Chapter

Challenges of Artificial Intelligence in Teacher Training: Perceptions of Future Teachers

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Abstract

The growing presence of AI-based tools in teaching practices presents new challenges for training institutions, requiring future teachers to be prepared not only to use these technologies but also to critically understand their implications. This study aims to investigate future teachers' perceptions of the main challenges of AI in teacher training, focusing on three central dimensions: technological, pedagogical, and ethical challenges. The research employed a quantitative–descriptive approach, utilizing a questionnaire-based method with a sample of 72 participants. The respondents were students enrolled in the Bachelor's degree in Basic Education and the professional Master's degree in Teaching at a higher education institution located in northern Portugal. The results not only reveal a widespread perception of the relevance of AI for pedagogical practice but also point to significant limitations. On the technological level, difficulties related to the available infrastructure and the digital training of teachers in training stand out. Pedagogical challenges are associated with the effective integration of AI tools into teaching strategies, as well as the redefinition of the teacher's role in a technology-mediated setting. Finally, ethical challenges include concerns about data privacy, algorithm transparency, and the risks of dehumanization of the educational process. It is concluded that teacher training should incorporate a critical and interdisciplinary approach to AI, promoting technical, pedagogical, and ethical skills that enable future educators to act responsibly and conscientiously in an increasingly digital and automated educational setting.

Keywords: artificial intelligence, challenges, future teachers, perceptions, teacher training

1. Introduction

In recent decades, artificial intelligence (AI) has evolved from a field restricted to technological research to a central element in social, economic, and cultural transformations. In the education sector, the progressive integration of intelligent systems – such as virtual assistants, adaptive platforms, data analysis systems, and

applications based on machine learning algorithms – has opened new possibilities for teaching and learning. At the same time, these innovations raise critical questions about the role of the teacher, the nature of pedagogical interaction, and the ethics of using data and algorithms.

In the context of teacher training, the growing presence of AI requires rethinking not only training content but also the essential competencies for professional practice. Initial teacher training, traditionally focused on pedagogical foundations and subject matter, is challenged to include technological and ethical dimensions that enable future educators to act critically and innovatively in digital environments. Therefore, it is not enough to simply understand how the tools work; it is also necessary to understand their limitations, potential biases, risks of dehumanizing teaching, and implications for privacy and data security.

Recent literature highlights the significant benefits of AI in supporting teaching, including personalizing learning, continuously monitoring student progress, and automating administrative tasks, thereby freeing up time for more meaningful pedagogical activities. However, studies also point to persistent obstacles, including insufficient technological infrastructure, a gap in teachers' digital literacy, the difficulty of effectively integrating AI tools into pedagogical practices, and the lack of clear ethical guidelines for their use in educational contexts.

In Portugal, as in other countries, the discussion about AI in education has been gaining relevance, but it still lacks research focused on the perspective of future teachers, key actors in the process of pedagogical innovation. Understanding the perceptions of this group is essential to guide training policies that respond to emerging challenges and ensure a critical, conscious, and humanized approach to the integration of AI in teaching.

Based on this premise, this study seeks to analyze the perceptions of students in the Bachelor's degree in Basic Education and the professional Master's degree in Teaching regarding the technological, pedagogical, and ethical challenges of AI in teacher training. The objective is to identify the areas of greatest concern and recognized potential, contributing to the design of training strategies better suited to the demands of contemporary education.

The article is organized as follows: the "Introduction" presents the theoretical framework and relevance of the study; the "Literature Review" discusses concepts, models, and previous studies related to the integration of AI in teacher training; the "Methodology" describes the research design, the construction and validation of the data collection instrument, the sample characterization, and the ethical procedures; the "Results" section presents and analyzes the data obtained; and finally, in the "Conclusions," the main findings are summarized, the practical implications are discussed, and recommendations for future research are presented.

