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*Scientific articles*

## **Dilemas Pedagógicos de la IAG en la formación docente: Una Revisión Sistemática**

*Pedagogical Dilemmas of Generative Artificial Intelligence in Higher  
Education: A Systematic Review*

*Dilemas pedagógicos da orientação e aconselhamento na formação de  
professores: uma revisão sistemática*

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## Resumen

La Inteligencia Artificial Generativa (IAG) ha reconfigurado las formas de producción y validación del conocimiento dentro de la formación docente, aspecto que ha generado tensiones derivadas de la expansión tecnológica que trastocan la limitada comprensión de las implicaciones formativas. Existe una postura que se concentra en el análisis instrumental de la IAG, es decir, la ejecución de tareas, la elaboración de textos y la producción de retroalimentación. Además, existe otra que estudia las reflexiones éticas y pedagógicas, aunque sus hallazgos aún no son concluyentes. Frente a esta brecha, esta investigación tuvo como objetivo comprender las tensiones, sentidos y dimensiones que configuran el uso formativo de la IAG en la formación docente. Se realizó una revisión sistemática de la literatura ( $n = 65$ ) siguiendo el protocolo PRISMA 2020, consultando las bases de datos Scopus, ERIC y RedALyC (2015–2025).

Los resultados revelaron un predominio de perspectivas instrumentales en contraste con una limitada exploración del potencial formativo, ético y reflexivo de la IAG. El análisis se centró en tres categorías principales: tecnológica, formativa/pedagógica y ética. Además de una categoría transversal, las tensiones, de las cuales derivaron seis dilemas pedagógicos cuya presencia puede utilizarse para análisis y discusión en futuras investigaciones. Se concluye que la IAG representa un desafío epistemológico más que técnico, que requiere reflexión y coherencia en las tareas de la formación docente.

**Palabras clave:** Inteligencia artificial; educación superior; revisión sistemática; formación de docentes.

## Abstract

Generative Artificial Intelligence (GAI) has reshaped the ways in which knowledge is produced and validated within teacher education, giving rise to tensions stemming from rapid technological expansion that outpace a comprehensive understanding of its formative implications. One line of inquiry has primarily focused on the instrumental dimensions of GAI, emphasizing task execution, text generation, and automated feedback. Another body of research has addressed ethical and pedagogical reflections; however, its findings remain inconclusive. In response to this gap, the present study aimed to examine the tensions, meanings, and dimensions that shape the formative use of GAI in teacher education. A

systematic literature review (n = 65) was conducted following the PRISMA 2020 guidelines, drawing on studies indexed in Scopus, ERIC, and RedALyC (2015–2025).

The findings reveal a predominance of instrumental perspectives, alongside limited exploration of the formative, ethical, and reflective potential of GAI. The analysis was organized around three principal categories: technological, formative/pedagogical, and ethical, as well as a cross-cutting dimension of tensions, from which six pedagogical dilemmas were identified. These dilemmas offer analytical lenses for future research and critical discussion. The study concludes that GAI constitutes an epistemological challenge rather than merely a technical one, requiring sustained reflection and coherence within teacher education practices.

**Keywords:** Artificial Intelligence; Higher Education; Systematic Review; Teacher Education.

## Resumo

A Inteligência Artificial Generativa (IAG) reconfigurou as formas de produção e validação do conhecimento na formação de professores, um aspecto que gerou tensões decorrentes da expansão tecnológica e da compreensão ainda limitada de suas implicações educacionais. Uma perspectiva concentra-se na análise instrumental da IAG, ou seja, na execução de tarefas, na produção de textos e na geração de feedback. Outra perspectiva estuda as reflexões éticas e pedagógicas, embora suas conclusões ainda não sejam definitivas. Diante dessa lacuna, esta pesquisa teve como objetivo compreender as tensões, os significados e as dimensões que moldam o uso educacional da IAG na formação de professores. Uma revisão sistemática da literatura (n = 65) foi realizada seguindo o protocolo PRISMA 2020, consultando as bases de dados Scopus, ERIC e RedALyC (2015–2025).

Os resultados revelaram uma predominância de perspectivas instrumentais em contraste com uma exploração limitada do potencial educacional, ético e reflexivo da IAG. A análise concentrou-se em três categorias principais: tecnológica, formativa/pedagógica e ética. Além disso, considerou-se uma categoria transversal, tensões, da qual emergiram seis dilemas pedagógicos. Esses dilemas podem ser utilizados para análise e discussão em pesquisas futuras. O estudo conclui que a IA representa um desafio epistemológico, e não técnico, exigindo reflexão e coerência na formação de professores.

