SPECIAL SECTION: AI IN TEACHING AND LEARNING PROCESSES

Generative artificial intelligence in higher education: implications, applications and tools[1][2]

Inteligência artificial generativa no ensino superior: implicações, aplicações e ferramentas

Inteligencia artificial generativa en educación superior: implicaciones, aplicaciones y herramientas

Betiana Elizabeth Vargas[3], Edgar Záyago Lau[4]

ABSTRACT

Generative artificial intelligence has rapidly gained prominence in higher education, becoming a transforming force in higher education. Its arrival has not only revealed the significant impact on teaching and learning, but also the need to comprehensively understand it. The aim of this article is to explore studies that address the social, pedagogical and cognitive implications of generative artificial intelligence in higher education and to identify and compare applications and tools employed for educational use. We used a qualitative methodology and a descriptive and explanatory approach based on a documentary review on the use of generative artificial intelligence in higher education. The studies reveal that ChatGPT is the most employed tool, although its incorporation and uses are varied; there are also other potential tools for educational use and the need to know the impact on academic integrity and critical thinking is identified. The incorporation of generative artificial intelligence is growing. If mishandled, it

[3] Autonomus University of Zacatecas (UAZ), Zacatecas, Mexico.
ORCID ID: https://orcid.org/0000-0002-1727-0483. E-mail: betiana.vargas@uaz.edu.mx
[4] Autonomus University of Zacatecas (UAZ), Zacatecas, México.
ORCID ID: https://orcid.org/0000-0002-3670-8356. E-mail: zayagolau@gmail.com

could exacerbate pre-existing problems related to technologies in education, so its prohibition is not an answer to the phenomenon. In conclusion, the need for strategic planning is suggested, in addition to continuous training for teachers and clear guidelines to promote a comprehensive approach, an ethical and pedagogical use and a critical understanding of its scope, risks, opportunities and challenges.

Keywords: generative artificial intelligence; higher education; educational applications; social implications; pedagogical implications.

RESUMO

A inteligência artificial generativa tomou o mundo rapidamente, tornando-se uma força transformadora no ensino superior. Sua chegada não apenas revelou um impacto significativo no ensino e na aprendizagem, mas, também, a necessidade de compreendê-la de forma integral. O objetivo deste artigo é explorar estudos que abordem as implicações sociais, pedagógicas e cognitivas da inteligência artificial generativa no ensino superior, identificar e comparar aplicações e ferramentas para uso educacional. Utilizou-se uma metodologia qualitativa e uma abordagem descritiva e explicativa, com base em uma revisão documental e seu uso. Os estudos revelam que o ChatGPT é a ferramenta mais utilizada, embora sua incorporação e seus usos sejam variados, também existem outras ferramentas com potencial para uso educacional e identifica-se a necessidade de conhecer as repercussões sobre a integridade acadêmica e o pensamento crítico. A incorporação da inteligência artificial generativa está em crescimento e, se mal conduzida, pode exacerbar problemas pré-existentes relacionados às tecnologias na educação, portanto, sua proibição não é uma resposta ao fenômeno. Conclui-se pela necessidade de planejamento estratégico, formação contínua de docentes e diretrizes claras a fim de promover uma abordagem integral, um uso ético e pedagógico e uma compreensão crítica de seu alcance, riscos, oportunidades e desafios.

Palavras-chave: inteligência artificial generativa; ensino superior; aplicativos educacionais; implicações sociais; implicações pedagógicas.

RESUMEN

La inteligencia artificial generativa ha tomado el mundo por asalto, constituyéndose en una fuerza transformadora en la educación superior. Su llegada no solo ha revelado el impacto significativo en la enseñanza y el aprendizaje, sino, también, la necesidad de asumir su comprensión de manera integral. El objetivo del presente artículo es explorar estudios que aborden las implicaciones sociales, pedagógicas y cognitivas de la inteligencia artificial generativa en educación superior e identificar y comparar aplicaciones y herramientas empleadas para uso educativo. Se utilizó una metodología cualitativa y un enfoque descriptivo y explicativo basado en una revisión documental sobre su uso. Los estudios revelan que

ChatGPT es la herramienta más empleada, aunque su incorporación y usos son variados; también existen otras herramientas potenciales para uso educativo, se identifica la necesidad de conocer las repercusiones en la integridad académica y el pensamiento crítico. La incorporación de la inteligencia artificial generativa es creciente y, si se maneja mal, podría exacerbar los problemas preexistentes relacionados con las tecnologías en la educación, de modo que su prohibición no es una respuesta al fenómeno. Se sugiere la necesidad de planificación estratégica, formación continua para docentes y directrices claras a fin de promover un abordaje integral, un uso ético y pedagógico, y una comprensión crítica de su alcance, riesgos, oportunidades y desafíos.

Palabras clave: inteligencia artificial generativa; educación superior; aplicaciones educativas; implicaciones sociales; implicaciones pedagógicas.

INTRODUCTION

The emergence of generative artificial intelligence (GenAI) in Higher Education represents an unprecedented transformation. It has rapidly gained prominence in higher education, in the words of Lim *et al.* (2023), generating significant tensions and urgent challenges in the field of education. Since the emergence of tools such as ChatGPT, debates have arisen about their potential to improve teaching processes and personalize the learning experience (Carranza Alcántar *et al.*, 2024), as well as about the risks and ethical challenges posed by their use.

