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Teacher training in Generative AI: ethical impact and challenges in Higher Education

Formación docente en IA Generativa: impacto ético y retos en educación superior

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Abstract

Generative Artificial Intelligence (GAI) is reshaping on higher education, and transforming instructional and assessment practices, therefore, educators must develop technical expertise and pedagogical awareness to ensure ethical and responsible use. This study evaluates the impact of an 80-hour GAI training program conducted with 299 lecturers from eight Ecuadorian universities, aiming to enhance their digital skills and openness to AI-based teaching strategies. Through a quasi-experimental design with pretest and postest assessments, findings reveal an increase in technical proficiency ($M = 2.62$ to 4.22, $t = -30.77$, $p < 0.0001$, $d = 0.85$) and lecturers' willingness to apply GAI in their teaching ($M = 3.63$ to 4.02, $t = -6.38$, $p < 0.0001$, $d = 0.52$). However, perceptions of AI-generated content originality remained unchanged perceptions ($M = 3.02$ to 2.94, $t = -0.82$, $p = 0.41$), indicating ongoing concerns regarding authenticity in academic settings. These results emphasize the necessity of training programs that merge technical instruction with active learning methodologies, such as project-based learning and formative assessment. Additionally, higher education institutions should establish clear policies regulating AI implementation, ensuring ethical standards and academic integrity. Moreover, developing institutional guidelines for assessing AI-generated content is essential for maintaining transparency, fairness, and responsible adoption in teaching and assessment to identify the best practices to support lecturers' development, and promote its effective use in academic fields.

Keywords: artificial intelligence, teacher education, higher education, educational evaluation, ethics of technology.

Resumen

La inteligencia artificial generativa (IA-G) está redefiniendo la educación a nivel superior, cambiando los enfoques en la enseñanza y evaluación, y para su integración, los docentes deben desarrollar habilidades técnicas y criterios pedagógicos que les permitan utilizar estas herramientas con conciencia ética. Este estudio analiza el impacto del programa de formación en IA-G de 80 horas impartido a 299 docentes de ocho universidades ecuatorianas, con el propósito de fortalecer sus competencias digitales y su disposición hacia estas tecnologías. Mediante un diseño cuasi-experimental con mediciones pretest y postest, los resultados mostraron mejoría en el conocimiento técnico sobre IA-G ($M = 2.62$ a 4.22, $t = -30.77$, $p < 0.0001$, $d = 0.85$) y en la predisposición docente para su aplicación en el aula ($M = 3.63$ a 4.02, $t = -6.38$, $p < 0.0001$, $d = 0.52$). Sin embargo, la percepción sobre la originalidad de los contenidos generados por IA no mostró cambios relevantes ($M = 3.02$ a 2.94, $t = -0.82$, $p = 0.41$), lo que sugiere incertidumbre sobre su autenticidad académica. Estos resultados destacan la importancia de una capacitación que combine instrucción con metodologías activas, como el aprendizaje basado en proyectos y la evaluación formativa. Asimismo, se recomienda establecer políticas institucionales claras sobre el uso de IA en la educación superior, priorizando ética y transparencia acorde con los principios de la UNESCO.

Palabras clave: inteligencia artificial, formación de docentes, enseñanza superior, evaluación de la educación, ética de la tecnología.

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1. Introduction

Generative artificial intelligence (G-AI) has transformed areas including higher education, where its application in teaching, assessment and academic development continues to advance (Kohnke et al., 2023; Michel-Villarreal et al., 2023; Sanusi et al., 2023) due to the ability to automate teaching tasks, personalize learning experiences and generate educational content, which has generated debate. While authors such as Chan (2023), Usher and Barak (2024) highlight the potential of AI-G to improve accessibility and personalized learning; Nam and Bai (2023), Vallis et al. (2024) warn about the risks to equity and privacy.

