THE METACOGNITIVE EDUCATOR IN THE AGE OF IA: CHALLENGES AND OPPORTUNITIES

IL DOCENTE METACOGNITIVO NELL'ERA DELL'IA: SFIDE E OPPORTUNITÀ

Alessandra Brafa
Università Kore di Enna
alessandra.brafa@unikorestudent.it

Antonio Giannone
Università Kore di Enna
antonio.giannone@unikore.it

Marinella Muscarà
Università Kore di Enna
marinella.muscara@unikore.it

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ABSTRACT
AI tools and application environments are revolutionizing the main functions of the educational ecosystem. The teacher's role is evolving into that of a co-learner (Limone, 2021), within a context where interactions occur with non-human epistemic partners (Moriggi & Pireddu, 2024). This contribution, at the intersection of different theoretical perspectives, offers some reflections on how to consciously integrate AI into teaching.

Tool e ambienti applicativi di Intelligenza Artificiale stanno rivoluzionando le principali funzioni dell'ecosistema educativo. Il ruolo del docente evolve in quello di co-apprendente (Limone, 2021), in un contesto in cui si interagisce con partner epistemici non umani (Moriggi & Pireddu, 2024). Il contributo, nell'intersezione tra diverse prospettive teoriche, propone alcuni spunti di riflessione per integrare con consapevolezza l'IA nella didattica.

KEYWORDS
Artificial Intelligence; Teacher Agency; Teacher Metacognition.
Intelligenza Artificiale; Agency Docente; Metacognizione Docente.

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Introduction

In an era traversed by rapid and profound technological, social, and cultural transformations, the school finds itself at the center of a complex reconfiguration, which requires radically rethinking its educational paradigms to effectively and sustainably respond to the challenges of the present. The contemporary educational ecosystem is increasingly structured as a hybrid space, in which human subjects and artificial agents cooperate in the construction of knowledge, progressively redefining the epistemological and relational coordinates of teaching and learning (Moriggi & Pireddu, 2024).

In this context, the introduction of Generative Artificial Intelligence (GAI) in educational processes cannot be considered a simple technological innovation. It represents a genuine paradigm shift, affecting not only the tools but also the roles, languages, and pedagogical visions.

Technologies, after all, never emerge in a historical-social vacuum; they are always the product of cultural, political, and symbolic forces and reflect their tensions (Eco, 2001), requiring critical revision also in the school environment, since today's students no longer correspond to the profiles for which traditional educational systems were designed (Muscarà et al., 2024). The life trajectories, cognitive practices, and forms of cultural participation that traverse the experience of students - and, in parallel, that of teachers - need to be recognized, heard, and transformed into new educational opportunities.

If until a few years ago digital technologies were mostly conceived as support tools for teaching, except for assistive technologies created for specific purposes, today GAI enters educational processes with a degree of autonomy and interactivity that marks a clear break with the past. It does not merely facilitate the delivery of content but actively and adaptively intervenes in cognitive mediation, contributing to personalizing learning, generating new materials, and providing contextualized feedback. In this way, GAI seems to assume an agentive valence, insofar as it supports and guides learning processes; a collaborative valence, as it configures itself as an interlocutor capable of interacting with learners and teachers; and finally a transformative valence, where it stimulates the rethinking of methodologies and didactic architectures.

These potentialities develop within a continuous dialogue between teacher, learner, and machine, which profoundly redesigns traditional educational

dynamics. The teacher is progressively called to position themselves as a co-learner (Limone, 2021), opening themselves to continuous professional learning also mediated by interaction with artificial intelligences (Ciasullo, 2024). Faced with this scenario, it becomes fundamental to reflect in a systemic and networked way on how teachers can use GAI critically, without falling into either blind delegation or a position of ideological resistance.

