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Academic literacy assisted by generative artificial intelligence: impact on the quality of disciplinary writing

La alfabetización académica asistida por inteligencia artificial generativa: impacto en la calidad de la escritura disciplinaria

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ABSTRACT

The present study examines the impact of integrating generative artificial intelligence (GenAI) tools into the development of academic writing skills, with a particular emphasis on disciplinary literacy and multimodal representation as foundational pillars for the construction and effective communication of scientific discourse. This quasi-experimental, mixed-methods research involved 150 university students, divided into an experimental group that exclusively used generative AI tools and a control group that applied traditional writing strategies. The AIAS scale and the PAIR intervention model were employed to ensure that the use of technology complemented critical thinking processes and student authorship rather than replacing them. Results, obtained through a validated rubric, assessed key aspects such as textual coherence and cohesion, grammatical accuracy, proper handling of bibliographic references, and integration of visual elements. Significant improvements were observed across all evaluated aspects, particularly in the ability to articulate more structured academic discourse and effectively integrate multimodal resources. These findings underscore the potential of generative AI not only to optimize writing processes but also to enhance analytical skills and expand students' expressive resources in academic contexts. The research highlights the need to establish pedagogical frameworks to regulate its implementation, fostering critical thinking and comprehensive education in higher education.

RESUMEN

El presente estudio examina el impacto de la integración de herramientas de inteligencia artificial generativa en el desarrollo de competencias de escritura académica, con un énfasis particular en la alfabetización disciplinar y la representación multimodal como pilares en la construcción y comunicación efectiva del discurso científico. La investigación, de diseño cuasiexperimental y enfoque mixto, involucró a 150 estudiantes universitarios, organizados en un grupo experimental que utilizó exclusivamente herramientas de IAG y un grupo de control que aplicó estrategias de composición escrita tradicionales. Se emplearon la escala AIAS y el modelo de intervención PAIR para garantizar que el uso de la tecnología complementara los procesos de pensamiento crítico y la autoría del estudiante, en lugar de sustituirlos. Los resultados, obtenidos mediante una rúbrica validada, evaluaron aspectos clave como coherencia y cohesión textual, corrección gramatical, manejo adecuado de referencias bibliográfica e integración de elementos visuales. Se evidenciaron mejoras significativas en todos los aspectos evaluados, especialmente en la capacidad para articular discursos académicos más estructurados y en la integración efectiva de recursos multimodales. Estos hallazgos ponen de relieve el potencial de la IAG no solo para optimizar los procesos de escritura, sino también para fortalecer las competencias analíticas y ampliar los recursos expresivos de los estudiantes en contextos académicos. La investigación evidencia la necesidad de establecer marcos pedagógicos que regulen su implementación, fomentando el pensamiento crítico y una formación integral en la educación superior.

KEYWORDS · PALABRAS CLAVES

Generative Artificial Intelligence; academic literacy; higher education; quality of disciplinary writing

Inteligencia Artificial Generativa; alfabetización académica; educación superior; calidad de la escritura disciplinar

1. Introduction

1.1. Academic writing and disciplinary literacy

Academic writing functions as a key instrument for integration and active participation within the scientific community of each discipline (Biber & Gray, 2010; Carlino, 2013). Mastery of this form of writing entails not only the capacity to communicate complex ideas clearly and coherently, but also to contribute to the advancement of disciplinary knowledge through discursive practices aligned with the epistemological and rhetorical standards of each field. In higher education, such training plays a crucial role in students' academic success, as it supports the appropriation of the discourses specific to each disciplinary domain and fosters autonomous, meaningful learning.

Proficiency in writing within formal academic contexts constitutes a complex challenge that encompasses aspects such as discursive organisation, the appropriate use of linguistic structures associated with formal registers, and the critical and relevant integration of bibliographic references (McKinley, 2013). Research has shown that explicit and systematic instruction in writing strategies contributes significantly to the development of advanced writing competences (Fathi & Rahimi, 2024; Cassany & Castelló, 2010). However, several factors—such as limited time, scarce resources, insufficient teacher training, and the lack of continuous support—hamper the effective implementation of pedagogical practices focused on academic writing development (Jin et al., 2025). These limitations highlight the need to explore alternative pedagogical approaches and support tools that complement teaching practice and strengthen teaching–learning processes in this area.

