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Teacher training for the future: insights from a Needs Analysis on Digital Technologies and Artificial Intelligence

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Abstract

This study aims to contextualize the pressing need for an updated framework in teacher training that responds to rapid technological advancement, particularly in Artificial Intelligence (AI), and the resulting shifts in educational practices. In today's evolving landscape, teachers are expected to increasingly adopt the role of facilitators, guiding students in a learning process that is responsive to digital innovation and interdisciplinary knowledge. Consequently, the structure of teacher training must be realigned to prioritize students' needs and core learning objectives of digital literacy. This contribution provides an in-depth analysis of the skills and competencies currently required by educators to effectively fulfill this evolving role. Through a comprehensive survey, the authors investigated the training needs of a sample of teachers, with a particular focus on digital literacy and Artificial Intelligence. The data gathered highlight the gaps and opportunities within existing training programs, offering insights that are essential for adapting teacher education to align with the demands of a digitally driven student-centered educational environment. The paper concludes with a reflection on the implications of these findings for future teacher training programs, emphasizing the necessity of a flexible, context-responsive, and technology-integrated training framework to equip educators with constructive, meaningful, and future-oriented learning.

KEYWORDS: Teacher Training, Artificial Intelligence, Student-Centered Learning, Digital Literacy, Educational Innovation.

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1. Introduction

In recent years, the educational landscape has undergone profound transformations driven by the rapid evolution of digital technologies and Artificial Intelligence (AI).

Digital literacy has emerged as a fundamental competency critical for navigating the demands of contemporary professional and societal contexts. As technological advancements reshape industries, most professions require continuous upskilling to effectively integrate these innovations. This aligns with the directive to develop the skills required for green and digital transitions through education, training, upskilling, and reskilling (Council of Europe, 2023, p. 1). Additionally, The European Pillar of Social Rights Action Plan proposes clear targets for adult participation in training (60% by 2030), including digital skills (European Commission, 2021). Accordingly, the need for both digital and AI literacy among educators has become increasingly urgent.

Teachers, as key facilitators of learning, must not only foster innovative pedagogical practices but also play a crucial role in promoting digital literacy and AI literacy, as well as through the critical implementation of AI within formal educational contexts. The importance also relies on countering, among students, the proliferation of disinformation and promoting its ethical and responsible use (European Commission, 2022).

From this perspective, a fundamental framework for the development and assessment of digital skills is the Digital Competence Framework for Citizens (DigComp), which serves as a key reference for educational, training, and certification initiatives (Vuorikari et al., 2022). Similarly, the Council

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Recommendation on improving the provision of digital skills and competences in education and training (Council of Europe, 2023) identifies confident, critical, and responsible use of digital technologies as a key competence essential for education, work, and societal participation. Teaching digital literacy in educational settings is crucial for preparing students for active engagement in today's society, with content tailored to learners' levels and aligned with the learning objectives of digital literacy (European Commission, 2022, pp. 22-23).

The Commission's Digital Education Action Plan 2021-2027 (European Commission, 2020a) outlines Europe's strategy for education in the digital age, identifying the development of digital skills and competencies as a strategic priority. A sound understanding of the digital world is particularly significant in the context of the ongoing digital transformation and growing impact of emerging AI-driven tools, highlighting the need for education and training institutions to prepare individuals for the responsible use of technology, grounded in a clear understanding of its functioning.

To achieve this objective, in Strategic Priority 1 (European Commission, 2020a), digital competence is identified as a core skill for all educators and training staff, integrating it into every aspect of teachers' professional development, including initial teacher education. The plan recognizes teachers as key players in promoting an understanding of emerging technologies and their applications in education, developing ethical guidelines for AI, and emphasizing the essential need for training in digital skills, including digital teaching methods.

As advanced technologies and AI become deeply embedded in society and educational settings, they drive fundamental changes in pedagogical practices and redefine the role of the teacher. This shift demands a rethinking of teacher training paradigms, moving away from traditional content-focused models toward more dynamic, learner-centered, and technology-integrated approaches.

In this evolving context, the role of the teacher has transitioned from that of a knowledge transmitter to a facilitator of learning, a collaborative knowledge producer and a guide to citizenship in the era of AI (UNESCO, 2024c).

In this regard, the Six Pillars for the Digital Transformation of Education framework (UNESCO, 2024b) serves as a key reference point for implementing a digital shift aligned with global standards and international education objectives, particularly Sustainable Development Goal 4 (SDG4).

