TEACHER EDUCATION, ARTIFICIAL INTELLIGENCE, EDUCATIONAL COMPLEXITY: EMPIRICAL EVIDENCE AND PEDAGOGICAL PERSPECTIVES

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ABSTRACT
Educational processes cannot be conceived as detached from the cultural contexts in which they are embedded, nor reduced to the mere transmission of disciplinary content; rather, they involve constructing complex perspectives that situate learners within their historical and cultural frameworks. Drawing on the Shelleyan metaphor, the study problematizes the risk that teacher education remains anchored in a "Frankenstein complex", whereby teachers act as mere assemblers of knowledge, rather than as guides accompanying learners' growth. This paper draws upon a previous study involving students from the Primary Education degree program, which highlighted a gap between their self-reported familiarity with AI and their perceived competence in using it for educational purposes. Based on these findings, a training initiative for future teachers is presented and discussed, utilizing the TPACK framework as the theoretical reference.

KEYWORDS
educational process; pre-service teachers; artificial intelligence

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1. Introduction

The debate on the influence of technologies on teaching-learning processes is inexhaustible. It was already initiated in the 1950s and 1960s with teaching machines (Skinner, 1958) and subsequently evolved through later transitions of a constructionist nature (Papert, 1980) and a socio-cultural one (Bolter & Grusin, 1999; Jenkins, 2006).

More recently, this debate has been considerably fuelled by the advent of Artificial Intelligence (hereafter AI) in our lives; the advantages and potential risks associated with its use - particularly when they fall within the domain of education - draw considerable attention to the cultural revolution currently underway. The construct of prosthetic evolution (Calvani, 2017) is increasingly relevant in this respect, as it acknowledges both the physicality and the symbolic nature of the devices that accompany our daily actions and that, on our behalf, perform increasingly complex tasks: it would be untenable not to recognise the enormous potential of digitalisation, especially in its most recent manifestations. Indeed, the invisible and pervasive fusion of biology, behaviour, and data opens promising prospects for future generations across multiple fields of application. Among these, there is clear confidence in facilitated access to knowledge - including more complex forms of knowledge - and, as a direct consequence, the hope that technology may lead to wellbeing, fostering better and more equitable social inclusion for all and for everyone. Within this epistemological framework, speaking of literacy in the sense shared by UNESCO (2023) is no longer sufficient: it would be worth recovering a construct already present in the literature, namely that of transliteracy, according to which technological innovations bring about a shift in the semiosphere - that is, in the set of meanings attributed to signs, images, and texts (Mininni, 2004). The networked nature of knowledge is situated within a

set of relations in which technology constitutes an integral part of the cognitive system, where it is regarded as a means of both accessing and producing information (Wästlund, Norlander & Archer, 2008).

The conscious and critical use of AI calls for a robust design of training pathways for teachers and educators who live within digital culture, nourishing it daily through their relationships with their students. The present contribution aims to explore in depth the role of intelligent systems in promoting educational processes oriented towards conscious and constructive forms of learning. Given the defining features of the AI era, this perspective takes on particular relevance for managing the processes of knowledge production, organisation, and circulation - rewriting and updating the forms of teacher mediation and moving beyond the myth of fabrication-and-abandonment (Meirieu, 2007), in order to promote an education that allows individuals to become the work of themselves.

2. The Frankenstein Temptation in the Age of AI

In the contemporary debate, one of the most pressing issues concerns the capacity to manage the wealth of information made available through AI systems. Pedagogical research, traditionally oriented towards grasping the nuances of experience to support and sustain adaptive and learning processes, is currently engaged in identifying strategies suited to the training of teachers and students, with a view to promoting and consolidating critical competences for conscious interaction with AI. In fact, the pervasiveness of algorithms in everyday practices, in production processes, and in mechanisms of cultural signification renders the mere integration of digital technologies into teaching-learning processes increasingly unsustainable (if indeed it ever was, ed.) and unhelpful. Environments, spaces, and contexts for the co-construction of

knowledge need to be rethought, as places in which human and non-human actors interact and evolve (Latour, 2005).