Academic production has historically been enriched through the incorporation of alternative modes of representation—such as images, graphs and diagrams—which, when combined with digital tools, enhance expository clarity and contribute to more effective discursive structuring (Kress & van Leeuwen, 2020; Díaz-Cuevas & Rodríguez-Herrera, 2024). Multimodal writing, by integrating diverse forms of communication, facilitates the understanding of complex concepts and promotes a dynamic interaction between text and readers, making it a highly relevant pedagogical strategy in educational settings (Derga et al., 2024; Walter, 2024). Within this framework, advances in generative artificial intelligence (GenAI) have broadened the possibilities for the revision, optimisation and enrichment of texts, supporting the ethical and critical integration of these resources into disciplinary literacy processes and academic training (Wang et al., 2024).

1.2. Integration of GenAI in academic writing

The incorporation of GenAI into writing processes has been the subject of critical analysis due to its capacity to enhance discursive cohesion, correct grammatical errors, and structure ideas in a logical manner (Goulart et al., 2024; Acosta, 2024). Recent studies have examined different tools (such as ChatGPT, Copilot and Gemini), highlighting their ability to improve the organisation and clarity of texts, thereby optimising their quality before reaching the final version (Aladini et al., 2025; Teng, 2024).

The use of GenAI in teaching and learning requires an approach grounded in solid pedagogical principles and appropriate regulation. Without clear guidance, these technologies may foster dependency on automated content generation, potentially limiting the development of key skills such as autonomous learning and students' argumentative

capacity (García-Peñalvo, 2024; Kalifa & Albadawy, 2024). For this reason, it is essential to establish pedagogical frameworks that not only guide the use of these tools but also promote metacognition and critical thinking—skills that are crucial for enabling students to analyse, evaluate and select, in a well-reasoned manner, the information generated by these technologies (Huang & Teng, 2025).

Furthermore, the development of models such as the AIAS (Artificial Intelligence Assessment Scale) has made it possible to identify levels of use in which GenAI functions as a complementary resource that strengthens students' abilities without replacing them. These strategies have proved effective in supporting more autonomous and meaningful learning, reinforcing the importance of integrating these technologies ethically and critically into educational processes (Perkins et al., 2024; Ayuso & Gutiérrez-Esteban, 2022). This perspective underscores the need to employ GenAI as a tool that enriches students' competences and fosters their overall development in academic settings.

1.3. Benefits, challenges and ethical considerations in the use of GenAI in higher education

The use of artificial intelligence in disciplinary writing has shown a positive impact across multiple dimensions. Among its most notable contributions are the optimisation of the time devoted to text production, improvements in grammatical and stylistic accuracy, and the mitigation of cognitive blocks that often hinder idea generation during writing (Román-Acosta, 2023). By providing immediate and detailed feedback, these technologies facilitate students' autonomous detection of errors, enhancing self-regulation processes and strengthening their confidence in written production (Wise et al., 2024). This approach not only expands opportunities for autonomous learning but also positions artificial intelligence as a tool with high potential for the development of advanced competences in academic writing.

Nevertheless, the incorporation of GenAI in educational contexts raises the challenge of potential overreliance on these tools, which may limit the development of fundamental skills such as argumentation and originality in writing (Davis & Csáik, 2024; Fiorillo, 2024). This risk underscores the need to train students in the critical use of these technologies, promoting practices that balance their integration with the strengthening of cognitive and creative competences (Su et al., 2024; Pigg, 2024).

From an ethical and regulatory perspective, the use of emerging technologies raises concerns regarding model transparency and algorithmic biases, issues that trouble the scientific community due to their implications for fairness and reliability (Ou et al., 2024). The assistance provided by GenAI in written composition constitutes a challenge for academic integrity, particularly in relation to authorship attribution and the limitations of current systems in identifying texts generated with these tools, which complicates the detection of potential plagiarism (Casheekar et al., 2024). In response to these concerns, regulatory proposals have been developed that include the implementation of policies focused on the ethical and responsible use of these technologies, together with the promotion of digital literacy programmes incorporating principles of accountability (García-Peñalvo, 2024). Moreover, the design of pedagogical strategies that guide the critical and strategic use of these technologies is essential for strengthening students' analytical capacity during the process of reviewing and editing AI-generated texts (García-Peñalvo et al., 2024; Ciaccio, 2023).