The process of digital transformation in education should be needs-driven and purpose-oriented, guided by principles that prioritize human-centered, ethical, sustainable, and future-oriented applications of technology in educational contexts. In particular, the Capacity and Culture Pillar focuses on the digital competencies, skills, attitudes, and mindsets of education stakeholders that are necessary for navigating digital transformation in education and beyond. It encompasses the technical ability to use digital tools, manage transformation initiatives, and critically assess the social and environmental impacts of digital technologies. Additionally, it addresses stakeholders' perceptions and expectations of technology use in education, emphasizing growth mindsets and openness to innovation (UNESCO, 2024b, p. 15).

Competencies and mindsets stand out among the components of the Capacity and Culture Pillar. These have a crucial role in developing the digital and hybrid pedagogical competencies of teachers through pre- and in-service training and continuous professional development opportunities (UNESCO, 2024b, p. 17). The importance lies in the need to address resistance to using technologies in educational processes, which represents one of the key barriers hindering the positive social impact of digital transformation in education.

Despite a growing interest in integrating digital tools into teaching, learning, and administrative processes, nearly half of the countries lack digital skills standards, and only a small number have incorporated AI and data competencies into national curricula. Globally, there remains asymmetry in capacity and low digital literacy, hindering the meaningful use of these technologies in education (UNESCO, 2024a).

The OECD Teaching and Learning International Survey (TALIS) (OECD, 2019), the largest international study conducted every five years to examine learning environments and the working conditions of teachers and school leaders, provides valuable insights into teacher training. The survey revealed that during their education and training, teachers predominantly received instruction on subject content, pedagogy, classroom practice, student behavior, and classroom management, with these areas included in the training of 72% of the participating teachers. However, less emphasis was placed on the use of information and communication technology (ICT) for teaching (56%). Once teachers completed their initial preparation and began their professional practice, only 38% participated in formal or informal induction at their first school.

Despite this, teachers reported that the areas in which they require the most additional training are the development of advanced ICT skills, teaching in multicultural and multilingual contexts, and teaching students with special needs, highlighting the need for digital and inclusive training.

With specific reference to AI, recent studies (Isidori et al., 2024) have highlighted teachers' limited understanding of its tools and potential in education. Further research (Rott et al., 2022) has investigated the needs and requirements for additional AI qualifications among apprentices and teachers, building on a foundational theoretical framework of AI.

Teacher training in Italy has traditionally followed a standardized lecture-based model that emphasizes subject-specific expertise and pedagogical theory. However, in contemporary educational landscapes,

these traditional approaches are increasingly inadequate for equipping educators to address the complexities of modern classrooms. The influence of digital progress is driving a shift towards what has been termed the post-method era (Kumaravadivelu, 2001), a pedagogical approach that transcends rigid methodologies, advocating instead for flexible, context-responsive, and student-centered teaching practices.

In this framework, teachers are encouraged to adapt and integrate diverse tools and strategies based on the specific needs and goals of their students, a task that increasingly requires digital literacy and foundational understanding of AI.

The customization of learners' educational pathways based on their needs, along with assessment, bureaucratic tasks, and lesson planning, requires an exponential increase in teachers' time. The TALIS Survey confirms this trend: on average, across OECD countries, teachers spend 38.8 hours per week on all tasks related to their jobs in the surveyed schools, of which only 20.6 hours are allocated to teaching. In other words, nearly half (47%) of the teachers' working time is spent on activities other than classroom teaching, such as planning, preparation, and grading. Teachers spend 6.5 hours a week on planning and lesson preparation, the equivalent of 17% of their total working time, and 4.2 hours a week on marking and correcting, which is 11% of their total working time (OECD, 2019).

Among the most common priorities for policy intervention reported by teachers is to offer high-quality professional development for educators (55%) and reduce teachers' administration load (55%)" (OECD, 2019, p.82).

2. The AI revolution for teaching and learning

Since 2022, the Artificial Intelligence (AI) revolution has been profoundly reshaping our societies and the world at large, inevitably extending its transformative influence on the realm of education (Yee et al., 2024). This rapid advancement has opened up entirely new horizons, enabling possibilities that were previously unimaginable (Fei-Fei, 2024). AI is not only redefining how knowledge is delivered and acquired but also paving the way for personalized, adaptive learning experiences tailored to individual needs.

By integrating cutting-edge technologies, educators and learners alike are discovering innovative methods to enhance engagement, accessibility, and outcomes in education, fundamentally altering the traditional paradigms of teaching and learning (Rajaram, 2023).

