Applications of Generative Artificial Intelligence in Higher Education: A Systematic Review of the Literature

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Abstract

Generative Artificial Intelligence (GenAI) has attracted growing attention in higher education due to its potential to transform teaching, learning, assessment, and academic production. This article presents a systematic literature review focused on the use of GenAI in university settings, conducted following Kitchenham's methodological model. A total of 41 studies published between 2020 and 2025 were analyzed across major databases such as Scopus, Web of Science, Springer, and IEEE Xplore. The findings reveal a wide range of applications, including learning personalization, automated feedback, academic writing support, content generation, and optimization of teaching and administrative tasks. However, the review also identifies significant ethical, pedagogical, and epistemological challenges, such as academic integrity, algorithmic bias, and the urgent need to strengthen critical digital literacy among both instructors and students. This review systematizes 26 GenAI tools, 21 educational strategies, and 12 ethical implications, providing a comprehensive foundation for institutional policy development and future research. The study ultimately aims to promote the responsible, ethical, and pedagogically meaningful integration of emerging generative AI technologies within higher education.

Keywords: *Generative artificial intelligence, higher education, systematic review, educational tools.*

Introduction

In the last decade, artificial intelligence has undergone accelerated development, and one of its most disruptive manifestations is generative artificial intelligence (AI-GEN). This technology allows the automatic creation of texts, images, sounds, and other content from trained models, and has begun to transform multiple sectors, including higher education (Ángel et al., 2024) . Its use in teaching-learning, assessment and academic production processes has generated both interest and concern, due to its potential to improve the personalization of learning, as well as the risks associated with academic integrity and critical thinking (Romo et al., 2023).

The integration of tools such as ChatGPT, DALL· E and Bard in university environments has not only modified the way students access knowledge, but also the methods of evaluation and the generation of academic content (Bernat-Sánchez, 2024). This has motivated teachers, researchers and educational designers to reflect on the pedagogical, ethical and methodological implications of the use of these technologies.

Despite the proliferation of studies on AI-GEN, there is still no systematic review that rigorously compiles and analyzes research developed in university contexts (Álvarez-Sepúlveda, 2023). This lack highlights the need for a structured analysis that identifies applications, benefits, ethical

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challenges and emerging trends, offering a solid basis for future research and for the design of educational policies.

The main objective of this article is to present a systematic review of the literature on AI-GEN in higher education, following the Kitchenham model, in order to synthesize the available information and guide pedagogical and ethical strategies for its implementation in university settings (Sotelo, 2025).

This article is organized as follows: section 2 presents the methodology; section 3 presents the results and discussion; Section 4 contains the conclusions, followed by the references that support the study.

Method

For the systematic review of the literature presented in this article, a methodological approach derived from the research processes used in Software Engineering and Computer Science was employed (Morales-Carrillo et al., 2021), adjusted to the context of interdisciplinary studies on educational technology. The main objective was to offer a structured overview of the field of generative artificial intelligence (AI-GEN) applied to higher education, to identify the volume and type of existing research, as well as the main findings, in order to build a thematic classification scheme and a basis for future critical analyses.

This methodological approach, based on the Kitchenham model, is widely recognized for its ability to generate reliable knowledge from indexed and peer-reviewed scientific publications (Gómez et al., 2023). The procedure integrates criteria of inclusion, exclusion and quality evaluation, ensuring the rigor of the analysis.

Figure 1.
Stages of the defined method.

2.1 Research Questions
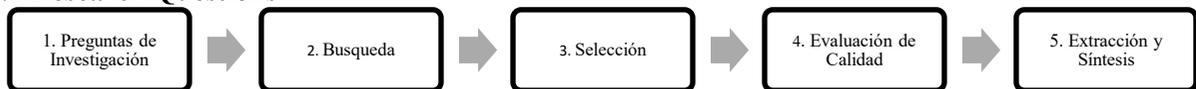
The purpose of this systematic review was to identify and analyze the main lines of research, tools used, reported benefits, potential risks, and emerging trends in the use of generative artificial intelligence in university settings. To construct the state of the art, the following research questions were formulated:

RQ1: What benefits have been reported in the use of generative AI in higher education?
RQ2: What risks, limitations, or ethical concerns have been documented around its educational implementation?
RQ3: What generative AI tools and platforms are being used for educational purposes?
RQ4: What pedagogical strategies have been adapted or transformed from the use of generative AI?
RQ5: What methodological frameworks have been used to assess the impact of generative AI on university education?
RQ6: What are the current and future trends in the use of generative AI that can modify traditional teaching/learning models?