2. Literature review

The incorporation of generative artificial intelligence (AI) in the field of education has been rapidly intensifying, encompassing a wide range of actors: students, teachers, technical support teams, and institutional managers. The relevance of this technology in the educational context, highlighted by national and

international studies [1–4], underscores the need to prepare everyone involved to address the demands of contemporary digital society (Web 4.0).

In addition to its direct impact on teaching and learning practices, the integration of AI has been gaining prominence in teacher training, considered strategic for the development of technical, pedagogical, and ethical skills [4, 5]. Recent literature, supported by national and international systematic reviews, indicates that we are facing a complex and multifaceted scenario in which significant opportunities coexist with substantial challenges that require critical reflection and coordinated action.

In recent years, particularly between 2020 and 2025, scientific production on AI in education has grown exponentially, especially after the popularization of generative tools such as ChatGPT and Gemini [3, 4]. These platforms have not only increased academic interest in the topic but also catalyzed discussions on issues such as reliability, ethics, pedagogical adequacy, and teacher training. Although European and North American countries concentrate most of the structured initiatives, there is a consistent movement of adaptation and innovation in Latin America [3, 4], which, despite facing restrictions, has sought to align new technologies with its sociocultural and economic realities.

In the specific case of initial teacher training, the literature reveals concrete experiences of integrating AI into teaching internships and curricula. Some studies report the use of virtual assistants to support lesson planning, while others analyze how adaptive systems can personalize the monitoring of future teachers during supervised practice. These contributions reinforce the need to align the discussion not only with ethical and technical dilemmas but also with real-world training contexts, where AI can directly influence the development of professional teaching skills.

2.1 Infrastructure, digital competence, and pedagogical reconfiguration

The effective adoption of AI in education depends heavily on the existence of adequate technical and human resources. From a structural perspective, many institutions – especially in the public sector – still lack access to compatible equipment, specialized software, and quality connectivity [3, 5]. This lack is not limited to the acquisition of resources but also involves system maintenance and updates, as well as the availability of technical support capable of quickly troubleshooting and guiding teachers and students on the correct use of the tools.

At the same time, the digital competency of teachers and future teachers presents significant gaps. Research indicates that many educators feel insecure about operating and interpreting AI-based resources [3]. This insecurity is not limited to the basic use of technology but also includes a critical understanding of its functioning, limitations, biases, and ethical implications. The lack of continuing education programs focused on both instrumental mastery and critical analysis of technology exacerbates this situation.

At the pedagogical level, AI integration requires profound changes in teaching strategies. The literature [3, 4] points to the need for curricular reconfiguration that goes beyond the simple inclusion of technical modules, seeking to train teachers capable of acting as mediators and critics of the pedagogical use of AI. This implies redefining the teaching role from a mere transmitter of content to a learning facilitator, research advisor, and information curator.

Tools like ChatGPT can help personalize teaching, automate assessments, and provide immediate feedback [5], expanding the possibilities for adaptive learning. However, excessive or uncritical use can generate technological dependence, affecting teachers' intellectual autonomy and reducing interpersonal interaction, a central element in the development of socio-emotional skills. The literature warns that, without a conscious pedagogical approach, AI adoption risks being more cosmetic than transformative, reproducing traditional practices with a new technological veneer.

2.2 Ethics, academic integrity, and reliability

The integration of generative AI into higher education and teacher training brings with it a set of ethical implications that cannot be overlooked. Academic integrity emerges as a central concern. Tools like ChatGPT enable the production of high-quality texts in a short time, which can facilitate plagiarism, question the limits of authorship, and encourage academic fraud [6, 7]. There are reports of the increasing use of AI to prepare assessment papers and scientific articles, often without due transparency [8]. To address this reality, experts advocate the adoption of clear academic conduct policies, the use of advanced software capable of identifying AI-generated texts [9], and the promotion of an institutional culture focused on intellectual honesty.