In the United States, the adoption of GenAI by university students reached 49% in the last semester of 2023 (Tyton Partners, 2023 *apud* García Peñalvo, 2024). Its arrival is introduced as a transformative force that is set to revolutionize education (Carranza Alcántar *et al.*, 2024). Its growing incorporation has generated both enthusiasm for its potential benefits and concerns about the authenticity of work and academic integrity. These technologies not only modify teaching and learning practices, but also reconfigure institutional dynamics and knowledge production.

In this context, it is necessary to understand GenAI from a comprehensive perspective that articulates social, pedagogical, and cognitive dimensions, considering both its applications and its implications. This article proposes two main objectives: 1) to explore studies that address the social, pedagogical, and cognitive implications of GenAI in Higher Education; and 2) to identify and compare applications and tools with potential for educational use.

To this end, a qualitative literature review was conducted, with a descriptive and explanatory approach. The selection and analysis of the literature allowed the studies reviewed to be classified into three main areas or categories: perceptions, uses, and challenges. In addition, the results were integrated into a comparative analysis and examples of specific applications in the university setting.

In terms of structure, a series of theoretical considerations are first presented. This is followed by a description of the methodological strategy. Next, the state of the art is afforded, organized into three key areas: perceptions, uses and challenges. A fourth section addresses the social, cognitive, and pedagogical implications, while the next section shows a comparison of common applications and tools in higher education. A sixth section attempts to arrive at a general synthesis. Finally, the concluding considerations offer reflections in pedagogical terms and recommendations with a view to strengthening educational quality in a constantly evolving digital environment.

THEORETICAL CONSIDERATIONS: ARTIFICIAL INTELLIGENCE AND GENERATIVE ARTIFICIAL INTELLIGENCE

Artificial Intelligence has been conceptualized in various ways, but none of its definitions has been universally accepted.

It is a branch of computer science, but it has also influenced other fields such as biosciences, neurosciences, and philosophy (Boden, 2017). Its study dates back to the early 20th century with the work of one of its leading exponents, Alain Turing. For Turing, "AI was born out of attempts to simulate and mechanize human thought processes" (Turing, 1950 *apud* UNESCO, 2021, p. 14).

In 1956, McCarthy coined the term Artificial Intelligence to refer to "intelligent machines" (Díaz Vera *et al.*, 2024). That same year, a group of scientists (McCarthy, Minsky, Rochester, and Shannon) began the "Artificial Intelligence" research project at Dartmouth College in the United States. Initially, their goal was to describe human intelligence so precisely that a machine would be able to simulate it. This concept was also known as "Generic Artificial Intelligence" to refer to AI equal to or superior to average human capacity (Porcelli, 2020).

However, recent critical readings argue that assuming the notion in these terms erases some of its implications, since AI "is neither artificial nor intelligent" (Crawford, 2022, p.29) given the materiality that composes it and the social and political structures on which it depends.

Beyond the debates and positions, one approach to the definition is that proposed by the European Commission's High-Level Expert Group on Artificial Intelligence, which states that:

> Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behavior by analyzing how the environment is affected by their previous actions (European Commission, 2019, p. 6).

They add that AI as a scientific discipline includes approaches and techniques such as machine learning, among which deep learning and reinforcement learning stand out; automatic reasoning, through planning, programming, knowledge representation and reasoning, search and optimization; and robotics, through control, perception, sensors, and actuators, as well as the integration of all other techniques into cyber-physical systems.

Within this framework, GenAI is a branch of AI that focuses on the creation of original content. In the words of Lim, *et al.* (2023): "Generative AI can be defined as a technology that (i) leverages deep learning models to (ii) generate human-like content (e.g., images, words) in response to (iii) complex and varied prompts (e.g., languages, instructions, questions)" (p.2).

One of the tools that has recently sparked great interest in education worldwide is ChatGPT. It is a linguistic model developed by OpenAI, an AI research organization in the United States founded in 2015. Today, ChatGPT has 200 million active users per week (Silverio, 2024). Its disruptive appearance has generated paradoxes and attitudes ranging from curiosity and enthusiasm to extreme fear; from "friend" to "foe" (Lim *et al.*, 2023). However, other tools have also emerged to compete with ChatGPT, such as Microsoft's Copilot, Google's Gemini, Anthropic's Claude, Meta's Llama, and DeepSeek-AI's DeepSeek (McIntosh *et al.*, 2025).

GenAI can be situated within the broader historical trajectory of capitalism, which continually incorporates additional aspects of human life into its domain. Rather than merely facilitating the purchase or ownership of goods, GenAI now influences the production of ideas and intellectual labor through profit-oriented algorithms. Marx (1867/1976) identified two phases of capitalist development: an initial phase in which traditional forms of labor persist within profit-driven frameworks, and a subsequent phase in which technological innovations fundamentally transform the nature of work. Activities previously regarded as mental labor are now subject to these new technological forces.

Tasks such as writing, translating, summarizing, coding, and conceptualizing are increasingly mediated by software rather than direct human intervention. While this technological mediation does not eliminate human cognition, it significantly alters the allocation of intellectual effort. This transformation is particularly evident within educational institutions, where individuals now curate, initiate, and evaluate outputs generated by software rather than producing text manually. Consequently, their roles shift from direct authorship to the management and assessment of algorithmically produced content.

Building on Castells (1996) analysis, the contemporary economy is increasingly structured around networks rather than traditional industrial production. GenAI not only transmits data but also produces novel content through mathematical modeling. As a result, educational institutions are reconsidering epistemological practices, with learning processes now incorporating feedback from algorithms trained on extensive corpora of human-authored texts. This raises questions regarding the equity of knowledge production, as large language

models are developed using vast quantities of freely available texts, often without attribution to original authors. In this context, GenAI can be interpreted as transforming collective knowledge into proprietary assets, reflecting Marx's (1867/1976) observation that capitalist systems tend to privatize previously communal intellectual resources. This is the framework in which GenAI is incorporated into universities and educational trajectories worldwide.