AI plays a crucial role in shaping learning designs and pedagogical strategies to achieve a high level of educational efficacy. With AI integration, teaching approaches should empower students to take on roles as evaluators, critical thinkers, and knowledge creators. This approach shifts the focus from mere content acquisition to an emphasis on the learning process itself. The priority moves toward fostering skills such as critical thinking, evaluative reasoning, constructive critique, and the ability to synthesize diverse perspectives. These skills enable students to engage more deeply with the material, promoting a holistic and meaningful understanding of the content.

AI in Education (AIED) technologies provide significant support for teachers by improving efficiency, allowing them to complete existing tasks more quickly and with less effort. By automating routine activities and streamlining workflows, AIED enables educators to focus more on high-value tasks, such as engaging with students and refining teaching strategies.

The literature highlights various ways in which AI can be applied in teaching and learning, categorized into student-focused, teacher-focused, and institution-focused AIED (Holmes & Tuomi, 2022). Each of these areas addresses different stakeholders and objectives, offering tailored solutions to enhance the educational experience.

Teacher-focused AIED concentrates on empowering educators with tools and functionalities designed to optimize their professional roles. The primary functions identified in the literature include:

- *Automated Grading and Assessment*: AI can handle repetitive grading tasks, especially for objective or semi-structured assignments, freeing teachers to dedicate more time to providing personalized feedback.
- *Plagiarism Detection*: advanced AI algorithms can detect instances of plagiarism, ensuring academic integrity while reducing the workload associated with manual checks.
- *Smart Curation of Learning Materials*: AI can assist teachers in finding and organizing educational resources tailored to their curriculum, saving time and ensuring the inclusion of diverse, high-quality content.
- *Classroom Monitoring*: intelligent systems can track student engagement and behavior during lessons, providing teachers with real-time insights to address inattentiveness or disruptions effectively.
- *AI Teaching Assistants*: virtual assistants powered by AI can support teachers by answering routine student queries, managing administrative tasks, and even facilitating discussions in digital learning environments.
- *Classroom Orchestration Tools*: AI-driven platforms help teachers manage classroom dynamics by organizing activities, monitoring group interactions, and providing actionable suggestions to maintain a productive learning atmosphere.

These applications exemplify the potential of teacher-focused AIED to revolutionize the educational landscape, enabling educators to work more efficiently

while fostering a richer and more personalized learning environment for their students.

Many AI-driven systems in education, particularly Intelligent Tutoring Systems (ITS), are primarily designed with students in mind. However, these systems often feature teacher-facing interfaces or dashboards, commonly built upon open learner models. These tools provide teachers with dynamic insights into both individual and group performance, highlighting areas of achievement as well as misunderstandings or misconceptions that require attention (Bodily & Verbert, 2017).

A particularly innovative application in this field leverages augmented reality (AR) technology. Teachers equipped with AR glasses can view dashboard-like information projected above students' heads while they engage with an ITS. This setup offers a real-time, contextual overlay of critical data, enabling more responsive and informed teaching interventions (Holstein et al., 2018).

Artificial Intelligence holds transformative potential for education, particularly in language teaching (Cinganotto & Montanucci, 2024). It offers tools to personalize learning, enhance accessibility, and streamline instructional processes. In teaching, AI can provide adaptive learning environments where systems respond to students' unique needs, allowing for personalized lesson plans, tailored feedback, and language practice at a comfortable pace. This individualized approach fosters learner autonomy and boosts engagement, which is particularly effective in language acquisition.

AI's integration into education is especially valuable in areas like automated assessment, virtual assistants, and content generation. For instance, machine learning algorithms can analyze students' performance to identify strengths and areas needing improvement, offering targeted support. Virtual teaching assistants can address routine inquiries and provide instant feedback, allowing teachers to focus on complex aspects of language instruction, like cultural context or higher-order thinking skills. Moreover, AI supports inclusivity in education. Natural language processing (NLP) tools help make learning resources accessible to non-native speakers, and speech recognition software can support pronunciation practice, vital in language teaching. Additionally, AI enables diverse content creation, making it easier to develop multilingual resources and tailored lessons that account for students' cultural backgrounds.

However, it is important to recognize the limitations of AI: it cannot create, conceptualize, or manage complex strategic planning, nor can it execute tasks requiring precise hand-eye coordination, address unfamiliar situations, or interact with empathy and compassion (Holmes et al., 2019).

These reflections outline the role of AI in educational settings, emphasizing its potential as an added value and an augmented intelligence that enhances teachers' work but can never replace it.