Data protection is another critical issue. AI-based tools frequently access, process, and store sensitive student and teacher information [9–12]. Without adequate safeguards, there is a risk of privacy breaches and misuse of this information. Compliance with specific regulations, such as the LGPD, is essential, as is the implementation of technical and administrative protocols that ensure security and exclusive use for educational purposes.

Algorithmic bias also deserves attention. Models trained with large datasets can replicate preexisting biases and inequalities, influencing decisions and assessments in a discriminatory manner. The case of GCSE (General Certificate of Secondary Education) and A-Level in the United Kingdom, where algorithms assigned grades favoring private schools [9, 13], is a concrete example of the risks involved.

The reliability of AI-generated information is equally problematic. The phenomenon of "hallucinations" [14, 15] in which AI produces incorrect or fictitious information, can seriously compromise the quality of teaching materials and academic research. Furthermore, the technology can be used maliciously to create and disseminate fake news, biased propaganda, and manipulative content [16].

Finally, there are concerns related to human–computer interaction. Excessive use of AI-generated content can reduce human interaction, compromise the development of practical skills, and generate technological dependence [8, 9, 17]. This scenario raises questions about students' ability to develop critical thinking and autonomy when excessively mediated by automated systems.

2.3 Recommendations and pathways for ethical and sustainable integration of AI in education

Given the technical, pedagogical, and ethical challenges posed by generative artificial intelligence, the specialized literature suggests a series of integrated strategies to ensure its adoption is simultaneously innovative, responsible, and inclusive [3–5].

First, the reformulation of teacher training curricula is highlighted, ensuring that AI is not treated solely as a technological resource but as a cross-cutting content that permeates the development of future teachers' digital, pedagogical, and ethical competencies. This approach should include teaching how technologies work, their potential, limitations, and social implications, preparing teachers to act critically and consciously in AI-mediated environments [3, 4].

Furthermore, ongoing training for in-service teachers is essential. Training programs should combine instrumental mastery of tools with critical reflection on their pedagogical and ethical use, strengthening professional autonomy and stimulating the development of critical thinking and creativity. The combination of these elements helps ensure that teachers do not become mere technology operators, but rather active mediators capable of leveraging the benefits of AI in learning [3, 5].

Another crucial aspect is investment in adequate infrastructure and ongoing technical support, especially in public education systems, which often face limited access to equipment, software, and a stable connection. Public policies committed to democratizing access to educational technologies are essential to prevent the widening of digital inequalities and ensure that innovation reaches all educational contexts equitably [3, 5].

Furthermore, the literature emphasizes the importance of interdisciplinary collaboration and the building of support networks involving teachers, researchers, technology developers, and policymakers. This cooperation is essential for the development of contextualized teaching resources, protocols for the ethical use of AI, and the sharing of good practices that promote sustainable educational innovation [5].

Finally, the creation and dissemination of frameworks, models, and guidelines for digital literacy and AI are identified as priorities for future research and educational policymaking. Such tools should facilitate the integration of AI into all stages of teacher training, ensuring that the use of technologies is guided by sound ethical and pedagogical principles, in addition to contributing to the reduction of gaps in knowledge and practice [18, 19].

In short, the successful integration of AI into education depends on a multidimensional and collaborative approach that combines technological innovation with ethical reflection and pedagogical adaptation, aiming not only for efficiency but also for humanization and equity in educational processes.

3. Methodology

This study adopted a quantitative–descriptive approach, aiming to investigate prospective teachers' perceptions of the main challenges posed by AI in teacher education. This approach was chosen due to the need to obtain objective and measurable data that allow for the systematic identification of trends and opinion patterns.

Data collection was conducted using a structured questionnaire designed with closed-ended questions and items assessed on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree." The instrument addressed three core dimensions: technological challenges (infrastructure, digital literacy, and access to resources), pedagogical challenges (integration of AI tools into teaching strategies

and redefinition of the teaching role), and ethical challenges (data privacy, algorithmic transparency, and risks of dehumanizing educational practices).

