Generative AI and critical thinking in online higher education: challenges and opportunities

IA generativa y pensamiento crítico en la educación universitaria a distancia: desafíos y oportunidades

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ABSTRACT

Generative artificial intelligence (GAI) is reshaping higher education, particularly in virtual learning environments where the prevalence of asynchronous activities requires students to take an active role in managing their own learning. Its integration presents both challenges and opportunities for educators, who not only support critical thinking but also need techno-pedagogical skills to guide its ethical and reflective use. This exploratory study examines the incorporation of GAI into distance education across five dimensions: barriers that limit critical thinking, factors that can enhance it, available socio-technological alternatives, social challenges and broader implications of strengthening this skill. A qualitative approach was used, based on semi-structured interviews with eleven higher education experts. The findings highlight key obstacles, including limited teacher training in GAI and critical thinking, institutional resistance and a lack of clear guidelines. However, digital literacy, pedagogical innovation and adapted assessment methods can help overcome these barriers. Among the proposed solutions are the development of edu-chatbots in controlled university environments and frameworks to assess algorithmic biases. Even so, ensuring equitable access and avoiding an uncritical reliance on AI persist as notable challenges. This study contributes by proposing five action areas to support educators and academic decision-makers in integrating GAI and shaping educational policies. Its implementation requires collaboration between institutions, faculty and policymakers to ensure that AI-driven automation not only enhances educational processes but also fosters critical thinking meaningfully.

Keywords: artificial intelligence in e-learning (AIeL); critical thinking; metacognitive awareness; online higher education; AI ethics; digital divide.

RESUMEN

La inteligencia artificial generativa (IAG) está transformando la educación universitaria, especialmente en entornos virtuales donde el predominio de actividades asincrónicas exige que los estudiantes gestionen activamente su aprendizaje. Su integración plantea desafíos y oportunidades para los docentes, quienes desempeñan un papel fundamental en el desarrollo del pensamiento crítico y requieren habilidades tecnopedagógicas para garantizar un uso ético y reflexivo de estas herramientas. Este estudio exploratorio analiza la incorporación de la IAG en la educación a distancia desde cinco dimensiones: barreras que limitan el pensamiento crítico, aceleradores que pueden impulsarlo, alternativas tecnológicas, retos sociales y consecuencias de fomentarlo. Se empleó un enfoque cualitativo basado en entrevistas semiestructuradas con once expertos en educación superior, los resultados identifican tres barreras principales: la falta de formación docente en IAG y pensamiento crítico, la resistencia institucional y la ausencia de directrices claras. No obstante, la alfabetización digital, la innovación pedagógica y la adaptación de los sistemas de evaluación pueden mitigar estos obstáculos. Entre las alternativas tecnológicas, se propone el desarrollo de *edu-chatbots* en entornos controlados y la implementación de marcos para analizar sesgos algorítmicos. Sin embargo, persisten retos como garantizar un acceso equitativo y evitar una dependencia acrítica. Como contribución, se proponen cinco vectores de acción que orientan la integración de la IAG y el diseño de políticas pedagógicas. Su implementación requiere una estrategia coordinada entre instituciones, docentes y responsables académicos, de modo que la automatización generada por la IA no solo optimice los procesos educativos, sino que también actúe como catalizador del pensamiento crítico.

Palabras clave: inteligencia artificial en *e-learning* (AIeL); pensamiento crítico; metacognición; educación universitaria a distancia; ética de la IA; brecha digital.

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INTRODUCTION

Generative artificial intelligence (GAI) is transforming education systems, mainly impacting the areas of administration, teaching and learning (Chassignol et al., 2018). In distance or online education environments, these tools optimise academic management by facilitating tasks such as addressing frequently asked questions and institutional communications. Likewise, intelligent tutoring systems automate the correction of continuous assessment tests, providing personalised feedback based on rubrics previously designed by teachers (Tang et al., 2021).

The use of GAI as a pedagogical tool allows teachers to personalise learning paths by creating adaptive content, in addition to simplifying the design and evaluation of tests adjusted to the needs of each student (Romero Alonso et al., 2025; Zhang et al., 2021; Bhutoria, 2022). Conversational agents such as *chatbots* and *cobots* can allay doubts, distribute materials and offer personalised feedback, fostering more student-centred environments (Adiguzel et al., 2023); in addition, their integration with virtual reality enables immersive simulations that favour the practical understanding of complex concepts (Timms, 2016).

These tools make it possible to identify learning deficiencies and address them to minimise their impact on long-term academic performance (Ocumpaugh et al., 2024). Through detailed analytics, GAI can track patterns, detect problem areas and offer personalised recommendations that optimise the educational process (Drugova et al., 2024). It also provides students with information about their performance and competencies, helping them choose training programmes that fit their interests and career aspirations (Chen et al., 2020).

From an institutional perspective, GAI facilitates real-time monitoring of academic progress, anticipating learning needs and strengthening self-regulation through models such as the *Open Learner Model* and *Knowledge Tracing* techniques. These approaches are aligned with *e-learning models* and recognised for their flexibility and ability to offer more inclusive and personalised educational experiences (Garcés & Bastías, 2025; Ilić et al., 2023).

However, their integration poses significant challenges. GAI can also amplify algorithmic biases, accentuate inequalities in access to technology and reduce the space available for critical reflection and student creativity (Adiguzel et al., 2023). In addition, immediate access to AI-generated information can discourage autonomous analysis and the formulation of one's own conclusions. The challenge is not only to incorporate GAI into education but also to do so critically and responsibly, thereby guaranteeing academic integrity (Eke, 2023; Kumar et al., 2024).

In this context, critical thinking is essential to rigorously analyse the feedback generated by these tools (Barrot, 2023). While many of the so-called *hard skills* have been delegated to machines due to their routine and technical nature, more complex human skills[1] have become more relevant. This trend is reflected in the *Future of Jobs Report* (World Economic Forum, 2023), which highlights analytical and creative thinking among the skills most valued by employers.

In today's work environments, characterised by volatility, uncertainty, complexity and ambiguity (*VUCA* environments), professionals must manage their learning continuously and autonomously (Aguilar Vargas et al., 2020). In this scenario, critical thinking is an essential tool for reflecting on one's own cognitive processes, making strategic decisions and facing complex challenges with innovative approaches (Ayyıldız & Yılmaz, 2021).

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In distance university education, the integration of GAI tools can contribute to the development of critical thinking; however, its effectiveness is conditioned by the skills and dispositions of the teaching staff, whose mediating role is fundamental in this process. Therefore, although various *stakeholders* intervene in education systems, this study places the teacher as the axis of action.

Based on this premise, the following research question was formulated: What barriers, drivers and ethical challenges do teachers face in promoting critical thinking in AI-mediated environments? To address it, a qualitative methodology based on semi-structured interviews organised around five dimensions was adopted. This exploratory study seeks to identify the obstacles that limit the development of critical thinking among students, the factors that can drive it, the potential benefits of GAI and strategies to mitigate the social and ethical challenges arising from its unguided use.

LITERATURE REVIEW

Various studies indicate that, although tools such as *ChatGPT* have limitations in higher-order thinking compared to humans (Deng & Lin, 2022; Guo et al., 2023), these gaps could be narrowed with technological advancement (Liu et al., 2023). Recent studies have also examined the integration of critical thinking (Cananau et al., 2025) and digital literacy (Ng et al., 2023) into education policies, teacher education and digital literacy plans.