One of the main challenges in the adoption of artificial intelligence (AI) in education is the role of the teacher, since, according to the existing literature, the lack of training in AI represents a significant obstacle for its correct implementation (Bendechache et al., 2021; Michel-Villarreal et al., 2023; Sanusi et al., 2023). Thus, some studies argue that resistance is mainly due to technical ignorance (Baron, 2024; Diao, 2020), others emphasize ethical concerns and the idea that AI could reduce autonomy in pedagogical design (Rudolph et al., 2024; Slimi and Carballido, 2023; Vallis et al., 2024); thus, this differences in findings suggests further analysis of how specific AI training influences teacher perception and willingness (Archambault et al., 2024; Celik, 2023). Weglarz et al. (2025) identify that performance expectancy, perceived effort, and institutional trust are factors that influence the adoption of AI tools, even out of the educational setting.

The use of AI-G in education has changed teaching processes and academic assessment; thus, Crawford et al. (2023) and Eager and Brunton (2023) have pointed out that although tools such as Turnitin AI and GPTZero were designed to detect AI-generated content, their accuracy is still questioned due to limitations in identifying manually rephrased texts. Likewise, Nikolic et al. (2023) argue that these systems do not always manage to accurately differentiate between original productions and AI-generated texts with subsequent modifications. On the other hand, Sanusi et al. (2023) warn that the reliability of these detectors is still evolving, since their performance may be affected by linguistic diversity and different academic writing styles. Similarly, Yin Albert et al. (2022) highlight that the increasing sophistication of AI models poses additional challenges, as texts generated by these technologies can mimic human writing patterns with a high degree of accuracy, making it difficult to identify them effectively in evaluative contexts.

Moreover, automated assessment using AI has been questioned due to potential algorithmic biases that could compromise fairness in grading (Chiu, 2024; Javed et al., 2022; Silva-Rodriguez et al., 2021), so teacher monitoring and auditing of AI systems have been proposed as key strategies to mitigate these risks (Almassaad et al., 2024; Eager and Brunton, 2023).

From an inclusive perspective, AI can expand access to education through personalized learning, but it can also reinforce pre-existing inequalities (Chiu, 2024), since recent research has revealed that the digital divide remains a key determinant of AI adoption in the classroom as access to technology infrastructure and specialized training is not equitable across institutions (Archambault et al., 2024; Diao, 2020); i.e., universities with greater resources have more opportunities to incorporate AI into their educational programs, while others face technological limitations in its implementation (Crawford et al., 2023; Sanusi et al., 2023).

Despite the interest in AI-G within the educational environment, most studies have prioritized the analysis of student perception, leaving aside the role of the teacher in its adoption and pedagogical application (Almassaad et al., 2024; Archambault et al., 2024; Celik, 2023). Although there is consensus on the importance of AI teacher training, current approaches have been fragmented and there is a lack of a comprehensive analysis of how training programs can influence their acceptance and effective use in the classroom (Nam & Bai, 2023; Slimi & Carballido, 2023). Thus, this study seeks to address this gap through a detailed analysis of the impact of AI-G training on university faculty's perception, attitude, and application of these technologies (Javed et al., 2022; Nikolic et al., 2023). Unlike previous research with general approaches, this comparative research allows us to assess changes in faculty's technical knowledge and willingness before and after receiving specific training (Chun & Elkins, 2023; Tubella et al., 2024).

Given the advance of AI-G in higher education, its effective adoption requires access to technology and to teacher training to ensure its pedagogical integration with clear ethical and methodological criteria; therefore, this study examines how an AI-G training program influences the perception and development of teaching competencies, in addition to identifying the main challenges for its application in university teaching (Slimi & Carballido, 2023).

Based on the findings obtained, strategies will be proposed to strengthen digital literacy and thus facilitate its effective incorporation in the classroom. To this end, the use of IA-G in education is analyzed, addressing its benefits and challenges. Then, the methodology used to evaluate teacher training is described, followed by an analysis of results that allows understanding how this training transforms the perception and its use in educational practice. Finally, key implications and recommendations are presented to design AI training policies, aligned with the realities and needs of the university context.

2. Methodology

Authors such as Gómez-Diago (2022) and Yue et al. (2024) have highlighted that quasi-experimental designs are an effective methodological strategy to evaluate changes in educational contexts without altering the institutional dynamics. This study used a quasi-experimental design without random assignment of participants to control and experimental groups, responding to ethical and operational restrictions within the university environment, allowing to analyze the impact of training in generative artificial intelligence (G-AI) on the perception and development of teaching skills within real teaching conditions.

