triangulation of sources; and (5) statistical-technological analysis for the synthesis of results and the detection of trends.

Scope and inclusion and exclusion criteria

To delimit the documentary corpus and ensure the relevance of the evidence, eligibility criteria were established on the basis of timeliness and methodological quality. The inclusion criteria (IC) were as follows: (1) studies published in the period 2021–2026, capturing the emergence of generative AI; (2) texts written in English or Spanish; (3) open-access articles, to guarantee knowledge transfer; (4) re-search focused on higher education and the active role of students; and (5) studies based on an empirical methodology.

The exclusion criteria (EC) applied were as follows: (1) documents whose main focus was not the development of critical thinking mediated by GAI; (2) duplicate records across databases; (3) theoretical review articles, state-of-the-art papers or pedagogical proposals without implementation; (4) languages other than those selected; and (5) studies falling outside the established time frame.

Information sources and search strategies

The identification phase was carried out in March 2026, selecting the Web of Science (WoS) and Scopus databases because of their leading position in the indexing of high-impact journals in the fields of Social Sciences and Educational Technology. An advanced search algorithm was designed using English descriptors and Boolean operators to optimize the sensitivity and specificity of retrieval:

Table 1.
Search phrase.

Database	Search phrase
WoS (Search date: March 2026) Scopus (Search date: March 2026)	(“Generative AI” OR “GenAI” OR “Artificial Intelligence” OR “ChatGPT”) AND (“Higher Education” OR “University” OR “College” OR “Undergraduate” OR “Postgraduate”) AND (“Student” OR “Learner” OR “Participant”AND (“Cognition” OR “Cognitive” OR “Critical Thinking” OR “Higher-Order Thinking” OR “Metacognition” OR “Memory” OR “Learning Development” OR “Knowledge Retention”) AND (study OR empirical OR “quasi-experimental” OR “experimental” OR “randomized controlled trial”).

The search was restricted to the subject area of “Education” or “Social Sciences”. Following the implementation of the strategy, a total of 108 documents were identified (8 in Scopus and 100 in Web of Science). Subsequently, the screening phase was carried out through the reading of titles and abstracts in order to exclude false positives and ensure that the final sample met the scientific rigor required for this bibliometric and systematic analysis.

Procedure for selection and data extraction

The construction of the final documentary corpus was governed by an exhaustive selection protocol, structured in sequential flow phases in accordance with the guidelines of the PRISMA 2020 statement (Page et al., 2021). This procedure ensures the traceability of the sample and minimizes the risk of publication bias, thereby safeguarding the internal validity of the study through the following stages:

Identification phase

After the search algorithm had been applied in the reference databases (Web of Science and Scopus), an initial total of 108 potentially relevant records was obtained. At this stage, the bibliographic metadata were exported to the Zotero reference management software (v.6.0) to carry out a technical cleaning of the records. Duplicate-detection algorithms were applied to ensure that the subsequent analysis operated on a single, standardized database, thereby avoiding the overrepresentation of evidence indexed simultaneously in both repositories. This stage is critical for ensuring the statistical integrity of subsequent bibliometric indicators.

Screening phase

The resulting records underwent a rigorous screening process based on thematic relevance and scientific rigor. In the first instance, the research team conducted a blind analytical reading of titles and abstracts. The primary objective was to verify the alignment of the studies with the object of analysis: the functional intersection between generative AI and the development of higher-order cognitive processes (critical thinking) among university students.

During this stage, so-called false positives were excluded. These were articles that, despite including the selected descriptors, addressed artificial intelligence from purely technical, infrastructural or administrative perspectives unrelated to the psych-pedagogical context of higher education. This manual filter enabled the sample to be refined towards documents with a qualified empirical basis and an explicit educational application.

Selection phase

At the final stage of the protocol, the preselected articles were retrieved in full text for diagnostic evaluation against the inclusion and exclusion criteria (see Section 3.1). To ensure the highest standards of inter-rater reliability, the review was conducted independently by the researchers. In cases of disagreement regarding the eligibility of a document, the consensus method was used, involving the triangulation of criteria and renewed consultation of the original research protocol.