In this context, the literature review focuses on teacher instruction in GAI-mediated settings, addressing the conceptual bases of critical thinking, its assessment tools and pedagogical interventions that integrate AI to enhance its development. This approach provides a comprehensive framework for understanding its implementation in contemporary educational scenarios.

Critical thinking as a metacognitive skill

Cognitive psychology provides keys to understanding the progression of critical thinking from basic processes to higher levels. The taxonomy of Bloom et al. (1956, p. 12) structures the 'mental acts or thought processes derived from educational experiences' in a hierarchy that distinguishes between lower-order thinking skills such as knowledge, understanding and application and higher-order skills (*HOTS)* such as analysis, synthesis and evaluation.

Although the taxonomy does not explicitly mention metacognition, its higher levels are closely linked to current conceptions of metacognitive thinking (Wegerif, 2002). In this framework, critical thinking is considered an essential mental habit within metacognition as it allows individuals to reflect on their own cognitive processes and regulate their learning. Metacognition, defined as the ability to monitor, evaluate and adjust thinking, is key to the development of critical thinking (Flavell, 1976). This two-way relationship is evidenced in skills such as evaluation, which not only involves analysing the quality of information but also questioning one's own judgements and beliefs. In other words, thinking critically means exercising the ability to 'think about thinking' (Flavell, 1979).

Metacognition encompasses awareness and control of the emotional and motivational processes that influence learning and decision-making (Papleontiou-Louca, 2003). In addition to facilitating understanding of how knowledge is processed and organised, it strengthens autonomy by allowing students to regulate and optimise

their learning on an ongoing basis (Çakıcı, 2018; Choy & Cheah, 2009; Maor et al., 2023). Consequently, critical thinking is intrinsically linked to metacognitive skills (Kuhn & Dean, 2004) such as self-regulation and the use of advanced cognitive processes, such as identifying biases, justifying conclusions and proposing innovative solutions (Ku & Ho, 2010). In this context, critical thinking can be understood as an advanced manifestation of metacognition, which allows knowledge to be managed effectively and complex problems to be tackled with a reflective and creative perspective.

Specific critical thinking skills

Distinguishing between specific critical thinking skills and related components, such as motivation and metacognition, helps to avoid conceptual overlaps and clarifies their scope. Their close relationship with metacognitive processes makes it difficult to delimit them as independent phenomena (Rivas et al., 2022). From this perspective, it is pertinent to analyse the cognitive abilities that make it up.

Defining critical thinking is challenging, as it integrates multiple interconnected skills. Pasquinelli et al. (2021, p. 170) describe it as 'the ability to assess the epistemic quality of available information and calibrate one's own confidence to act accordingly'. This approach highlights its multi-dimensional nature and its connection to advanced cognitive skills.

Various theoretical frameworks have identified the essential sub-skills of critical thinking (Halpern, 1998; Pascarella & Terenzini, 2005). However, the lack of validated and standardised tools for their measurement and implementation remains a challenge (Ku, 2009; Plummer et al., 2022). Among the most widely used tests are the *California Critical Thinking Skills Test* (Facione, 1990), the *Cornell Critical Thinking Test* (Ennis & Millman, 1985) and the *Watson–Glaser Assessment* (Watson & Glaser, 1980). In this context, Facione (2023) developed a solid theoretical framework with a reliable rubric to assess these skills, which has been selected as the conceptual basis of this study (see Appendix; Table 1).

In online learning environments, virtual platforms offer an ideal space to encourage critical thinking using strategies such as Socratic questioning, argumentation, collaborative problem-solving and peer assessment. Tools such as forums, concept maps and group environments favour dynamics that stimulate reflection and critical analysis (Goodsett, 2020; MacKnight, 2000; Ertmer et al., 2011; Yang et al., 2008). The combination of these approaches strengthens the practical application of critical thinking in virtual education.

GAI as a driver or limiter of the development of critical thinking

Lipman (1988) argues that critical thinking is a form of intelligence that can be taught and learned. Along these lines, Niu et al. (2013), based on a meta-analysis conducted in the university environment, concluded that educational interventions favour their development. At the same time, the rise of technology in the classroom has generated debate about its impact on learning. As teachers integrate digital tools, it is imperative to assess how AI applications affect the development of critical thinking (Delgado et al., 2015).

GAI tools can enhance critical thinking by generating dynamic, interactive learning experiences that encourage active participation (Baidoo-Anu & Owusu Ansah, 2023).

However, their effectiveness depends on frameworks that guide their pedagogical implementation and allow the analysis of the real development of these skills.

In this context, Shanto et al. (2024) proposed the 'AI-CRITIQUE' framework to foster critical thinking in environments with GAI. However, due to its limitations in flexibility and adaptability, the present study adopts the approach of Yusuf et al. (2024), which structures learning into five interconnected phases: familiarisation, conceptualisation, enquiry, assessment and synthesis (see Appendix; Table 2). This model highlights the importance of progressing from basic cognitive processes to higher levels while promoting a critical analysis of the information generated by AI.

As Table 2 shows, integrating GAI into assessment offers an opportunity to foster critical thinking through hands-on, personalised learning. These tools broaden approaches to complex topics, provide immediate feedback and incorporate examples, analogies and what-if scenarios that stimulate critical reasoning (Javaid et al., 2023). Through simulations and guided discussions, students can develop skills such as evaluating arguments, identifying fallacies and formulating informed answers. This will strengthen their ability to structure ideas coherently, question assumptions and consider alternative perspectives.

The evaluation of these interventions combines longitudinal and cross-sectional designs. The former employs *ex ante* and *ex post* questionnaires to measure changes in students' perceptions and abilities over time, while the latter includes control groups to compare the impact of the intervention between exposed and unexposed students, identifying significant differences attributable to the use of GAI.

Recent empirical evidence supports the potential of these tools in higher education. Studies (Guo & Lee, 2023; Ruiz-Rojas et al., 2024) indicate that the effective integration of GAI improves students' self-perception in terms of their competence in critical thinking, with notable advances in the formulation of exploratory questions, rigorous evaluation of information, the construction of logical conclusions and the understanding of complex topics.

However, improper integration of these tools comes with risks. Fuchs (2023) warns that an over-reliance on GAI without understanding the underlying concepts can limit genuine learning (Ivanov, 2023). This risk is evidenced in the research by Dilekli and Boyraz (2024), where graduate students were asked to conduct a reflective self-assessment by comparing their own essays with those generated by *ChatGPT*. Most accepted the information provided by the AI without questioning or verifying its reliability, despite having taken a course on 'Teaching Thinking Skills'.

These previous findings reinforce the need for active teacher supervision to guide students towards a more reflective and critical use of GAI. Without adequate guidance, these technologies can limit the development of critical thinking and creativity, since, faced with the pressure of deadlines or the optimisation of resources, students could accept the information generated without validating it, even when its accuracy is not guaranteed.

METHODOLOGY

Data

Semi-structured interviews were conducted with eleven teachers from face-to-face and distance learning universities. Although a non-probabilistic convenience sampling method was used with a small sample and limited diversity, the homogeneity of the

participants and the structure of the interviews reinforce the validity of the results. Young and Casey (2019) argue that small and homogeneous samples identify codes and themes effectively, reaching significant representations with 6–9 cases, while 7–10 participants are more suitable for complex topics. For their part, Almanasreh et al. (2019) suggest a threshold of close to 10 experts. Table 3 (see Appendix) presents the blind profile of the informants used in this study.