This point is further emphasized in the already mentioned UNESCO AI Competency Framework for Students and Teachers (UNESCO, 2024c), which provides a comprehensive guide to integrating AI literacy into education. The framework outlines the knowledge, skills, and attitudes required for both students and educators to effectively understand, and engage with AI technologies in educational contexts.

For students, the framework focuses on fostering critical awareness of AI, equipping them with the skills to navigate a world increasingly shaped by AI-driven systems. It highlights the importance of ethical considerations, data literacy, and the ability to critically assess the impact of AI on society and their own learning journeys.

For teachers, the framework identifies competencies that enable them to incorporate AI tools into their teaching practices effectively. It emphasizes the dual role of teachers as both users of AI-enhanced technologies and facilitators of AI literacy for students. Teachers are encouraged to understand the technical underpinnings of AI, apply it to personalize learning experiences, and address ethical concerns such as bias, transparency, and privacy in AI systems.

UNESCO frameworks underscore the need for a balanced approach that harnesses AI's potential to enhance teaching and learning while critically addressing its limitations and ethical challenges. This holistic perspective ensures that both teachers and students are not only consumers of AI technologies but also informed contributors to discussions about their responsible use. In fact, AI's integration in education also presents challenges: ethical considerations, data privacy, and the risk of over-relying on automated systems require careful planning and oversight. Technological advances must always be balanced with pedagogical goals: AI can help reach deeper learning goals emphasizing "versatility, relevance, student motivation, and transfer" (Holmes et al., 2019, p. 4), enabling learners to apply concepts in new contexts. This also calls for the expansion of a cross-curricular approach that embeds digital skills across various subjects.

In response to the needs and challenges arising from the AI revolution, teacher training has become increasingly essential to raise awareness about both the strengths and potential risks of AI in education.

3. The rationale of the study

This study, as presented in this paper, aimed to investigate the evolving paradigms of teacher training in relation to AI through a survey conducted among public school teachers in Italy. It focused on their training experiences, perceptions, preferences, and professional needs.

To answer the question of what specific training needs and competencies teachers need to effectively integrate

digital technologies and AI in a post-method educational framework, this study provides insights into the skills that teachers consider essential for navigating an AI-enhanced educational landscape. The findings reveal that, while teachers recognize the transformative potential of digital technologies in the classroom, they face significant challenges in adapting their instructional practices. By exploring teachers' perspectives and identifying their training needs, the study's findings, despite being based on a limited sample, could inform the development of an updated, needs-based teacher training framework. This framework would prioritize digital competencies and AI literacy as essential components for modern and future educational contexts.

4. Materials and Methods

The study employed a mixed methods design to explore the specific training needs and competencies that teachers require to effectively integrate digital technologies and Artificial Intelligence within a post-method educational framework. The target population comprised teachers working in Italian public schools across various levels of education and with diverse training backgrounds. Data were collected through an online survey administered via Google Forms, which included both multiple-choice and open-ended questions, to capture a comprehensive range of insights. The survey's quantitative component, consisting of structured multiple-choice questions and Likert-scale items (ranging from 1 to 5), was designed to assess teachers' current competencies and familiarity with digital tools and AI as well as their perceived training needs.

Qualitative data were gathered from open-ended questions, allowing participants to elaborate on the specific challenges and professional development requirements encountered when adopting technology-enhanced pedagogical approaches.

The data collected using Google Forms were analyzed using descriptive statistics, processed in Google Sheets to generate summary statistics and visual representations. Qualitative responses were thematically coded and analyzed manually to identify recurring themes related to training needs and instructional competencies.

This study sought to examine the professional training needs of teachers in the Italian public school system, focusing on their perceptions, practices, and aspirations. The study was guided by the following research questions:

- in which instructional areas do teachers feel the greatest need for professional development, and what program formats do teachers prefer?
- how familiar are teachers using digital tools and AI for teaching and to what extent do they integrate these tools into their practice?
- do teachers perceive their formal preparation to be sufficient to address the challenges of contemporary education?
- how interested are teachers in acquiring new skills related to the integration of digital technology and AI into educational practices?

These questions aim to provide a comprehensive understanding of teachers' professional development priorities and readiness to integrate emerging technologies, particularly AI, into contemporary educational practices. These findings will be instrumental in designing professional development paths tailored to address the real needs of teachers, starting from their existing practices, competencies, and challenges.

5. Profile of the respondents

The sample is composed of 139 teachers at Italian public schools from various educational levels, encompassing primary (25.2%), lower secondary (30.5%), and upper secondary schools (41.2%), with pre-primary educators being underrepresented. The participants covered a wide range of ages and teaching experience, with 50% having over 15 years of experience in education. The survey was distributed in schools where the authors were conducting online teacher training programs, allowing direct engagement with potential participants. Additionally, the questionnaire was shared through various professional and personal networks, ensuring a diverse and representative sample of teachers with different backgrounds and experiences.

