

Guided use of generative artificial intelligence in undergraduate thesis: a formative and ethical experience in medical education.

Integración tutelada de inteligencia artificial generativa en el Trabajo de Fin de Grado: una experiencia formativa y ética en el Grado de Medicina.

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Summary.

The emergence of generative artificial intelligence (GAI) in higher education has transformed teaching, learning, and research processes, especially in formative stages such as the Final Degree Project (FDP). This article presents a pilot experience of the supervised integration of GAI tools into the FDP of four medical students. Through a qualitative and exploratory design, instruments such as ethical guidelines, rubrics, reflective journals, and questionnaires were applied with the aim of promoting a critical, formative, and ethical use of these technologies. The results reveal predominantly positive perceptions, improvements in autonomy and academic writing, and a critical awareness of associated risks, such as inappropriate attribution or the generation of erroneous information. The experience suggests that GAI, when accompanied by critical mentoring and ethical protocols, can become a valuable tool for developing research skills.

Keywords: Generative Artificial Intelligence; Medical Education; Final Degree Project; Academic Tutoring; Academic Ethics; Critical Thinking; Research Skills.

Resumen.

La irrupción de la inteligencia artificial generativa (IAG) en la educación superior ha transformado los procesos de enseñanza, aprendizaje e investigación, especialmente en etapas formativas como el Trabajo de Fin de Grado (TFG). Este artículo presenta una experiencia piloto de integración tutelada de herramientas de IAG en el TFG de cuatro estudiantes del Grado en Medicina. A través de un diseño cualitativo y exploratorio, se aplicaron instrumentos como guías éticas, rúbricas, diarios reflexivos y cuestionarios, con el objetivo de promover un uso crítico, formativo y ético de estas tecnologías. Los resultados revelan percepciones mayoritariamente positivas, mejoras en la autonomía y la redacción académica, y una conciencia crítica sobre los riesgos asociados, como la atribución inadecuada o la generación de información errónea. La experiencia sugiere que

la IAG, cuando es acompañada de tutoría crítica y protocolos éticos, puede convertirse en una herramienta valiosa para el desarrollo de competencias investigadoras.

Palabras clave: Inteligencia Artificial Generativa; Educación Médica; Trabajo de Fin de Grado; Tutoría Académica; Ética Académica; Pensamiento Crítico; Competencias Investigadoras.

1. Introduction

The emergence of generative artificial intelligence (AI) in higher education has brought about a profound change in teaching, learning, and research processes. Tools such as ChatGPT and Gemini allow students to generate ideas, write texts, organize content, and conduct literature searches more quickly and efficiently (1-6). Their use has spread rapidly in recent months, in many cases outpacing the capacity of educational institutions to regulate or pedagogically integrate them, presenting significant challenges. These include the risk of an increased workload for faculty, the need for continuous adaptation to new developments in AI, and the importance of addressing cultural and ethical diversity in policymaking (7-9). This phenomenon has opened opportunities to improve academic productivity, facilitate access to resources, and personalize learning, but it has also generated legitimate concerns about authorship, academic integrity, and the development of critical thinking (10-12).

Thus, although the benefits of generative artificial intelligence in the academic context are evident, its use also poses significant educational challenges. Several studies warn of a possible decline in argumentative originality and critical thinking when the use of these tools is not accompanied by adequate pedagogical reflection. In this way, the intensive use of AI without supervision can foster a passive attitude toward the research process, limiting the development of key competencies such as metacognition or academic agency (13-14), understood as the ability to critically and autonomously take ownership of one's own research process.

From an ethical standpoint, the risks include unintentional plagiarism (15-16), inappropriate attribution of ideas (14, 17-18), and the proliferation of references fabricated by the models themselves (16). These issues have led numerous authors to call for responsible use frameworks, including clear institutional policies, specific training for students and tutors, and measures such as the explicit declaration of AI use in academic work (13-16, 18). Their studies advocate for ethical principles such as openness, transparency, honesty, and accountability for the use of AI in academic work, seeking precisely to balance the benefits of these tools with the need to preserve academic integrity and ensure meaningful learning.