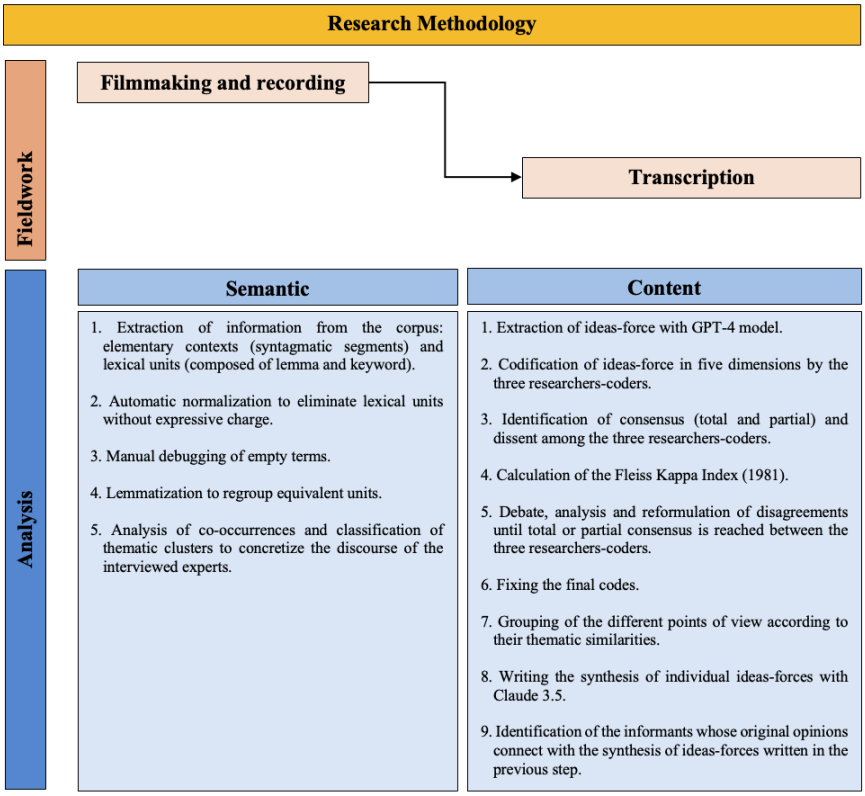
The interviews followed the pentagonal model proposed by De Vicente and Matti (2016) for the processes of systemic reflection. In line with the objectives of this study, the interviews focused on exploring the development of critical thinking in the context of the use of GAI by distance university students within the European Higher Education Area (EHEA). This model structured the interviews in five blocks: (1) barriers to the development of critical thinking; (2) accelerators that could power it; (3) available socio-technological alternatives; (4) social challenges to be addressed; and (5) consequences of a general improvement in the acquisition of this competence.

The eleven interviews, conducted in November 2024 through *Microsoft Teams*, had an average duration of 53 minutes, with a standard deviation of 20 minutes, adding up to a total of 10 hours and 54 minutes. Previously, the participants received an informed consent form, prepared according to the models of the UNED Ethics Committee. The sessions were recorded for later transcription and analysis, obtaining a total of 52,720 words transcribed.

Figure 1 shows the guideline of the methodology used, providing a structured view of the process followed for data collection and analysis.

Figure 1

Sequence guide of the methodological process



Source: created by the authors.

Semantic analysis

Based on the transcription of the interviews, a qualitative–quantitative textual analysis was carried out using the *T-LAB v.10.2.7 software*, which allows for identifying word patterns through statistical and graphical applications.

This methodology has been widely used in the analysis of linguistic corpora in different disciplines, such as the study of discourse in social media on political–social issues (Gil & Guilleumas, 2017), content analysis in psychology (Mazzoni et al., 2018) and the field of tourism (Mondo & Gândara, 2017). Its versatility makes it a tool with great potential for scientific research (Cortini & Tria, 2014).

The *software* extracts information from the linguistic corpus using elementary contexts (textual segments in syntagmatic units) and lexical units, composed of lemmas and keywords. An automatic normalisation was applied to eliminate lemmas without expressive load, complemented by a manual debugging of empty terms. Subsequently, a lemmatisation process was carried out to group equivalent units; for example, the keywords 'AI' and 'artificial intelligence' were grouped under the same lemma 'AI'. Finally, 120 lemmas were identified, which allowed an analysis of co-occurrences and categorisation of thematic clusters to structure the discourse of the experts interviewed.

Content Analysis

In addition to the semantic analysis, a content analysis of the interviews was carried out. The *GPT-4o* language model was used to assist the researchers in the task of extracting the main strong ideas expressed by the experts. Each strong idea was transcribed verbatim to preserve its minimum thematic precision. Subsequently, they were independently coded and mapped to the dimensions of the pentagonal model. To ensure the consistency and reliability of consensus among the coders, the Fleiss Kappa (Fleiss, 1981) was calculated, considering three scenarios: (1) total consensus (the three coders agreed); (2) partial consensus (two out of three agreed and the majority option was adopted); and (3) dissent (no agreement). Cases of dissent were resolved by discussion among the researchers until partial or total consensus was reached before proceeding to final codification.

In the next stage, the Claude 3.5 language model was used to support the reformulation of the wording of these strong ideas to carry out a synthesis of the main consensuses identified in the previous stage. This process of seeking consensus made it possible to condense shared points of view among the informants, articulating a common sensitivity regarding the five dimensions analysed: barriers, accelerators, alternatives, social challenges and visible consequences. In this way, the results were synthesised, reflecting a wide spectrum of perceptions shared among the participants.

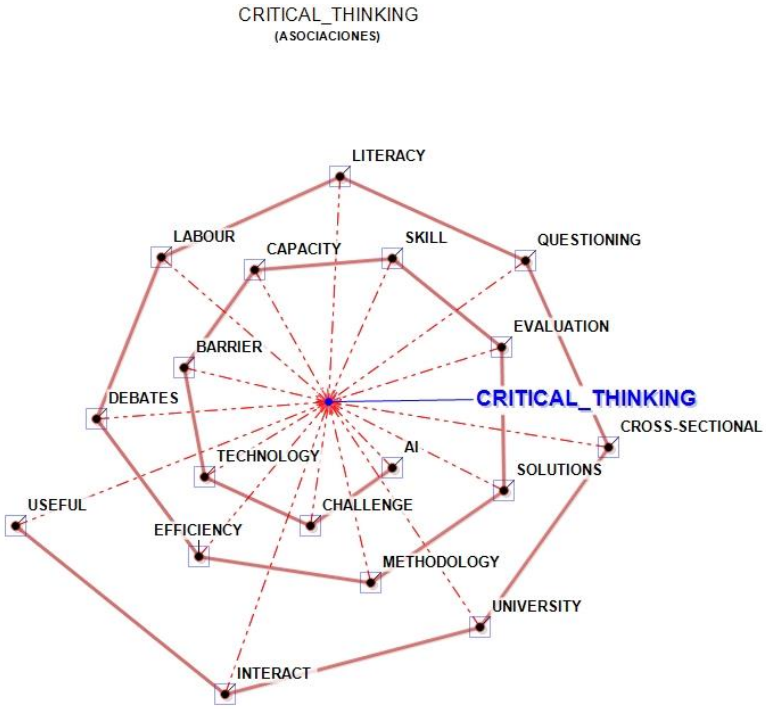
RESULTS, DISCUSSION AND IMPLICATIONS

Semantic analysis of co-occurrences

From the 120 lemmas selected from the linguistic corpus, a co-occurrence analysis was developed to identify word associations and calculate the frequency with which

two or more lemmas coincided in identical elementary contexts. Figure 2 reports the link between the *critical thinking* lemma, the focus of the study and other lemmas with which it shows statistically significant co-occurrences (chi2 test, $p < 0.05$).