2. Objectives

General objective

To analyse the impact of GenAI tools on the development of disciplinary writing competences in university students.

Specific objectives

- To evaluate the quality of academic texts produced with and without the use of GenAI tools, considering dimensions such as coherence, cohesion, terminological accuracy, argumentation, and adherence to disciplinary conventions, including bibliographic referencing.
- To examine the impact of GenAI tools on the different stages of the disciplinary writing process, encompassing idea generation, planning, text structuring, revision and editing.
- To explore students' perceptions regarding the use of GenAI tools in academic writing, analysing their perceived usefulness, ease of use, and influence on confidence and autonomy during the writing process.
- To determine the relationship between the use of GenAI tools and the development of disciplinary writing competences, assessing the extent to which these tools contribute to improved argumentation, logical structuring and appropriate use of academic language.

3. Methodology

The study adopted a mixed-methods approach (quantitative–qualitative) and a quasi-experimental design with non-equivalent groups, appropriate for educational contexts in which random assignment is not feasible (Creswell, 2014; Shadish, Cook & Campbell, 2002). The experimental group integrated GenAI tools into the academic writing process, whereas the control group employed conventional strategies.

The intervention was aligned with Level 3 of the AIAS scale (Perkins et al., 2024), which defines a formative and reflective use of GenAI. This level was selected for its relevance in educational contexts that aim to strengthen students' autonomy and writing competence. Within this framework, GenAI functions as a cognitive mediator, offering feedback and structural support without replacing authorship or critical thinking. Learning is therefore oriented towards the development of metacognitive and discursive competences, avoiding technological dependency.

Complementarily, the PAIR framework (Problem, AI Selection, Interaction and Reflection) was applied as the pedagogical structure of the intervention. This model was operationalised through work sequences in which students (1) identified a specific writing need, (2) selected the most suitable tool to address it, (3) interacted critically with the GenAI system by evaluating its suggestions, and (4) reflected on the revisions made. This process enabled GenAI to be incorporated as a dialogic resource in learning, fostering self-regulation, critical thinking and awareness of one's own writing process.

3.1. Sample

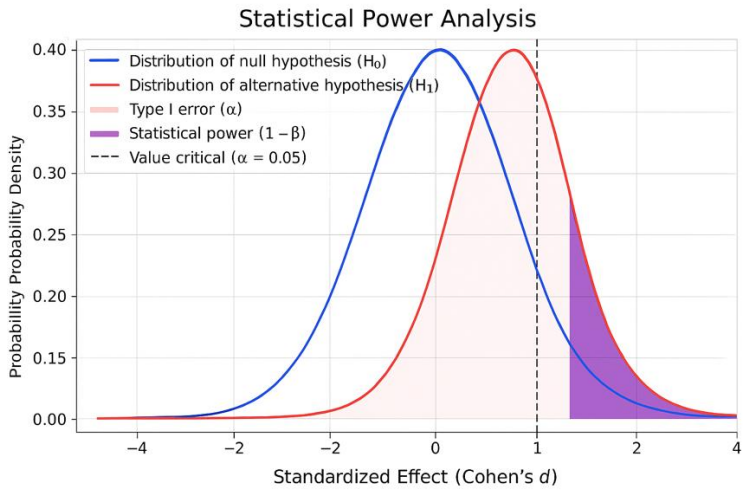
A total of 150 fourth-year students from the Primary Education Degree at the University of Almería participated in the study (75 in the experimental group and 75 in the control group). The sample size was determined through a power analysis (α = 0.05, power = 0.80, d = 0.50), which confirmed its adequacy for detecting significant differences between groups (Cohen, 1988).

The selection was non-probabilistic and based on convenience, respecting the pre-existing organisation of the groups. Students with prior experience using GenAI tools or those who did not complete all phases of the study were excluded. The attrition rate (3.3%) was statistically negligible.

Before the intervention, an initial diagnostic test was administered, consisting of a brief academic writing task on a general educational topic. The texts were assessed using the same rubric employed in the study to verify the initial equivalence between groups. The results confirmed homogeneity in writing skills ($t(148) = 0.87$, $p = 0.382$), ensuring the validity of subsequent comparisons.

Figure 1

Statistical power analysis.



Source: own elaboration.

3.2. Study phases

The study was carried out in three phases: pre-test, intervention and post-test.