On the other hand, Nikolic et al. (2023) emphasize the importance of forming heterogeneous samples in studies on technological adoption, since diversity in teaching experience and academic environments influences the results. Based on this criterion, teachers from different disciplines and levels of experience were selected, allowing a more representative evaluation of the phenomenon studied. In addition, Zhao et al. (2023) and Michel-Villarreal et al. (2023) mention that the triangulation of measurement instruments is essential to reduce biases in educational studies; therefore, this research implemented multiple data collection techniques and a covariate analysis was performed to mitigate external factors that could influence the results.

Finally, Chiu (2024) and van den Berg and du Plessis (2023) argue that in educational research where accessibility and willingness of participants are determining factors, non-probability convenience sampling presents as a valid methodological alternative. Hence, the selection of teachers was based on their interest and willingness to integrate AI-G into their pedagogical practices, which allowed for a more in-depth examination of its impact on university teaching; Therefore, the sample of 299 university teachers was based on both methodological criteria and operational considerations associated with the feasibility of implementing the IA-G training program in different institutional contexts and the need to ensure adequate representativeness to allow statistical analysis (such as t-test for related samples, multiple regression and effect size estimation).

Because of the latter, measures were adopted to minimize selection bias, such as the inclusion of participants from public and private institutions, with equal representation in terms of gender, age and teaching experience (Nikolic et al., 2023; Sullivan et al., 2023). An age range of 25 to 60 years was established, with a mean of 45 years, and teachers were checked for similar levels of prior AI knowledge before training (Diao, 2020; Zhao et al., 2022).

Data were collected through structured surveys with five-point Likert scales, applied as: pretest and posttest (Celik, 2023; Gómez-Diago, 2022) where the variables assessed included the level of knowledge about AI-G, the perceived originality of AI-generated content, and concerns about data privacy and ethics in teaching (Saltos et al., 2023; Vallis et al., 2024). To verify the validity of the instrument, it was sent for validation by experts in educational technology and digital ethics using Aiken's V coefficient (0.82), which confirmed the relevance of the selected items (Almassaad et al., 2024; van den Berg & du Plessis, 2023). Likewise, reliability was assessed by Cronbach's alpha coefficient ($\alpha = 0.87$), reflecting consistency in the responses obtained (Sanusi et al., 2023; Zhao et al., 2022).

In the quantitative approach, the t-test for related samples allowed evaluating differences between pretest and posttest results, where the normality of the data distribution was verified by the Shapiro-

Wilk test, obtaining values of W = 0.978, p = 0.12 in the pretest and W = 0.982, p = 0.08 in the posttest. Given that both p-values are greater than 0.05, it was confirmed that the data followed a normal distribution, allowing the use of parametric tests (Rudolph et al., 2024; Sullivan et al., 2023).

Multiple regression was performed to control possible confounding variables, considering factors such as academic discipline, teaching experience and previous level of familiarity with AI-G, where the coefficient of determination $R^2 = 0.65$ ($p < 0.01$) indicated that the model explains 65 % of the variability in the posttest results, suggesting a considerable impact of training on the knowledge and perception of AI-G in the classroom (Michel-Villarreal et al., 2023; Zhao et al., 2022). Additionally, the effect size was calculated using Cohen's d, obtaining a value of 0.85, which confirms improvement in the understanding and perception of AI-G after training (Archambault et al., 2024; Gómez-Diago, 2022).

From a qualitative approach, inductive thematic coding was used, which allowed to identify five emerging categories in the teachers' perception of AI-G in higher education: 1. Confidence in the use of AI-G: Greater confidence in the application of AI tools in teaching. 2. Perception of originality: Concerns about the generation of content and its impact on student creativity. 3. Ethics and privacy: Considerations about data security and responsible use of AI in education. 4. Adoption in teaching practice: Differences in implementation by academic discipline. 5. Continuing education: Interest in expanding knowledge about AI and its educational applications.

According to the above, an intersubjective validation was performed among researchers to ensure the reliability of the qualitative analysis, obtaining a Cohen's Kappa index ($\kappa = 0.79$), indicating substantial agreement in the interpretation of the data (Chiu, 2024; Sullivan et al., 2023) using the software NVivo for the segmentation and classification of responses, and optimizing the processing and organization of the findings (Leoste et al., 2021; Zhao et al., 2022). Thus, the results of this study will provide empirical evidence on the effectiveness of AI-G training, contributing to the design of strategies for its responsible adoption in higher education (Gómez-Diago, 2022).