As shown in Figure 1, regarding digital competencies for teaching, 34.5% of respondents rated their skills as advanced or expert, while 65.5% identified as having intermediate or beginner skills.

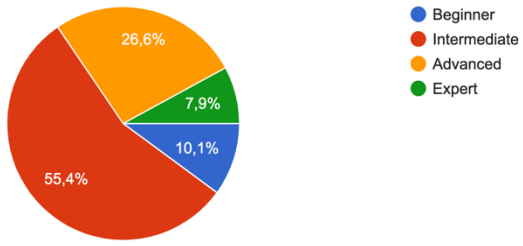

Figure 1 - Teachers' self-reported digital competence for teaching.

The question, 'Do you use multimodal approaches in your teaching (integrating different resources such as videos, audio, written texts, and images)?' yielded very interesting responses, as shown in Figure 2. A significant 60.4% of participants answered 'Always,' indicating a generally tech-savvy approach to teaching and a frequent integration of digital technologies into their lessons.

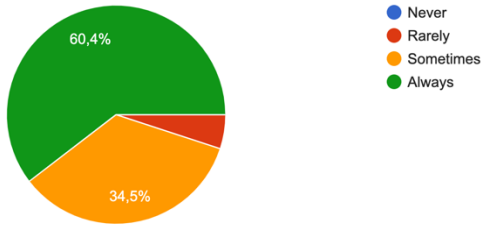

Figure 2 - Teachers' self-reported multimedia approaches used for teaching.

6. Results

The survey provides diverse insights into teachers' perspectives on professional training and digital competencies.

The findings highlight several critical areas where teachers feel they need further training to meet the demands of modern classrooms. The most identified instructional priorities include active methodologies (38.1%), educational technologies (23%), and inclusive teaching practices (20.9%) (Figure 3). These areas underscore a growing recognition of the need for pedagogical strategies that are not only innovative but also adaptable to diverse learner needs.

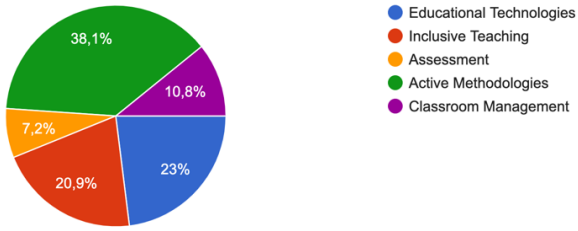

Figure 3 - Teachers' self-reported needs for training.

Over 70% of teachers rated the importance of training in inclusion and personalized learning as high or very high (4 or 5 on a 5-point scale), reflecting a strong demand for professional development opportunities that prepare them to address the diverse needs of their students. However, there appears to be a significant gap in existing teacher preparation programs, with approximately 50% of respondents rating their formal training as insufficient (1, 2, or 3 on a 5-point scale) to equip them for the complexities of today's educational environment.

Interest in digital personalization tools was notably high, with 72.5% of teachers rating their utility at four or five, particularly for customizing learning pathways. This indicates a growing reliance on technology to enhance differentiated instruction and student engagement.

Regarding the use of digital tools in everyday teaching practices, the survey revealed a high level of engagement with various technologies.

The most frequently reported tools include learning management systems (85.5%), presentation software (66.7%), document collaboration tools (55.1%), multimedia creation tools (54.3%), educational applications (51.4%), and interactive whiteboards (50%).

These results highlight the importance of digital literacy and the integration of technology in creating dynamic, interactive, and inclusive learning environments.

Overall, the findings emphasize the need for teacher training programs to focus more on equipping educators with the skills and knowledge to effectively implement active methodologies, leverage educational technologies, and create inclusive learning experiences.

As shown in Figure 4, 89.9% of participants reported rarely or minimally using AI-based tools, and 86.9% considered acquiring skills in applying AI to teaching extremely important.

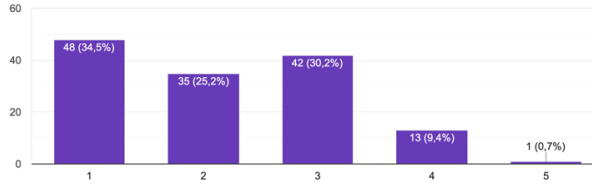

Figure 4 - Frequency of AI tool usage in teaching.