The formulation of these questions was carried out using the PICO model (Sánchez-Martín et al., 2023), with the purpose of guaranteeing a precise framing of the research problem. Table 1 presents the criteria considered:

Table 1
Definition of the general concepts according to the PICO model

Criterion	Description
Population	Teaching/learning processes in higher education
Intervention	Use of tools and methodologies based on generative artificial intelligence
Results	Scientific publications that assess impacts, benefits, challenges, or trends
Professional	Teachers, researchers and instructional designers
Context	Higher education institutions at national and international level

2.2 Search

The search strategy consisted of the systematic exploration of key terms related to the use of generative artificial intelligence (AI-GEN) in university educational contexts, within specialized academic databases. To ensure broad and accurate coverage, general terms were used along with their respective synonyms, and additional filters were applied according to educational, technological, and temporal focus.

The objective was to identify relevant scientific literature that would allow analyzing the applications, challenges, opportunities, and trends of generative AI in higher education. Searches were carried out on the title, keywords, abstract and full text fields, when the database allowed it. The selection of databases was based on their recognition for academic quality and visibility. Table 2 presents the terms used, their synonyms and the filters applied. Table 3 shows the link between the terms and the databases queried, and Table 4, the search string used.

The literature search was limited to the period between 2020 and 2025, given the relevance of that interval in the development of technologies such as GPT-3, GPT-4 and DALL·E.

Table 2
Terms, synonyms and filters to compose the search string

Terms	Related Synonyms	Additional Filters
Generative Artificial Intelligence	GenAI, AI-generated content, generative AI tools, transformer-based models	Year of publication >= 2020
Higher Education	University, College, Tertiary education	Education
Teaching-learning strategies	Educational methods, instructional strategies, pedagogical approaches	Computer's science
AI in education	Artificial intelligence in education, educational AI, AI-assisted learning	Software
Impact of generative AI	Effectiveness of GenAI, learning outcomes, student performance, teacher perceptions	Literature review, empirical studies.

Table 3

Main term and databases consulted

Main Term	Database
Generative Artificial Intelligence Higher Education + GenAI	Scopus Web of Science Springer IEEE Xplore

Table 4
Search string

Main term	Search string
Generative Artificial Intelligence in Higher Education	("Generative Artificial Intelligence" OR "GenAI" OR "AI-generated content" OR "Generative AI tools" OR "Transformer-based models" OR "ChatGPT" OR "Large Language Models") AND ("Higher Education" OR "University" OR "College" OR "Tertiary education") AND ("Teaching" OR "Learning" OR "Educational strategies") AND (publication year >= 2020 AND publication year <= 2025)

2.3 Selection

All studies covered in this systematic review were analysed in detail. For its evaluation, the following elements were considered: title, keywords, abstract, introduction, background, methodology, results, discussion and conclusions. This made it possible to establish the relevance and relevance of each document in relation to the central research topic.

Inclusion and exclusion criteria were defined in order to ensure the quality and consistency of the selected documents.

Inclusion criteria:

✓ Scientific documents (articles, reviews, book chapters or papers) related to the use of generative artificial intelligence (generative AI) in teaching-learning processes in higher education.
✓ Publications between 2020 and 2025.
✓ Studies that address strategies, tools, applications, pedagogical or ethical implications of the use of generative AI in university academic contexts.
✓ Documents available in full text and in English or Spanish.

Exclusion criteria:

✓ Documents without support in a recognized academic source or without bibliographic citations.
✓ Studies focused solely on generative AI applications in non-educational contexts or at educational levels other than higher education (e.g. primary or secondary).

✓ Articles that do not include terms related to generative AI, higher education, or teaching-learning processes.
✓ Documents without access for download or full reading.

The selection of primary sources was developed in four moments, corresponding to the four specialized databases consulted. At each time, three phases of debugging were applied: Phase 1: Elimination of duplicate documents, phase 2: Elimination of documents that are not accessible or without available full text, and phase 3: Rigorous application of the inclusion and exclusion criteria defined above.

Since each database has different criteria and indexing structures, it was necessary to carry out the searches on different dates, adapting the filters and search strings to each case. This information is summarized in Table 5.