**Palabras-chave:** Inteligência artificial; ensino superior; revisão sistemática; formação de professores.

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## **Introduction. The context for conducting this research**

This article is part of the first phase of a research project entitled “Generative Artificial Intelligence (GAI) in Teacher Training: Critical Use and Formative Value,” which is being conducted at a teacher training college in the state of Veracruz, Mexico. The overall objective of this research is to analyze the uses, perceptions, and meanings that faculty and students attribute to GAI, so that its integration into educational processes strengthens its formative value.

Before proceeding with the analysis, it is pertinent to clarify how the object of study has been configured within the research and, therefore, how the epistemological positioning in this article is defined. First, the research focuses on teacher training, which corresponds to normal schools, pedagogical universities, and higher education institutions due to their specific conceptual and curricular characteristics (Pirella et al., 2022).

In teacher training, although it is possible to differentiate between the actions carried out by the teaching staff, which are oriented towards didactic intervention and the establishment of conditions to mediate the teaching and approach to the contents, and those carried out by the students, who to a greater extent concentrate on carrying out school tasks through the use of technology, the metacognition of both agents constitutes the core point.

This research focuses on the use of technology and how, from each function, possibilities open up for the educational use of IAG (Information and Communication Technologies) for any user of these technologies. The study of teacher training becomes meaningful when it is understood as a reflective, ethical, and transformative process with the potential to consolidate pedagogical practices with formative value (Feixas et al., 2015).

In accordance with what was established by Pirella (2022), who despite distinguishing that teacher training is made up of a diversity of institutions, in Mexico, Normal Schools maintain a historical tradition and institutional relevance in the training of teachers.

Thus, according to current regulations (Official Gazette of the Federation, 2022), teacher training in Mexico is governed by guidelines issued by the State, which grants Normal Schools the responsibility of training professionals capable of working in diverse

contexts, where adaptability is fundamental. To this end, lifelong learning processes are strongly influenced by the use of technological resources such as IAG (Information and Communication Technologies) to enable efficient performance within the country's Basic Education institutions (Martínez, 2025).

In accordance with the purposes and characteristics of teacher training, the research that underpins this article begins with a review of previous studies. The literature on higher education reflects a marked trend toward studying the appropriation of IAG-based resources within educational processes (Chica-Elizalde et al., 2025; Zamora-Úbeda & Gómez, 2024), in order to recognize the need to redirect knowledge production toward a deeper understanding of how technology has been integrated into the academic lives of users, while also representing epistemological shifts (Ferrarelli, 2025) regarding the ways in which knowledge is constructed.

Perhaps the emphasis has been placed on the wrong point, focusing on discussing or identifying whether or not GIA is used, generating views oriented towards surveillance and prohibition that usually lead to regulatory frameworks, when rather the problem that has been identified in this research, lies in not making use of technological resources as a response to the current era that requires reflective and ethical emphasis, or rather, making indiscriminate use, without formative purposes and functions for the use of information.

As has been recognized, IAG allows the production of information from the instructions provided by the users, which does not guarantee that the automatic generation of information necessarily contributes to the construction of learning, since this occurs only when prior knowledge and human reasoning process and give meaning to the information received (Tapia, 2022).

Thus, the need arises to place the debate in an epistemological dimension, where the problem can be understood, initially, from the rates of use and the generation of information, but requires further analysis of the epistemological notions of the actors involved in teacher training.

In this context, the guiding question of this article is to recognize: how does the analysis of IAG in teacher training generate tensions, meanings, and dimensions for its incorporation for training purposes? This systematic review article focuses on understanding the tensions, meanings, and dimensions of the use of IAG in teacher training.

As part of the background review, the findings of Bannister et al. (2023) are revisited, who point out the need to investigate the implications of IAG in teacher training.

Likewise, the contributions of Romani et al. (2025) and Alonso et al. (2024) are revisited, highlighting the importance of teachers understanding the technological potential to foster critical thinking, reflection, creativity, and autonomy, thus contributing to transforming teaching and learning (Ballesteros et al., 2025; Silgado-Tuñón & López-Flores, 2025).

Based on the foregoing, this article contributes to the contemporary academic field by offering new insights for future research, starting with the identification of tensions that place those involved at the center of the main contribution: six pedagogical dilemmas that highlight risks if the way in which the phenomenon is recognized and understood is not transformed. Therefore, these dilemmas are proposed as raw material for analysis in future research.