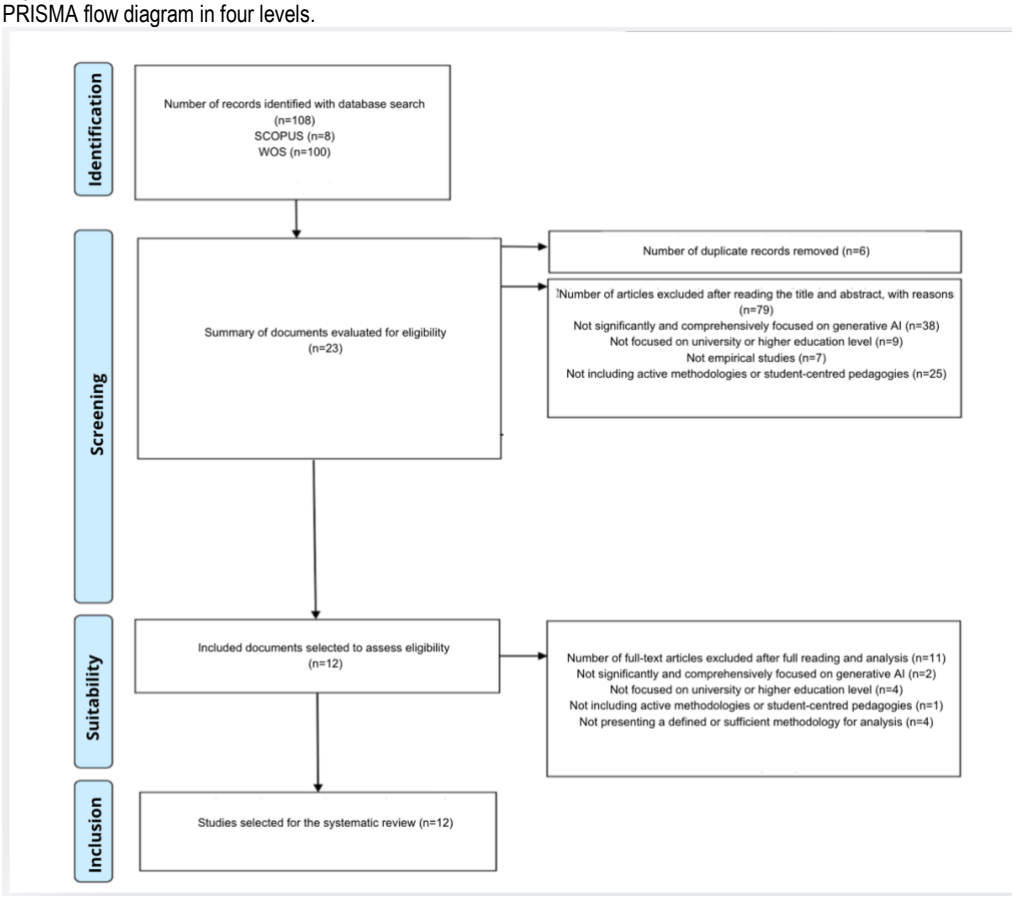
Finally, the definitive sample consisted of 12 highly relevant articles, which were subjected to a data-extraction process using a systematized synthesis matrix. In this analytical instrument, the following dimensions were coded and tabulated for subsequent qualitative-quantitative analysis:

- Production identifiers: Authorship, year of publication, institutional affiliation, and geographical distribution.
- Methodological design: Research approach (qualitative, quantitative or mixed), sample size and data collection tools used.

- GAI variables: Specific language models (LLMs) and pedagogical interaction modalities implemented.
- Cognitive constructs: Reported impact on the dimensions of critical thinking (analysis, evaluation, inference) and other executive functions.

This rigorous methodological procedure ensures that the analysis of the results is not merely a biblio-graphic description, but rather a critical and holistic synthesis of the most robust scientific evidence produced globally over the last five years on artificial intelligence in higher education.

Figure 1.
PRISMA flow diagram in four levels.