- Pre-test. Students were asked to produce an argumentative essay without technological assistance ("How can AI improve teaching and learning?"). The texts were assessed using an ad hoc rubric composed of six dimensions: coherence, cohesion, linguistic accuracy, argumentative strength, use of references and quality of visual elements.
- Intervention. Over four weeks, academic writing activities were implemented using differentiated methodologies. The experimental group worked with tools such as ChatGPT, Copilot, Gemini, DeepSeek, Scopus AI, Consensus, Canva

and Napkin, exclusively for revising, structuring and optimising their own texts, in accordance with Level 3 of the AIAS scale. The control group followed traditional methods without technological mediation.

- Post-test. Students were asked to write a new argumentative essay ("Should the use of AI in education be regulated?"), assessed using the same rubric. In addition, the experimental group completed a perception questionnaire and a tool-use log (frequency, duration and type of modifications).

3.3. Data analysis instruments

Three main instruments were used: a writing assessment rubric, a perception questionnaire, and a log of GenAI tool use. All were designed and validated by specialists in Language and Literature Didactics and educational assessment.

The analysis of academic writing was conducted using a rubric that enabled precise and consistent evaluation of the pre-test and post-test productions. The rubric included six dimensions: textual coherence and cohesion, grammatical and stylistic accuracy, appropriate use of bibliographic references, quality of graphs and tables, integration of visual elements, and academic clarity. Each dimension was rated on a Likert scale from 1 (very low) to 5 (excellent).

The instrument underwent a validation process through expert judgement, during which specialists reviewed the clarity of the criteria and their alignment with the study objectives. Cronbach's alpha ($\alpha = 0.91$) confirmed a high level of internal consistency and accuracy in the evaluation.

The perception questionnaire was administered to the experimental group to explore students' views on the use of GenAI tools in academic writing. It included Likert-scale items (1–5) and open-ended questions addressing aspects such as ease of use, perceived usefulness, impact on confidence and creativity, and challenges in technological integration.

Before administration, a pilot test was conducted with 20 students with similar characteristics to the sample but not involved in the intervention. This phase allowed verification of item clarity and relevance, leading to the revision of two questions. The questionnaire showed high internal reliability ($\alpha = 0.94$).

Open-ended responses were analysed through inductive thematic coding (Braun & Clarke, 2006), carried out in three stages: exploratory reading, open coding, and category grouping. This process identified four main categories:

1. Facilitation of the writing process, highlighting that GenAI helped organise ideas and improve text structure.

2. Optimisation of reference use, valuing the tool's capacity to manage citations and sources.

3. Incorporation of multimodal elements, recognising the positive impact of AI-generated graphics and visualisations.

4. Challenges in adapting to GenAI, referring to initial difficulties and the evaluation of the reliability of AI-generated suggestions.

Finally, the tool-use log recorded the frequency and duration of use of each application, as well as the functionalities employed during the planning, drafting and revision of the essays. These data made it possible to quantify interaction with the technology and analyse its influence on the improvement of written production.

3.4. Data analysis

For the data analysis, SPSS software was used (IBM SPSS Statistics for Windows, Version 28.0), applying different statistical tests to assess the evolution of writing quality and the relationship between the use of GenAI tools and the outcomes obtained. First, an analysis of covariance (ANCOVA) was conducted to compare post-test scores while adjusting for initial pre-test differences, ensuring that the effects observed were attributable to the intervention rather than to pre-existing variations between groups. ANCOVA was selected due to its capacity to control potential biases and to improve the accuracy of results by reducing unexplained variability. The assumptions of homogeneity of regression slopes and normality of residuals were verified, ensuring the validity of the statistical model. In addition, F-statistic and p-value results were calculated to determine the significance of the differences identified.

Alongside the ANCOVA, descriptive analyses were performed to characterise the frequency and duration of GenAI tool use in the experimental group. The number of interactions with each tool, the total time dedicated, and the specific functionalities employed were documented. To complement the quantitative analyses, a qualitative analysis of the open-ended questionnaire responses was carried out, enabling the identification of patterns in students' perceptions regarding the usefulness of the tools, the difficulties encountered, and the impact on confidence and creativity when writing academic texts.