How, then, are schools and the various educational agencies positioned within this scenario, in which humans, data, intelligent devices, and social expectations are weaving new forms of experience? The technocratic conviction, closely related to the Frankenstein myth, rests, according to Reboul (1989, in Meirieu, 2007), on five postulates that remain strikingly topical, however fallacious: the first regards technique as the panacea for every problem; the second attributes to human beings an absolute capacity to control and predict the world; the third reduces reality to what is scientifically observable and measurable; the fourth treats technical choices as beyond discussion, since they are justified by purely technical reasons; the fifth ascribes supreme value to the very technique just mentioned. The fragility of these arguments, and the irresponsibility of choices made because of such assumptions, becomes evident in the conflict typical of education - that between educator and learner. This is because experience and education are beset by misfortunes, setbacks, and returns: unpredictability eludes programming, and everyday life is written and rewritten according to rules that elude the predictive capacity of even the most sophisticated algorithms.

Since the end goal of educational work is not “assembly” (Meirieu, 2007), AI is not an end but a tool of educational action, capable of accompanying human beings in the world. Working with AI in teaching for learning calls for design practices that reject oversimplifications and both technophile and technophobic drifts (Gallese, 2025), to promote inclusion, encourage divergent and creative thinking, and prepare future generations to face the challenges of the contemporary infosphere with awareness (Floridi, 2014; 2022).

Within today's "*échange de services*" (Touraine, 1970), the teacher must remember "to ensure the predictability and reversibility of his or her productive tasks" […] while favoring (ed.) "actors -individual subjects who commit themselves and meet one another in the unpredictability of what may arise from their involvement and their encounter" (Imbert, 1992, p. 112). Education in the age of AI, including with and within AI, therefore requires the joint commitment and shared intent of the various actors involved; and education "can escape the symmetrical drifts of pedagogical extension (in the name of respect for the child) and of the fabrication of the latter (in the name of social demands) only by focusing on the subject's relationship with the world" (Meirieu, 2007, p. 72). This rethinking also involves the pedagogical intentionality and professional responsibility of educators and teachers, since algorithmic systems do not merely support processes of knowledge co-construction but also shape access to and dissemination of knowledge, as well as the construction of common sense (Long & Magerko, 2020).

Far from offering mere operational guidelines, or "recipes" for use, education must promote critical competences for a conscious interaction with AI, must promptly identify empty automatism, and must valorize its agentive and generative potential. Technologies - and, before them, techniques - do not in themselves constitute a problem, nor do they carry inherent risk: what requires investment is method, design choices that have an impact at the cognitive, social, and cultural level. The role of the school, understood as a public space for cultural development and democratic education, today translates into the need to actively guide the contemporary transition, fostering critical judgement and a horizon of global citizenship sheltered from ideological rigidities (World Economic Forum, 2020). The introduction of generative AI systems amplifies the complexity of this task, revealing its profound ambiguity. The potential of

large-scale language models offers undeniable advantages in terms of differentiating learning pathways, ensuring timely assessment, and producing multimedia content; at the same time, such tools act as mediators of teachers' own professionalism, lightening and complementing their work across the design, assessment, and management dimensions of teaching.

At the same time, concealed within the workings of algorithmic systems are the risks of the "fabrication" of human beings brought into the world and then left alone within it, of sterile standardization, of normalism and reductionism (Alliaud, 2007), as well as the risk of bias propagating through datasets — hence the need to guarantee educational equity, human oversight, and data protection (Rivoltella, 2020).

The current challenge for education lies in the capacity to elude the risk associated with AI within the infosphere, by promoting critical competences capable of establishing new dialogical and generative forms of relation with the non-human (of human fabrication… who is Frankenstein?).