Moreover, a significant majority (84.5%) agreed that advancements in AI necessitate a rethinking of the content delivered in the classroom, with 89.1% supporting parallel rethinking of traditional approaches and methodologies, as reported in Figure 5.

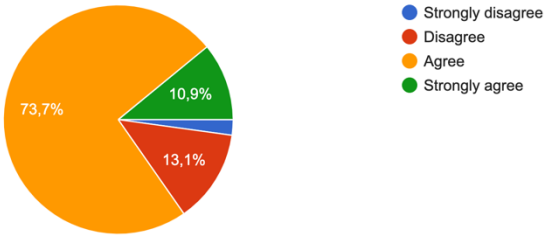

Figure 5 - Teachers' attitudes to rethinking traditional approaches and methodologies.

When considering preferred formats for professional development, 37.4% favored hybrid courses that combined in-person and online sessions, 25.9% preferred in-person workshops, and 23.7% opted for fully online courses (see Figure 6).

Most of the respondents (84.8%) had participated in training on the use of digital technologies in teaching, with 86.2% reporting that such courses were helpful to varying degrees in enhancing their skills.

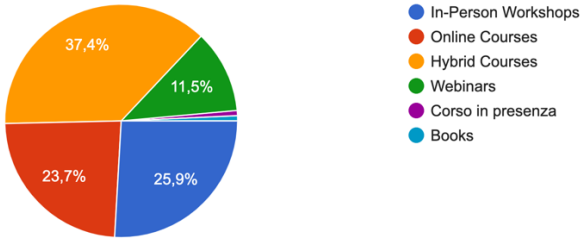

Figure 6 - Preferred formats for professional development courses.

Considering technological advancements, Figure 7 demonstrates that 91.4% of the sample expressed the need for further training on integrating digital technologies and AI into teaching, whereas 60.9% reported having never received specific training on the implementation of AI in education.

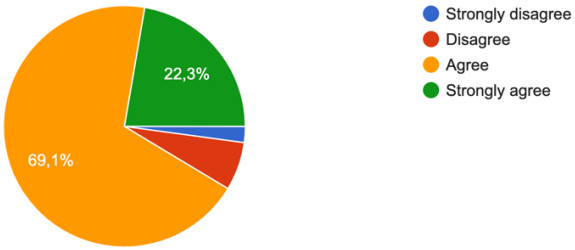

Figure 7 - Teachers' perceptions of the need for additional training on digital technologies and AI integration.

In response to the first open-ended question, 'If you could design your next professional development course, what topics would you prioritize, and how would you structure the course?', the most frequently mentioned topics were artificial intelligence, with a focus on subject-specific applications and active methodologies incorporating hands-on approaches and practical implementations directly applicable in teaching contexts. Additional areas of interest included classroom management and CLIL methodology, highlighting the perceived lack of practical focus on existing training offerings.

In the section dedicated to reflections on AI for teaching, there was unanimous agreement in considering AI as 'interesting, helpful, and useful' (the most frequently mentioned adjectives), especially for languages and scientific subjects, and valuable for integration into educational practices. Alongside recognizing its significant potential, participants also expressed concerns about its use in the classroom, emphasizing the limited knowledge of AI among teachers. Additionally, the respondents acknowledged the paradigm shift that AI adoption could bring to the teacher's role, underscoring the necessity of specific methodological training to support its effective implementation.

In the additional comments (provided in English), participants reiterated their interest in specific training on AI, while also highlighting the importance of training focused on relational dynamics, as clarified by this statement "the psychological, emotional, relational aspect of teaching is what is missing in today's teacher training", which was noted as lacking within the teaching community, alongside the need for a balanced use of technologies. They also emphasized the challenges posed by a lack of time for lesson planning and the necessity of updating teaching practices through practical applications and subject-specific approaches.

The following comments highlight the teachers' attitude and reactions on the crucial role of AI literacy and training:

> *"We mustn't be scared at all; we have to use it and take the best from it!"*

> *"We need to know about artificial intelligence because it is used in our society and because it can also be useful for teaching. At the same time, we need to understand its limits".*

> *"I believe that AI is extremely important, both for the study and for the ability to use it".*

> *"AI is a reality which must be seen as a new way of communication among students and teachers. Therefore, we must make the best of it, and we must encourage ourselves to find the newest and most exciting ways to use AI in our classrooms".*

The importance of adopting a humanistic approach is emphasized in several teachers' comments. AI is seen as a valuable tool for enhancing teaching practices and improving students' learning outcomes by personalizing the learning experience to align with their needs and cognitive styles.