Despite the growing interest in generative artificial intelligence in academia, the literature on its concrete application in final degree projects (TFG) remains scarce, especially in the Spanish university context. Most existing studies focus on students' general perceptions or on analyses of institutional policies, but they barely document practical experiences of the responsible and educational use of these tools in real-world tutorials. Although some institutions have developed guides or rubrics that recommend

declaring the use of AI in theses (19), no systematic experiences documenting supervised, educational, and reflective practices for integrating these tools by students have been published, as far as can be ascertained. This absence creates a gap that hinders the construction of ethical and pedagogical models adapted to our university reality. This article aims to contribute to this effort by presenting a pilot experience that combines reflective tools, guided tutorials, and mechanisms for ethical self-regulation.

Therefore, this work aims to share a specific experience of the supervised integration of generative artificial intelligence tools in the development of Final Degree Projects, exploring both the perceptions of the participating students and the resulting benefits, challenges, and lessons learned, in order to contribute to the development of responsible and ethical pedagogical practices in the academic use of AI. The objective of the study was to explore, through a pilot experience of supervised integration of generative AI in the Final Degree Project in Medicine, its educational and ethical impact on students and the pedagogical feasibility of critical guidance from the supervisor. Specifically, it seeks to describe perceptions and usage patterns, identify benefits and risks, and draw practical implications for its responsible implementation in the Final Degree Project.

2. Methods

Context and participants

The experience was carried out during the 2024-2025 academic year in the Bachelor of Medicine program at the European University of Madrid, within the framework of the Final Degree Project (TFG) course. The professor who authored this study acted as clinical supervisor for four students who voluntarily participated in a pilot project integrating generative artificial intelligence tools into the process of developing their final degree projects. The topics of the projects were diverse within the field of obstetrics, allowing for the exploration of the applicability of AI in different methodological approaches and types of academic work.

Design and methodological approach

This is an exploratory qualitative study aimed at describing a specific training experience. It does not seek to establish statistical generalizations, but rather to understand in depth the perceptions, processes, and challenges that emerge when integrating generative AI tools in a guided manner into the completion of a final degree project. The design included a combination of reflective observation, document analysis, and data collection through questionnaires and reflective journals.

Instruments and materials

A set of resources and strategies to support the ethical and pedagogical use of AI was designed, described below.

- General protocol for working on the final degree project with AI, which established the conditions, limits and phases of the process.
- Ethical AI use guide for students, with practical guidance on how to use AI tools responsibly and transparently.

- Assessment rubric for the use of AI, focused on the development of skills such as ethical reflection, critical thinking and conscious integration of the tool.
- Observation matrix of tutoring sessions, designed to record the degree of participation, emerging doubts and the type of interactions related to the use of AI.
- Reflective journals of the tutor, completed after each session to document the evolution of the process, pedagogical dilemmas and relevant observations.
- Perception questionnaire for students, applied after the initial sessions, with questions about usefulness, confidence, concerns and expectations.
- Final self-assessment of the students, focused on the learning acquired, the benefits and risks perceived after completing the final degree project.
- Individual written reflections from the students, integrated as appendices in their final papers.

Procedure

During the initial phases of the final degree project (TFG), information sessions were held to contextualize the proposal. Students signed informed consent forms to participate in the experience. Throughout the mentoring process (which spanned several months), the aforementioned instruments were applied, including individual tutorials, guided review of AI use in their drafts, and structured critical reflection sessions. Each student developed and added a specific transparency appendix to the end of their TFG report, explaining in detail when they had used AI tools, for what purposes, what limitations they had encountered, and how they assessed their impact on their learning.

Data analysis

The data collected (questionnaires, tutor journals, rubrics, and student reflections) were analyzed using qualitative thematic coding techniques to identify common patterns, emerging dilemmas, and shared values. The analysis was performed manually, triangulating information from different sources to strengthen interpretive validity.

3. Results

Based on the qualitative thematic analysis of the questionnaires, written reflections and tutor diaries, three main areas of results were identified: perceptions and patterns of AI use, perceived educational benefits and emerging difficulties and risks.