Despite the growing availability of these technologies in education in general, the emerging research on the uses and conditions for incorporating GenAI into teaching practice and learning may vary given the organizational culture and profile of academic disciplines (Díaz Vera *et al.*, 2024). According to Carranza Alcántar *et al.* (2024), studies such as those by Tramallino *et al.* (2024) and Fanning Balarezo *et al.* (2024) show that in areas of exact sciences or engineering, earlier adoption is observed, while in the humanities and social sciences, skepticism and questioning of issues such as plagiarism, the depersonalization of learning, and the reliability of information generated by GenAI prevail. On the other hand, use also varies according to activity, with greater use in teaching practice in activities such as content preparation and the development of teaching materials compared to others such as assessment (Díaz Vera *et al.*, 2024).

METHODOLOGY

The methodological strategy of this study is structured around a qualitative approach and a descriptive and explanatory documentary review design. The purpose was to identify and analyze recent research addressing the social, pedagogical, and cognitive implications of GenAI in Higher Education, as well as to compile and compare applications and tools used in this field. For this second point, contributions from the comparative study were used to contrast the applications and classify them according to type, function, access, and number of users.

The search and selection of studies was carried out between January and April 2025 in specialized academic databases (Scopus, Scielo, Dialnet, ResearchGate, Redalyc) and in institutional repositories such as SEDICI and CONICET Digital, among others. Keywords in Spanish and English were used, such as "generative artificial intelligence", "generative AI", "higher education", "pedagogical implications", and "educational applications".

The selection criteria were: a) peer-reviewed academic publications between 2023 and 2025; b) explicit focus on the use of GenAI in higher education contexts; c) explicit information on methodology, findings and conclusions; d) some disruptive factor for interpretation. Based on this last criterion, an article from 2020 was included that reveals the increase in scientific production linked to digital mediation in educational spaces. Works without access to the full text, press releases, reports without academic review, and documents focused exclusively on AI in general and outside the educational field were excluded.

The final corpus comprises 12 chief studies reviewed in the next section. These texts form the basis for the analysis of the implications and comparing the applications and tools collected. It should be noted the analysis does not follow a strictly linear structure; rather, it integrates key contributions aligned with the study's objectives.

Regarding the collection of data on applications and tools, it should be noted that identification was carried out in two ways: a) literature review, through the detection of tools in the selected studies; b) complementary exploration of technological and educational sources (specialized websites, official developer pages, reports, among others) to collect missing data.

Data collection on applications and tools was carried out between March and April 2025. For each tool identified, the following was recorded: type of generation, main educational function, access mode (free or paid), and data on the number of users, prioritizing official sources or recent statistics.

Finally, thematic content analysis was used to process and analyze the information. For the studies reviewed, categories related to perceptions, uses, and challenges were identified, which then allowed for the analysis of the social, pedagogical, and cognitive implications of GenAI. For the table of applications and tools, they were first grouped according to type of generation and key function and then compared with other data collected in the document analysis.

This procedure allowed us to integrate two dimensions of the study—empirical evidence reflected in recent studies and the characterization of tools—in order to jointly discuss their scope, limitations, and challenges for higher education.

REVIEW OF STUDIES ON GENAI IN HIGHER EDUCATION

The emergence of GenAI in Higher Education has led to pedagogical, organizational, and epistemological transformations. Below is an overview of the state of the art, considering recent lines of research, methodologies, and findings, with a special emphasis on challenges and opportunities for universities, teachers, and students.

For ease of reading, three axes or categories are proposed to group the studies that address: a) teacher and student perceptions; b) pedagogical and methodological applications; and c) challenges and conditions for effective institutional implementation.

Studies addressing teacher and student perceptions explore how teachers and students view GenAI, its benefits, risks, and concerns about academic integrity or issues related to plagiarism, reliability, or ethics. In this context, Lim *et al.* (2023) offer an analysis of the debate on AI and lay the groundwork for GenAI to exist as a transformative resource in education. To do so, they use critical analysis as a method and paradox theory as a theoretical lens. Thus,

they define GenAI and transformative education; establish the paradoxes of GenAI; and finally, offer implications for the future of education from the perspective of educators in management. The paradoxes established are fourfold: a) it is both "friend" and "foe"; b) "capable" and "dependent"; c) "accessible" and "restrictive"; and d) it becomes 'popular' when it is "prohibited."

Vera (2023) analyzes the integration of GenAI in Higher Education, exploring its benefits, challenges, and associated ethical implications from the perspective of 23 university teachers. Their conclusions show that the integration of GenAI offers benefits but also raises ethical dilemmas and pedagogical challenges.

Carranza Alcántar *et al.* (2024) explore university teachers' perceptions of the integration and effectiveness of GenAI applications in Higher Education. They use a quantitative, cross-sectional, and descriptive methodology, through a survey of 105 higher education teachers from different universities in Mexico. The results reveal that, although teachers have a basic knowledge of GenAI, tools such as ChatGPT are frequently mentioned, but their educational use remains low. The need for adequate training and concerns about plagiarism are identified, reflecting a duality of opinions about the associated benefits and risks. The conclusion is that continuous training and critical understanding are important to maximize the benefits of GenAI and mitigate its risks, ensuring that the knowledge transmitted is reliable and of high quality.