3. Results

3.1 Evolution of the technical knowledge on Generative IA

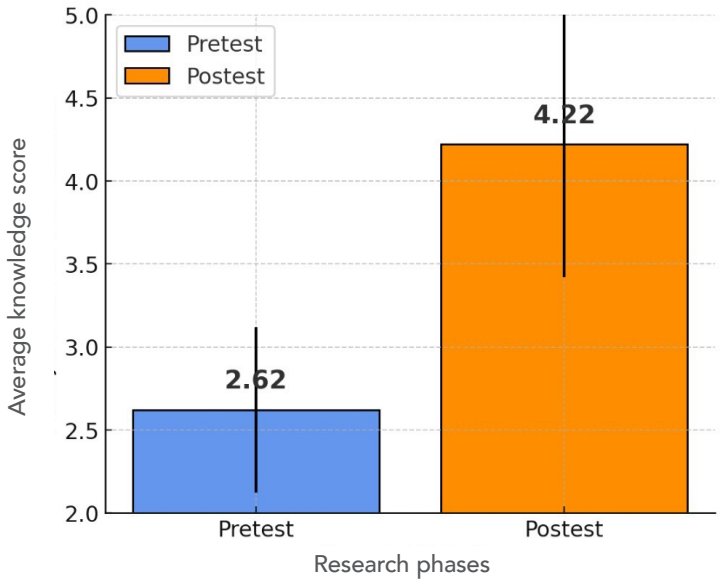
The quantitative analysis evidences a significant improvement in the technical knowledge about AI-G after the training, where the comparison of pretest and posttest measurements applied to the same participants allowed evaluating the evolution of their understanding about this technology; so the normality of the data was done by means of the Shapiro-Wilk test, confirming the suitability of the use of parametric tests; and the t-test for related samples, which presented a statistically significant difference between both measurements, with a t-value of -30.77 and a p-value lower than 0.0001 (Lozano and Blanco Fontao, 2023; Moorhouse et al., 2023).

The effect size, measured with Cohen's d (0.85), indicates a considerable impact on the acquisition of technical knowledge presented on Table 1, and Figure 1 shows that the mean score in AI-G knowledge increased from 2.62 in the pretest to 4.22 in the posttest, supporting the effectiveness of the training program (Dai et al., 2023).

Table 1. *Pretest-Posttest Comparison of IA-G Technical Knowledge*

Variable	Mean of Pretest (± SD)	Mean of Posttest (± SD)	T Value	P Value	Cohen's d	95 % CI
Knowledge of AI-G	2.62 ± 0.71	4.22 ± 0.68	-30.77	<0.0001	0.85	[2.41, 4.03]

Figure 1. *Evolution of technical knowledge about IA-G*



3.2 Change in teaching attitude towards IA-G

The evolution in teaching attitude towards the use of IA-G in teaching also showed a positive change; the mean went from 3.63 in the pretest to 4.02 in the posttest, with a statistically significant improvement (t-value of -6.38, $p < 0.0001$) (Puerto and Gutiérrez-Esteban, 2022).

The effect size (Cohen's d = 0.52) indicates a moderate impact. As detailed in Table 2, these findings evidence an advance in teachers' willingness to use AI-G in their pedagogical strategies (Flores-Vivar and García-Peñalvo, 2023).

Table 2. *Pretest-Posttest Comparison on Teaching Attitude towards IA-G*

Variable	Mean of Pretest (± SD)	Mean of Posttest (± SD)	T Value	P Value	Cohen's d	95 % CI
Teaching attitude towards IA-G	3.63 ± 0.88	4.02 ± 0.75	-6.38	<0.0001	0.52	[3.49, 4.15]

3.3 Perception on the originality of AI-generated content

The results suggest that the training failed to significantly change teachers' perception on the originality of AI-G-generated content. The mean went from 3.02 in the pretest to 2.94 in the posttest, with a non-significant difference (t-value = -0.82, p = 0.41), and a low effect (Cohen's d = 0.12) (Sperling et al., 2024). This pattern was also identified by Firat and Kuleli (2024), who observed that even after anintensive AI training, the teacher's perception on the originality of the generated content did not show substantial improvements, revealing the resistance linked to ethical and cognitive factors.