However, the teacher's role in mediating relationships and interactions with AI is consistently regarded as essential, as illustrated by the following comments:

> *"I do believe that AI might have a significant impact on both learning and teaching. It must, however, be duly and critically addressed to real teaching needs and not passively utilized by stunners and teachers".*

> *"Artificial Intelligence in teaching has incredible potential [...]. It can help identify student strengths and challenges, allowing teachers to adapt lessons more effectively. However, AI should complement – not replace – the human aspects of teaching, as empathy, creativity, and adaptability remain essential qualities that technology cannot fully replicate".*

> *"Artificial Intelligence can be a very useful tool for teaching and learning, but I don't think it's going to replace the role of the person-to-person teaching".*

These findings highlight the need for AI training that fosters a human-centered approach, emphasizing

relational dynamics in which teachers act as mediators, ensuring a balanced and pedagogically meaningful integration of technology in education.

7. Discussion and Conclusions

The results collected very interesting insights to answer the research questions reported below:

- in which instructional areas do teachers feel the greatest need for professional development, and what program formats do teachers prefer?
- how familiar are teachers using digital tools and AI for teaching and to what extent do they integrate these tools into their practice?
- do teachers perceive their formal preparation to be sufficient to address the challenges of contemporary education?
- how interested are teachers in acquiring new skills related to the integration of digital technology and AI into educational practices?

The teachers in the sample perceived active methodologies, educational technologies, and inclusive teaching practices as their greatest training needs. These three areas are closely interconnected and show a context in which teachers seeking innovation in their instructional practices face challenges stemming from a lack of familiarity with emerging technologies and difficulties in their methodological integration.

There is a widespread perception of unpreparedness regarding active methodologies for inclusion that foster students' active participation as protagonists in their learning. Equally prevalent is the awareness that this represents a significant barrier preventing teachers from effectively addressing contemporary educational demands. This includes the pivotal role of the teacher as a guide in supporting students in acquiring digital and AI literacy.

Half of the respondents considered the formal programs they had attended insufficient for effectively managing the current complexities of teaching, which include, among other factors, the heterogeneity of students and different students' needs. Consequently, the importance of training in inclusion and personalized learning has emerged as central to teaching practice, with a strong interest in digital personalization tools.

Although most teachers reported possessing intermediate digital skills and regularly incorporating digital technologies into their lessons, the findings highlight the necessity of embedding technological competence within a comprehensive and robust methodological framework. This approach ensures that the integration of digital tools is not merely an add-on but is deeply connected to pedagogical goals, instructional design, and effective teaching strategies.

While digital proficiency enables teachers to utilize various technologies, its true impact lies in leveraging these tools to enhance learning outcomes, foster engagement, and address diverse student needs. Embedding technology within a methodological framework also equips educators to critically assess and adapt digital resources, ensuring their alignment with curricular objectives and the overall learning experience. Furthermore, such a framework can help bridge the gap between technology use and evidence-based teaching practices, promoting a more meaningful and effective integration of digital innovations into education.

According to the data collected, the most widely used digital tools in classrooms are learning management systems (LMS), presentation software, and document collaboration tools. However, less than half of the respondents reported using tools designed to foster interaction and active learner engagement.

In response to an open-ended question, attention was drawn to the challenges posed by designing interactive activities and the time that generally demands detailed lesson planning. As one teacher noted,

> *"I would like to teach in a different way, but I don't have much time to create interactive lessons".*

The participants emphasized that AI could assist teachers in streamlining the design and personalization of educational materials, empowering them to manage classroom complexities more effectively. By enabling the creation of resources tailored to diverse needs and providing structured guidance for planning, AI can help educators overcome these challenges while enhancing their teaching practices. In this context, AI tools and Large Language Models (LLMs) can be effectively utilized by educators to reduce workloads and enhance productivity in their professional activities. For instance, they can be used for the development of evaluation rubrics, the design of course syllabi, the creation of test questions, the preparation of activity-rich lesson plans and worksheets, the generation of visual data representations, drafting email responses, managing administrative tasks, and much more, thereby streamlining processes and supporting various aspects of teaching and academic management. It is evident that the conscious and proficient use of these emerging technologies can serve as a significant added value in educational practices, empowering teachers in ways that no other technology has ever achieved.