Perezchica-Vega *et al.* (2024) explore teachers' concerns about the use of GenAI, how they use it, the preventive measures they take, and their training on the subject. This is a quantitative, non-experimental, cross-sectional study with an exploratory and descriptive scope, using a questionnaire developed and administered to teachers. The results show that teachers: a) are concerned about the risk of exams and assignments being solved with GenAI; b) recognize the benefits of GenAI for data analysis, idea generation, writing learning activities, and creating teaching materials; and c) are training themselves, but to the extent that they perceive themselves as capable of integrating these tools into their classes, they also feel concern about the risks.

Finally, García Peñalvo (2024) explores the impact of GenAI from the perspective of teachers, students, administrators, and developers through literature reviews, interviews, surveys, and observations during 2023 and 2024. Among the findings are opportunities for personalizing learning, improving educational resources, and optimizing administrative and assessment processes. In addition, risks and challenges related to mistrust due to a lack of digital literacy, regulatory frameworks, and environmental impact are highlighted. The study emphasizes that, while GenAI has the potential to transform education, successful implementation requires a collaborative approach involving all actors in the educational ecosystem.

However, there are other studies that analyze pedagogical and methodological applications. These are studies that describe why and how GenAI-based tools are used, whether in relation to personalized learning, teaching material design, automated tutoring, research, among others. Based on this, Cordón García (2023) analyzes and reflects on the benefits and risks of AI in Spanish universities. To do so, he makes an initial assessment of the current framework, lists the applications of AI in education, and compiles technological tools and use cases. Finally, he proposes keys for effective implementation in the Spanish university system, as well as technological, pedagogical, legislative, and ethical challenges and risks.

Díaz Vera *et al.* (2024) seek to identify the tools most used by teachers, as well as the benefits and challenges of their adoption. The methodology consisted of a literature review and the application of structured surveys to 334 teachers from various faculties at the University of Guayaquil, Ecuador. The results show that ChatGPT is the most widely used tool, although its adoption varies according to discipline. While it has advantages such as personalization and optimization of educational planning, challenges such as resistance to change and lack of adequate training are identified. It is concluded that ChatGPT has great potential to enrich education, but requires strategic planning, ongoing teacher training, and clear guidelines to ensure its ethical and pedagogical use.

McIntosh *et al.* (2025) explore the changing landscape of GenAI with a focus on technological advances and the possible scope of General Artificial Intelligence. It examines the current state and future trajectory of GenAI by exploring how innovations in the development of actionable, multimodal AI agents capable of solving complex reasoning tasks are reshaping research priorities and applications in various fields.

Within this group of studies, it is worth highlighting the contributions made by Dominguez Figaredo, Reich Ruipérez e Valiente (2020) to what they call learning analytics and data-driven education, based on the growth of digital mediation in educational spaces. The authors analyze the growth of research that takes as its reference the information that comes from student activity in these digital spaces and describe trends and challenges.

Other studies analyze the challenges and conditions for effective institutional implementation based on ethical, regulatory, academic integrity, or methodological challenges, as well as proposals for strategies or frameworks. This is the case of Chávez Solís *et al.* (2023), who seek to evaluate the contributions of GenAI in Higher Education and propose strategies to strengthen learning. The methodology they propose is qualitative. Through intentional sampling, they develop a convenience case strategy in students at public universities in Mexico. They conclude with the need for continuous improvement in the use and exploitation of AI and technological innovation.

García-Peñalvo, Llorens-Largo e Vidal (2024) reflect on the advantages, disadvantages, potential, limits, and challenges of generative artificial intelligence technologies in education,

with the aim of avoiding the biases inherent in extremist positions. To this end, they have carried out a systematic review of both the tools and the scientific output that has emerged in the first six months since the appearance of ChatGPT. They conclude that GenAI is extremely powerful and improving at a rapid pace, but it is based on large model languages with a probabilistic basis that may contain errors that need to be verified. On the other hand, many of the problems associated with these technologies in educational contexts already existed before their emergence, but now, due to their power, they are exposed and challenge teaching practice.

Lozada Lozada *et al.* (2023), through a documentary study, analyze the risks of AI in education and its repercussions on academic integrity and critical thinking. Among the results, they recognize the need for students to develop critical thinking and recommend that educational institutions include ethical and information protection statements in their regulatory frameworks.

Below there is a table summarizing the 12 articles mentioned and the site from which they were extracted: 5 studies from Dialnet ([2], [3], [5], [10], [12]), 3 studies from ResearchGate ([4], [6], [7]), 2 from Redalyc ([9], [11]), 1 from Scopus ([1]), and 1 from MDPI ([8]) (see Table 1).

Table 1 – Studies included in the analysis corpus

Code	Article	Database
[1]	Lim, et al. (2023)	Scopus - ScienceDirect
[2]	Vera (2023)	Dialnet
[3]	Carranza Alcántar et al. (2024)	Dialnet
[4]	Perezchica-Vega et al., (2024)	ResearchGate
[5]	García Peñalvo (2024)	Dialnet
[6]	Cordón García (2023)	ResearchGate
[7]	Díaz Vera et al. (2024)	ResearchGate
[8]	McIntosh et al., (2025)	MDPI
[9]	Dominguez Figaredo et al. (2020)	Redalyc
[10]	Chávez Solís et al., (2023)	Dialnet
[11]	García-Peñalvo, et al. (2024)	Redalyc
[12]	Lozada Lozada (2023)	Dialnet

Source: own elaboration.