Table 3. *Pretest-Posttest Comparison on Perception of Originality in IA-G*

Variable	Mean of Pretest (± SD)	Mean of Posttest (± SD)	T Value	P Value	Cohen's d	95 % CI
Perception of originality in AI-G	3.02 ± 0.91	2.94 ± 0.87	-0.82	0.41	0.12	[2.81, 3.15]

3.4 Qualitative analysis of teacher perception

The qualitative analysis complemented the findings through a process of inductive thematic coding, allowing the identification of changes in teacher perception, whose data were processed with NVivo, facilitating the categorization of open-ended responses in the pretest and posttest surveys (Ma, 2021). Thus, in the initial phase, expressions of uncertainty and lack of knowledge about IA-G predominated, while in the post-test, more specific mentions of concrete tools and pedagogical strategies emerged (Yin Albert et al., 2022). The following are some textual responses from teachers:

> I am interested in learning about AI tools, but I don't know how they can be applied in education.
>
> I think they can be useful, but I have doubts about the originality of the content generated.
>
> I am now more clear on how to use AI in my classes, especially ChatGPT and Copilot.
>
> I still have concerns about plagiarism, but I have a better understanding of the detection mechanisms available.

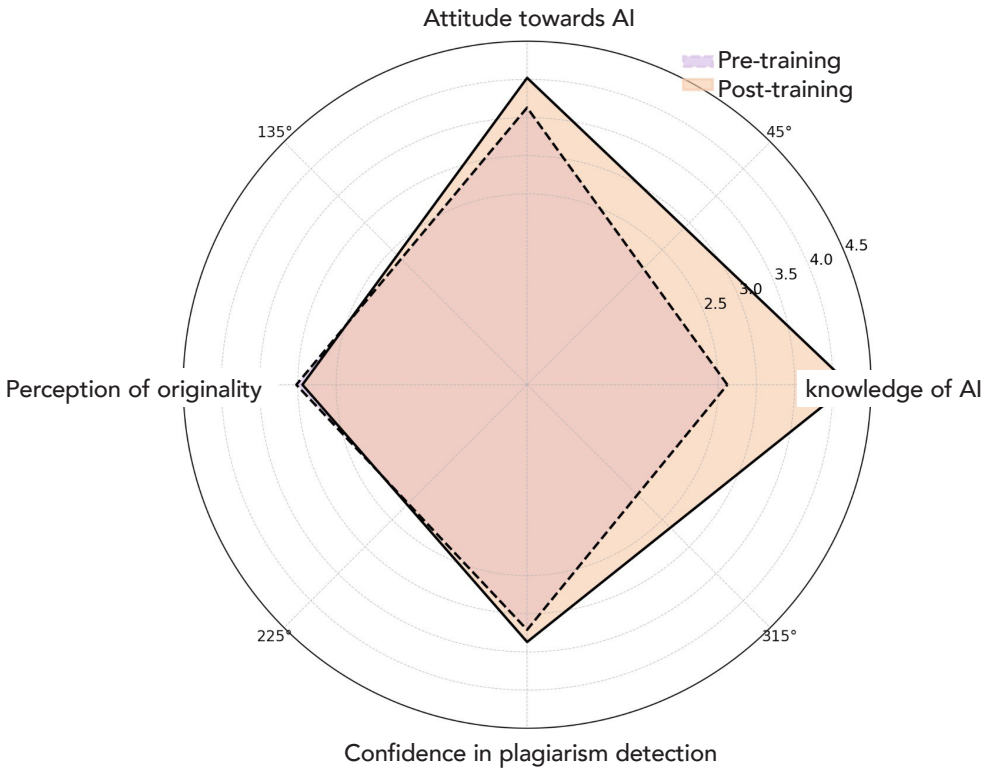
4. Discussion and conclusions

4.1 Discussion

This section discusses the findings of the study in relation to its objectives and to the existing literature, evaluating the impact of generative AI training in higher education. It examines the evolution of technical knowledge, teaching attitude, the perceived originality of AI-generated content, and the effectiveness of plagiarism detection tools.