Figure 2
Radial Diagram of Lemma Association for Critical Thinking



Source: created by the authors.

In the radial diagram, the lemma *critical thinking* (lemma A) is located in the centre, while the rest of the lemmas (lemmas B) are distributed around. The B lemmas closest to the school have a higher level of co-occurrences and those farther away have less frequent associations. The lemmas with the highest level of co-occurrence regarding *critical thinking* (motto A) are *AI*,[2] *challenge*, *technology*, *barrier* and *capacity*. The concentration of co-occurrences around these lemmas indicates that critical thinking is situated at an intersection between GAI and educational innovation.

Conversely, the lemmas *literacy*, *ability* and *capacity* refer to the importance of digital and critical literacy as a basis for developing advanced skills. In the same way, the lemmas *evaluation* and *questioning* connect with the need to integrate critical thinking in evaluation systems and in the design of educational activities that promote the analysis and evaluation of information generated by AI.

The resistance to change faced by the development of critical thinking in the context of GAI is reflected in the lemmas *challenge* and *barrier*. In turn, *labour* and *solution* highlight the need to apply critical thinking not only as a competency but also as a tool to solve problems in professional environments. By contrast, the lemma *debates* points to the importance of creating spaces for dialogue, where students and teachers can discuss and build knowledge collaboratively. In the same vein, the lemma

interact alludes both to the relationship between students and teachers and to their link with GAI.

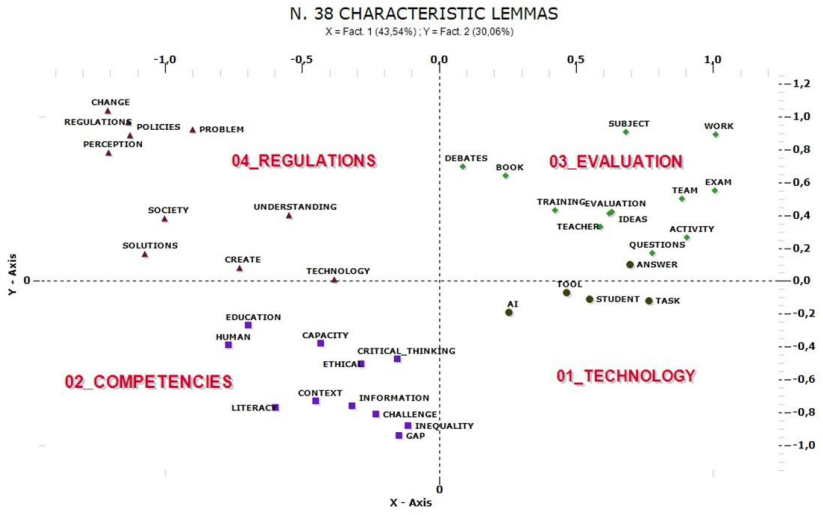
The data suggest that the interviewees have an impact on the understanding of critical thinking from an approach focused on transferable competencies, critical literacy and technological challenges. The integration of GAI and technology into educational environments emerges as a strategic axis; however, it requires methodological changes and solid training for students and teachers. In addition, the role of critical appraisal, debates and applied solutions reinforces the need to foster dynamic educational environments that prepare students to respond to the challenges of the digital society and the labour market.

Thematic analyses

Through the *unsupervised* clustering method (*k-average bisecting* algorithm) offered by *T-LAB*, the content of the interviews was categorised into significant clusters or thematic groups, defined according to the pattern of lemmas that compose them. The thematic analysis of the linguistic corpus identified 1,197 elementary contexts, of which 1,006 (84.04%) were classified. A partition into four *clusters was chosen*, as it presented the highest statistical adherence for the research. These four key dimensions, linked to the educational and social spheres, presented the following distribution: *Cluster 01-Technology* (31.9%); *Cluster 02-Competencies* (25.5%); *Cluster 03-Evaluation* (19.9%); and *Cluster 04-Regulations* (22.7%).

The distribution of clusters and their associated lemmas (Figure 3) facilitates the identification of trends in the subject of study. These four *clusters* offer an integrated vision of critical thinking, structured in two axes: (1) *Axis X*–operational perspective, related to the pedagogical development of competencies in the classroom; and (2) *Axis Y*–strategic perspective, contextualised in a broader normative, social and political framework (see Appendix; Table 4).

Figure 3
Clusters and Lemmas



Source: created by the authors.

Content Analysis

The transcription of the interviews allowed the extraction of 801 strong ideas, distributed according to the blocks presented in Table 5 (see Appendix). To ensure consistency and validity, the researchers coded these strong ideas individually by assigning them to the dimensions of the pentagonal model. The Fleiss Kappa index ($\kappa = 0.82$) *confirms a high degree of agreement among coders, supporting the robustness of the analysis (Altman, 1990*). Tables 6, 7, 8, 9 and 10 included in the Appendix report the details of consensus identified among the interviewed informants for each of the five dimensions[3]. The barriers, accelerators, socio-technological alternatives, social challenges and visible consequences included in these tables are presented synthetically, ensuring fidelity to the meaning expressed by the informants. Next, the ideas that have the greatest consensus[4] in each dimension are discussed and connected to the previous academic debate.

Consensus on barriers to critical thinking development

The analysis of the informants' opinions regarding the main barriers that hinder the development of students' critical thinking (Appendix; Table 6) agrees on a gap between the rapid advance of GAI and the slow adaptation of education systems. This problem, which is widely documented, has been pointed out by Barrett and Pack (2023), who warn that the absence of clear policies and institutional guidelines generates uncertainty and ethical concerns, making it difficult to integrate GAI into the classroom. In response, universities have begun to establish guidelines for the ethical use of GAI, such as the framework proposed by Chan (2023). Likewise, strategic orientations have been developed for public policymakers, among which the contributions of Miao et al. (2021) stand out. UNESCO (2024), in its *Competence Framework on Artificial Intelligence for Teachers*, stresses that education systems must go beyond technical teaching (teaching about GAI) and foster critical understanding (teaching for GAI).

Currently, training in GAI is primarily led by private companies that prioritise the development of technical skills. Therefore, it is essential to increase awareness of the need to integrate critical thinking in those educational contexts where AI is used. This idea was also supported by informants, who advocate process-centred learning practices, with approaches that encourage reflection, exploration and critical thinking.

The resistance to change among educational actors and at all institutional levels reflects a relevant consensus. Evidence suggests that this systemic barrier responds to organisational inertia that hinders the implementation of the pedagogical and technological innovations necessary to promote critical thinking in distance learning. The willingness of teachers to promote a critical use of GAI is an indispensable condition for its integration into the educational environment. In this sense, understanding their attitudes, beliefs and preconceptions operates as a fundamental lever to ensure effective integration (Choi et al., 2023).