### **The central theme: An epistemological problem in teacher training**

Today, the era in which *digital devices* produce information instantly upon user request is a reality, as Generative Artificial Intelligence (GAI) has established an unprecedented presence in education. Despite this, its integration into academic life has generated two noteworthy tensions. On the one hand, there has been an accelerated instrumental adoption that transforms academic activities in terms of information retrieval, text production, and resource design (Romani et al., 2025); on the other hand, there is an urgent need for epistemological reflection on the very meaning of education (Ferrarelli, 2025; Gorodneff et al., 2025).

From the perspective of this article, and in light of the contemporary literature, the central point is still in transition from notions of surveillance or prohibition on the use of IAG in teacher training, towards the need to discuss an apparent imbalance between the concern for the efficiency that the production of information offers, versus the need to add formative value that every educational process should contain (Pirella et al., 2022; Tapia, 2022).

This article starts from analysis models derived from the ease of access to technological resources (related to theoretical models such as TAM and UTAUT), which leads to a shift from a methodological debate (how much they are used) to an epistemological one that discusses how these tools are being used and where they should be directed to enhance human development, critical thinking and the consolidation of reflective pedagogical practices (Alonso et al., 2024).

Within the context of teacher training, it is possible to distinguish that multinational analyses (Zamora-Úbeda & Gómez, 2024) and recent studies in Latin America (Alonso et al., 2024; Ferrarelli & Pereyra, 2024; Sánchez, 2025) indicate the existence of a diagnosis where IAG has been integrated across education. However, it is acknowledged that its use is predominantly technical.

Within this diagnostic framework, it has been found that teachers often use IAG-based resources to optimize time in task execution and as support in content synthesis, but rarely for designing learning activities that involve delving deeper into specific situations based on particular contexts (Benavides-Lara et al., 2025). In the case of students, a special responsibility has been assigned for the immediate resolution of tasks without engaging in reflective processes that promote understanding of the content covered (Rodríguez & Ramos, 2025).

The above presents a scenario where the immediacy in the generation of information could be altering the purposes of teacher training. And it would be reducing them to the indiscriminate production of items that each user requires, diminishing reflection on the role they will play in society. This is worrying, since the teaching profession demands that teachers possess the capacity for contextual analysis and adaptation to the specific conditions in which their daily work is carried out.

It has become evident that, while higher education institutions are conducting research on the integration of IAG (Intercultural and Gender-Based Education), the phenomenon still lacks exploration within the specific context of teacher training colleges as a fundamental component of teacher education. Therefore, this review began with concepts similar to those explored in higher education; that is, it examined teacher training and higher education.

Given this scenario, the present research is justified because it becomes relevant to synthesize and analyze contemporary literature to characterize the nature of these problems and, primarily, to understand how different agents and contexts are processing the rapid transformations related to the field of education. Thus, this article presents the findings of a systematic literature review, conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

For the analysis, a perspective was adopted that defined formative value as the capacity to use technology to mediate the construction of meaningful learning, following Vygotsky's traditional sociocultural perspective (García, 2025). This value is articulated

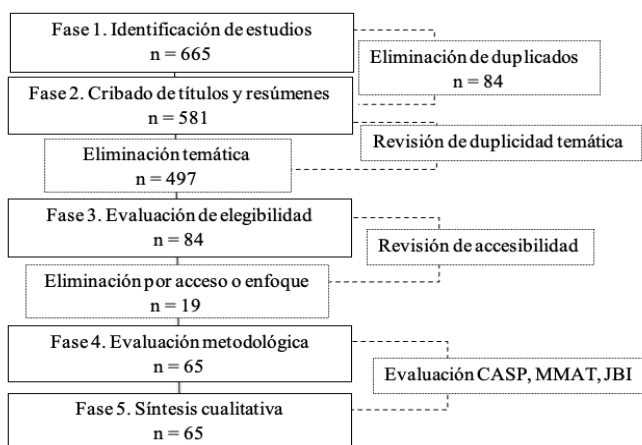
on the conceptual axis of regulated learning, where users are consolidated as autonomous agents who control their cognitive processes (Torrano et al., 2017), on metacognitive reflection, understood as the capacity to critically examine one's own ways of thinking and the ethical implications of technological mediation (Molina, 2024), and on a socioconstructivist perspective, which recognizes learning as the construction of meaning through interaction, where IAG may (or may not) enhance reflective instances.

## Method

The methodological design of this article was designed under the standards of the PRISMA 2020 protocol indicated by Page et al. (2021). Given the nature of the object of study, a qualitative approach with a hermeneutic-interpretive positioning was adopted (Gadamer, 1993; Guba & Lincoln, 1994).