SOCIAL, COGNITIVE AND PEDAGOGICAL IMPLICATIONS OF GENAI IN HIGHER EDUCATION

GenAI burst onto the Higher Education scene as a disruptive technology with the potential to redefine teaching and learning processes. Tools such as ChatGPT and Copilot enable the automation of tasks, the generation of personalized content, and support for other processes, such as curriculum design, formative assessment, and even research (Carranza Alcántar *et al.*, 2024).

However, it poses ethical and cultural challenges. According to Bedoya Villa *et al.* (2024) in Carranza Alcántar *et al.* (2024), one of the emerging problems is the ethical and regulatory gap that exists in Higher Education; as these technologies advance, genuine concerns arise about the authenticity of academic work, educational integrity, and responsible use. Along the same lines, Lozada Lozada *et al.* (2023) raise concerns about these types of risks and point to the need for further research to reveal the repercussions on both academic integrity and the development of critical thinking in students.

Other studies, such as that by Dominguez Figaredo, Reich Ruipérez e Valiente (2020), point to the growing use of digital mediation systems in most educational spaces. Digital educational tools facilitate interaction between students, teachers, and learning resources and continuously generate a significant volume of data, highlighting education as a field of data collection.

García Peñalvo (2024) reviews studies and compares benefits, risks, and future challenges from the perspective of teachers, students, administrators, and software developers. To take one example, from the students' point of view, the use of GenAI tools is recognized as a Socratic opponent, but the problem of so-called "hallucinations" is also identified, that is, invented content that, in the absence of further questioning, can condition learning and the development of critical thinking in students.

For García Peñalvo, Llorens-Largo e Vidal (2024), the application of GenAI in education and tools such as ChatGPT highlights weaknesses in current educational practices that already existed before its arrival but were difficult to admit. As the authors argue, the education system in general, and the university system in particular, were designed for a world with a scarcity of information, and people in the process of training went to educational centers to acquire it and store it for when it was needed. This has changed. Today, societies have immediate access to information and face the risks of information overload (truths or tautologies, half-truths or indeterminacies, and falsehoods or contradictions). The question then is whether universities can respond to the challenge posed by the arrival of "intelligent" applications that have caused an informational earthquake; in other words, confronting the emperor who is naked in front of the mirror of reality.

According to Carranza Alcántar *et al.* (2024), if the incorporation of GenAI is mishandled, it could exacerbate pre-existing problems related to technologies in education.

GENERATIVE AI APPLICATIONS AND TOOLS IN HIGHER EDUCATION

In accordance with the first objective of the study, the preceding section addresses an approximation of the social, pedagogical, and cognitive implications of GenAI in Higher Education. Now, in view of the second objective aimed at compiling and comparing GenAI

applications and tools in Higher Education, a systematization of tools identified in the literature is proposed.

Although we sought to meet this objective, it is also true that we did not necessarily intend to provide an exhaustive list of applications. The proposal is limited to establishing a preliminary classification with a tentative comparison of characteristics and potential educational use that highlight the sources of the analytical corpus and other references consulted to supplement the information. In effect, the comparison in Table 2 considers: a) type of creative content generation; b) function linked to the educational use of the tool; c) mode of access; and d) number of users (see Table 2).

Table 2 – GenAI applications and tools in Higher Education

Type of generation	Application / tool	Function	Access	Number of users
Chatbot as an educational assistant	ChatGPT (OpenAI)	AI-based assistant for content generation and virtual tutoring	Free with paid version (ChatGPT Plus)	200 million active users per week
	Gemini (Google)	Conversational assistant integrated into Google	Free with advanced paid features	No data
	Copilot (Microsoft)	Conversational assistant integrated into Microsoft products (Word, Excel, Teams)	Free with Microsoft 365 subscription	Between 20 and 30 million active users throughout 2024 (Curry, 2025)
	Grok (xAI-Elon Musk)	AI-based chatbot with a focus on dynamic and personalized responses	Free with X Premium+ subscription	Built into X
	DeepSeek	AI-based assistant for information retrieval and academic text generation	Free and open-source	33.7 million monthly active users worldwide (Backlinko, 2025)
Text generation and research support	Chat PDF	Conversion and analysis of PDF documents with AI	Free with payment options	No data
	Consensus	AI-based academic search engine for research	Free with payment options	No data
	Scite Assistant	AI assistant for citations and references in academic papers	Payment	No data
	Elicit	AI tool for searching and analyzing academic literature	Free	No data
	Scispace	Reading and analyzing scientific articles with AI	Free	No data
	Connected Papers	Explore academic articles in a visual graph	Free with payment options	No data