Perceptions and usage patterns of AI

The four participating students used generative artificial intelligence tools, primarily ChatGPT (ChatGPT 4th Edition, free version), during different phases of their Bachelor's Thesis. The most frequent uses included data analysis, results writing, discussion, and literature searches. All of them stated that they used AI as a support tool, without it replacing their own work. In the tutoring sessions, the students described their interaction with AI as helpful and productive, highlighting that the technology allowed them to clarify doubts, move forward with greater confidence, and generate more organized ideas. In all cases, they rated the overall usefulness of AI during the sessions a 5 out of 5, expressing a very high level of satisfaction and understanding of the process developed with the help of the tool.

Perceived training benefits

From the students' perspective, the use of AI contributed to an improved understanding of complex concepts, especially those related to statistical analysis, as well as greater clarity in the structure and writing of academic texts. In their final reflections, the students acknowledged that the use of these tools gave them confidence, professionalism, and autonomy in developing their work. From the tutor's point of view (Figure 1), the reflective journals show that AI facilitated active learning in most cases, promoting the understanding of analytical logic, the interpretation of results, and methodological decision-making. Moments of critical dialogue between the student and the tool were observed, as well as reflective use aimed at the progressive improvement of their work.

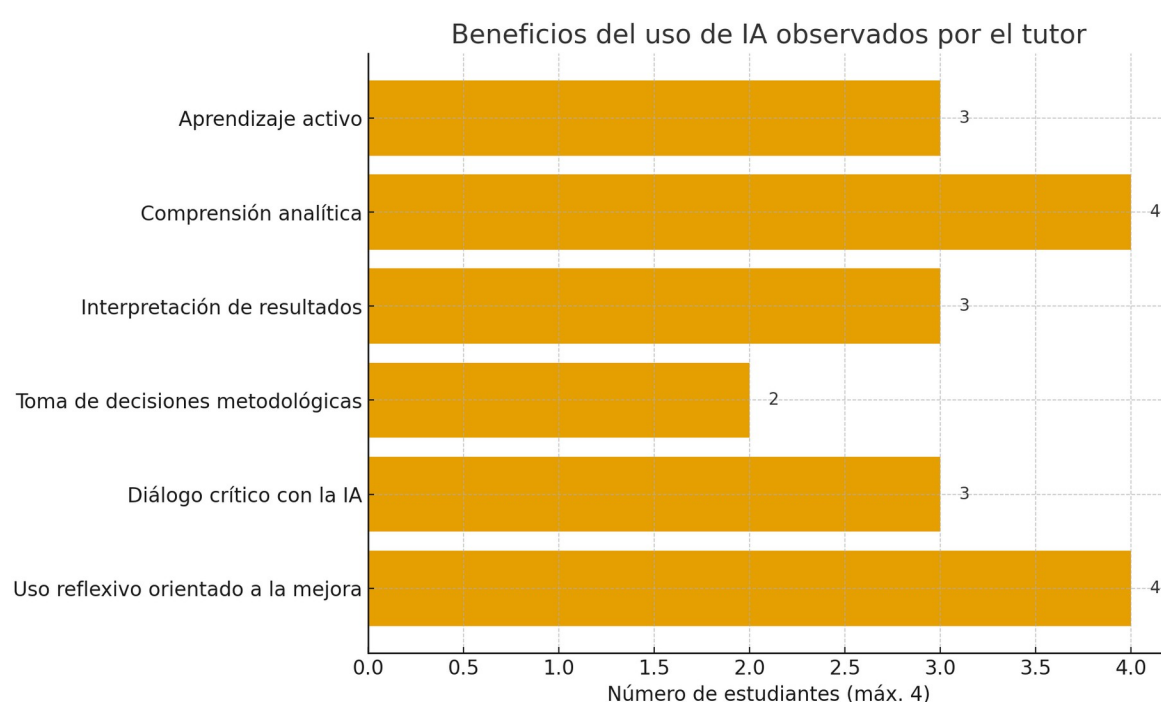


Figure 1. Tutor's assessment of the educational impact of AI use during the final degree project (TFG) development process. Representation of the frequency with which the tutor identified positive effects of using generative artificial intelligence tools in different aspects of the learning process: active learning, analytical understanding, interpretation of results, methodological decision-making, and critical reflection. Data collected from the tutor's reflective journals during follow-up sessions.