In total, 106 studies were identified in the four selected databases. After eliminating 15 duplicate documents, 91 full texts were evaluated. Of these, 50 were excluded because they did not meet the inclusion criteria, which allowed the consolidation of a final corpus of 41 unique, relevant articles available in full text. Table 5 presents the search schedule by database, and Table 6 details the search, debugging, and selection process.

Table 5
Search results by database

Database	Search Date
Scopus	17/09/2025
IEEE Xplorer	20/09/2025
Springer	24/09/2025
Web of Science (ISI)	29/09/2025

Table 6
Quality Revaluation in Search and Selection Processes by Databases

Database	Search Result	Duplicate	Excluded	Selected
Scopus	48	11	19	11
IEEE Xplorer	27	3	13	8
Springer	8	0	1	7
Web of Science (ISI)	23	1	8	15
Total	106	15	41	41

2.4 Quality assessment
In the quality evaluation process of the documents selected for this review, seven criteria were taken into account: origin of the sources, relevance of the content, impact of the study, objective of the research, context of the study, objectivity of the methodological design and scientific rigor in the analysis of the data. These seven criteria respond to three key components of quality management: planning, organization and control.

The evaluation involved a complete and detailed reading of the 41 documents considered relevant. This process included three consecutive phases: (1) elimination of duplicate articles; (2) exclusion of items not available for download: and (3) application of the inclusion and exclusion criteria previously defined. The result of this procedure is presented in Table 7.

Table 7
Studies included in the systematic review

Year	Quantity	References
2021	2	[12] [36]
2023	11	[2] [4] [11] [13] [18] [19] [20] [21] [33] [35] [39]
2024	13	[1] [3] [6] [10] [14] [17] [22] [24] [25] [32] [34] [37] [41]
2025	15	[5] [7] [8] [9] [15] [16] [23] [26] [27] [28] [29] [30] [31] [38] [40]
Total	41	

2.5 Data Extraction and Synthesis of Results
Since the main objective of this systematic review is to identify the state of the art on the applications of Generative Artificial Intelligence in Higher Education, a detailed data extraction was carried out from the 41 selected studies. The information was organized taking into account variables such as year of publication, type of application of the AGI, educational context, objectives of the study, methodology used and main findings. This systematization made it possible to identify trends, challenges and opportunities in the use of these technologies in university environments.

Results and Discussion
The systematic review of the 41 selected studies made it possible to identify a wide variety of approaches, applications and reflections on the use of generative artificial intelligence (AI-GEN) in higher education. The findings were organized into six thematic dimensions: benefits, ethical risks, tools used, pedagogical strategies, methodological approaches, and emerging trends.

3.1 Benefits of using Generative AI in Higher Education
One of the benefits most widely reported in the literature is the personalization of learning, present in 72% of the studies analyzed. Generative AI platforms allow content and activities to be adapted to the student's profile, pace, cognitive style and interests. This ability to personalize contributes to the development of self-regulated learning, by offering differentiated routes, adaptive exercises, and personalized feedback, which is particularly valuable in environments with high student diversity (Perezchica-Vega et al., 2024).

Another important benefit identified in more than half of the studies (54%) is the improvement in the efficiency of teaching processes. IA-GEN automates administrative and operational tasks such as exam development, assignment grading, rubric development, presentation preparation, and teaching materials design. This automation frees up time for teachers to focus on tasks of greater pedagogical value, such as reflective accompaniment, instructional design, mentoring,

and critical evaluation (López Tineo et al., 2025).

Likewise, generative AI strengthens critical thinking and metacognition. By interacting with conversational models such as ChatGPT, students develop skills in analysis, understanding ideas, and evaluating sources, as they are challenged to compare their arguments with the answers generated by artificial intelligence. This process, guided by critical teacher guidance, enhances informed decision-making and cognitive self-regulation (Zuñiga, 2025).

The creativity and academic innovation they also benefit from the use of AI-GEN, especially in contexts of textual production, multimedia design and generation of novel solutions. The iterative use of these tools allows us to explore multiple possibilities, enrich ideas and perfect academic products. In fact, 22 studies (44%) report positive impacts on the quality and quantity of assisted academic output, including essays, white papers, articles, critical abstracts, and interdisciplinary collaborative projects (Ortega Ryberg, 2024). In fact, 22 studies (44%) report positive impacts on the quality and quantity of assisted academic production, in activities such as the writing of essays, technical reports, articles, critical summaries and interdisciplinary collaborative projects.