Results

The findings derived from the bibliometric analysis and systematic review of the selected corpus are presented below. The results have been structured to provide a holistic overview, ranging from the quantitative evolution of scientific output to the qualitative analysis of the evidence on generative AI and critical thinking.

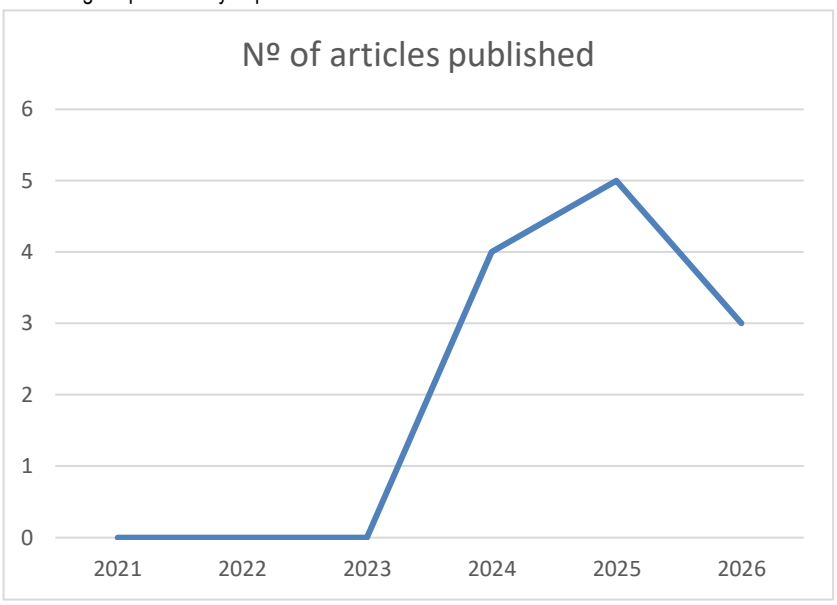
Chronological productivity

Scientific output on the impact of GAI on critical thinking in higher education shows a clearly recent pattern, concentrated in the last three years. Between 2021 and 2023, no empirical publications meeting the inclusion criteria were identified, reflecting the absence of systematic evidence in the early years of GAI's emergence in higher education. From 2024 onwards, a turning point can be observed, with the appearance of four studies, followed by a peak of five articles in 2025 and a slight decline to four studies

in 2026, while nevertheless maintaining a level clearly above that of the initial years of the period analyzed (see Figure 2).

This temporal pattern confirms that this is an emerging line of research, closely linked to the democratization of generative models such as ChatGPT since the end of 2022 and their rapid incorporation into university classrooms. The concentration of studies between 2024 and 2026 indicates, on one hand, a swift response by the academic community to technological disruption and, on the other, that the field remains at an early stage of empirical consolidation, in which studies are beginning to explore the effect of GAI on specific dimensions of critical thinking more rigorously.

Figure 2.
Chronological productivity of publications.



Geographical distribution

The geographical distribution of the 12 articles analyzed reveals an international pattern that extends beyond the traditional centers of research in educational technology, although a clear predominance of Anglophone and European contexts remains. In terms of the country of publication of the journals, the United Kingdom and Switzerland account for most of the output (5 articles each), followed by the United States (1 article) and Malaysia (1 article), revealing a clearly defined axis between Western Europe and the Anglophone world. This distribution reinforces the idea that the debate on GAI and critical thinking is being articulated primarily within university systems with a strong tradition of pedagogical research and technological innovation (see Figure 3).

At the same time, the presence of a journal based in Malaysia (Arab World English Journal) and the diversity of the institutional contexts represented in the included studies point to a gradual expansion of this line of research into Southeast Asia and other non-Western settings. The combination of publishing countries such as Switzerland, the United Kingdom, the United States and Malaysia suggests that concern about the cognitive impact of GAI constitutes a cross-cutting issue affecting university systems with different academic cultures and levels of technological development, but which share the need to rethink the place of critical thinking in GAI-mediated teaching and learning processes. This geographical diversity adds contextual richness to the review and strengthens the external validity of the conclusions.