This approach was considered the most relevant since the objective goes beyond mapping scientific production, focusing instead on hermeneutics and seeking to understand and interpret the meanings, tensions, and theoretical gaps that shape the formative incorporation of IAG (Information and Communication Technologies) in teacher training. Thus, the process was structured in five phases. To provide a clear and illustrative overview of the process of searching, selecting, evaluating, and synthesizing the literature, Figure 1 presents the design and organization of the phases according to the PRISMA 2020 protocol.

**Figure 1** Process of searching, selecting, evaluating and synthesizing the review



Nota. Elaboración propia.

Therefore, a summary of the actions carried out in each phase of the comprehensive literature review process is presented below.

## Phase 1. Identification and search strategy

The phase of identifying and establishing the search strategy represents a relevant point for the beginning of the systematic review, so the exploration, analysis and discussion about the possibilities of the available databases can significantly determine the course of the research.

The search for studies was conducted on July 29, 2025, in three highly relevant databases for educational research: Scopus, ERIC, and RedALyC. The selection of these databases was based, firstly, on consulting previous references that highlighted significant findings from published studies. In addition, the availability of access to the information was considered. An institutional account was used for Scopus, while ERIC and RedALyC are open access. Based on this, specific search queries were designed for each database, applying filters for document type, language, and time period, aimed at the comprehensive retrieval of literature linking IAG (Intercultural Gender Analysis) with teacher training contexts, focusing on its pedagogical or formative dimension.

The search strategy intentionally included terms associated with classic models of technology adoption (Davis, 1989; Venkatesh et al., 2003) to use them as a starting point, ensuring that the consulted studies would be based on those models. This decision does not aim to replicate them, but rather to capture literature where instrumental adoption is problematized, allowing for the identification of the tension between implementation and the way in which GIA is used within educational processes.

The search equations were formed by combining terms, both in English and Spanish, about the constructs to be investigated, where synonyms were also included and Boolean operators such as OR, AND and NOT were used.

The final equations were:

- Scopus: (“generative artificial intelligence” OR “Generative AI” OR “ChatGPT” OR “large language models”) AND (“teacher training” OR “higher education” OR “teacher education”) AND (“formative use” OR “pedagogical mediation” OR “technology adoption” OR TAM OR UTAUT).

- ERIC: (“generative artificial intelligence” OR “ChatGPT” OR “large language models” OR “AI tool”) AND (“teacher education” OR “higher education”) AND (“formative use” OR “pedagogical mediation” OR “teaching practice” OR “learning innovation”).

- RedALyC: (“generative artificial intelligence” OR “Generative AI” OR “ChatGPT” OR “large language models”) AND (“teacher training” OR “higher education” OR “teacher education”) AND (“formative use” OR “pedagogical mediation” OR “technology adoption” OR TAM OR UTAUT).

The timeframe established for the search (2015–2025) was divided considering that during the period 2015–2022, academic production focused on identifying initial reflections on the use of AI in education, thus serving as a reference point prior to its widespread adoption. Specifically, the period 2022–2025 was established as the main cohort where the use of generative language and information production models is more deeply integrated into teacher training. In this way, both timeframes were considered according to the proposal by Arksey & O'Malley (2005), who determined the feasibility of establishing dual criteria for this and other types of searches.

The second temporal criterion was also established through a review of previous studies (Romani et al., 2025; Silgado-Tuñón & López-Flores, 2025), which identified studies with relevant findings. This ensured that the bibliographic references were firmly grounded in prior research and stemmed directly from their findings and reflections.

The types of studies consulted and filtered using the databases responded to the need to consult peer-reviewed publications with academic and scientific rigor; therefore, high priority was given to research articles, theoretical articles, and systematic reviews. Once the aforementioned criteria were defined, the initial search was carried out, which yielded a total of 665 records (Scopus  $n = 325$ ; RedALyC  $n = 220$ ; ERIC  $n = 120$ ).

## Phase 2. Screening

The screening phase in systematic reviews involves reviewing the results and deciding which materials meet the established criteria based on the metadata provided by the consulted databases (Polanin et al., 2019). For this research, two authors reviewed the material, and a third facilitated the consensus. The metadata for the 665 records were exported to Zotero for management and duplicate removal, which resulted in the elimination of 84 materials, yielding a total of 581 unique records.

During this phase, titles and abstracts were screened to assess thematic relevance. As a result, 497 studies were excluded because their central themes did not address IAG or were not situated within the context of teacher training. Therefore, a total of 84 articles were selected for full-text evaluation in the next phase, following the PRISMA protocol.