Insufficient teacher training in critical thinking and the use of GAI limits the ability of educators to design pedagogical strategies that integrate both dimensions in the teaching–learning process. Along these lines, several studies highlight the importance of promoting critical thinking in initial teacher training programmes (Mpofu & Maphalala, 2017; Lorencová et al., 2019; Ronderos et al., 2024) and using

metacognitive strategies that strengthen digital skills in the classroom (Pereles et al., 2024).

The uncritical use of GAI and the latent risk of plagiarism by students constitute another consensus among the experts interviewed. This issue underscores the need to develop competencies for ethical and reflective use of these tools (Cotton et al., 2023). The lack of assessment and prioritisation of transferable skills such as critical thinking, together with the absence of clear metrics, hinders their monitoring and development in students. This challenge is intensified in distance education, particularly in asynchronous activities that employ essays as an assessment tool. According to Eke (2023), the integration of these tools raises concerns about academic integrity and the limits of co-authorship, compromising the capacity of essays to reflect the student's cognitive process faithfully and assess their critical reasoning effectively. To mitigate this risk, this research proposes the dissemination of the frameworks presented in Tables 1 and 2, which offer tools to critically analyse the information generated by the GAI and strengthen critical thinking in students.

The lack of specific literacy in GAI and critical thinking limits the ability of teachers and students to harness the educational potential of these tools. The academic literature addresses the need for literacy from various training areas: curriculum design (Chiu & Chai, 2020), literacy frameworks in GAI (Luckin et al., 2022), didactic applications (Wilton et al., 2022), professional development programmes (Vazhayil et al., 2019) and ethical considerations (Celik, 2023; Gartner & Krašna, 2023).

A widely recognised consensus is the perception, shared by teachers and university authorities, of GAI as an educational substitute rather than a complement. This vision can hinder its integration as a support tool for the development of critical thinking. In this sense, the literature emphasises the importance of creating balanced learning environments that prioritise analytical reasoning before resorting to GAI (Malik et al., 2023). In any case, given the rapid evolution of this technology, strategies such as its prohibition or investment in plagiarism detection methods are unsustainable (Martín & López, 2023). Therefore, the main challenge is to achieve its ethical and effective integration into educational processes.

Consensus on accelerators for the development of critical thinking

Regarding accelerators (Appendix; Table 7), the updating of transferable and specific competencies for the critical use of GAI is presented as the broadest consensus among the interviewees, with seven agreements. To address these training needs, some research (Kong et al., 2023) proposes the need to design an introductory literacy course in GAI, which strengthens participants' technological understanding and ethical awareness, preparing them to apply and evaluate GAI critically in their future careers.

The evidence found indicates the need to reform existing assessment systems, integrating GAI to optimise *feedback* and curricular adaptation. The alignment of educational policies with technological advances, from an ethical and responsible approach, could act as an accelerator to strengthen critical thinking. In this context, the experts consulted highlight teacher training and motivation (Ayanwale et al., 2022) and adequate coordination of public policies as key factors in overcoming the barriers identified.

Other points of consensus among informants include the accessibility of GAI to reduce educational gaps and strengthen self-assessment and peer review systems. These practices are fundamental to promoting metacognition and reflection in

learning, allowing students to analyse their performance and adjust their processes. The integration of these assessments with GAI tools expands their scope by objectively detecting biases, inaccuracies and areas for improvement (Guàrdia Ortiz et al., 2024). This approach is linked to the concept of learning by comparing (Longarela-Ares & Rodríguez-Padín, 2023), stimulating learning by comparing AI assessments, peers and the student themself. In this way, critical thinking is stimulated and the use of technology is balanced with human intervention.

Another point of consensus highlights that GAI optimises automatable tasks, freeing up time that can be redirected to more complex activities, such as the development of critical thinking. This idea is closely associated with the potential of AI to transform the learning and work process through immediate feedback (Cavalcanti et al., 2021). Likewise, the need to implement specific policies that strengthen the connection between the university and the labour market is recognised, ensuring that the training of future graduates responds to professional demands. However, a dichotomy emerges: on the one hand, the importance of education systems going beyond technical teaching of GAI and fostering critical understanding; on the other hand, the urgency of adapting to an ever-changing work environment that requires knowledge of specialised GAI applications in different professional fields.

Consensus on socio-technological alternatives for the development of critical thinking

Among the socio-technological alternatives available (Appendix; Table 8), the informants highlight the need to ensure equitable access to GAI technologies. They warn that, if not properly managed, these tools could widen the digital and productive divide between those who have the skills to formulate effective *prompts* and those who do not, underlining the active role that the university must assume in the democratisation of their access.

The informants highlight the importance of training the entire university community in the critical use of AI, fostering skills to evaluate and interpret its results reflectively. To do this, they consider it essential to understand their limits, algorithmic biases and hallucinations (Baker & Hawn, 2022). In this context, the informants propose implementing *chatbots* in safe and controlled environments to ensure ethical and responsible use. However, they warn that restricting these tools to academic questions could lead to algorithmic biases, limiting both diversity and scope of the answers, in contrast to the broader and more flexible possibilities of other, more versatile GAI applications.

Finally, the experts propose incorporating an ethical dimension that preserves academic integrity and fosters students' self-reflective capacity. Although this line of action is decisive in higher education in general, it acquires special relevance in distance learning, where autonomous learning and limitations in teacher supervision make it difficult to control the use of GAI by students (Dilekli & Boyraz, 2024).

Consensus on social challenges for the development of critical thinking

Informants highlighted the main societal challenges that need to be addressed to strengthen critical thinking in distance university education in a context marked by the widespread use of GAI (Appendix; Table 9). There is a broad consensus regarding the

need to transform current teaching roles to mitigate the uncritical dependence on GAI and promote autonomy of thought.

The experts identify digital literacy and the reduction of technological gaps as the main social challenges, emphasising the need to develop digital skills from the formative educational stages before going to university. In this context, Lin and Van Brummelen (2021) point out that primary and secondary school teachers require additional scaffolding in the use of AI tools and in curriculum design to facilitate debates on ethics and data, strengthen assessment, promote student participation, foster peer collaboration and stimulate critical reflection and questioning of the information generated by GAI. This challenge once again highlights the imperative to ensure equitable access to emerging technologies, a priority already envisaged in UNESCO's *Strategy (2021) on Technological Innovation in Education*. This framework stresses the importance of adopting a human-centred approach, in which AI contributes to reducing inequalities in access to knowledge, research and culture, avoiding the widening of technological gaps and ensuring that its benefits are accessible to all.

Consensus on visible consequences of the development of critical thinking

In the opinion of the experts consulted (Appendix; Table 10), from a pedagogical perspective, developing the capacity to question the results of GAI would allow the current evaluation to be transformed into a new evaluation dimension that would lead to the development of new analytical and creative skills.

Based on the consensus reached, the informants highlighted that the risks associated with the use of GAI could be mitigated through digital literacy and algorithmic transparency. They also pointed out that one of the main consequences of strengthening critical thinking in students would be that, as it is supported by GAI, it would improve the speed of the teaching–learning process. However, they warned that, depending on how education policies are implemented, significant risks could arise of widening pre-existing social and educational inequalities. Finally, the interviewees agreed that the effective development of critical thinking strengthens leadership and problem-solving skills in future graduates, favouring more adaptable profiles and reducing the risk of homogenisation of thinking.