The need to promote specific and consolidated competences re-emerges with disruptive force. Within the contemporary infosphere, transliteracy is configured as a pedagogical and relational meta-competence, indispensable for navigating the complexity of hybrid and opaque information ecosystems. It is not limited to mere technical dexterity in the use of heterogeneous channels through specific competences (media literacy, information literacy, data literacy) but extends to the capacity to activate and manage dialogical and reflective processes with AI systems. Within this scenario, the act of communicating unfolds across linguistic, critical, ethical, and expressive dimensions (Ranieri et al., 2023), translating into the co-construction of meaning between humans and machines. Promoting transliteracy from an

educational perspective means equipping learners with the critical lenses needed to understand algorithmic logic, to formulate effective prompts according to an interactive logic (prompt literacy), and to critically validate synthetic outputs. From this perspective, technical and operational mastery becomes a form of computational grammar, capable of detecting ostensibly neutral rhetorics, questioning the transparency of processes, and exercising creativity in the social rethinking of generative devices (Rivoltella, 2024).

In the current scenario, teaching practice should move beyond the logic of passively receiving technological innovations and arrive at a strategic, intentional, and purposeful integration: in this way, it becomes possible to structure flexible learning environments oriented towards personalization, capable of fostering student agency and the development of critical thinking (Buckingham, 2020; Minerva & Conte, 2025). Such a horizon implies an ongoing exercise of reflexivity on the part of the teacher, who is called upon to monitor the educational sustainability of digital media and to recalibrate his or her design postures to enhance their formative effectiveness (Rivoltella, 2020).

On the policy front, Europe has progressively outlined increasingly binding macro-level reference frameworks. The Ethical Guidelines on the Use of AI and Data in Teaching and Learning for Educators (European Commission, 2022) make the use of intelligent systems conditional upon respect for the principles of equity, inclusion, the valorizations of diversity, and the centrality of human oversight (human-in-the-loop). In close synergy, the DigComp 2.2 framework (Vuorikari, Kluzer & Punie, 2022) maps competence descriptors specific to AI and data literacy, urging school institutions to promote a responsible and critical appropriation of technologies.

Within the Italian context, the Guidelines for the Use of Artificial Intelligence in Schools (Ministry of Education and Merit, 2025) translate these supranational orientations into practice, acknowledging AI's capacity to optimize organizational, managerial, and educational processes. The ministerial document underlines how, through adequate pedagogical supervision, algorithmic systems can ease teachers' administrative burden, enhancing the accessibility of content and fostering differentiated instruction.

From this perspective, the 2025 MIM Guidelines represent an essential advancement on the regulatory level, yet they confirm the urgency of a pedagogical mediation capable of translating value-based principles into situated practice. The initial and in-service training of teachers emerges as a priority strategic lever: only teachers equipped with solid critical and methodological competence in the use of AI can guide students towards the acquisition of genuine AI literacy, transforming technology from a potential risk factor into a generative resource. The educational challenge lies in recognizing AI as a structural dimension of school experience, as well as a prerequisite for the exercise of digital and critical citizenship. Within this framework, the development of transliteracy - first among the teaching profession and, consequently, among the younger generations of learners - together with compliance with regulatory constraints, converge towards a single aim: enabling educational communities to inhabit the infosphere consciously, bridging techno-scientific innovation with the founding principles of equity and social justice, and thereby escaping the myth of "perfectibility" and of "fabrication".

3. Artificial Intelligence Literacy in initial teacher education: the TPACK model

Considering the reflections developed thus far, this contribution aims to examine the potential role of intelligent systems in fostering educational processes oriented toward conscious and constructive forms of learning. This perspective is particularly relevant in a historical phase characterized by the increasing diffusion of Artificial Intelligence (AI) in the processes of knowledge production, organization, and dissemination, a phenomenon that is increasingly affecting educational contexts as well. Educational systems are therefore called upon to engage with tools that not only support teaching activities but also intervene in the cognitive, decision-making, and evaluative dynamics that accompany learning.

AI-based technologies, in fact, do not merely perform operational or data-processing functions; today, they can generate original content, supporting complex linguistic interactions, and simulating processes associated with human intelligence. These characteristics contribute to redefining the traditional relationship between individuals, knowledge, and cultural production (Panciroli & Rivoltella, 2023). The generative dimension of AI does not simply represent technological evolution; rather, it introduces transformative elements that affect the ways in which knowledge is constructed, interpreted, and developed. Having moved beyond the specialized boundaries of computer science, intelligent algorithms have become an integral part of everyday practices, making pedagogical reflection increasingly necessary to investigate their educational significance and their implications for innovation in teaching and learning processes (Ranieri, Cuomo & Biagini, 2024).