The questionnaire underwent content validation by a panel of three experts in education and technology, who assessed the clarity, relevance, and suitability of the items for the study's objectives. The suggestions received were incorporated into the final version of the instrument, ensuring its relevance and consistency.

To ensure the instrument's reliability, Cronbach's alpha was calculated for the three dimensions of the questionnaire. Values ranged from 0.78 to 0.84, indicating acceptable to high internal consistency. While expert validation was essential to ensure the clarity and relevance of the items, the presentation of objective metrics reinforces the study's methodological robustness.

The sample consisted of 72 students from a higher education institution located in northern Portugal, enrolled in the Bachelor's degree in Basic Education and the professional Master's degree in Teaching. Participants were selected non-probabilistically for convenience, considering accessibility during the data collection period.

It is important to recognize that the sample has representative limitations, given that it comprises students from only one institution in northern Portugal, with a strong female predominance (88.9%) and a concentration of 17–23-year-olds. This profile does not fully reflect the diversity of future teachers' educational paths, such as different subject areas or internship experiences. Therefore, generalizations of the results should be made with caution.

All ethical procedures inherent to the research were strictly adhered to. Participants were informed in advance of the objectives and nature of the study, and informed consent was obtained freely and voluntarily. The anonymity and confidentiality of responses were guaranteed, as well as the use of data exclusively for scientific purposes. The right to withdraw at any time was also respected, without any detriment to the participants.

Data analysis was conducted using descriptive statistics, including the calculation of absolute and relative frequencies, measures of central tendency, and measures of dispersion, to identify patterns and highlight prevailing perceptions. This analysis allowed us to comprehensively understand how prospective teachers perceive the impacts of AI on pedagogical practice and which challenges they consider most relevant in their training.

4. Results

4.1 Sociodemographic data

Table 1 presents the sociodemographic data of the students participating in the study.

The sociodemographic analysis of the sample shows a significant predominance of females (88.9%), in contrast to a minority of males (9.7%), complemented by a residual percentage of participants who did not specify their gender (1.4%). This asymmetrical distribution, in fact, reflects the phenomenon of feminization that characterizes teacher training courses in Portugal.

Concerning the age variable, there was a significant concentration in the 17–23 age group (81.9%), followed by a significantly smaller representation in the 24–28

Variable	Category	Frequency	Percentage (%)
Sex	Female	64	88.9%
	Male	7	9.7%
	I'd rather not say	1	1.4%
Age group (years)	17–23	59	81.9%
	24–28	7	9.7%
	29–34	1	1.4%
	Over 35	5	6.9%
International/ Erasmus student	No	61	84.7%
	Yes	11	15.3%
Cycle of studies	Degree	61	84.7%
	Master´s degree	11	15.3%
Year/ Graduation course	First year of Basic Education	46	75.4%
	Second year of Basic Education	4	6.6%
	Third year of Basic Education	11	18%
Year/Master's degree	First year Master's degree in Teaching the first cycle of Basic Education and Portuguese, and History and Geography of Portugal in the second cycle of Basic Education	1	9.1%
	Second year Master's degree in Teaching the first cycle of Basic Education and Portuguese and History and Geography of Portugal in the second cycle of Basic Education	4	36.4%
	First year of the Master's degree in Pre-School Education and Teaching of the first cycle of Basic Education	2	18.2%
	Second year of the Master's degree in Pre-School Education and Teaching of the first cycle of Basic Education	2	18.2%
	First year Master's degree in Teaching the first cycle of Basic Education and Mathematics and Natural Sciences in the second cycle of Basic Education	2	18.2%

Table 1.
*Sociodemographic distribution of participants (*N = *72).*

age group (9.7%), the over-35 age group (6.9%), and the 29–34 age group (1.4%). This distribution shows a predominantly young profile, corresponding to the usual pattern of entry and academic progression in study cycles leading to teaching qualifications.