Figure 3.
Productivity by geographical location of publications.

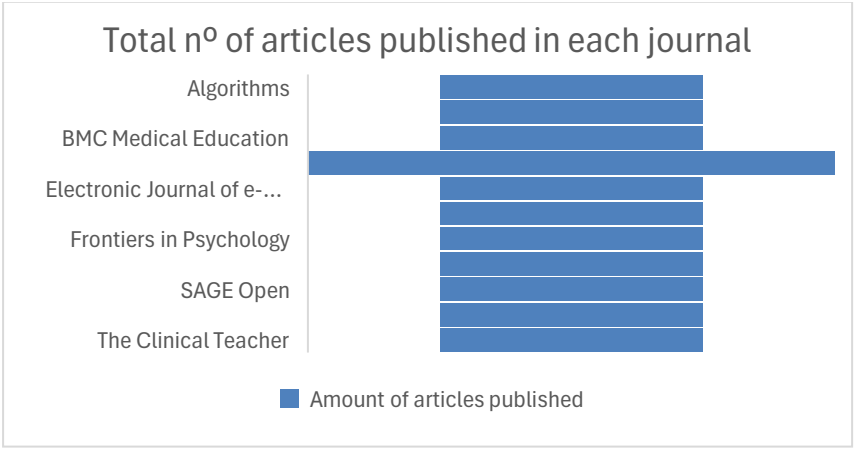


Articles published by journal

From the perspective of journal dispersion, the corpus analyzed consists of 12 articles distributed across 11 scientific journals, most of them indexed in the top quartiles of JCR and/or SJR in the fields of Education, Psychology and Social Sciences. In terms of frequency, there is a slight concentration in Education Sciences (2 articles), a Swiss open-access journal specializing in educational research. The remaining studies are distributed individually across Algorithms (1), Arab World English Journal (1), BMC Medical Education (1), Electronic Journal of e-Learning (1), Frontiers in Education (1), Frontiers in Psychology (1), Journal of Computer Assisted Learning (1), SAGE Open (1), Social Sciences & Humanities Open (1) and The Clinical Teacher (1) (see Figure 4).

This structure partially accords with Bradford's Law, identifying a small core consisting of a single journal that contains more than one article (Education Sciences), complemented by a number of specialised publications that contribute evidence from specific fields such as medical education, language teaching and educational technology. The fact that most of the studies were published in high-impact journals clearly focused on education and the social sciences suggests that the discussion on GAI and critical thinking is being shaped primarily from a pedagogical and psychoeducational perspective, rather than from purely technical or computational approaches. This concentration in established academic forums reinforces the methodological robustness of the corpus and lends international relevance to the findings of the present review.

Figure 4.
Journals included in the review.



Systematic analysis

This section examines the content of the 12 selected articles in greater depth (see Table 2).

Table 2.
Summary of the documentary corpus: Relationship between Generative AI and Critical Thinking.