Knowledge about how generative AI works is an additional educational benefit, since transformative models (GPT, BERT, DALL· E) teach students and teachers about data processing, linguistic, semantic, visual and structural patterns, promoting advanced skills in information analysis and content modelling(Articles & García, 2024).

The development, training, and effective use of generative AI fosters technological, ethical, and pedagogical literacy, which is a benefit for higher education. Students and teachers acquire competencies in the use of advanced tools, as well as in the understanding of their educational impact, which strengthens the ability to adapt to a constantly evolving digital environment(Sánchez et al., 2025).

The use of AI-GEN promotes a profound transformation in teaching-learning processes, by automating routine tasks, personalizing feedback, generating adaptive educational content and enhancing creativity. This not only facilitates the teaching work, but also improves the educational experience of students, making it more dynamic, interactive and effective (Quiroz Martínez, 2025).

In addition, generative AI allows the development of multidisciplinary skills in higher education. Its use requires an understanding of computing, data science, critical pedagogy, instructional design and technological ethics, strengthening comprehensive competencies that combine technical, pedagogical and social knowledge (Díez-Gutiérrez & Jarquín-Ramírez, 2025). Its use involves a deep understanding of concepts such as neural networks, natural language processing, synthetic image generation, algorithmic bias, and data privacy, as well as the appropriation of prompt engineering techniques and methodologies and the critical evaluation of the content generated (Jos & Le, 2024).

Finally, the relationship of generative AI with intelligent software represents a strategic benefit for higher education. Platforms based on AI-GEN simulate human reasoning patterns and allow large volumes of information to be handled, accelerating learning processes, content generation

and development of advanced digital skills (Cuestas, 2023). This capacity contributes to preparing students and teachers for the challenges of education in the twenty-first century, provided that their integration is mediated by sound pedagogical, ethical and scientific criteria.

3.2 Risks and Ethical Challenges Associated with Generative AI in University Contexts

Despite its benefits, the implementation of generative AI in higher education also poses significant risks. The review identified 12 broad categories of ethical implications. One of the most recurrent is related to academic integrity, present in 76% of the studies, where the possibility of automated plagiarism, delegation of intellectual tasks to AI, impersonation of authorship and loss of the sense of effort and academic authorship is warned. These practices, if not critically mediated, can deteriorate the culture of academic honesty and foster an unproductive reliance on technological tools (Gallent Torres et al., 2023).

Second, algorithmic bias is an ethical challenge documented in 46% of the publications reviewed. AI models, being trained with large volumes of data that reflect social, linguistic and cultural biases, can generate responses that reproduce stereotypes, discrimination or inequality. This represents a significant pedagogical risk, since students could assume as neutral or true biased statements, affecting their critical training (Sánchez Mendiola, 2023).

The third concern is related to privacy and data protection, indicated in 42% of the studies. IA-GEN platforms collect and process sensitive information entered by users, often without them knowing the conditions of use, storage or transfer of data to third parties. This situation requires an institutional review of AI use policies, especially in educational contexts that handle personal and academic information (Franganillo, 2023).

Other ethical risks include technological dependence, which can limit the autonomous development of thought (75.6% of students surveyed), the dehumanization of pedagogical interaction, and the opacity of models ("black box"), which makes it difficult to explain, validate or trace the content generated. These problems reinforce the need to train students in critical literacy in artificial intelligence, which allows them to interact ethically with these technologies(Amo-Filva et al., 2023). Fig. 1 presents these risks that affect higher education.

Figure 2
Ethical risks
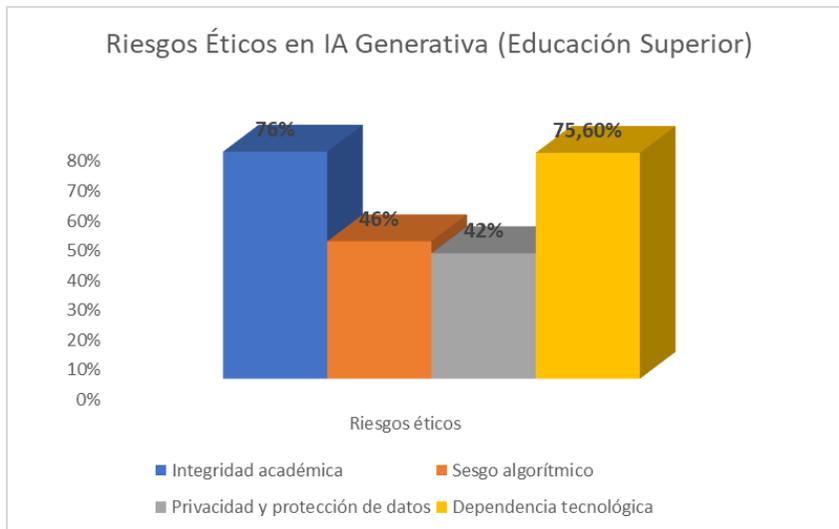
3.3 Generative AI Tools and Platforms Used for Educational Purposes