### Phase 3. Eligibility

The eligibility assessment of the materials consisted of reviewing the texts based on the inclusion and exclusion criteria established in the review protocol to ensure consistency and rigor. Therefore, the evaluation of the 84 full texts was conducted independently by the three authors of this article.

Within this phase, inclusion and exclusion criteria served as the primary element considered in defining the material to be used. Thus, inclusion/exclusion criteria were based on:

- Document type (theoretical research articles and systematic reviews/essays, non-peer-reviewed articles),
- Study context (teacher training/other educational levels),
- Subject of study (generative artificial intelligence/AI, Open Educational Resources, digital platforms),
- Objective of the study (formative perspective/instrumental analysis of the tools),
- Language (Spanish and English/other languages) and,
- Accessibility (open access/restricted access).

After applying these criteria, there was a new filter where 19 articles were discarded, so the final corpus used for the qualitative synthesis consisted of 65 studies.

### Phase 4. Methodological quality assessment

A systematic review characterized by rigor has the responsibility to ensure the credibility, relevance, and transparency of the studies being analyzed, so the evaluation of the methodological quality of the materials is an aspect that must be monitored.

To address the aforementioned point, the 65 selected studies were evaluated using standardized instruments suggested in the literature (Hong et al., 2018; Long et al., 2020; Munn et al., 2023) to determine the quality of each manuscript based on its characteristics. A summary of the instrument used and the aspect assessed in each case is presented below:

- For the qualitative studies (n = 28), the Critical Appraisal Skills Programme (CASP) was used, which focuses on evaluating validity, rigor, and relevance (Long et al., 2020). A database was designed to compile scores for

evaluating: objectives, design, sampling, data collection, reflexivity, ethics, analysis, results, and the value of the research.

- The internal consistency of the documents and the integration of findings in the mixed-methods studies ( $n = 22$ ) were examined using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018). Indicators such as clarity of questions, justification for the mixed-methods design, integration of components, coherent interpretation, and bias control were evaluated using a database that compiled the information.

- Regarding the theoretical studies or literature reviews ( $n = 15$ ), the JBI Critical Appraisal Tools were applied, evaluating the consistency of the research and the value of the analytical contributions they present (Munn et al., 2023). The instrument takes into account the assessment of clarity of objectives, explicit conceptual framework, reasoning, coherence, evidence, and relevance.

Through the actions carried out in this phase and the evaluation of each study consulted within the systematic review, satisfactory general results were obtained, where the score of the methodological quality of the materials was medium-high to high (scores between 8 and 10) within the analysis matrix, which gives relevance and solvency to the present systematic review.

## **Phase 5. Qualitative synthesis and interpretation**

In the initial phases of this systematic review, work was done at the level of the metadata exported by the search engines used. However, in order to delve deeper into the analysis of the findings of this study, the final phase consisted of a qualitative analysis of the content (Viramontes, 2024).

The 65 articles were systematized in an analysis matrix within Excel, which recorded metadata and extracted deeper information on objectives, findings, and educational and ethical implications, where the perspective of the three authors of this work was a primary aspect. Thus, the content analysis was carried out through two rounds of open and independent coding, ensuring triangulation of reviewers for consensus-building (Flick, 2007).

The coding process followed a dual perspective (deductive and inductive). Initially, and as part of the deductive perspective, the adoption models (TAM, UTAUT), the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler,

2006), and the approaches of mediation and ethical literacy (Holmes & Tuomi, 2022) were used as references. Through this work, the models served as a theoretical framework to compare how the findings of each study revealed rates of appropriation and integration, as well as how IAG-related resources are being used in higher education.

Secondly, the Inductive Perspective and open coding allowed the consolidation of categories based on the findings, where the processing of information led to reflections that confirmed the way in which the consulted studies were theorizing the phenomenon studied.

From this analysis and coding, three categories were derived: Technological Perspective, Formative/Pedagogical Perspective, and Ethical Perspective. Working from these three categories allowed us to distinguish the presence of a cross-cutting theme, reflecting on aspects worthy of analysis to understand the phenomenon in depth: the tensions.

First, the Technological Perspective category focused on considering theoretical models (TAM, UTAUT and TPACK) to recover ways in which technological resources are incorporated within the context of the consulted research, where utility, ease of use, performance expectation or effort, among others, produced findings that were also categorized.

Regarding the Formative/Pedagogical Perspective category, it was intended to distinguish the possibilities for the use of IAG-based resources, where they are especially used for formative purposes, that is, oriented towards participation, mediation or self-regulation in the tasks carried out by those who use them.