Grammar checker and writing assistance	**Trinka**	Grammar checker and academic and technical writing assistant	Payment	No data
	Grammarly	Writing assistant with grammar correction and style suggestions	Free with payment options	30 million monthly active users worldwide (González, 2023)
	Scholarcy	Generator of summaries of scientific articles and long documents	Payment	No data
Mind maps and text organization	**MindMeister**	Collaborative creation of online mind maps	Free with payment options	Over 20 million users
Image generation	**DALL-E (OpenAI)**	Creating images from textual descriptions	Free with payment options	Built into ChatGPT
	Midjourney	Image creation using AI	Payment	No data
Presentations and visual content	**Sway (Microsoft)**	Creating presentations with AI	Free with Microsoft subscription	Built into Microsoft
	Canva AI	Creation of presentations and images based on textual descriptions	Free with payment options	More than 100 million users
Video generation and editing	**WeVideo**	AI-based video editing	Free with payment options	More than 30 million users
	RunwayML	Video generation and advanced editing with AI	Payment	No data
Code generation and programming support	**Code Whisperer (Amazon)**	Code suggestions in programming	Free with payment options	No data
	Tabnine	AI-powered code completion in various programming languages	Free with payment options	No data
Generation of questionnaires and exams	**Quizbot**	Generation of multiple-choice, fill-in-the-blank, true/false, and matching question formats	Free with payment options	No data
	WirisQuizzes	Generation of online math exams	Free on learning platforms for schools with basic use	No data
	Thinkster Math	Online mathematics tutor	Payment	No data
Languages and translation	**Duolingo**	Language teaching through AI and gamification	Free with payment options	More than 500 million users
	DeepL	High-precision AI-powered machine translation	Free with payment options	No data
	Wordtune	Improve your English writing with AI	Free with payment options	No data
Plagiarism detection and text generation with AI	**Turnitin**	Plagiarism detection and AI detection in academic texts	Payment	15.000 educational institutions
	GPTZero	Detection of AI-generated texts	Free with payment options	No data
	Copyscape	Detection of plagiarism in academic texts	Payment	No data
	Sclaping AI	Detection of AI-generated texts and writing assistant	Payment	No data

Source: own elaboration.

Based on the analysis in Table 2, a series of general considerations are proposed related to perceptions, uses, and challenges for the implementation of GenAI in the university setting, such as:

a)   The universe of tools is vast, and there is a wide range on offer, especially since the launch of ChatGPT in 2022.

b)   According to Díaz Vera *et al.* (2024), ChatGPT is the most widely used tool. According to the literature, it has more than 200 million active users per week.

c)   The most prevalent type of generation is text generation, which can become important tools for research support and educational assistance.

d)   However, other types of creative generation are identified, such as the generation or transformation of text into high-quality images and videos; grammar correction and writing assistance; text organizers such as mind maps; code generation and programming support; questionnaire and exam generation; language teaching and translation; and plagiarism detectors and AI-generated texts.

e)   As shown by McIntosh *et al.* (2025) and corroborated in Table 2, in addition to ChatGPT, other models such as Gemini, Claude, Llama3, DeepSeek, among others, have been identified. While ChatGPT's dominance is significant, these other tools compete to expand and/or improve their service.

f)   The most emblematic and recent case is DeepSeek. According to McIntosh *et al.* (2025), DeepSeek offers similar features but with significant advantages, such as being a free and open-source tool.

g)   In terms of access, although there is a wide range of tools available, the free versions are limited in terms of advanced features.

h)   Studies such as García-Peñalvo, Llorens-Largo e Vidal (2024) warn that plagiarism detectors and AI-generated texts still have major limitations.

TOWARDS AN INTEGRATIVE ANALYSIS

Beyond interpretations linked to the implications and applications and tools corresponding to the previous sections, it is enriching to move forward with an integrative analysis that links the analytical corpus with the systematized applications.

In terms of perceptions and uses, Cordón García (2023) points out that AI applications in education have been developing for decades, while Vera (2023) indicates the potential of ChatGPT to provide information on a variety of topics, making it a valuable tool for teachers, researchers, and students alike.

For their part, Chávez Solís *et al.* (2023) suggest that teachers perceive the use of GenAI as a support for teaching. However, this study identifies chatbots and virtual assistants as educational assistance tools highlighted in the literature. This leads to a difference with the authors cited, who highlight that teachers recognize videoconferencing software as the main GenAI tools.

Likewise, Chávez Solís *et al.* (2023) note a lack of use by teachers of tools such as ChatGPT for assessment tasks. In dialogue with this proposal, Diaz Vera *et al.* (2024) argue that the activities of "content preparation" and "development of teaching materials" are the most

frequently used, while the least frequent are "grading methods and rubrics", "feedback and student assistance" and "document summarization and consultation".

In Table 2, under the description of functions, a lack of specificity in terms of assessment-related features can be observed. Applications linked to assessment, especially free ones, seem to be limited to the generation of questionnaires rather than promoting formative assessment proposals (see Table 2).

Finally, as noted by Vera (2023) and Perezchica-Vega *et al.* (2024), the growing effectiveness in solving specific tasks such as writing articles, translating languages, or solving mathematical operations raises concerns in the academic field and a need to explore strategies that promote critical thinking, creativity, and academic integrity, but also proposals that urgently address ethical and justice challenges.

CONCLUSION

The review provided a comprehensive examination of the incorporation of GenAI in Higher Education, identifying its main uses, challenges, and risks. In response to the first objective, the analysis showed that, although these tools have the potential to offer opportunities for pedagogical innovation, personalized learning, and the optimization of teaching tasks, they also pose significant challenges for access, academic integrity, and critical understanding—both for students and for the automation processes themselves.

The findings confirm that the social, pedagogical, and cognitive implications are interdependent: digital divides and inequalities in access affect the possibilities for effective incorporation; application without a specific ethical and regulatory framework can affect critical thinking; technological overuse influences academic integrity, the autonomy of teachers and students, knowledge production, and creativity, as well as additional related domains.

With regard to the second objective, it is necessary to develop teacher training programs and appropriate pedagogical strategies to ensure the responsible and critical use of these tools; promote digital skills and design methodologies that promote critical thinking, as well as assessment systems in line with these proposals. This requires clear guidelines on the responsible use of AI and regulatory frameworks to guide its use, establishing limits and responsibilities for teachers and students, as well as for institutions in general.