As far as nationality is concerned, there is a significant majority of students of Portuguese nationality (84.7%), complemented by a significant number of students in international mobility programs/Erasmus (15.3%). These figures indicate a significant degree of internationalization of the institution's training offer.

In terms of the level of education, students enrolled in Bachelor's degree courses predominate (84.7%), with a minority of Master's degree students (15.3%).

Analysis of the distribution by curricular year in Basic Education shows a marked concentration in the first year (75.4%), followed by the third year (18%), and a significantly smaller representation in the second year (6.6%). As far as Master's degrees are concerned, there are three areas of specialization: Teaching in

the first cycle of Basic Education and Portuguese, and History and Geography of Portugal in the second cycle of Basic Education (five students, distributed between the first and second years), Pre-school Education and the second cycle of Basic Education (four students, equally distributed between the two curricular years), and Teaching in the first cycle of Basic Education and Mathematics and Natural Sciences in the second cycle of Basic Education (two students, both in the first year).

4.2 Pedagogical challenges in the use of AI in the context of initial teacher training

The statement, "The incorporation of AI-based technologies can transform and optimize initial teacher training," obtained an average of 4.43, revealing a high degree of agreement among participants about the transformative potential of AI in the educational context. However, there is concern about over-dependence on these tools, with the statement, "The use of AI can contribute to future teachers becoming over-dependent on these tools," having an average of 3.86, showing some division in students' perceptions.

The need for balance between pedagogical knowledge and the use of AI, with an average of 4.78, indicates a consensus on the importance of integrating AI without compromising pedagogical foundations. In addition, the preparation of future teachers for the critical and effective use of AI also received a high level of agreement (M = 4.57).

As for the updating of initial teacher training concerning the use of AI, the responses show a moderate degree of satisfaction, with the statement "Initial teacher training is up to date concerning the use of AI in education" obtaining an average of 3.39. Similarly, the statement "Initial teacher training prepares teachers to use AI tools in the classroom" had an average of 3.46, indicating that students recognize some initiatives but still identify gaps in preparation for the practical use of AI.

The statement, "There is a lack of opportunities in initial training to learn how to use AI effectively in teaching and learning", with an average of 3.79, reveals a pertinent concern regarding the lack of training opportunities in the area. In addition, students find it challenging to keep up with the evolution of AI tools and their applications in education (M = 4.04).

Respondents recognize the importance of empowering teachers to use AI in an inclusive and responsible way (M = 4.58), as well as the potential of AI to make assessments less subjective and more data-driven (M = 3.73).

Finally, the participants expressed their opinions on the biggest pedagogical challenges of using AI in initial teacher training, which are shown in **Table 2**.

4.3 Technological challenges in the use of AI in the context of initial teacher training

The statement, "The quality of the internet available at school is a factor that limits the use of AI in the classroom," with an average of 4.21, indicates that the internet infrastructure is seen as a significant challenge. The availability of enough technological devices for everyone to use AI in teaching activities is not satisfactory for everyone (M = 3.40).

Categories	Pedagogical challenges
Ethics and critical thinking	Excessive dependence on AI. Lack of critical thinking about the content generated. Loss of pedagogical autonomy. Risk of teaching standardization.
Teacher training	Lack of specific training in AI. Difficulty in curriculum integration. Resistance to change on the part of teachers. Lack of familiarity with the tools.
Equity and access	Inequality in access to technology. Differences in the level of digital literacy. Limited technological infrastructure in schools.
Human role in education	Loss of human contact in learning. Balance between automation and personalized teaching. Valuing empathy and creativity in teaching.
Security and privacy	Ethical issues in the use of data. Risk of exposure and manipulation of personal information. Lack of knowledge about how algorithms work.
Technological evolution and updating	Need for constant updates on AI. Rapid technological evolution makes it difficult to keep up. Integration of new tools into teaching practice.

Table 2.
Main pedagogical challenges.

Regarding the perception of technical support ("The school offers the technical support needed to solve problems related to the use of AI"), the average of 3.29 indicates an area that may need improvement.