Authors	Article title	Main findings and conclusions
Waluyo, B., & Kusumastuti, S. (2024)	Generative AI in student English learning in Thai higher education: More engagement, better outcomes?	The effectiveness of GAI requires a shift from passive consumption to active supervision. Critical thinking functions as an indispensable filter for ensuring integrity and in-depth learning.
Eltahir, M. E., & Babiker, F. M. E. (2024)	The influence of artificial intelligence tools on student performance in e-learning environments: Case study	Personalised AI outperforms traditional teaching in terms of retention. It functions as an adaptive mechanism that enhances active engagement and cognitive development in higher education.
Jai Lamimi, I., El Jemli, S., & Zeryouh, I. (2025)	Enhancing critical thinking: Exploring human-AI synergy in student cognitive development	The study proposes human-AI synergy as a cognitive catalyst. Delegating routine tasks allows students to focus on higher-complexity evaluation and synthesis under teacher guidance.
Zheng, K., Shen, Z., Chen, Z., Che, C., & Zhu, H. (2024)	Application of AI-empowered scenario-based simulation teaching mode in cardiovascular disease education	AI-based simulations recreate high-fidelity scenarios that require medical students to exercise critical thinking under pressure, thereby narrowing the gap between theory and practice.
Avilés Mariño, E., & Sarasa Cabezuelo, A. (2025)	AI-enhanced PBL and experiential learning for communication and career readiness: An engineering pilot course	The study integrates problem-based learning (PBL) with AI, fostering practical critical thinking focused on the validation and evaluation of algorithmic solutions in engineering.
Teng, D., Zhou, X., Al-Samarraie, H., & Fang, L. (2026)	Enhancing critical thinking and self-efficacy with GenAI: A social cognitive perspective using structural equation modelling	GenAI interactivity enhances self-efficacy. It transforms passive learning into an active evaluative process, strengthening students' confidence and analytical capacity.
Zhou, X., Teng, D., & Al-Samarraie, H. (2024)	The mediating role of generative AI self-regulation on students' critical thinking and problem-solving	The successful use of AI depends on students' self-regulation. Strategic use and critical supervision are necessary to transform the tool into a cognitive enhancer.
Zhang, W., & Liu, X. (2025)	Artificial intelligence-generated content empowers college students' critical thinking skills: What, how, and why	AI-generated content (AIGC) functions as a driver of curiosity. It compels students to adopt a sceptical and analytical stance through the active verification of information.
Fakour, H., & Imani, M. (2025)	Socratic wisdom in the age of AI: A comparative study of ChatGPT and human tutors in enhancing critical thinking skills	Through Socratic questioning, AI matches the effectiveness of human tutors by challenging preconceived ideas and strengthening the logical dimensions of reasoning, and thereby critical thinking.
Liu, C., Zhu, K., Zhang, Z., & Ding, Y. (2025)	The impact of Chinese undergraduates' perceived acceptance of AI technology on academic achievement: The mediating role of critical thinking	Critical thinking is the key mediator that transforms technological acceptance into academic success, enhancing core intellectual capacities through the use of AI.
Hao, H., Razali, A. B., & Zuo, R. (2026)	Exploring the impact of integrated AWE and generative AI feedback on Chinese EFL undergraduates' higher-order thinking in argumentative writing	AI functions as a superior cognitive scaffold compared with traditional methods, improving not only grammar but also students' critical self-evaluation of their own writing, and therefore of their thesis development.
Taylor, A. W. R., Patel, F. Y., Smyth, E. K., Gay, S., & Bird, T. (2026)	AI in the classroom: Observing preclinical students' use of ChatGPT during case-based learning at a UK medical school	Excessive use of GAI can automate learning and reduce students' critical thinking. It is essential to design tasks that reward the reflective process rather than the immediacy of the result.

Discussion

The empirical evidence reviewed shows that GAI exerts an ambivalent and conditional impact on critical thinking in higher education: it can activate and deepen critical thinking when integrated through pedagogical designs that require analysis, comparison and self-regulation, but it may also encourage the uncritical delegation of reasoning when used instrumentally and oriented solely towards the final product (Waluyo & Kusumastuti, 2024; Taylor et al., 2026).

Articulation with the theoretical framework of critical thinking

The 12 empirical studies analyzed are consistent with the conception of critical thinking as a reflective, intentional and self-regulated process of judgement set out in the theoretical framework (Facione, 1990; De-Juanas, 2013), as well as with the higher levels of Bloom's revised taxonomy (analyze, evaluate, create) (Anderson & Krathwohl, 2001). In general, the studies do not present GAI as a substitute for such operations, but rather as an environment that shifts students' cognitive focus towards the evaluation, synthesis and decision-making involved in algorithmically generated content, provided that the activity design requires it (Hao, Razali, & Zuo, 2024; Zheng et al., 2024; Fakour & Imani, 2025).

This dynamic is particularly evident in studies that use GAI in argumentative writing and simulated scenarios. Hao et al. (2024) show that the combination of Automated Writing Evaluation (AWE) tools with GAI-generated feedback encourages students to review the coherence of their thesis, the strength of their arguments and the logical organization of their texts, which aligns with Bloom's levels of analysis and evaluation. Convergently, Zheng et al. (2024) show that GAI-based simulations in cardiovascular education require students to integrate conceptual knowledge, clinical data and decision-making under pressure, operating at the levels of application, analysis and inference, which are central elements in the definitions of critical thinking presented in the introduction.