Among the limitations, it is worth mentioning that this is a literature review proposal that recognizes the difficulties in covering the vast academic production, given the novelty of the subject and the constant changes in technology. Future research should delve deeper into case studies that allow for a more detailed analysis of the incorporation of these technological solutions, according to institutional cultures and the profile of academic disciplines; review of

good practices and research and monitoring strategies, so that frameworks for action can be constructed that integrate innovation and educational justice. In other words, rather than asking whether GenAI should be incorporated, the relevant question for universities is how to redesign pedagogical, evaluative, and institutional frameworks in a context where generative systems are already embedded in cognitive and academic practices.

REFERENCIAS

BACKLINKO. DeepSeek AI Usage Stats. *Backlinko*, 25 fev. 2025. Available in: https://backlinko.com/deepseek-stats. Access at: 7 oct. 2025.

BODEN, Margaret. *Inteligencia artificial.* Madrid: Turner, 2017.

CARRANZA ALCÁNTAR, María del Rocío; MACÍAS GONZÁLEZ, Gizelle Guadalupe; GÓMEZ RODRÍGUEZ, Horacio; JIMÉNEZ PADILLA, Alma Azuzena; JACOBO MONTES, Fátima Montserrath. Percepciones docentes sobre la integración de aplicaciones de IA generativa en el proceso de enseñanza universitario. *REDU. Revista de Docencia Universitaria*, Valencia, v. 22, n. 2, p. 158-176, 2024. DOI: https://doi.org/10.4995/redu.2024.22027. Available in: https://polipapers.upv.es/index.php/REDU/article/view/22027. Access at: 7 oct. 2025.

CASTELLS, Manuel. *The rise of the network society* (Vol. 1). Blackwell, 1996.

CHÁVEZ SOLÍS, María Elena; LABRADA MARTÍNEZ, Esther; CARBAJAL DEGANTE, Eric; PINEDA GODOY, Erika; ALATRISTE MARTÍNEZ, Yadira. Inteligencia artificial generativa para fortalecer la educación superior. *LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades*, Asunción, v. 4, n. 3, p. 767-784, 2023. DOI: https://doi.org/10.56712/latam.v4i3.1113. Available in: https://latam.redilat.org/index.php/lt/article/view/1113. Access at: 7 oct. 2025.

CORDÓN GARCÍA, Oscar. Inteligencia artificial en educación superior: oportunidades y riesgos. *RiiTE Revista Interuniversitaria de Investigación en Tecnología Educativa*, Murcia, v. 15, p. 16-27, 2023. DOI: https://doi.org/10.6018/riite.591581. Available in: https://revistas.um.es/riite/article/view/591581. Access at: 7 oct. 2025.

CRAWFORD, Kate. *Atlas de inteligencia artificial: poder, política y costos planetarios*. Buenos Aires: Fondo de Cultura Económica, 2022.

CURRY, David. Microsoft Copilot revenue and usage statistics (2025). *Business Of Apps*, 22 jan. 2025. Available in: https://www.businessofapps.com/data/microsoft-copilot-statistics/#:~:text=Copilot%20ha%20tenido%20entre%2020,m%C3%B3vil%20y%20el%20sitio%20web. Access at: 7 oct. 2025.

DIAZ VERA, Janeth Pilar; MOLINA IZURIETA, Rosa; BAYAS JARAMILLO, Carlota Maria; RUIZ RAMÍREZ, Alicia Karina. Asistencia de la inteligencia artificial generativa como herramienta pedagógica en la educación superior. *RITI Revista de Investigación en Tecnologías de la Información*, Barcelona, v. 12, n. 26, p. 61-76, 2024. DOI: https://doi.org/10.36825/RITI.12.26.006. Available in: https://riti.es/index.php/riti/article/view/294. Access at: 7 oct. 2025.

DOMÍNGUEZ FIGAREDO, Daniel; REICH, Justin; RUIPÉREZ VALIENTE, José. A. Analítica del aprendizaje y educación basada en datos: un campo en expansión. *RIED-Revista Iberoamericana de Educación a Distancia*, Madrid, v. 23, n. 2, p. 33-43, 2020. DOI: https://doi.org/10.5944/ried.23.2.27105. Available in: https://revistas.uned.es/index.php/ried/article/view/27105. Access at: 7 oct. 2025.

EUROPEAN COMMISSION. *High-Level Expert Group on Artificial Intelligence. A definition of AI: main capabilities and scientific disciplines*. 2019. Available in: https://digital-strategy.ec.europa.eu/en/library/definition-artificial-intelligence-main-capabilities-and-scientific-disciplines. Access at: 7 oct. 2025.

GARCÍA-PEÑALVO, Francisco José. Inteligencia artificial generativa y educación: un análisis desde múltiples perspectivas. *Education in the Knowledge Society (EKS)*, Salamanca, v. 25, p. 1-10, 2024. DOI: https://doi.org/10.14201/eks.31942. Available in: https://revistas.usal.es/tres/index.php/eks/article/view/31942. Access at: 7 oct. 2025.

GARCÍA-PEÑALVO, Francisco José; LLORENS-LARGO, Faraón; VIDAL, Javier. La nueva realidad de la educación ante los avances de la inteligencia artificial generativa. *RIED-Revista Iberoamericana de Educación a Distancia*, Madrid, v. 27, n. 1, p. 9-39, 2024. DOI: https://doi.org/10.5944/ried.27.1.37716. Available in: https://revistas.uned.es/index.php/ried/article/view/37716. Access at: 7 oct. 2025.