The statement, "Students in initial training have the digital skills to use AI in educational practices," obtained a low average (2.99), suggesting a tendency toward disagreement or uncertainty about the digital skills of future teachers to use AI.

The high average (4.32) obtained for the statement, "The lack of technical knowledge about AI among future teachers is a barrier to its effective use," shows that most participants recognize that the lack of technical knowledge is an obstacle.

About finding AI tools and content adapted to the educational reality, the average of 4.10 indicates that this is a challenge for initial training. Another relevant challenge is the compatibility of AI tools with the technological systems already implemented in educational institutions (M = 3.90).

The idea that AI updates and maintenance are a challenge for institutions is a consensus among respondents (M = 4.06), and, even more so, the lack of ongoing technical support is a factor that hinders the use of AI (M = 4.43).

Finally, in the answers given to the question about the biggest technological challenges of using AI in initial teacher training, we identified some themes and concerns which, although directed at technology, touch on pedagogical aspects or have direct consequences for teaching practice, as can be seen in **Table 3**.

4.4 Ethical challenges in the use of AI in the context of initial teacher training

The results reveal an informed and critically constructive perception on the part of the students regarding ethical challenges.

Categories	Technological challenges
Technological infrastructure and access	Inadequate internet quality. Lack of adequate technology and internet in schools. Insufficient technological devices. Updating systems. Inequality in access to technology.
Technical training and lack of knowledge	Gaps in the technical and pedagogical training of future teachers to use AI. Difficulties for trainee teachers when using AI for the first time. The need to develop specific digital skills for integrating AI into educational practice.
Integration of AI into the curriculum and teaching practices	Difficulty in integrating AI effectively into the existing curriculum without compromising the pedagogical foundations. The need to adapt technologies in a way that is coherent with teaching and learning objectives. Risk of overcomplicating educational processes with poorly implemented technological tools.
Ethics, privacy and data security	Concerns about the collection, use, and protection of personal data in the educational context. Lack of clarity about the ethical limits of using AI tools with students. Need to guarantee the safety and privacy of users (teachers and students).
Quality and suitability of AI tools	Difficulty in identifying AI tools that are reliable, appropriate, and pedagogically relevant. Concerns about the quality of AI-generated content (inaccuracy, bias, superficiality). The need for critical and continuous evaluation of the technological solutions used in the teaching–learning process.

Table 3.
Main technological challenges.

The statement "Initial teacher training should include topics on ethics and social responsibility in the use of AI" obtained an average of 4.69, indicating high agreement with the need to integrate an ethical approach into training curricula. Similarly, the relevance of topics such as privacy, transparency, prejudice, and human responsibility (M = 4.47) was widely recognized.

There were also significant concerns about the potential for AI to compromise the privacy of students and teachers (M = 3.61), generate injustices in assessment processes (M = 3.46), and widen social inequalities (M = 3.46). Teacher autonomy also emerges as a sensitive dimension (M = 3.82), reflecting a perception that AI can, in some contexts, devalue the human pedagogical role. In this regard, there is a tendency to disagree with the statement that educational decisions should be attributed exclusively to AI systems without human supervision (M = 2.68).

Statements such as the need to comply with the General Data Protection Regulation (GDPR) (M = 4.42) and the view of AI as a complementary tool, rather than a substitute for the teacher (M = 4.57), obtained high consensus. The statement "AI can be beneficial if it is used in a transparent, inclusive way that respects data privacy and security" had one of the highest averages (M = 4.62). Uncertainty about the lack of normative guidance also proved to be a concern among students (M = 4.12).

Table 4 shows the greatest ethical challenges perceived by the participants.