The combined use of quantitative and qualitative methods provided a comprehensive understanding of the impact of GenAI tools on academic writing. The inclusion of ANCOVA in the statistical analysis strengthened the reliability of the findings, ensuring that differences between the experimental and control groups were the result of the intervention rather than external factors. Furthermore, the validation of the instruments employed ensured the consistency and accuracy of the data collected. This approach enabled a rigorous determination of the impact of artificial intelligence on the improvement of academic writing, offering both objective and subjective evidence regarding participants' perceptions and performance throughout the study.

4. Results

The findings of the study show statistically significant differences between the experimental group and the control group across all dimensions of academic writing. The analysis of covariance (ANCOVA), with pre-test scores included as a covariate, confirmed that the pedagogical use of GenAI produced substantial and consistent improvements in text quality, both in linguistic and discursive aspects as well as in multimodal components. Table 1 presents the means, standard deviations and F-values for the post-test in each of the evaluated dimensions.

Table 1

Comparison of means by academic writing dimensions (post-test).

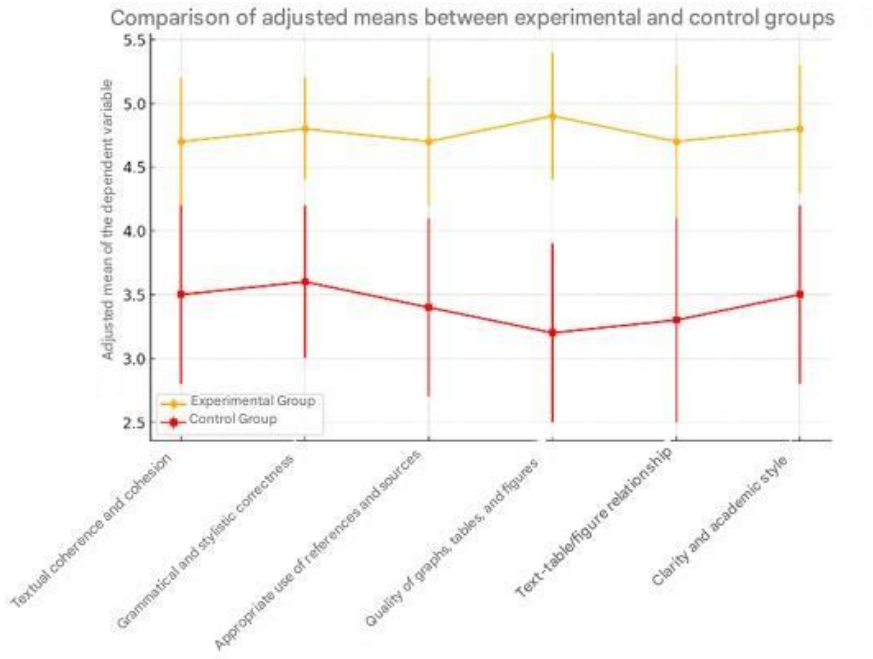
Evaluated dimension	Control group (M ± DT)	Experimental group (M ± DT)	F	p
Coherence and cohesion	3.5 ± 0.7	4.7 ± 0.5	52.41	<.001
Grammatical and stylistic accuracy	3.6 ± 0.6	4.8 ± 0.4	58.33	<.001
Use of bibliographic references	3.4 ± 0.7	4.7 ± 0.5	49.02	<.001
Integration of visual elements	3.3 ± 0.8	4.7 ± 0.6	54.89	<.001
Academic clarity and style	3.5 ± 0.7	4.8 ± 0.5	56.12	<.001

As shown in Figure 2, the experimental group presents significantly higher adjusted means across all dimensions of academic writing, once initial differences were controlled through the analysis of covariance (ANCOVA).

The consistent separation between the two lines reflects a sustained overall improvement, particularly in textual coherence and cohesion, grammatical accuracy, and the use of references. These differences confirm that the pedagogical integration of GenAI enhanced the discursive and stylistic quality of the texts produced.

Figure 2

Adjusted mean comparison between the experimental and control groups (ANCOVA).



Source: The bars indicate the 95% confidence intervals of the adjusted means. Author's elaboration.

Use of GenAI tools

The activity log of the experimental group enabled the analysis of the frequency and duration of use for each tool.

As shown in Table 2, ChatGPT and Copilot were the most frequently used, followed by Gemini and DeepSeek. Reference management tools (Scopus AI and Consensus) and visual design tools (Canva and Napkin) showed moderate but consistent use, indicating a balanced integration of linguistic, documentary and visual functions.