GONZÁLEZ, Fernanda. GrammarlyGO: la nueva IA generativa que promete revolucionar la escritura. *Wired*, 20 mar. 2023. Available in: https://es.wired.com/articulos/grammarlygo-inteligencia-artificial-para-escribir-correctamente. Access at: 7 oct. 2025.

LIM, Weng Marc; GUNASEKARA, Asanka; PALLANT, Jason Ian; PALLANT, Jessica Leigh; PECHENKINA, Ekaterina. Generative AI and the future of education: ragnarök or reformation? A paradoxical perspective from management educators. *The International Journal of Management Education*, v. 21, n. 2, p. 1-13, 2023. DOI: https://doi.org/10.1016/j.ijme.2023.100790. Available in: https://www.sciencedirect.com/science/article/pii/S1472811723000289?via%3Dihub. Access at: 7 oct. 2025.

LOZADA LOZADA, Roberto Fernando; LOPEZ AGUAYO, Estefany Maria; ESPINOZA SUQUILANDA, Mariana de Jesus; ARIAS PICO, Narcisa de Jesus; QUILLE VÉLEZ, Grace Edith. Los riesgos de la inteligencia artificial en la educación. *Ciencia Latina Revista Científica Multidisciplinar*, Ciudad de México, v. 7, n. 5, p. 7219-7234, 2023. DOI: https://doi.org/10.37811/cl_rcm.v7i5.8301. Available in: https://ciencialatina.org/index.php/cienciala/article/view/8301. Access at: 7 oct. 2025.

MARX, Karl. *Capital: A critique of political economy* (Vol. 1, B. Fowkes, Trans.). Penguin Books, 1976. (Original work published 1867).

MCINTOSH, Timothy. R.; SUSNJAK, Teo; LIU, Tong; WATTERS, Paul; XU, Dan; LIU, Dong; HALGAMUGE, Malka. From Google Gemini to OpenAI Q* (Q-Star): a survey on reshaping the generative artificial intelligence (AI) research landscape. *Technologies*, Basel, v. 13, p. 51,

2025. DOI: https://doi.org/10.3390/technologies13020051. Available in: https://www.mdpi.com/2227-7080/13/2/51. Access at: 7 oct. 2025.

PEREZCHICA-VEGA, José Eduardo; SEPÚLVEDA-RODRÍGUEZ, Jesuán Adalberto; ROMÁN-MÉNDEZ, Alan David. Inteligencia artificial generativa en la educación superior: usos y opiniones de los profesores. *European Public & Social Innovation Review*, Madrid, v. 9, p. 01-20, 2024. DOI: https://doi.org/10.31637/epsir-2024-593. Available in: https://epsir.net/index.php/epsir/article/view/593. Access at: 7 oct. 2025.

PORCELLI, Adriana Margarita. La inteligencia artificial y la robótica: sus dilemas sociales, éticos y jurídicos. *Derecho global. Estudios sobre derecho y justicia*, Guadalajara, v. 6, n. 16, p. 49-105, 2020. DOI: https://doi.org/10.32870/dgedj.v6i16.286. Available in: https://derechoglobal.cucsh.udg.mx/index.php/DG/article/view/286. Access at: 7 oct. 2025.

SILVERIO, Mario. ChatGPT: número de usuarios y estadísticas. *Primeweb*, 9 dez. 2024. Available in: https://www.primeweb.com.mx/chatgpt-usuarios-estadisticas#:~:text=Fecha%20de%20lanzamiento%3A%20ChatGPT%20fue,2024%20(axios.com). Access at: 7 oct. 2025.

UNESCO. *Inteligencia artificial y educación: guía para las personas a cargo de formular políticas*. Paris: UNESCO, 2021. Available in: https://unesdoc.unesco.org/ark:/48223/pf0000379376. Access at: 7 oct. 2025.

UNESCO. *ChatGPT e inteligencia artificial en la educación superior: guía de inicio rápido*. 2023. Available in: https://unesdoc.unesco.org/ark:/48223/pf0000385146_spa. Access at: 7 oct. 2025.

VERA, Fernando. Integración de la inteligencia artificial generativa en la educación superior. *Transformar*, v. 4, n. 4, p. 36-46, 2023. Available in: https://www.revistatransformar.cl/index.php/transformar/article/view/108. Access at: 7 oct. 2025.

Betiana Elizabeth Vargas

Master´s degree in Social Sciense (FLACSO-Argentina). PhD candidate in Development Studies (UAZ-Mexico). Fellow of the Secretariat of Science, Humanities, Technology, and Innovation (SECIHTI), Mexico. Doctoral research topic: Artificial Intelligence (AI) in Higher Education in Mexico and Argentina in the period 2018-2025. Specialist in Education and New Technologies (FLACSO-Argentina). Bachelor´s degree in Psychopedagogy (UNRC-Argentina). Diploma in Strategic Anticipation and Risk Management (UNDEF-Argentina) and in Community, Peasant, and Popular Feminisms in Abya Yala (UNJu-Argentina).

betiana.vargas@uaz.edu.mx.

Edgar Záyago Lau

Master´s degree in Development Studies from Saint Mary's University, Canada (2005) and PhD in Development Studies from Autonomous University of Zacatecas (2009). Postdoctoral fellow at the Center for Nanotechnology and Society at the University of California (2012-2013). Technical Secretary of the Latin American Network on Nanotechnology and Society (ReLANS). Member of the National System of Researchers of Mexico – SNI III level II, and of the Mexican Academy of Sciences (AMC).

zayagolau@gmail.com