Categories	Ethical challenges
Privacy and data protection	Ethical use of data. Informed consent. Identity protection. Risks of surveillance and exposure of students' and teachers' personal data.
Inequality and access (digital equity)	Barriers to accessing technology. Digital exclusion. Lack of equity in learning opportunities. Risk of deepening social and educational inequalities.
Transparency and explainability	Difficulty understanding how AI systems work. Lack of clarity in automated evaluation criteria. Right to an explanation of AI processes and decisions.
Autonomy and the role of the teacher	Reduced teacher autonomy. Devaluation of the teacher's role. Replacement of human interaction with automated systems. Loss of pedagogical control.
Bias and algorithmic discrimination	Reinforcement of social prejudices through AI. Biased decisions are based on algorithms. Negative impact on justice and educational inclusion.
Dependence and responsible use	Uncritical use of tools. Excessive trust in AI. Weakness in digital literacy. Loss of critical thinking and intellectual autonomy on the part of future teachers.
Responsibility and accountability	Unclear who is responsible for AI decisions. Ethical risks in the misuse of tools. Need for accountability and effective regulation.
Lack of knowledge/Uncertainty	Indication of a lack of knowledge on the subject. Perception of uncertainty or fear regarding the use of AI in teaching practices.

Table 4.
Main ethical challenges.

5. Conclusions

This study is part of higher education research exploring the pedagogical, technological, and ethical challenges associated with integrating AI into initial teacher training. It aimed to identify the perceptions of students enrolled in a Bachelor's degree in Basic Education and a Master's degree in Professional Teaching at a higher education institution in Portugal. The results reflect a diverse range of opinions on the pedagogical, technological, and ethical challenges of adopting AI in education.

The pedagogical challenges of AI in initial teacher training go beyond the mere use of technology. They include the need for adequate training, curriculum updates, practical preparation, keeping pace with technological developments, balancing automation and humanization, addressing ethical issues, and ensuring equitable access. Therefore, the integration of AI must be accompanied by critical and ethical thinking, ensuring that future teachers know how to use it consciously, creatively, and pedagogically.

Technological challenges are significant and need to be addressed to facilitate the effective integration of AI. These challenges range from basic infrastructure (internet, devices) to technical knowledge, the availability of adequate resources, compatibility with existing systems, the need for technical support, and the digital skills of future teachers.

Ethical challenges highlight a critical but open stance on the use of AI in initial teacher training. Participants recognize the potential of AI to positively transform education if its implementation respects ethical, legal, and pedagogical principles.

In response to the study findings, the following hierarchically structured recommendations are proposed:

Curriculum and pedagogical development

- Include curricular modules dedicated to the critical and ethical use of AI in classrooms.
- Implement practical workshops where prospective teachers can experiment with AI tools in simulated teaching situations, guided by supervisors who discuss limitations and potential.
- Review pedagogical approaches to integrate AI in a more structured and equitable way into teacher training programs.

Institutional Policies

- Develop internal policies guiding the responsible use of AI.
- Align institutional guidelines with national and international standards on data protection and digital equity.
- Define clear pedagogical and political guidelines to promote the conscious, safe, and ethically grounded integration of AI in education.

Technological Development and Support.

- Ensure adequate infrastructure (internet access, devices, system compatibility).
- Provide technical support and digital skills development for future teachers.
- Promote continuous technological updates and maintain a balance between automation and human-centered teaching practices.

Despite the challenges identified, students demonstrated a constructive and open attitude toward the use of AI, provided it is applied ethically, inclusively, and under proper regulations. This critical ambivalence represents a relevant starting point for designing teacher training pathways that are more aware of and prepared for the pedagogical, technological, and ethical challenges of integrating AI in education.

Finally, while this research offers important insights, it also has some limitations. The convenience sample, primarily first-year undergraduate students, limits the generalizability of the findings. Data were largely based on subjective perceptions

from questionnaires and open-ended questions, reflecting concerns and expectations rather than direct practical effects of AI integration. Additionally, the technological scope was broad, preventing a detailed analysis of specific tools or platforms. Future research could focus on comparative analyses of AI tools or case studies of their implementation in specific teaching contexts.

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Conflict of Interest

The authors declare no conflicts of interest

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