Within this perspective, the role of the teacher retains indispensable centrality. Educational mediation can be understood as a metacognitive support activity through which teachers guide students in assuming responsibility, exercising critical thinking, and constructing learning pathways that are epistemologically coherent. A complementary relationship thus emerges between human agents and intelligent systems: while the latter may be entrusted with the processing and management of large amounts of information, the ability to attribute meaning, formulate critical judgments, and make pedagogically grounded decisions remains a prerogative of human agency (Hwang & Tu, 2021).

Such complementarity acquires educational value only when situated within paradigms that interpret learning as an active, contextualized, and relational process (De Corte, 2010). From this perspective, constructivist theory conceives knowledge not as the result of a linear transmission of content, but rather as a process of progressive construction emerging from the interaction between the learner and the context in which educational experiences take shape.

Accordingly, education can be viewed as a space for the shared construction of knowledge, within which AI may also be interpreted as a potentially meaningful resource, if it is embedded within a conscious and pedagogically oriented educational design.

Intelligent systems challenge educational institutions and universities to engage in critical reflection on the pedagogical, professional, and ethical models that shape contemporary educational processes (OCSE, 2021). Within this scenario, the concept of Artificial Intelligence Literacy (AIL) has become increasingly relevant, referring to the set of knowledge, skills, and attitudes required to understand, use, and critically evaluate intelligent technologies. Initial teacher education is therefore called upon to prepare professionals

capable of exercising pedagogical mediation by guiding the integration of AI within educational frameworks grounded in ethical principles and pedagogical coherence.

The analysis presented in the preceding sections has highlighted that the introduction of AI into educational settings cannot be reduced merely to the availability of new technological tools; rather, it requires a re-evaluation of the professional competencies needed to manage their use in an informed manner. In this context, initial teacher training takes on particular importance, as it must foster not only knowledge of emerging technologies but also the ability to integrate them critically into teaching and learning processes. From this perspective, evidence from previous studies has revealed a gap between self-reported familiarity with AI and the perceived possession of the competencies required to use it effectively in education (Gragnaniello, Tiso & Ferrantino, 2025). This finding underscores the need for training that goes beyond technical knowledge of the tools, focusing instead on the ability to integrate them in relation to educational objectives, instructional design processes, assessment, and critical reflection on the outputs generated.

Based on this evidence, this paper focuses on the design and implementation of a training intervention for prospective teachers. It is designed to foster AI-related competencies that go beyond mere operational skills, instead linking the possibilities offered by technology with pedagogical and subject-matter knowledge, as well as the specificities of educational contexts. This need for integration informs the adoption of the Technological Pedagogical and Content Knowledge (TPACK) framework (Figure n.1) as the theoretical basis for the training program. The model views the integration of technology into educational processes as the outcome of the interaction between subject-matter, pedagogical, and technological knowledge (Mishra & Koehler, 2006);

consequently, the effectiveness of teaching does not depend on the use of technology per se, but rather on the teacher's ability to select and integrate digital tools in alignment with learning objectives, methodological strategies, content, and the characteristics of the educational context (Harris & Hofer, 2009).

The TPACK framework is rooted in the work of educational psychologist Shulman (1986), who highlighted that the quality of teaching depends on a teacher's ability to connect subject-matter knowledge with appropriate pedagogical knowledge and strategies. Building on this foundation, the model was subsequently expanded to include a technological dimension, identified as a third domain of knowledge (Angeli & Valanides, 2005; Koehler & Mishra, 2005; Mishra & Koehler, 2006). Thus, while TPACK retains Shulman's original approach, it broadens the perspective by considering the dynamic relationship between content, pedagogy, and technology. Technology is not viewed as a standalone component to be added to the educational process, but rather as a dimension to be integrated with subject-matter and pedagogical knowledge within a broader instructional context. It is precisely the interaction among these domains that enables teachers to use technology effectively for teaching specific content (Niess, 2005).