Implications

The findings of this study concur with previous studies on GAI (Castelló-Sirvent & Cortés-Pellicer, 2024), which highlight the concerns of future graduates about the potential for error, the quality and impartiality of information, the manipulation of biased or false content and the need for AI training to improve employability. The study by Rusdin et al. (2023) underscores the perception that students have of AI as a valuable tool for critical thinking, particularly in academic research and theoretical analysis. However, they warn of risks such as the lack of personalisation, generation of echo chambers and difficulties in understanding nuances of knowledge.

In addition, this study contributes to orienting the academic debate about the main implications proposed in Table 12. The five vectors of action serve as a strategic guide for teachers, university managers and those responsible for the design of educational policies, facilitating decision-making in the integration of AI in teaching and learning processes.

Table 12
Proposed vectors of action for the development of critical thinking in GAI contexts

Strategy	Actions
Develop an institutional framework for the ethical integration of GAI	- Define clear guidelines for the ethical use of GAI. - Promote GAI as a complementary tool in education. - Reduce the risk of plagiarism with responsible criteria. - Create special committees to oversee integration. - Ensure supra-institutional coherence in GAI policies. - Prioritise teacher training within the institutional framework. - Establish standards for assessing critical thinking. - Ensure equity in access to GAI technologies.
Promote teacher training programmes in GAI and critical thinking	- Design training in critical thinking and GAI. - Include technical, ethical and pedagogical aspects in the programmes. - Create spaces for mentoring and teacher collaboration. - Extend good practices in teaching with GAI. - Incorporate evidence-based strategies into training. - Promote reflective methodologies to integrate critical thinking. - Facilitate the transition to GAI-supported pedagogies. - Ensure the constant updating of teaching skills.
Design and implement specific digital literacy programmes in GAI	- Create accessible materials about the limits and potential of GAI. - Encourage critical reflection in the use of digital tools. - Establish mandatory modules on the ethical use of GAI. - Tailor programmes to the specific needs of students and teachers. - Provide practical and ethical training in the use of GAI. - Design resources to validate information and avoid bias. - Emphasise self-regulation in autonomous learning. - Attend to the particularities of distance education without synchronous teaching.
Update evaluation systems focused on analytical processes	- Prioritise the evaluation of reasoning over final results. - Design specific rubrics for critical analysis with GAI. - Promote the reflective use of GAIs in evaluation processes. - Integrate metacognitive skills into assessment systems. - Implement evaluations that value arguments developed with GAI. - Align assessment with critical and analytical competencies. - Encourage vigilant collaboration between students and teachers. - Facilitate feedback focused on reflective processes.
Redesign university curricula	- Transform curricula to include critical skills with GAI. - Coordinate redesign with meso and macro institutional levels. - Ensure equitable access to GAI licences and resources. - Promote equal opportunities in critical development. - Include modules on critical thinking and algorithmic biases. - Strengthen attention to diversity and special needs. - Ensure alignment with labour market demands. - Incorporate critical and reflective components into curricula.

Source: created by the authors.

CONCLUSION

Research on the development of critical thinking in the context of the widespread use of GAI remains limited and fragmentary. This exploratory study constitutes a first effort to identify the factors that affect its development, analysing barriers, accelerators, technological alternatives, social challenges and consequences of their integration. The consensus reached and the proposed vectors of action can serve as a basis for the design of measurement instruments, such as surveys aimed at university teachers. Having a sufficiently large and diversified sample will allow the contrasting of expert perceptions with empirical data, thereby strengthening the external validity and reliability of the findings. This triangulation will allow evaluation of the coherence between qualitative trends and quantitative measurements, identifying possible discrepancies or convergences in the relationship between GAI and critical thinking, and providing a more solid framework for decision-making in the design of pedagogical policies and teacher training strategies.

Although this study was carried out in distance learning universities within EHEA, which could restrict the generalisation of the results to other systems with different regulations and organisational structures, the consensus reached and the proposed lines of action show a high capacity to adapt to different digital educational environments, favouring its applicability in contexts with similar learning dynamics.

Although this study has focused the analysis on the role of teachers in the implementation of GAI, future work should broaden the spectrum of actors involved, including the perspective of students, educational policymakers and representatives of the private sector. Incorporating these profiles would allow for a more holistic and multi-dimensional approach, facilitating a comprehensive understanding of the challenges and opportunities that GAI poses in the development of critical thinking. This would enrich the academic debate and strengthen the design of pedagogical strategies that are more contextualised and adjusted to the needs of the educational ecosystem.

GAI can make learning more immersive, dynamic and personalised, improving academic performance, motivation and self-regulation (Huang et al., 2023; Yuan & Liu, 2025). However, without adequate mediation, its use could generate uncritical dependence, leading students to accept automated responses without analysing them reflectively, which would limit their ability to question (Chng et al., 2023). To mitigate this risk, it is essential to balance technological integration with teacher intervention, ensuring that GAI does not replace student's cognitive process but, rather, enhances it through structured and reflective strategies.

Engagement in distance education depends not only on access to innovative tools but also on the quality of teacher–student interaction, a determining factor for knowledge retention and academic satisfaction (Bae et al., 2020; Hoi & Le Hang, 2021). Therefore, pedagogical planning must integrate GAI without displacing teaching work, aligning with objectives that promote the validation of information, the identification of algorithmic biases and reflection on the impact of AI on learning (Martín & López, 2023).

For effective integration, teachers require institutional support. Institutions must establish guidelines that regulate their use, ensuring an ethical, accessible implementation aligned with pedagogical standards that stimulate critical thinking. Likewise, teacher training in digital literacy and AI is essential to design assessment strategies that promote authentic learning. In distance learning environments, where

the essay has been the main assessment tool, contrasting AI-generated responses with verified sources, designing strategic *prompts* and analysing *algorithmic outputs* critically can foster more thoughtful interaction with technology.

Future empirical studies should analyse how educational interventions with AI tools impact critical thinking and the affective and behavioural dimensions of student *engagement*. To this end, it would be useful to combine cognitive skill assessment instruments with self-reports, interaction analysis and quantitative metrics extracted from virtual platforms. In addition, longitudinal studies could examine its effect in the medium term, identifying its influence on reducing dropout rates, mitigating disengagement and academic isolation and noting its contribution to the development of autonomy, self-regulation of learning and student motivation.

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NOTES

1. Some authors (Van Laar et al., 2017; Thornhill-Miller et al., 2023) describe them as *21st Century Skills* or the '4 Cs' (creativity, critical thinking, communication and collaboration).
2. The term GAI, although almost all of the informants used the term AI in a colloquial sense that referred to GAI. As a consequence, textual and content analysis use both terms interchangeably in the literal expression or in the discussion of the results, respectively.
3. Table 11, included in the Appendix, provides an example of literal expressions of the informants that are linked to the strong ideas of each dimension.
4. Although Tables 6 to 10, included in the Appendix, include consensuses equal to or greater than two respondents, the following section on consensuses describes agreements equal to or greater than three informants.