Finally, the Ethical Perspective category primarily recognized professional responsibility and academic integrity, where, among other factors, consideration was given to how, from the regulations, ethical and mainly epistemological frameworks are continuously constructed and reconstructed, which disrupt the meaning, purposes and functions with which IAG resources are used in higher education.

Regarding the transversality of the Tensions category, it provided possibilities to analyze the implications on the formative use of IAG in higher education, grouping the conflicts, frictions and dilemmas (Verdejo & Cruz, 2024), in the integration of IAG, which constitutes the main analytical axis of this article and is intended to seek answers to the research questions raised in the initial section.

## Discussion of the results

In accordance with the hermeneutic-interpretive design of this article, the results are organized according to each category used for analysis. Based on these categories, reflections are formulated as pedagogical dilemmas, which are presented to the academic community as contributions of this manuscript. These dilemmas, far from being immutable, aim to spark dialogue about how diverse educational contexts may find themselves in situations where there is an apparent inability to determine what is morally acceptable, academically correct, or institutionally permissible, a situation brought about by educational processes in teacher training.

At the end of the presentation of the results and dilemmas of each category, a section is presented with the declaration of tensions at the systemic level, with the aim of contributing to the generation of knowledge and projecting some future actions.

## Technological Perspective

The analysis of the literature allowed us to distinguish that the technological perspective is the basis on which pedagogical and ethical discussions are built, in addition to the fact that the predominant theoretical frameworks (TAM, UTAUT) are used by the authors not only to measure the adoption and use of IAG in education, but, progressively, they seek to problematize it and position IAG as a resource with epistemological potential on the construction of knowledge, which can be explored to extend different aspects of educational processes (Aliaga & Molina, 2024; Castillo et al., 2024; Rossete & Clemente, 2024).

Based on the above, the results suggest that technology does indeed represent an area that should be strengthened within educational processes. However, it also paints a picture where its indiscriminate use without educational purposes represents areas of opportunity that must be addressed; otherwise, the production of information would significantly disrupt learning processes in teacher training. From the analysis of this tension, two pedagogical dilemmas emerge that make this discussion pertinent:

### **Dilemma 1: The cognitive cost of accessibility**

The literature agrees that ease of use is a necessary condition for technology adoption (Molina, 2024). However, what might seem simple to analyze in terms of access generates the dilemma known as the cognitive cost of accessibility. Within this dilemma, the benefits in terms of access and efficiency (perceived utility) could represent a loss in effort and cognitive development in teacher training (Pineda et al., 2024), creating a complex scenario for education in the short and medium term within teacher training contexts.

The studies consulted in this systematic review indicated that GAI could reduce the function that requires reasoning processes (Calle et al., 2025; Castillo et al., 2024; Rossete & Clemente, 2024). Given this tension, the literature projects high potential for using GAI in teacher training, emphasizing that its practicality should be leveraged as an opportunity to design more complex learning situations where those using the resources have the possibility of enhancing their learning processes (Norman-Acevedo, 2024; Pagola et al., 2024).

### **Dilemma 2: Technical effectiveness versus reflective effectiveness**

Performance expectation (UTAUT model) is redefined in the literature related to GIA because it is associated with improved productivity (academic and teaching). However, more recent analyses focused on teacher training challenge this utilitarian view, which reduces it to the mere incorporation of technology into educational processes. In this regard, it is evident that performance in teacher training should be associated less with the quantity of tasks completed and more with the quality of critical thinking and metacognition (Calle et al., 2025), which offers potential for change when discussing the formative role of GIA in education.

Norman-Acevedo (2024) emphasizes the need to foster dialogue between users and IAG (Information and Communication Technologies). In this way, the performance expectation shifts from technical efficiency, focused on *speed*, to reflective efficiency, aimed at *better thinking*. In other words, ease of use and performance expectation (Yilmaz et al., 2024) only acquire formative relevance when mediated by institutional conditions and solid epistemological frameworks that extend beyond their application. Otherwise, there is a risk of exacerbating tensions such as those evidenced in this article.

Addressing these dilemmas could depend primarily on two factors. First, *prompt design can be recognized* as a competency in terms of using interactive learning (IL) critically, questioning the veracity and role of the information obtained, as well as using the information generated responsibly. Therefore, the possibilities for constructing learning mediated by IL depend largely on the human capacity to formulate precise prompts that give formative value to the interaction (Cassany, 2024; Castillo et al., 2024; Rossete & Clemente, 2024).

Secondly, it would be advisable for teacher training institutions to stop viewing IAG as something to be monitored or punished. Instead, they should guide and strengthen, through clear and viable policies, the way in which these resources are being incorporated into training processes.