Difficulties and risks detected

Despite the benefits, the students also identified risks and limitations in the use of AI. Among the most frequently mentioned were the need to verify data reliability, potential errors in bibliographic references, and the tool's tendency to provide incorrect or imprecise answers if questions are not well-formulated. Furthermore, one participant mentioned the possibility that AI might not detect methodological errors without human supervision. The tutor observed that while most interactions were in-depth and well-guided, one student demonstrated a more instrumental and less reflective use of the tool, raising concerns about her level of understanding and ownership of the research process. This

highlights the importance of accompanying AI use with critical mentoring, ethical reflection, and continuous verification.

4. Discussion

Student perceptions and attitudes

The results of this study are consistent with recent research that shows a generally positive assessment of the use of generative AI tools by university students. In the study by Holechek and Sreenivas (20), for example, a large percentage of students perceived these technologies as facilitators of learning, especially in tasks related to academic writing and information retrieval. Similarly, Park et al. (21) found a favorable attitude toward AI in a sample of undergraduate students, highlighting its usefulness in clarifying concepts and structuring content, although they also warned about training gaps regarding its ethical use.

In the experience presented in this work, the students' perceptions were also positive, but with a nuance that deserves to be highlighted: the presence of a critical and reflective attitude regarding the use of AI. The students not only recognized the practical utility of these tools, but also showed a clear awareness of their limitations and risks. This aspect is especially relevant when compared with other studies that reveal a tendency towards the uncritical instrumentalization of technology or a lack of questioning about its ethical and methodological implications (14, 22).

It should be noted that this difference may be related to the design of the intervention: tutorial support, the existence of ethical usage guidelines, and spaces for structured reflection (such as transparency annexes or reflective journals) appear to have contributed to generating a culture of more conscious and responsible use. The students did not delegate their intellectual responsibility to AI, but rather used this tool as support in a process that remained autonomous and genuinely educational.

Impact on critical thinking and agency

One of the main pedagogical dilemmas that emerge around the use of generative AI in higher education is its potential inhibiting effect on students' critical thinking, creativity, and academic agency. Han (14) warns of a significant decrease in argumentative originality (19%) and metacognitive skills (15%) when students make intensive and unreflective use of these tools. This data reflects a real risk of delegating complex thinking to the machine, turning the research process into a succession of automated tasks.

However, the results of this experience suggest that this risk can be mitigated, and even transformed into a learning opportunity, by incorporating a pedagogical approach based on critical mentoring, guided reflection, and ethical self-regulation. The development of transparency appendices, the integration of reflective journals, and the ongoing discussion about the limits and purpose of AI use appear to have fostered a more conscious and deliberate appropriation of these tools. In most cases, active interaction between students and technology was observed, characterized by questioning, reinterpretation, and continuous improvement of academic work. This finding suggests

that, far from inhibiting agency, a guided use of AI can strengthen it by offering a safe space for experimentation, error, and informed decision-making.

Ethical concerns

The emergence of generative artificial intelligence in academic contexts has brought with it a broad ethical debate, especially in relation to authorship, the attribution of ideas, and academic integrity. Recent studies have documented risks such as the generation of false references (23), the inappropriate attribution of AI-produced content, and cases of unintentional plagiarism, especially when students do not receive specific training in the responsible use of these tools (22).

In the experience presented, these risks were not only considered from the outset but also addressed in a structured manner through a series of resources focused on transparency and academic ethics. The work protocol included, from the very beginning, the requirement to explicitly declare the use of AI, as well as the preparation of a final transparency appendix by each student. The evaluation rubrics incorporated specific criteria on the reflective, ethical, and contextualized use of AI, which facilitated meaningful discussions during tutorials about the limits of the legitimate use of these technologies.

This approach not only helped prevent questionable practices but also fostered greater ethical awareness among students. The students demonstrated a high level of responsibility by reporting limitations, potential errors in the model, and their commitment to always validating the information obtained with other sources. In this sense, the implementation of self-regulation and critical reflection mechanisms emerges as a key strategy for mitigating the ethical risks associated with the use of AI in final degree projects.