Table 2

Frequency and average time of use of GenAI tools (experimental group).

Tool	Mean frequency (± SD)	Mean time (min ± SD)
ChatGPT	9.2 ± 2.1	125 ± 15
Copilot	7.8 ± 1.9	110 ± 14
Gemini	6.5 ± 1.6	95 ± 12
DeepSeek	5.9 ± 1.8	85 ± 10
Scopus AI	5.3 ± 1.4	75 ± 11
Consensus	4.7 ± 1.5	68 ± 9
Canva	4.5 ± 1.2	62 ± 8
Napkin	3.8 ± 1.0	55 ± 7

The usage pattern shows that students employed GenAI primarily as a support resource for revising, structuring and optimising their texts, in line with Level 3 of the AIAS scale, which promotes a formative and reflective use of technology.

Perceptions and qualitative analysis

The perception questionnaire administered to the experimental group confirmed a broadly positive evaluation of the use of GenAI tools in the academic writing process.

Ninety-five per cent of participants considered that the tools facilitated idea generation and organisation, 97% perceived an improvement in grammatical and stylistic accuracy, and 93% highlighted the contribution of visual resources to the clarity and presentation of their texts. In addition, 89% reported that GenAI helped them manage their writing time more effectively and meet deadlines.

The thematic analysis of the open-ended responses identified five main categories (see Table 3), which synthesise the students' most representative perceptions.

Table 3

Synthesis of qualitative categories, evidence and pedagogical guidelines.

Category	Definition	Evidence and codes	Relevance	Pedagogical guideline
Organisation and structuring of discourse	Use of GenAI to plan and organise ideas	“initial outline”, “transitions”, “mind map”	High	Promote planning guides and metacognitive reflection.
Grammatical and stylistic improvement	Linguistic revision and adjustment to academic register	“academic tone”, “terminological coherence”	High	Clarify the role of GenAI as support rather than substitution.
Reference management	Search and formatting of academic sources	“citation verification”, “APA format”	High	Include protocols for traceability and reliability.
Integration of visual elements	Use of graphics and diagrams coherent with the text	“graphic summary”, “text–figure cohesion”	Medium	Design rubrics for critical reading of visual resources.
Initial difficulties in use	Usability barriers and comprehension of outputs	“learning curve”, “tool opacity”	Focused	Provide initial training and prompt templates.

Students’ perceptions confirm that GenAI is viewed primarily as a cognitive mediator that facilitates planning, revision and the integration of resources, rather than as a substitute for the writing process. Students acknowledge both the formative potential of these tools and the need for teacher guidance and critical reflection to ensure ethical, autonomous and informed use.

Taken together, the quantitative results, usage logs and qualitative perceptions converge in indicating that the didactic and reflective integration of GenAI significantly enhances university students’ writing competence. The use of AI as a cognitive mediator promotes self-regulation, metalinguistic awareness and the ability to carry out critical revision of one’s own text, provided that it is embedded within pedagogical strategies that preserve authorship, autonomy and the ethical dimension of academic learning.

5. Discussion and conclusions

The findings of this study confirm that the pedagogical incorporation of GenAI tools has a positive impact on the quality of academic writing in higher education, in line with previous research highlighting their potential to improve discursive coherence, linguistic accuracy and the argumentative organisation of texts (Amo Sánchez-Fortún & Domínguez-Oller, 2024; Dai et al., 2023; García-Peñalvo, 2024; Zheng et al., 2024). The improvements observed in the experimental group—particularly in coherence, accuracy, use of references and integration of visual elements—demonstrate that GenAI can function as an effective cognitive mediator when its use is framed within a structured formative approach.

The use of Level 3 of the AIAS scale and the PAIR model (Problem, Selection, Interaction, Reflection) was decisive in ensuring a balanced pedagogical integration of the technology. This approach allowed GenAI to operate as a support resource for the thinking process rather than as a substitute for academic judgement. Students retained an active role in planning, revising and validating their texts, thus avoiding cognitive automation. This finding aligns with the warnings of Wise et al. (2024) regarding the risks of excessive technological dependence, which can limit creativity and the development of critical competences if guided-use frameworks are not established. Similarly, Perkins et al. (2024) argue that a model of reflective integration—such as PAIR—supports student autonomy and informed decision-making regarding the contributions of AI.