### **Formative/Pedagogical Perspective**

Through a review of findings corresponding to this category, it is recognized that the formative value of IAG does not reside *per se* in the tool, but rather in the quality of the interactions carried out by those involved (Zárate-Moedano et al., 2022). Thus, the formative potential of IAG is only achieved when it acts as a space for the cognitive and ethical construction of information for learning and never as a substitute for thinking (Calle et al., 2025; Cassany, 2024). In this line of thought, the teacher's role is identified as a determining factor in guiding the exploration, verification of information, and construction of learning from a metacognitive perspective (Calle et al., 2025; Pagola et al., 2024). The analysis of specific pedagogical practices within this category revealed two dilemmas:

### **Dilemma 3: The Illusion of Personalization**

The literature review highlights the presence of IAG-mediated feedback processes, emphasizing their potential for immediate feedback (Kohnke & Ulla, 2024; Norman-Acevedo, 2024; Silgado-Tuñón & López-Flores, 2025). However, this generates what has been termed the illusion of personalization, as what appears to be personalized learning is, in some cases, a superficial automation where the immediacy of the response does not guarantee a formative foundation (Castillo et al., 2024). The literature suggests that this automated feedback only acquires value when it is reconfigured as a starting point for discussion and analysis.

#### **Dilemma 4: The illusion of evaluative assistance**

Assessment processes have historically been a valuable area for analysis in order to recognize the possibilities of enhancing student learning. In the context of IAG (Integrated Assessment and Evaluation), this is not a lacking topic, as it has been identified that IAG provides an illusion that has been projected for some years now, by questioning the role of assessment instruments in relation to approaches focused on formative elements, where the core issue lies in how information is used (Verdejo & Herrera-Meza, 2022).

On the one hand, it is true that IAG can assist teachers in the creation of instruments (rubrics, scenarios), enhancing evaluative design (Pagola et al., 2024), however, it is also true that this automation, without processes of reflection and intervention of human thought, could introduce evaluative biases, loss of context and homogenization of judgment, which would again be undermining the formative value of the evaluation.

Through these findings, a scenario is observed where IAG could be used as a tool for negotiating meanings in evaluation, but never as an instance of legitimizing judgments, apparently far removed from subjectivities with the promise that, through it, the evaluation will be carried out under formative standards (Popham, 2013).

#### **Ethical Perspective**

The analysis of the ethics-related category provides a cross-cutting framework for the findings. The studies agree that the ethics of using IAG should not be approached as a set of compliance rules, but rather as a formative dimension related to professional responsibility (Rossete & Clemente, 2024) and commitment to one's own training processes within teacher education. Therefore, the following dilemmas were identified:

#### **Dilemma 5: From integrity as a discipline to integrity as reflection**

Academic integrity is the most recurring concern in the studies consulted, which challenges traditional notions of authorship (Castillo et al., 2024; Pagola et al., 2024). However, more recent literature proposes a shift where, instead of a prohibition and surveillance approach related to detecting who uses resources, it is seen as a formative opportunity to discuss research ethics and the collective construction of knowledge (Norman-Acevedo, 2024).

In this way, integrity would cease to be a disciplinary requirement and become a relevant educational object for reflection that will potentially be present within teacher training, but which could actually disrupt the very construction of personal identity.

### **Dilemma 6: Institutional Coherence Gap**

The review reveals a fundamental gap between the rapid expansion of the use of IAG and the slow response of institutional policies, as regulatory gaps are reported that leave students and faculty without clear guidance (Pagola et al., 2024; Pineda et al., 2024).

Finally, the ethical discussion converges on the epistemological view of the phenomenon, given that studies question the meaning of producing information, disguised as knowledge, in a context where cognitive processes are shared between humans and generative systems (Artopoulos, 2025). The literature concludes that a merely instrumental stance is insufficient (Calle et al., 2025; García & Martínez, 2024), while emphasizing that the real concern is not whether GAI is used, but what is done with the generated information and how meanings are constructed from it.

## **Conclusions**

The objective of this research was fulfilled by showing that the integration of IAG disrupts what happens in teacher training, so far from being seen as a unified phenomenon, it is a field of epistemological, ethical and formative dispute.