The framework is grounded in three primary dimensions of knowledge, Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK), and their intersections, which define the integrated forms of knowledge essential for designing and implementing instructional activities (Mishra & Koehler, 2006; Koehler, Mishra & Yahya, 2007; Messina & De Rossi, 2015; Iannotta, 2023). From this perspective, the selection and use of technology do not serve as a starting point; rather, they are situated within a design process where objectives, content, methodologies, and tools are considered in relation

to one another (Harris & Hofer, 2009). This approach is particularly significant regarding AI; integrating AI into educational processes requires future teachers not only to understand the operational capabilities of these tools but also to critically examine output quality, prompt formulation, potential biases, and the pedagogical and ethical implications of their use. In this context, technological competence intertwines with pedagogical and subject-matter expertise, creating an integration process in which interaction with AI becomes a subject of analysis, verification, and refinement: “quality teaching with technology requires understanding the synergistic relationship among all three elements considered together to develop appropriate, specific, and contextualized strategies and representations” (Koehler, Mishra & Yahya, 2007, p. 741).

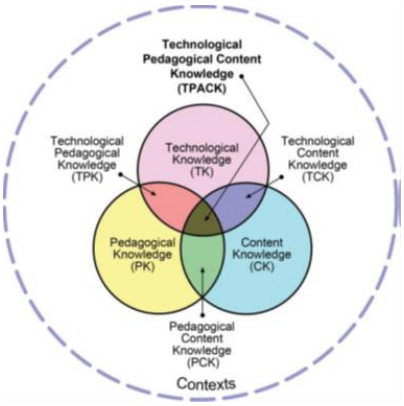


Fig. 1 TPACK (Mishra & Koehler, 2006)

Balancing these dimensions fosters the development of integrated knowledge capable of guiding informed instructional choices and amplifying the educational value derived from their mutual interaction; teachers must be able to use technologies in an informed and flexible manner, adapting them to educational contexts and subject-specific goals to effectively support student learning (Dexter et al., 2006).

At a practical level, the TPACK model guides instructional design toward the informed selection of technologies—choices that align with subject content, educational goals, methodological approaches, and contextual characteristics. From this perspective, the selection of technological tools follows the definition of learning objectives and instructional activities, as their educational value depends on their ability to integrate functionally into the teaching-learning process (Harris & Hofer, 2009).

4. Design and implementation of the training program

Considering the foregoing, a seminar series was conducted in February 2026 at the University of Salerno, integrated into the Educational Technologies Laboratory of the Master's Degree Program in Primary Education.

The program, aimed at the same sample group involved in the previous study (Gragnaniello, Tiso & Ferrantino, 2025), consisted of six three-hour sessions (18 hours in total) and featured the participation of a digital humanist with expertise in knowledge management, instructional design, and innovation involving Generative AI.

The methodological approach alternated between in-depth theoretical discussion and hands-on workshop activities; the latter were primarily organized in small groups and followed by sessions for sharing results and

collective discussion. The activities followed a recurring structure: the expert's presentation and discussion of theoretical concepts were followed by small-group practical tasks, which were subsequently shared with the larger group. The sharing phase served as a moment of joint analysis aimed at identifying strengths, critical issues, and areas for refinement, thereby transforming the practical experience into an opportunity to reflect on the use of AI in educational settings. This structure enabled the practical application of the TPACK framework principles by presenting scenarios in which AI usage was constantly aligned with the goals of the educational activity, the subject matter, and the characteristics of teaching and learning processes. From this perspective, the program addressed two closely interconnected themes: prompt engineering and the critical analysis of algorithmic bias.