To facilitate the visualization of these results and their comparisons, Figure 2 shows the evolution of the four dimensions analyzed before and after the training, making it possible to clearly identify the changes experienced in technical knowledge and attitude towards AI, as well as the stability in the perception of originality and confidence in plagiarism detection systems (Cordero et al., 2024).

Figure 2. *Impact of AI-G training on technical knowledge, teaching attitude, perception of originality and confidence in plagiarism detection.*



The first objective of this research was to determine the impact of training on teachers' technical knowledge, and the results show an increase in mean knowledge from 2.62 in the pretest to 4.22 in the posttest ($t = -30.77$, $p < 0.0001$, Cohen's $d = 0.85$) (Table 1), indicating an improvement. Thus, previous research has documented the effectiveness of digital skills training programs in university teachers (Sanusi et al., 2023), reinforcing the idea that structured AI literacy can reduce gaps in access and use of these technologies in higher education (Crompton and Burke, 2023; Ng et al., 2025).

Regarding teachers' attitude towards generative AI, a positive change was obtained with an increase in the mean from 3.63 in the pretest to 4.02 in the posttest ($t = -6.38$, $p < 0.0001$, Cohen's $d = 0.52$) (Table 2); thus, this finding shows the relationship between the acquisition of technological competencies and the willingness to adopt new tools in teaching (Leoste et al., 2021). However, the unsignificant change in this dimension suggests that although teachers have more information about AI, they may still have doubts about its effective implementation in the classroom. Recent research highlights the importance of providing training programs that integrate both technical and ethical skills and pedagogical considerations in the use of AI in education (Feigerlova et al., 2025; Keith et al., 2025).

Likewise, the results indicate that training did not produce significant changes in the perceived originality of AI-generated content, as the mean went from 3.02 in the pretest to 2.94 in the posttest ($t = -0.82$, $p = 0.41$, Cohen's $d = 0.12$) (Table 3), coinciding with studies that have pointed to a persistent distrust of the authenticity of AI-generated texts in academic settings (Baron, 2024). Thus, one possible explanation is the absence of clear regulations on the use of AI as a tool for academic support, generating uncertainty about its application in scientific evaluation and publication (Hagendorff, 2024; Sperling et al., 2024).

In contrast, the perception of the effectiveness of plagiarism detection tools in identifying AI-generated texts showed a slight increase in the mean from 3.21 to 3.37 ($t = -2.01$, $p = 0.045$, Cohen's $d = 0.18$) (Table 4); although the difference is statistically significant, its impact is limited. Given this, previous research has pointed out that current AI detection systems still present difficulties in accurately identifying algorithmically generated content, especially when texts have been manually edited (Cordero et al., 2024); therefore, it is important that training programs include practical exercises on the use and limitations of these tools in real academic contexts (Corfmat et al., 2025).

From the qualitative analysis, it was observed that after the training the teachers demonstrated greater familiarity with the available artificial intelligence tools, although they continued to express concerns about their regulation and their application in academic assessment. While in the pretest the responses were general, in the posttest they began to mention platforms such as ChatGPT or Turnitin AI, suggesting progress in their technical understanding.

These results indicate that the training process allowed teachers to develop a clearer vision about the potential and limitations of artificial intelligence in education (Feigerlova et al., 2025). However, doubts persist about the originality of the content generated by these tools, as well as the possible risks of plagiarism. Consequently, there is a need to establish clear institutional regulations to guide their ethical and pedagogical use (Leoste et al., 2021; Ng et al., 2025).

A case that illustrates these shortcomings is the study by Ramírez Vergara, López-Chau and Rojas Hernández (2024), in which an AI-based inclusive storytelling system was implemented, but without incorporating pedagogical guidelines or teaching mediation to support its integration in the classroom. Although the findings of this study show advances in technical knowledge and teacher attitudes towards generative AI, there are still areas of uncertainty regarding its real impact on authorship and originality, as well as on the effectiveness of automated detectors. In this regard, several studies agree that addressing these challenges requires technological competencies, critical thinking and informed decision making about the ethical use of these technologies in educational contexts (Crompton and Burke, 2023; Hagendorff, 2024).