Beyond the individual ethical implications, it is necessary to recognize that generative artificial intelligence tools operate within non-neutral technological ecosystems, designed and trained by corporations that impose cultural, linguistic, and gender biases and criteria. In this sense, the use of AI in academia cannot be considered transparent or devoid of its own agency. These models, by generating content based on probabilistic patterns, can reproduce epistemic inequities and class or language biases, which demands critical reflection on their role as mediators of knowledge. In the experience described, critical mentoring and spaces for structured reflection acted as a pedagogical counterweight, helping students to question the reliability, provenance, and apparent neutrality of the answers provided by the tool.

Educational value of AI

Several studies have highlighted the potential of generative artificial intelligence to improve technical writing, academic productivity, and student autonomy in university contexts. Namanya and Talibong (13), for example, emphasize how these tools can act as catalysts for learning by facilitating the structuring of ideas, improving writing, and providing immediate feedback, provided their use is mediated by appropriate training processes.

The findings of this study align with these observations. Participating students reported clear improvements in the clarity and coherence of their writing, particularly in the results and discussion sections. Access to tools like ChatGPT allowed them to reorganize their ideas, adjust their academic tone, and revise grammar and style more efficiently. Furthermore, this technical support led to increased confidence and autonomy, as expressed in their self-assessment questionnaires and final reflections.

It is worth noting that, beyond its technical aspects, AI also served as a tool for structured thinking and work planning. Several students acknowledged using the tool to compare approaches, generate alternative arguments, and anticipate potential questions, suggesting its active and integrated use in the research process. In this sense, the educational value of AI lies not only in what it does for the student, but also in how it can activate deeper learning processes when used critically and under appropriate supervision.

Models and reference frameworks

The experience developed in this study aligns with recommendations in recent literature on the responsible use of artificial intelligence in educational contexts, which emphasize the importance of establishing clear frameworks for ethical use, promoting specific training for teachers and students, and ensuring continuous monitoring processes (24-25). These approaches highlight that the pedagogical integration of AI should not focus solely on access to the tool, but rather on how it is used, contextualized, and reflected upon within the learning process. In this sense, the present intervention incorporated key elements such as reflective guidance, the development of ethical guidelines, the explicit declaration of AI use, and the critical analysis of the products generated, both by the students and the tutor. This design fostered not only technically correct use of the tool, but also a formative, self-regulated, and conscious approach.

Based on these principles, and as a result of the analysis of this experience and the prior literature review, the development of a possible conceptual framework is being explored: the OTHA model (Openness, Transparency, Honesty, Accountability). This model, still under development, seeks to bring together the fundamental pillars for an ethically and pedagogically meaningful integration of AI in higher education. Although its full description exceeds the scope of this article, it is mentioned here as a future line of theoretical development based on the lessons learned. The approach adopted in this experience could therefore represent a preliminary application of these principles. Openness was promoted through the open exchange of experiences and difficulties in the tutoring sessions; transparency, through transparency appendices that documented when and how AI was used; honesty, by requiring the explicit declaration of AI use and the verification of sources; and accountability, through critical tutor supervision and the incorporation of ethical rubrics in the evaluation. This operational framework, although incipient, made it possible to transform the technological tool into a responsible learning resource, reinforcing academic integrity and student autonomy.

Strengths and limitations of the study

This study presents several significant contributions. First, it represents a pioneering and systematic experience in the supervised integration of generative artificial intelligence

tools into the process of developing undergraduate theses within the Spanish university context. The intervention was not only applied to real-world cases in a clinical setting (Medical Degree), but also supported by a series of specific instruments (guides, rubrics, reflective journals, and transparency appendices) that lend the proposal a practical character and make it potentially replicable in other university contexts.

Furthermore, the pedagogical value of ethical-reflective guidance is evident in the benefits observed in the development of research skills, the fostering of autonomy, and the critical integration of AI by students. The developed protocol also allows for progress in building models for the responsible integration of AI, adapted to the educational requirements of higher education.