Regarding format, hybrid formats were the most preferred delivery method for professional development courses (37.7%), combining in-person and online sessions. This approach was favored over exclusively in-person (25.4%) or online courses (23.9%) as it was perceived to encourage participation while offering practical, immediately applicable workshop-style activities for classroom use. Teachers acknowledged that the paradigm shift AI could bring to teaching methodologies, underlining the need for targeted training in active methodologies for inclusion as well as CLIL methodology. Indeed, the findings also highlight the need to redefine the teacher's role in modernizing

education and integrating new technologies effectively. As noted in the Council's Conclusions on European teachers and trainers for the future (European Commission, 2020b), teachers play a pivotal role as drivers of change and should actively contribute to shaping education and training policies. Simultaneously, robust support is required through a holistic approach that encompasses initial education, induction, and continuous professional development. Notably, digital competence has been identified as a key area in which most teachers express a strong need for professional development (OECD, 2019).

In alignment with this, the survey highlights a nearly unanimous perspective among respondents on the need for training that focuses on integrating digital technologies and AI into teaching. Participants called for subject-specific applications within a methodological framework that fostered student engagement, interest, and inclusion. At the same time, almost all participants either did not use AI in education or had just begun exploring it. Nevertheless, they expressed openness to innovation, demonstrating their willingness to engage in continuous professional development on this topic.

The perception of AI's potential in education was overwhelmingly positive, as reiterated in the open-ended responses, reflecting a strong willingness to embrace widespread AI literacy.

However, participants also stressed the importance of adopting an ethical and critical approach, considering the limitations, biases, and risks that the use of AI in schools may entail. Lack of proficiency and familiarity with AI among teachers was recognized as a significant barrier to its implementation in teaching practice.

The open comments further underscored the need to develop digital and AI literacy among teachers before integrating AI-enhanced tools into educational activities. Such preparation is deemed essential for introducing these tools effectively, safely, and responsibly.

Among the identified professional development needs, participants frequently cited the necessity of improving classroom management. Specific training on relational dynamics and strategies to foster positive relationships within the school context was also highlighted.

A particularly pressing issue is the recognized need to rethink the content offered to learners, assessment methods, and approaches to study. This should align with what students will likely need to learn in the AI era, moving beyond traditional approaches and curricula. This perspective significantly shapes teacher training and prepares educators to address the critical challenge of equipping learners to navigate an evolving and increasingly complex society.

The following comment from one of the respondents, designing a potential training course in detail, is particularly noteworthy, as it succinctly captures the general needs and expectations regarding training opportunities. It offers valuable insights that could inform and guide the design of future professional development initiatives. By reflecting the perspectives of educators, this input can help ensure that training programs are not only relevant but also aligned with the actual challenges and aspirations of teachers in their professional practice. This feedback underscores the importance of developing targeted, practical, and context-sensitive training opportunities that effectively address teachers' evolving needs:

> *"I would implement regular compulsory professional updating courses and not random interventions. I would prioritize topics that enable educators to effectively integrate technology into teaching methodologies, particularly in language education. My course would begin with foundational sessions on digital literacy, ensuring that all participants are comfortable with basic tools and platforms. Next, I would introduce modules that focus on specific technologies such as adaptive learning systems, natural language processing tools, and AI-based applications that can enhance language acquisition and cultural competence. These sessions would cover both the technical aspects of these tools, and the pedagogical frameworks needed to apply them. I would include a reflective session, encouraging educators to consider the ethical implications and potential challenges of using technology in teaching. The course would conclude with a collaborative session where participants share their newly created resources and strategies, creating a community of practice that can continue beyond the course".*

As concluding remarks, teacher training and educational content must be fundamentally reconsidered, redesigned, and adapted to address the rapidly evolving demands brought about by the AI revolution. This transformation involves integrating AI literacy, digital competencies, and ethical considerations into teacher training programs to ensure educators are prepared to navigate and leverage the complexities of AI-driven educational environments.

Reimagined teacher training should go beyond the mere technical use of AI tools, focusing instead on equipping teachers with the pedagogical and critical thinking skills needed to integrate AI into their practice effectively. This includes fostering the ability to personalize learning experiences, critically evaluate AI systems, and address challenges such as bias, privacy concerns, and the ethical implications of AI in education.

Furthermore, educational content must be aligned with the realities of an AI-enhanced world, emphasizing interdisciplinary approaches, collaboration, and problem-solving skills. By embedding these principles into curricula and professional development, educational systems can ensure that both teachers and students are equipped to thrive in a rapidly changing world shaped by AI technologies. This holistic approach

will not only enhance the quality of education but also prepare future generations to be responsible citizens in a society increasingly influenced by AI.

Authors' contribution

The paper was developed collaboratively by the authors. However, Letizia Cinganotto wrote paragraphs 2,4,6,7 and Giorgia Montanucci wrote paragraphs 1,3,5.

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