Dialectic between enhancement and the risk of superficiality

At the same time, the empirical results confirm the dialectic outlined in the theoretical framework regarding the tension between the enriching potential of GAI and the risks of cognitive superficiality. Waluyo and Kusumastuti (2024) show that, in the context of English learning in Thai higher education, GAI increases engagement and improves outcomes when oriented towards active supervision and the critical revision of AI-generated proposals, but they also warn that the same environment can deteriorate into passive consumption if students simply accept generated responses without questioning them. Similarly, Taylor et al. (2026), in a case-based learning environment at a UK medical school, found that intensive use of ChatGPT facilitates rapid access to diagnoses and plans, but reduces clinical effort and differential reasoning when tasks do not explicitly reward reflective processes.

This ambivalence is consistent with the concerns about information overload and low levels of algorithmic literacy noted in the theoretical framework (UNESCO, 2023; García-Peña et al., 2020). The studies suggest that the immediate availability of AI-generated content may reinforce habits of externalizing thought and delegating interpretation when it is not accompanied by an educommunicative approach that makes explicit the biases, limitations and quality criteria of generated outputs (Zhang & Liu, 2025). In terms of competences, this implies that GAI may both facilitate access to more complex tasks and consolidate a superficial mode of use oriented towards "solving" without understanding, which stands at the opposite end of the spectrum from the deep learning

and autonomous construction of knowledge advocated in the theoretical framework (Ribera et al., 2024).

Pedagogical strategies and the role of self-regulation

The results strongly support the idea, already anticipated in the introduction, that the determining factor is not the tool itself, but the educational strategy and the student's self-regulation (Muñoz Martínez et al., 2025; Juárez-Cádiz, 2026). Avilés Mariño and Sarasa Cabezuelo (2025) show that, in a pilot engineering course, the integration of AI within a problem-based and experiential learning environment promotes practical critical thinking oriented towards the validation of algorithmic solutions, the comparison of AI outputs with professional criteria and reflection on the technical limitations of the models. This approach responds to the theoretical recommendation that GAI should not be used merely to automate tasks, but rather to trigger processes of analysis and evaluation under teacher supervision.

In the motivational and self-regulatory domain, the studies by Teng, Zhou, Al-Samarraie and Fang (2026) and Zhou, Teng and Al-Samarraie (2024) provide robust evidence. The former, from the perspective of social cognitive theory, shows that interaction with GenAI can increase perceived self-efficacy and, consequently, promote more active participation in tasks requiring critical judgement, provided that students use the tool to verify information, explore alternatives and request deeper reasoning. The latter identifies self-regulation in the use of AI as a mediating variable between the tool and outcomes in critical thinking and problem-solving, such that the cognitive benefits are concentrated among those who plan, monitor and evaluate their interaction with AI rather than accepting it as a final answer.

In addition, Liu et al. (2025) provide correlational evidence showing that critical thinking acts as a mediator between technological acceptance and academic performance, reinforcing the hypothesis that a merely favorable disposition towards GAI does not guarantee educational improvements unless it is accompanied by critical competences that channel its use towards deep understanding and transfer. Taken together, these empirical studies support the central claim of the theoretical framework that algorithmic literacy, educommunication and the explicit teaching of self-regulation strategies are necessary conditions for transforming GAI into a cognitive enhancer rather than an uncritical shortcut.

Integration practices: from human AI synergy to Socratic questioning

Beyond the general effects identified, the review makes it possible to distinguish specific patterns of effective pedagogical practice. Jai Lamimi, El Jemli and Zeryouh (2025) propose human-AI synergy as an approach to cognitive development, in which the delegation of routine tasks, such as searching for examples, generating preliminary texts and producing initial solution proposals, frees cognitive resources for more complex evaluation and synthesis under teacher mediation. This strategic use is consistent with the theoretical framework's argument that cognitive effort should be redirected from lower-level tasks towards the higher levels of Bloom's taxonomy, namely analysis, evaluation and creation.