4.2 Conclusions

This study shows a significant contribution on AI-G teacher training in Latin America by empirically evaluating the impact of a structured 80-hour program taught to 299 teachers from eight Ecuadorian universities. Through a mixed approach

(quasi-experimental and qualitative), it indicates how the training improves knowledge (d = 0.85), and favors the teaching attitude towards AI (d = 0.52). In addition, tensions in the perception of originality of the contents generated are still present. These findings allow us not only to validate the proposed training model, but also to identify institutional gaps between public and private universities, which provides input to design evidence-based ethical educational policies. These inequalities were also evidenced by Aguirre-Aguilar et al. (2024), who, based on an advanced quantitative approach, highlighted significant differences in the access and pedagogical use of AI between institutions with different levels of infrastructure and institutional support.

Thus, research such as Sanusi et al. (2023) and Crompton and Burke (2023) have documented how structured AI training not only reduces gaps in technology adoption, but also encourages more thoughtful use aligned with innovative pedagogical strategies. However, one of the main challenges identified is the perceived originality of AI-generated content. Despite the training received, teachers have not changed their minds about the authenticity of these texts, suggesting the need for clearer criteria to assess creativity and relevance in academia. Previous studies, such as those by Baron (2024) and Hagendorff (2024), have pointed out that uncertainty about the originality of automatically generated texts continues to be a determining factor, limiting their acceptance in higher education; therefore, it is important to develop regulations that allow the establishment of clear standards to evaluate the transparency and reliability of these materials.

From an applied approach, the increase in knowledge and greater openness on the part of teachers towards G-CI can be understood as a favorable willingness to its use in daily teaching practice. However, there are still ethical and methodological concerns that need to be addressed by both authorities and planners for future training, as suggested by authors such as Feigerlova et al. (2025) and Keith et al. (2025). Given the above, it is necessary to design training that goes beyond technical issues, incorporating interactive scenarios and case studies where teachers can evaluate the implementation of AI in their teaching practice and critical thinking.

Regarding the perception of the effectiveness of plagiarism detection tools, the results reflect a slight increase in teachers' confidence in this technology, although concerns persist about its accuracy; authors such as Cordero et al. (2024) and Corfmat et al. (2025) have pointed out that these detectors still present difficulties in identifying AI-generated texts, especially when they have been manually reformulated. Therefore, it is even more necessary for teacher training to include a critical analysis of the scope and limitations of these tools, allowing educators to make more informed and grounded decisions in their academic work.

5. Recommendations

5.1 Lines of future research

Regarding the perception of originality, it is recommended to explore what specific factors influence teachers' confidence in the authenticity of IA-G-generated content. Co-creation of content with IA, comparison with student-produced texts, and adoption of specific academic standards could significantly impact such perception. Furthermore, in the evaluation of the impact of AI on teaching, both this and previous research have focused on the short term. Therefore, it is necessary to move towards a progressive and sustainable adoption of AI in higher education, accompanied by longitudinal studies to examine its effects on teaching practice over time.

The effectiveness of AI detectors in academic assessment varies according to the generative model and the strategy used to reformulate texts, so a comparative analysis between different platforms is necessary to determine which ones offer greater reliability in specific educational contexts.

Practical applications

The lack of regulations in higher education generates uncertainty among teachers and limits the adoption of G-GI in the classroom. Therefore, the definition of clear institutional policies on its use will allow universities and regulatory bodies to establish guidelines on transparency in its application, originality criteria in academic production and its impact on learning assessment.

In addition, providing training with a practical and contextualized approach by incorporating active

methodologies such as case studies, project-based learning and simulations in real environments will allow teachers to develop effective strategies for their pedagogical application.

Finally, AI-based pedagogical innovations will allow taking advantage of its benefits in the automatic generation of didactic materials, personalized learning and the automation of feedback processes. However, their implementation must be accompanied by periodic evaluations that measure their impact on teaching and student performance.

Author contributions

Flavio Eduardo López-Vasco: conceptualization, data curation, research, formal analysis, methodology, project management, supervision, original draft writing, writing-revision and editing.

Mishell Romina Angulo-Alvarez: conceptualization, research, writing original draft, writing-revising and editing.

David Ismael Sosa-Zúñiga: data curation, writing of the original draft.

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