The initial phase was developed through Prompt Engineering activities. Based on the premise that the quality of generated outputs depends largely on how requests are formulated for intelligent systems (Baldassarre et al., 2024), the seminars explored strategies for constructing prompts aligned with specific educational and training objectives. The focus was placed not only on the technical aspects of instruction formulation but, above all, on the ability to critically guide the interaction with intelligent algorithms considering educational goals. From this perspective, prompting competence was viewed as a form of pedagogical mediation that enables teachers to manage the use of generative technologies, leveraging their potential while maintaining critical control over teaching and learning processes. The ability to "engage in effective dialogue" with AI is a defining characteristic of the digital teacher's professional profile. It is, therefore, a new competence that goes beyond mere technology use, emphasizing how to maximize the benefits of human-machine interaction to enhance learning (Redecker, 2017). At a practical level, students were

involved in constructing prompts for educational design and assessment tasks, thereby grappling with the need to articulate the task clearly, define its objectives, identify the target audience, and specify the relevant content. The construction of the request was thus grounded in a concrete educational context, where the choice of how to interact with the generative system depended on a prior definition of the educational intent. The identification of concrete teaching situations was facilitated by the experiences gained by fourth-year students during their direct internships at schools, where they are directly involved in teaching activities.

Formulating the requests required students to define the task, specify its objectives, and consider the target audience and content, while relating these elements to the capabilities and constraints of the generative tool. Subsequent discussion among the subgroups allowed for an examination of the various formulations, identifying ambiguities, implicit assumptions, and aspects open to rephrasing. Thus, the discussion went beyond merely evaluating the formal correctness of the prompt; it addressed the prompt alignment with the educational task and the expected output. The opportunity to rephrase requests introduced an iterative dimension to the activity, wherein interaction with the system was subjected to observation and subsequent revision. The activity thus operationalized the TPACK framework by combining knowledge of the technological tool with the definition of pedagogical intent and consideration of the task's subject matter. In this way, prompting served as a mechanism for simultaneously engaging the technological, pedagogical, and disciplinary dimensions of the model: knowledge of the tool's capabilities was linked to the intended learning content, the organization of the activity, and the educational objectives being pursued.

The second key area focused on algorithmic biases, viewed as a critical factor to consider when integrating AI into educational settings, by examining the non-neutral nature of algorithms and the potential educational implications of using systems trained on data containing gaps, imbalances, or prejudices.

Within this context, the analysis covered:

- **linguistic biases**, which can favor specific cultural and social representations;
- **confirmation biases**, which tend to reinforce information and beliefs already held by the user;
- **temporal biases**, linked to the use of outdated data or data that no longer reflects reality;
- **accessibility biases**, relating to the tendency to prioritize information that is immediately available online.

In the educational sphere, this dynamic can lead to a progressive reduction in the complexity of research and source-selection processes, steering attention toward content that is immediately accessible rather than content that is truly relevant, authoritative, or scientifically grounded (Daugherty & Wilson, 2018; Noble, 2018; Floridi, 2022). However, the analysis of these phenomena was not presented merely as an exploration of the technical characteristics of algorithmic systems, but rather as an issue directly linked to the teacher's pedagogical responsibility. Attention was paid to how the framing of queries, the information taken as a given, and the characteristics of the generated responses can influence the construction and selection of content used in educational settings.

In this instance, too, the workshop activities involved analyzing interactions with generative systems and subsequently comparing participants'

experiences, focusing particularly on linguistic phrasing, information taken as a given, and the ways in which specific prompts can shape the resulting outputs. The discussion also prompted reflection on the need to critically verify and refine these outputs based on their relevance to educational goals, the subject matter, and the context of use. Consequently, the work on bias engaged the technological dimension alongside pedagogical and subject-matter knowledge, serving as an exercise in raising awareness regarding the educational and instructional suitability of the generated responses.

Taken together, these two components allowed the TPACK framework to be applied in two complementary ways. The work on prompting emphasized designing the interaction with technology based on specific educational objectives, whereas the analysis of bias encouraged a critical evaluation of the outputs and the factors influencing their generation. In both cases, technology was viewed as part of a process in which pedagogical, subject-matter, and technological knowledge all contribute to defining, verifying, and refining instructional practice.

This training program designed based on empirical evidence from a previous study involving students from the Primary Education degree course (Gragnaniello, Tiso & Ferrantino, 2025), presents certain critical aspects that should be highlighted.