The analysis of the 50 studies identified 26 generative AI tools used for pedagogical purposes in higher education. ChatGPT, developed by OpenAI, was the most cited tool (in 80% of the studies), used for writing assistance, resolution of doubts, generation of thematic content and preparation for evaluations (Rita Cecilia Sanmartín Ureña et al., 2024). Its ease of use, free availability, and conversational capability have favored its rapid adoption in educational settings.

Other widely used tools include DALL· E, Midjourney and Stable Diffusion, which enable the creation of AI-generated images, used in careers such as design, architecture, communication, advertising and art. These platforms have allowed students and teachers to experiment with visual representation, digital narrative and creative prototyping(Roque López, 2025) .

Also mentioned were Bard (Google), Claude (Anthropic), Copilot (Microsoft) and emerging tools such as Perplexity, Notion AI, Jasper, Tome and Socratic, which offer functions such as assisted editing, academic planning, presentation generation, automatic summaries and cognitive support. These platforms can be classified into four functional categories: text generation, image generation, productivity assistants, and multimodal systems (Quevedo Zamora & Cáceres Mendoza, 2024).

The use of these tools shows a trend towards the integration of AI in various phases of the educational process, from planning to evaluation, and in multiple disciplines, from the human sciences to the applied sciences. This variety demonstrates the cross-cutting and potentially transformative nature of AI-GEN in university education settings (García Valiente, 2024).

The growing diversity of generative AI-based tools reveals an ever-expanding technology ecosystem, with each platform geared toward solving different educational challenges. For example, while tools such as Notion AI and Jasper focus on individual productivity by generating structured content, others such as Tome and Socratic facilitate the visualization and explanation of complex concepts, which is especially useful in active teaching or self-learning contexts (Mahajan & Sarode, 2025).

3.4 Pedagogical Strategies Transformed by the Use of Generative AI

The review made it possible to systematize 21 pedagogical strategies that have been adapted or resignified thanks to the incorporation of generative AI. Project-based learning (PBL) has been one of the most impacted methodologies, as it allows students to use AI to perform specialized searches, organize information, generate ideas, simulate scenarios or validate proposals. This technological mediation expands the creative and methodological possibilities of PBL (Rodríguez et al., 2025).

A growth in the use of assisted academic writing has also been observed, as a metacognitive development strategy and guided textual production. AI acts as a scaffolding that offers suggestions for structure, coherence, style or grammar, but it can also encourage critical revision of texts, by generating alternative versions that students must contrast and adapt (Larico, 2025).

Other documented strategies include gamification through automatic generation of playful elements (challenges, scenarios, characters), dynamic simulations in contexts such as medicine or economics, and automated formative assessment, where AI platforms are used to provide feedback on responses, identify frequent errors and propose personalized improvement strategies (Ordoñez-Pacheco, 2025).

Adaptive instructional design has also been enhanced by AI-GEN, allowing teachers to adjust content, difficulty levels, and delivery formats according to their students' learning profiles. This translates into learning environments that are more inclusive, sensitive to diversity and focused on individual training needs (Arias Coronado et al., 2025).

3.5 Methodological Approaches Used to Assess the Impact of Generative AI

The systematic review identified a methodological diversity in the studies analyzed, although with a strong presence of qualitative exploratory designs (46%). These studies employed techniques such as semi-structured interviews, focus groups, content analysis, participant observation, and reflective journaling, to understand teachers' and students' perceptions, attitudes, and experiences in the use of generative AI (Jiménez López et al., 2025).

Likewise, 38% of the studies adopted cross-sectional quantitative designs, through the application of surveys, technology acceptance questionnaires, usability scales and academic performance tests. These designs made it possible to establish correlations between the use of AI and variables such as motivation, performance, satisfaction or cognitive load (Changoluisa et al., 2024).