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APPENDIX

Table 1
Foundational critical thinking skills and questions to stimulate them

Ability	Description by expert consensus	Skills	Questions to stimulate	Evaluation Activities
Interpretation	Understand and express the meaning or relevance of experiences, situations, data, events, judgments, rules, procedures, or criteria.	Categorize. Decoding meanings. Clarify concepts.	What does this mean? What's happening? How should we interpret this statement or situation? What factors influence this interpretation?	Identify problems and describe them without bias. Distinguish the main ideas from the secondary ones in a text. Clarify graphs or diagrams.
Analysis	Identify inferential, intentional, or actual relationships between statements, concepts, and representations of ideas or judgments.	Examine ideas. Identify arguments. Detect premises.	What are the reasons for this statement? What is it concluding? What are the arguments for or against? What assumptions underlie this position?	Identify similarities, differences, and assumptions implicit in arguments. Graphically represent relationships between key ideas.
Inference	Identify the elements necessary to formulate reasonable conclusions, build hypotheses and analyze relevant information to foresee consequences.	Consult evidence. Formulate alternatives. Draw valid conclusions.	What conclusions can we draw from this information? What does this evidence imply? What consequences can we foresee? What additional information do we need?	Formulate hypotheses, anticipate implications and design strategies to address them. Validate hypotheses through experiments.
Evaluation	Evaluate the credibility of statements and the logical coherence of their relationships.	Evaluate credibility. Evaluate deductive / inductive arguments.	What criteria allow us to determine the quality of the evidence? How strong are these arguments? What fallacies can be present in these arguments? Is the evidence presented reliable?	Assess the credibility of sources, the strength of arguments, and the coherence of reasoning, identifying potential contradictions or biases.

Ability	Description by expert consensus	Skills	Questions to stimulate	Evaluation Activities
Explanation	Justify reasoning based on evidence, concepts, methods and criteria, and present it in a structured and coherent way.	Communicate results. Justify procedures. Present arguments.	What are the specific findings? What reasons justify this conclusion? What criteria support this assessment? How would you justify this decision?	Communicate findings, justify decisions with evidence, and design graphics to structure hierarchical concepts.
Self-regulation	Consciously monitor and evaluate one's own thought processes to question, validate, or correct reasoning and results.	Questioning one's own judgments. Confirm results. Validate or correct reasoning.	Are we being accurate enough? Do we question our assumptions? What consequences can we foresee? What are we overlooking?	Review one's own judgments considering biases. Verify understanding and correct errors in calculations, interpretations or conclusions.

Source: adapted from Facione (2023).

Table 2

Framework for critically analysing the information generated by AI

Phase	Purpose	Top Actions with AI	Expected Result
1. Familiarization	Explore and understand AI-generated content.	Read AI-generated text critically. Identify recurring biases, assumptions, or patterns in content. Reflect on the context in which the information is produced.	Solid initial understanding of the content and detection of potential limitations inherent in the use of AI.
2. Conceptualization	Organize the key ideas identified in the AI-generated content.	Extract main concepts from the generated content. Design visual maps that connect ideas and use them as a reference for further analysis.	Building a solid structure to dig deeper into the content and encourage critical analysis.
3. Inquiry	Question and critically analyze the concepts generated by AI.	Formulate questions directed at the AI, using *specific prompts* ("why?", "how?"). Evaluate the relevance and depth of the responses generated, considering alternative approaches to the content provided by AI.	Development of critical skills through active questioning and exploration of diverse perspectives.

Phase	Purpose	Top Actions with AI	Expected Result
4. Evaluation	Validate the credibility, relevance, and consistency of AI-generated responses.	Contrast AI responses with reliable external sources. Evaluate the consistency of responses in the face of additional evidence. Identify and correct potential errors or misinformation generated by AI.	Develop the ability to critically evaluate the validity of arguments, distinguishing between those with solid foundation and those without support.
5. Synthesis	Integrate AI-generated content with external sources and prior knowledge.	Combine information from AI with external sources and prior knowledge.	To promote a structured and connected understanding of the content, facilitating its application to different contexts.

Source: adapted from Yusuf et al. (2024).

Table 3
Blind profile of informants

Informant	Contractual figure	Sex	Area of knowledge	Experience in educational management and innovation
1	University Professor	Man	Didactics	Specialist in educational innovation, virtualization and instructional design
2	University Professor	Man	Statistics and Operations Research	Expert in AI and technological ethics, with experience in leading knowledge transfer strategies and university-business alliances.
3	Assistant Professor	Woman	Didactics and Educational Technology	Specialist in educational technology, with leadership in innovation, methodology planning, teacher training and design of autonomous learning models
4	University Professor	Man	Economic History	Teacher with institutional leadership in educational innovation and technologies applied to teaching, responsible for the planning and adaptation of methodological frameworks in virtual environments
5	Senior Technician	Woman	Pedagogy	Professional in educational innovation and pedagogical training, with experience in teacher advice
6	University Professor	Man	Electronic Technology	Exercises institutional leadership in educational innovation and is responsible for academic observatories specialized in technology applied to teaching
7	University Professor	Man	Financial Economics and Accounting	Researcher specialized in artificial neural networks and in the dissemination of the impact of ICTs

Informant	Contractual figure	Sex	Area of knowledge	Experience in educational management and innovation
8	Associate Professor	Woman	Business Management	Teacher with experience in strategic management and educational innovation, specialized in the application of IAG
9	University Professor	Man	Systems Engineering and Automation	Academic Director with experience in the integration of digital technologies and IAG in learning environments; He leads technological development and institutional digital transformation projects.
10	Associate Professor	Woman	Philosophy	Professional dedicated to promoting critical thinking and ethics in decision-making in work environments
11	Private University Professor	Man	Philosophy	Teacher specialized in strengthening critical thinking in digital environments and analyzing the philosophical and educational implications of technological singularity.

Source: created by the authors.

Table 4

Descriptors about the clusters in Figure 3

Cluster	Remarks
Cluster 01: Technologies (31.9%)	Located at the bottom right, it brings together slogans such as AI, tool, task and student, which points to a reflection on the impact of technologies on educational processes. In addition, it highlights the role of students as main actors in an educational environment transformed by technology.
Cluster 02: Competencies (25.5%)	In the lower left, this cluster focuses on slogans such as literacy, education, ethics, capacity and information, reinforcing the idea that critical thinking should be integrated into educational programs as an essential competence that encompasses technical and ethical aspects. The slogans inequality, gap and context suggest a concern about the differential impact of these technologies and underline the need for digital literacy and equity in access to resources. It represents the conceptual core of critical thinking as an educational objective.
Cluster 03: Evaluation (19.9%)	Located in the upper right, this thematic group groups slogans such as training, evaluation, questions, response and activity, reflecting a methodological approach to critical thinking. In fact, it is linked to the importance of designing innovative methodologies that encourage participation and reflective analysis in the classroom. It also refers to the role of the teacher in the implementation of activities that develop critical skills.

Cluster	Remarks
Cluster 04: Regulations (22.7%)	Located in the upper left, it includes slogans such as policies, regulations, society and solutions, which underlines the structural and political dimension of critical thinking and indicates that its implementation in education requires solid regulatory frameworks and a strategic approach that allows the creation of favorable conditions for the implementation of ethical and inclusive approaches to learning. The distribution of clusters suggests that critical thinking depends on specific educational activities and normative factors that frame their implementation.

Source: created by the authors.