The central contribution of this study is not limited to the descriptive level, but rather seeks to enhance the conceptualization of the tensions identified in the literature as six pedagogical dilemmas that should not be interpreted as contradictions to be resolved or problems to be eliminated. They could be recognized as spaces for analysis where educational practice in teacher training must be redefined through the convergence of human and artificial intelligence in technology-mediated educational environments. Thus, the presence of the dilemmas proposed in this research is discussed below, according to the systemic level and the tensions that comprise them:

### **Tensions in pedagogical practice (Micro-level)**

1. The cognitive cost of accessibility: This dilemma challenges the role of intellectual effort in teacher training. The literature analyzed reveals a dilemma where the democratization of access to information can lead to superficial understanding (Cassany, 2024; Pineda et al., 2024), since the speed of information generation does not guarantee comprehension, much less the construction of learning. The challenge, therefore, in addition to managing access, involves designing situations that reposition the value of reflective processes, questioning, and argumentation as essential components of learning (Norman-Acevedo, 2024). How is it possible to revalue comprehension and reflective processes in an era where the speed of production seems to be more relevant?

2. The mirage of personalization: This dilemma challenges the discourse of adaptive education, as the apparent personalization offered by IAG risks becoming a simulation that homogenizes the individual (Pineda et al., 2024), due to a lack of understanding of context, history, and individuality in teacher training. Its implications center on the idea that formative value is irreplaceable, since personalizing learning does not imply automating a response, but rather accompanying the construction of meaning based on the interpretation of diverse realities. What is the purpose of education and society if they do not respond to the characteristics of the individuals within them?

### **Tensions between design and practice (Meso-level)**

3. The Illusion of Evaluative Assistance: This dilemma lies in the tension between technical efficiency and deliberation in assessment. While GIA can optimize instrument design, automation threatens to obscure the formative understanding of the evaluative act (Pagola et al., 2024), recognizing that assessment is an interpretive act that demands situated judgment. The challenge is not to delegate assessment, but to integrate GIA as input for reflective co-assessment, where the judgment made defines and reconstitutes the criteria and perspectives. How can we enhance the formative processes of assessment through the construction of unified instruments for students?

4. Technical efficiency versus reflective effectiveness: This dilemma reveals the tension between technological speed and the pace of human learning. The logic of immediacy (more results in exchange for less effort) can be incompatible with certain teacher training scenarios, which require time for questioning, discussion, and elaboration (Calle et al., 2025). The implication is that a gain in technical efficiency does not automatically translate into improved learning; in fact, it can negate it. How can we respond to society's demand for immediacy without neglecting the processes of reflection and analysis that lead to learning?

### **Systemic Tensions (Macro-level)**

5. From integrity as a discipline to integrity as reflection: This is one of the most complex dilemmas, as it transforms the very notion of knowledge production. Uncertainty about authorship (Artopoulos, 2025) transcends the debate on plagiarism and challenges the relationship between the subject and knowledge. The question is no longer whether authorship was used, but how the process was examined, which demands a new epistemological responsibility where the metacognitive role is fundamental, since it not only involves production, but also accountability for the process of constructing learning. How and for what purpose is information produced, disguised as legitimate knowledge?

6. The institutional coherence gap: This dilemma highlights that the adoption of GIA is a systemic phenomenon, as the literature review reveals a widespread gap between the promotion of technology and the absence of clear pedagogical policies (Kohnke & Ulla, 2024; Pagola et al., 2024). Institutions face the decision of adopting GIA as an instrumental trend or incorporating it as an educational project toward which they have the opportunity to direct actions and perspectives. What is the epistemological stance of institutions regarding teacher training, and where is their training project headed?

This systematic literature review concluded that GIA is here to stay in the educational and academic practices of both faculty and students within teacher training, which represents a formative and epistemological challenge, not merely a technical one. The technological, pedagogical, and ethical dimensions used as the analytical framework for this article do not operate in isolation, but rather are interwoven in a network where

each technical decision (which tool to use) impacts an epistemological position (what it means to know) and carries formative implications (how knowledge is reflected).

### **Future lines of research**

As this study is a systematic review, this research was based on published literature and does not capture undocumented emerging practices. A predominance of studies focused on instrumental adoption was identified; therefore, further research is recommended, particularly in-depth qualitative studies (ethnographies or case studies), that analyze situated practices and meaning-making processes in the classroom. This would generate opportunities to situate the proposed dilemmas not only within pedagogical mediation practices but also within the learning processes of student teachers. Likewise, studies are needed that analyze the design and impact of institutional policies that attempt to address the dilemmas presented here.

While a limitation of this study is its reliance on a review of higher education literature, it is also seen as an opportunity to outline lines for educational research that will affect both teachers and students in teacher training, mainly due to their great responsibility as mediating agents between these technologies and the new generations of students with whom they will work upon completion of their educational journey.

Ultimately, this research argues that the potential of IAG in teacher training lies not in its operational efficiency, but in its ability to be used as a catalyst that strengthens critical thinking, metacognitive reflection, and the construction of learning with formative value.

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