From an epistemological perspective, the findings invite a reconsideration of the notion of academic authorship in environments mediated by artificial intelligence. The technology does not replace the author's voice; rather, it puts it to the test, requiring constant decision-making regarding what to accept, modify or discard. In this way, the quality of the written text depends not only on the final product but also on the critical capacity with which the human author evaluates, adjusts and validates automated suggestions. This interaction shapes a new scenario of textual co-production, where cognitive responsibility and process traceability become central pillars of contemporary academic ethics.

In pedagogical terms, the integration of GenAI supported the acquisition of metacognitive skills. Students not only improved discursive organisation and textual cohesion—as noted by Teng (2024) and Ou et al. (2024)—but also developed greater awareness of their own linguistic and structural decisions. This reflective dimension is key to preventing cognitive dependence and consolidating critical academic literacy. Teaching students to distinguish between what the tool suggests and what disciplinary criteria validate therefore becomes a core competence in higher education.

The study also showed a positive impact of GenAI on the use of academic references. Information retrieval and management tools enhanced the precision and reliability of citations, facilitating the construction of more robust and well-documented arguments. Recent research confirms this potential of AI to optimise the search and processing of sources (Dabis & Csáki, 2024; Goulart et al., 2024), although—like the present study—it also warns of the need for systematic verification and ethical training in the evaluation of bias and algorithmic opacity. In this sense, digital literacy at university level must include the teaching of validation and traceability protocols for AI-generated information.

In the field of multimodal writing, the results indicate that the incorporation of visual and graphic elements—facilitated by tools such as Canva or Napkin—not only enriched the presentation of texts but also strengthened their argumentation by offering complementary representations of concepts. This finding supports multimodality theories that highlight the integration of different modes of representation as an essential component of contemporary academic discourse (Kress & van Leeuwen, 2020; Xu et al., 2022). Thus, university literacy expands into a digital and multimodal dimension that redefines the relationship between text, image and knowledge.

From the students' perspective, GenAI was perceived as useful and accessible, although it required initial training for optimal use. This result is consistent with Ayuso-del Puerto and Gutiérrez-Esteban (2022) and García-Peñalvo et al. (2024), who emphasise that the effectiveness of educational technologies largely depends on users' digital literacy. For this reason, the integration of GenAI in university teaching cannot be limited to its

instrumental dimension: it must be part of an educational project that includes criteria for interpretation, ethics and reliability assessment.

Finally, the behaviour observed among participants suggests a strategic and reflective interaction with the technology: students adjusted and personalised the generated outputs rather than accepting them automatically. This conscious use confirms the potential of GenAI as a facilitator of critical thinking and self-regulation in the writing process (Kang et al., 2023; Pigg, 2024). Moreover, the differentiated use of tools according to the stage of the process—text-focused tools for planning and drafting; visual tools for presentation—aligns with the findings of Díaz-Cuevas and Rodríguez-Herrera (2024), which show that the impact of AI varies depending on the task and the user's purpose.

In conclusion, this study demonstrates that GenAI can play a transformative role in higher education when incorporated within robust pedagogical frameworks such as the AIAS scale and the PAIR model. Under these conditions, the tools do not replace authorship or critical thinking; instead, they amplify them. GenAI thus redefines university digital literacy practices, orienting them towards comprehensive training that combines disciplinary rigour, academic ethics and responsibility in the use of generative technologies. Ultimately, learning to write with AI involves learning to think with discernment, to engage in dialogue with technology and to uphold intellectual autonomy in algorithm-mediated environments: the new horizon of academic literacy in the digital age.

6. Limitations and future directions

This study has certain limitations that should be taken into account when interpreting its findings. First, the sample was non-probabilistic and composed of students from a single institution, which restricts the generalisation of the results to other educational contexts. Future research should consider incorporating larger and more diverse samples, including students from different universities and disciplines, in order to broaden the applicability of the findings. Secondly, the diversity and continuous evolution of GenAI tools represent an ongoing challenge. Although this study included representative tools, the rapid advancement of these technologies requires continuous evaluation to understand their impact on academic writing in an up-to-date manner. Finally, the duration of the intervention—limited to four weeks—prevents an analysis of whether the observed effects persist over time. Longitudinal designs could be highly valuable for exploring the development of writing competences over longer periods.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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