Zhang and Liu (2025) focus on AI-generated content (AIGC) and conclude that, when integrated into activities designed to foster informed skepticism, such as fact-checking, the identification of biases or errors, and comparison with academic sources, AIGC can become a driver of curiosity and of the adoption of an analytical stance, compelling students to engage in sustained critical thinking. In a complementary way, Fakour and

Imani (2025) explore a ChatGPT-mediated Socratic questioning approach, showing that AI can, in certain contexts, match the effectiveness of human tutors in challenging preconceived ideas, identifying inconsistencies in students' arguments and guiding them towards more logical and better-structured reasoning.

In clinical and health science settings, the combination of these approaches appears especially relevant. While Zheng et al. (2024) demonstrate the potential of GAI-based simulations to require critical decision-making under pressure, Taylor et al. (2026) warn that, if task design does not require students to justify their reasoning or make explicit the alternatives they have rejected, the same tool may be used to reach apparently "correct" solutions quickly without deep cognitive processing. This tension reinforces the conclusion that activity design and process-oriented assessment are key elements in ensuring that GAI promotes, rather than replaces, critical thinking.

Limitations of the evidence and needs for future research

From a methodological perspective, the synthesis of the 12 studies highlights several limitations. The first is temporal: the concentration of studies between 2024 and 2026 reflects the speed with which GAI has emerged, but it also means that most of the research is short term, with limited interventions and no longitudinal follow-up of effects on critical thinking and other executive functions. A second limitation concerns geographical and disciplinary distribution: there is a marked predominance of contexts from East Asia, Thailand and the United Kingdom, as well as a concentration in areas such as language teaching, engineering and medicine, leaving other fields of knowledge and institutional realities comparatively underexplored.

With regard to assessment instruments, many studies rely on self-report questionnaires or specific tasks, such as argumentative writing or the resolution of a particular type of case, which limits comparability across studies and the possibility of extracting robust effect sizes in relation to critical thinking in its broader sense, including analysis, evaluation, inference, critical disposition and metacognition. In this context, it is necessary to move towards mixed method designs that combine standardized measurements of critical thinking, performance analysis in authentic tasks and qualitative data that make it possible to understand how students experience and regulate their interaction with GAI.

In line with the specific objectives of the present study, the following future research priorities are identified: (a) the development and validation of specific instruments to assess critical thinking in GAI-mediated contexts; (b) more in-depth analysis of mediating and moderating variables, such as self-efficacy, self-regulation and algorithmic literacy; and (c) comparative exploration of different models of pedagogical integration of GAI, including unrestricted versus guided use, automated versus hybrid human-AI feedback and product-oriented versus process-oriented assessment.

Conclusion

The results of this systematic review support the conclusion that GAI does not have a univocal effect on critical thinking in higher education. Rather, its impact depends on the pedagogical, ethical and institutional framework that structures its use, in line with the reflections of Salazar et al. (2024), González and Medina (2023) and Juárez-Cádiz, (2026). When incorporated into authentic tasks through designs that require analysis, comparison, justification and revision, GAI can operate as a form of cognitive scaffolding, facilitate access to complex situations and strengthen the dimensions of analysis,

evaluation and inference characteristic of critical thinking in higher education (Waluyo & Kusumastuti, 2024; Avilés Mariño & Sarasa Cabezuelo, 2025; Hao et al., 2024).

By contrast, when used as a shortcut for producing texts, responding to cases or solving problems without requiring transparency in reasoning or reflection on process, GAI encourages the externalization of thought and erodes students' intellectual autonomy, reproducing forms of superficial learning that higher education itself seeks to overcome (Taylor et al., 2026; Zhang & Liu, 2025). On the basis of the available evidence, the immediate challenge for higher education is not to decide between prohibiting GAI and adopting it uncritically, but rather to design pedagogical, evaluative and ethical integration frameworks that transform it into a mechanism of cognitive emancipation rather than a new vector of intellectual heteronomy.

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