However, only 16% of the studies adopted quasi-experimental or experimental approaches, which allowed comparison of intervention and control groups. This limited presence of studies with high empirical rigor shows a relevant methodological gap. Similarly, longitudinal designs or mixed approaches were scarce, limiting the possibility of identifying sustained changes or causal relationships. Therefore, it is necessary to strengthen scientific production through research with robust methodologies, data triangulation and external validation (Molina-Siles & Giménez Ribera, 2023).

This methodological landscape suggests that much of the current knowledge about the impact of generative AI in education is based on subjective perceptions, exploratory studies, and short-term results. Although these contributions are valuable for mapping the emerging field, their limited scope makes it difficult to build solid conclusions about the real effectiveness of AI tools in learning and training processes (Padilla Piernas & Martín-García, 2024).

In this context, it is essential to promote research with quasi-experimental and longitudinal approaches, which allow the evaluation of the evolution of learning, the transfer of skills and attitudinal changes over time. The monitoring of student cohorts, comparative analysis between groups with and without AI-based intervention, and the incorporation of qualitative and quantitative indicators would facilitate a more comprehensive understanding of the phenomenon (Banda Guzmán et al., 2023).

Likewise, mixed-approach studies offer a promising avenue for combining the depth of qualitative analysis with the accuracy of quantitative data. Methodological triangulation would make it possible to contrast the subjective experience of users with objective evidence of performance, which would enrich the available knowledge and strengthen the basis for the design of evidence-based educational policies (Rodríguez et al., 2021).

3.6 Emerging Trends in the Use of Generative AI in Higher Education

Finally, the studies analyzed identified at least six emerging trends in the use of generative AI in university contexts. The first is the curricular integration of AI, not only as a pedagogical tool, but as transversal teaching content, with an emphasis on digital literacy, computational thinking and technological ethics (Gutiérrez González & Ocádiz Amador, 2024). The second trend is related to the development of skills in prompt engineering, that is, the ability to design precise, ethical and efficient instructions to interact with AI systems. This competence is being incorporated into teacher training programs and educational innovation workshops (Knoth et al., 2024). A third trend is the evolution towards intelligent learning environments, where adaptive systems, predictive learning analytics, automated feedback and co-creation with AI are integrated, promoting personalized and collaborative experiences. Fourthly, there is the growing automation of evaluation and administrative processes, through the automatic generation of items, rubrics, performance analysis and progress reports(By Icaza & Garzón Sherdek, 2023).

In addition, human-machine collaboration is gaining strength as a new pedagogical model, in which AI acts as a mediating agent that stimulates creativity, critical thinking and collective problem solving. Finally, there is an increase in the development of institutional policies, ethical guidelines and regulatory frameworks for the responsible use of AI in educational environments, reflecting a growing concern for its governance, transparency and equity(Briceño-Álvarez et al., 2025).

These trends configure a scenario of profound transformation in traditional educational models, posing new challenges in terms of teacher training, curricular redesign, technological infrastructure and ethical regulation. Higher education, in the face of these challenges, must position itself as a strategic actor in the critical and pedagogical appropriation of generative artificial intelligence (Segarra Ciprés et al., 2024).

Conclusions

Generative artificial intelligence (AI-GEN) has great potential in higher education by offering clear benefits, such as personalizing learning, strengthening critical thinking, stimulating creativity, and optimizing teaching processes, significantly transforming the educational experience for both students and teachers. The automation of administrative and operational tasks, such as the generation of evaluations and teaching materials, allows teachers to dedicate more time to high-value pedagogical activities, promoting a closer and more reflective accompaniment of students.

The implementation of AI-GEN requires advanced digital literacy, including technological, pedagogical, ethical and communicational aspects, so that teachers and students are prepared to critically interact with these tools, understanding both their capabilities and their limitations. Despite its benefits, generative AI carries significant ethical risks that require institutional attention, including academic integrity, algorithmic bias, data privacy, technological dependency, and the dehumanization of pedagogical interaction. These risks highlight the need to establish clear policies for use, as well as training programs in ethics and critical thinking on the use of AI.

The findings show that generative AI should not be considered only as a technological resource, but as a transformative tool that, if integrated in a strategic and pedagogical way, can enhance educational quality, methodological innovation and the active participation of students in their learning. This work provides consolidated evidence on the relevance of generative AI in higher education and highlights the need to continue investigating its impact, especially in the creation of effective didactic strategies that favor both autonomous and collaborative learning, guaranteeing a comprehensive development of competencies in students.

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