Table 5

Distribution of the strong ideas by dimensions included in the interviews

Dimension	Strong Ideas	Quota
Barriers	172	21%
Accelerators	162	20%
Socio-technological alternatives	159	20%
Social challenges	153	19%
Visible consequences	155	19%

Source: created by the authors.

Table 6

Consensus on barriers expressed by the informants participating in the study

Barriers to the development of critical thinking	1	2	3	4	5	6	7	8	9	10	11
Gap between the rapid advance of AI and the slow adaptation of education systems	✓	✓	✓								
Resistance to change at all institutional levels and educational actors	✓	✓	✓								
Insufficient teacher training in critical thinking and the use of AI	✓			✓			✓		✓		
Lack of evaluation and prioritization of critical thinking in education systems		✓		✓					✓	✓	
Uncritical use and risk of plagiarism in the use of AI by students						✓	✓	✓			✓
Absence of a clear regulatory and legal framework for the educational use of AI			✓						✓		
Lack of specific literacy in AI and critical thinking								✓		✓	✓
Social and media context unfavorable for the development of critical thinking				✓							✓
Lack of integration between AI and critical thinking activities					✓			✓			✓
Misperception of AI as a substitute for rather than an educational supplement		✓							✓		✓

Source: created by the authors.

Table 7

Consensus on accelerators expressed by the informants participating in the study

Accelerators for the development of critical thinking	1	2	3	4	5	6	7	8	9	10	11
Updating of transversal and specific competences in the critical use of AI	✓	✓	✓	✓	✓	✓	✓				
Promotion of the training and motivation of teachers as leaders of educational transformation		✓					✓			✓	
Transformation of evaluation systems towards process assessment with AI			✓	✓		✓	✓				
Promoting education in the ethical and responsible use of AI			✓	✓		✓		✓			✓
Priority implementation of AI literacy from the start of university								✓			✓
Aligning education policies with technological advances		✓	✓			✓					
Strengthening the Academia-Labor Market Connection in AI Skills		✓				✓			✓		
Process optimization and time management using supervised AI					✓		✓		✓		
Facilitating equitable access to AI to bridge gaps								✓	✓		✓
Promotion of self-evaluation and peer evaluation systems				✓	✓		✓				

Source: created by the authors.

Table 8

Consensus on socio-technological alternatives expressed by the informants participating in the study

Socio-technological alternatives for the development of critical thinking	1	2	3	4	5	6	7	8	9	10	11
Development of AI tool assessment and validation skills	✓	✓						✓			
Implementing critical AI interaction systems that encourage questioning	✓			✓							
Creation of *Frameworks* to understand algorithmic limitations and biases	✓	✓						✓			
Integrating ethical values into the educational use of AI	✓		✓		✓						
Establishing teacher training programs in critical use of AI		✓								✓	
Early Incorporation of Critical Digital Literacy in AI		✓	✓								
Democratizing access to AI tools in education				✓		✓	✓				✓
Development of models for the use of AI as a complementary tool					✓					✓	
Creating safe university environments for AI experimentation							✓		✓		
Implementation of AI-assisted Socratic debate systems								✓	✓		
Establishment of transparency protocols and documentation in the use of AI								✓	✓		

Source: created by the authors.

Table 9

Consensus on social challenges expressed by the informants participating in the study

Social challenges for the development of critical thinking	1	2	3	4	5	6	7	8	9	10	11
Effectively integrating digital literacy and ethics in AI in basic education	✓	✓		✓	✓	✓	✓	✓			
Reducing technology gaps and inequalities in access to AI		✓		✓		✓	✓	✓	✓		
Overcoming uncritical dependence and promoting autonomy of thought			✓				✓			✓	
Capacity Building for AI Information Assessment and Questioning			✓	✓		✓	✓		✓	✓	
Transforming the Teaching Role towards the Pedagogical Integration of AI				✓	✓				✓		
Establishing regulatory and ethical frameworks for the use of AI						✓			✓		
Implementing ethics education for global AI governance						✓					✓
Ensuring equitable and adaptive access to AI tools								✓	✓		

Source: created by the authors.

Table 10

Consensus on visible consequences expressed by the informants participating in the study

Visible consequences of the development of critical thinking	1	2	3	4	5	6	7	8	9	10	11
Prevention of homogeneous thinking and development of AI questioning capacity	✓		✓			✓	✓				✓
Transformation towards assessments based on analytical competencies and creative processes	✓	✓			✓			✓			
Mitigating Educational Risks through AI Literacy and Transparency	✓					✓	✓				
Revaluation of the human factor in the educational process			✓					✓			✓
Greater competitiveness and professional adaptability in automated environments				✓				✓	✓	✓	
Improving the quality of public debate and strengthening democracy				✓						✓	
Optimization of educational time for critical analysis					✓		✓	✓	✓		
Potential amplification of educational and social inequalities						✓	✓	✓	✓		
Effective personalization of education through AI					✓				✓		
Strengthening ethical decision-making in technological contexts			✓		✓	✓					
Improved results and motivation through practical projects with AI		✓					✓				
Development of a more mature and demanding society										✓	✓

Source: created by the authors.

Table 11

Examples of literal expressions indicated by the informants for each dimension

Dimension	Strong Ideas	Examples of literal expressions	Informant
Barriers	Gap between the rapid advance of AI and the slow adaptation of education systems	*"There is a barrier, and that is that we have not educated, we are not educating and it is also that now we are living in a stage of a real tsunami with this AI, but nevertheless talking about education, of course, our students reach university and what happens? That we are experiencing digital denialism, prohibiting; innovative teachers who want to do something with emerging pedagogies, for example, that have to do with the emerging technologies of each moment and they are able to do so."*	3
Accelerators	Updating of transversal and specific competences in the critical use of AI	*What do we want our students to learn? What do we want a philosopher to be? What do we want a philologist to be? Well, we will have to rethink the competencies including these new tools and including competencies that in that case I think is critical thinking would surely be of the nature of what we call transversal competencies, which are in English the soft skills, that is, competing, just like that AI, because it is also interesting to know how to use media, knowing how to organize oneself, knowing how to look for references, knowing how to collaborate with others, etc., personal autonomy. Well, maybe we will have to review. This is a type of competence that sometimes we are not aware that we must review and here is an example that it is time to review, it is time to review because there is a knock on the door, so now we can no longer ignore it."*	1
Socio-technological alternatives	Development of AI tool assessment and validation skills	*"We, for example, if we go from the point of view of evaluating competencies, on the one hand, for the use of AI, divided into two parts; On the one hand, the evaluation processes, a part that is the development of a work on a series of topics that I previously explain, in the part I am on are issues of artificial intelligence or for good artificial intelligence, that they have to make an application, develop it and defend it."*	2
Social challenges	Effectively integrating digital literacy and ethics in AI in basic education	*"It's critical that we really learn how to use AI, learn how to use it as a tool to work with it [...] It is also true that, especially in a professional environment, what is going to be valued is not really the process, but what you offer."*	4
Visible consequences	Prevention of homogeneous thinking and development of AI questioning capacity	*"We could take a problem and ask two AIs and probably the answers that the two AIs give you, as you told me, are different, so what the student has to do is compare it [...] The risk, and I'm concerned, is how they're going to judge something when the view they have of the whole is a very biased and very biased whole, and actually a lot of times, right now, the hallucinations that [AI] generates are probabilistic."*	4

Source: created by the authors.