First, organizational conditions and available resources did not allow for the expansion of the training, either in terms of scope (e.g., by increasing the number of sessions) or in terms of the target audience (e.g., by including fifth-year students).

A further limitation concerns the absence of a systematic assessment at the end of the program designed to document learning outcomes using structured

tools. This absence makes it impossible to draw conclusions regarding the intervention's effectiveness or to identify any changes in the participants' knowledge, skills, or perceptions. Nevertheless, throughout the activities, the research team observed a significant level of participation, evidenced by relevant and engaged contributions during group discussions and active involvement in subgroup tasks. While these elements do not constitute systematic indicators of effectiveness, nor can they replace an outcome assessment, they provide observational evidence regarding participant engagement and the conduct of the training activities.

Having access to structured data on outcomes would have made it possible to complement these observations with more systematic documentation of the initiative's processes and results. Consequently, future iterations of the program could incorporate monitoring and evaluation tools, such as pre and post-intervention assessments and structured observation methods, to more rigorously verify the training's impact.

5. Conclusions

Insights drawn from the relevant scientific literature, identified through a narrative approach to selection, and evidence emerging from a prior study conducted at the University of Salerno with students from the Primary Education degree program highlight the urgent need to rethink teacher training epistemologically and methodologically within the "infosphere", a landscape dominated by generative AI. That study, which was the subject of an earlier publication (Gragnaniello, Tiso & Ferrantino, 2025), served as the starting point for shaping subsequent training initiatives; it underscored the understanding that familiarity with AI tools does not encompass the full complexity of the

competencies required of future teachers and that the educational use of these tools demands intentional, critical, and contextualized pedagogical mediation.

The link between the conceptual framework and the educational experience presented here highlights a critical yet fundamental issue: future teachers clearly perceive the gap between abstract, or purely “declarative”, knowledge of AI systems and the “operational” ability to translate them into tools for pedagogical mediation. This divide confirms the persistence of what Meirieu (2007) terms the “Frankenstein temptation”: the risk that educators might abdicate their pedagogical intentionality, reducing themselves to mere “manufacturers” of information or, conversely, to passive executors of standardized technological protocols.

In contrast, integrating AI into educational processes demands a professional approach capable of upholding pedagogical judgment and educational responsibility as central dimensions of teaching, thereby reaffirming a student-centered and anthropocentric model of education in which pedagogical judgment remains an exclusively human prerogative.

From this perspective, training oriented towards transliteracy cannot be limited to instruction on the instrumental use of machines; instead, it must foster a critical “computational grammar” capable of supporting processes of meaning co-construction within human-machine dialogue and interrogating the opacity of algorithmic systems (Floridi, 2014; 2022). Consequently, AI education derives its value not so much from the mastery of specific tools as from the ability to understand their possibilities, constraints, and implications within the framework of teaching and learning processes.

The workshop-based training initiative sought to address precisely this challenge by bridging theory and pedagogical practice. By adopting the TPACK

framework (Mishra & Koehler, 2006), technology was presented not from a technocratic perspective—akin to the postulates of Reboul (1989, in Meirieu, 2007)—but rather as a variable interconnected with the teacher's pedagogical, professional, and technological knowledge. Focusing the training program on Prompt Engineering (conceived as a new form of pedagogical and dialogic mediation) and on the deconstruction of algorithmic biases (linguistic, confirmation, temporal, and accessibility-related) made it possible to address the training needs identified in the prior assessment through activities centered on designing interactions with AI and critically evaluating its outputs.

In conclusion, AI can no longer be viewed as an episodic innovation or a mere external tool; rather, it constitutes a structural dimension of the contemporary infosphere in which citizenship is exercised. To prevent the adoption of such technologies from resulting in a reductionist standardization of learning, initial teacher training must be treated as a priority strategic lever. Only a teaching body possessing a high level of "enhanced responsibility" and solid critical thinking skills will be able to guide future generations to navigate the digital transition consciously, transforming AI from a potential source of alienation into a genuinely generative, equitable, and democratic resource.

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