However, the study has significant limitations that must be considered. The small sample size (four students) and the absence of a comparison group limit the generalizability of the results. Furthermore, given the voluntary nature of participation, the influence of social desirability bias on some student responses cannot be ruled out. Additionally, the impact of AI use on final academic performance was not quantitatively assessed, which could be explored in future studies. Finally, it should be noted that complete interactions with the AI tools (prompts and responses) were not systematically preserved, preventing a more comprehensive analysis of the dialogue type and communication strategies employed by the students. This documentation could be incorporated as a supplementary data source in future studies, always ensuring confidentiality and informed consent.

Social and structural implications

Beyond the benefits observed in the pilot program, it is important to consider the challenges arising from a potential widespread adoption of generative AI across the student body. Not all students—nor all tutors—have the same level of readiness, digital literacy, or resources to incorporate these tools, so their widespread use could exacerbate existing inequalities and lead to unequal or uncritical practices. Furthermore, critical tutoring and ethical guidance require an additional investment of time and effort from both students and, especially, faculty, raising questions about the sustainability and appropriateness of such initiatives if implemented on a large scale. This increased effort, while educational, raises concerns about the viability and sustainability of extending this tutoring model to larger cohorts without additional institutional resources. Likewise, the widespread use of language models can have social, cultural, and environmental consequences that should not be ignored, ranging from technological dependence and the perpetuation of structural biases to the high energy consumption associated with these tools. In this sense, ethical reflection on AI in medical education must go beyond the classroom or the final degree project, integrating a critical look at the institutional and technological conditions that determine its development and application.

Implications for educational practice and future lines of research

The results of this pilot project highlight the relevance and necessity of integrating generative artificial intelligence tools into Bachelor's theses from a formative, supervised, and ethical perspective. Far from replacing the research process, AI can enhance it when accompanied by critical supervision, spaces for reflection, and clear criteria for responsible

use. In this regard, the importance of incorporating into theses not only technical guidelines but also specific rubrics on the ethical use of AI, as well as transparency appendices that allow for the visualization of each student's process, is reinforced.

Furthermore, direct implications for teacher professional development are identified. AI literacy should not be limited to students; it is crucial to establish specific training programs for tutors, including reflective mentoring tools, fair assessment criteria, and strategies to promote self-regulation and academic integrity.

Looking ahead to future research, it would be advisable to replicate these types of experiences with larger samples and across different degree programs or disciplines within the Medicine degree. This would allow for the examination of disciplinary variations and broaden the validity of the findings. Furthermore, complementing this qualitative approach with quantitative assessment tools would contribute to a more precise measurement of the real impact of guided AI use on academic performance and the development of research skills. Similarly, longitudinal follow-up of student cohorts would offer a deeper understanding of the evolution of perceived academic agency, autonomy, and critical thinking over time. It would also be interesting to develop comparative studies between groups that have received guided intervention and those that have not, as well as to conduct longitudinal evaluations of the impact of AI use on dimensions such as autonomy, critical thinking, and perceived academic agency.

Finally, the systematization of ethical frameworks applicable to these contexts emerges as a necessity. In this sense, the OTHA model (whose principles implicitly underpinned this experience) could represent a basis for future theoretical and regulatory proposals to guide the educational use of AI in higher education.

5. Conclusions

- The guided and reflective integration of generative artificial intelligence tools into the development of the Final Degree Project can represent a valuable pedagogical opportunity, provided it is accompanied by clear ethical principles, critical supervision, and structured spaces for reflection. The experience presented shows that, far from fostering technological dependence or a loss of academic agency, the responsible use of AI can enhance key competencies such as autonomy, critical thinking, and academic writing, within a framework of integrity and transparency.
- This practical and systematic approach helps fill a gap in the literature, especially within the Spanish university context, and offers a model that can be replicated in other educational settings. It also underscores the need to train both students and faculty in the ethical and educational use of these tools, reinforcing the role of tutoring as a key space for self-regulation and responsible decision-making. In a constantly evolving landscape, medical education faces both the challenge and the opportunity to lead technological innovation processes without losing sight of its educational and humanistic mission.

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