GAI, if understood as an epistemic ally and not as a professional antagonist, can represent valuable cognitive and design support. For this to happen, it is necessary that it is integrated into teaching practice through conscious pedagogical direction, capable of mediating technological tools according to clear and intentional educational principles. This is precisely the central challenge that the transition to School 4.0 poses to contemporary pedagogy: combining technical innovation with an educational vision that knows how to preserve the centrality of the person, the quality of the relationship, and the humanistic sense of learning.

Moving at the intersection of different theoretical perspectives, this contribution proposes a reflection on the relationship between Artificial Intelligence and teacher training, with the aim of outlining new theoretical-pedagogical trajectories oriented toward the re-definition of competencies necessary to direct educational action in the complexity of the contemporary.

1. GAI as epistemic partner: cognitive and educational implications

The idea of an intelligence different from human intelligence has its roots in the first half of the last century, when the pioneering works of Alan Turing, together with the development of modern computing, began to outline the theoretical possibility of systems capable of processing information and solving problems autonomously. The seminar at Dartmouth College in 1956, during which John McCarthy coined the term Artificial Intelligence for the first time, marked the official beginning of a new field of research destined to progressively expand, eventually permeating scientific, economic, and cultural domains deeply (Riguzzi, 2006).

From its origin, however, the application of the concept of "intelligence" to machines has raised considerable criticism, linked especially to the risk of inappropriately attributing to technology characteristics proper to human

cognition. As Floridi and Nobre (2024) observe, the term itself represents a strongly ambiguous linguistic borrowing, which tends to mask an epistemologically relevant distinction: that between operational capacity and intentional awareness. Believing that an algorithmic system "thinks" or "understands" like a human being introduces a conceptual distortion that compromises our ability to rationally evaluate its implications, potentialities, and limits.

To avoid such misunderstandings, it is useful to consider AI not as a form of intelligence strictu sensu, but rather as a sort of operational agency capable of carrying out complex tasks, even creative ones, without however possessing - at least until today - consciousness, intentionality, or subjective experience. Adopting this perspective allows us to overcome anthropomorphic visions and to address the debate on emerging technologies with greater critical lucidity. At the same time, this entails the need to equip ourselves with theoretical and conceptual tools capable of reading and interpreting the impact of AI on social, cultural, and educational levels to open the way to a critical and plural confrontation on the future development of technology and its use in school and educational contexts.

In recent years, the pervasive diffusion of GAI has been marked by strong acceleration, also outlining new pedagogical scenarios because, unlike traditional artificial intelligence systems of which schools have extensive and robust experience, GAI does not limit itself to reproducing content or solving standardized problems: it generates new content, through deep learning models capable of processing enormous amounts of data through probabilistic architectures. Among the most advanced expressions of this technology, Large Language Models (LLMs) occupy a position of primary importance, as they are capable of producing linguistically plausible and coherent responses to human inputs, simulating sophisticated cognitive processes. The most emblematic tool in this field is ChatGPT, developed by OpenAI, whose impact in educational contexts has been as disruptive as it was unexpected, considering that it was born outside the ordinary circuits of Educational Technology.

The growing impact of AI in the educational field has not gone unnoticed or under the radar, so much so that UNESCO (2021) and the OECD (2024) have long emphasized the need to systematically address the ethical, epistemological, and pedagogical implications linked to the use of AI in learning processes, and at the same time, digital literacy actions have been promoted among students (Buckingham, 2006; Messina et al., 2024), as well as among teachers, to prepare

them to critically and effectively manage the new learning environment (Ranieri, 2022).

The relationship between digital technologies and education has produced, over the last two decades, a true metamorphosis in the paradigms of access to knowledge, just as educational pathways themselves have evolved from transmissive and mono-sensory configurations to increasingly complex multichannel, interactive, and immersive ones (Marzano et al., 2015). This change has directly affected the cognitive architecture of learners, enhanced by the digital environment in which they are immersed (Limone, 2021).

On the didactic level, AI mediation, through Intelligent Tutoring Systems (ITS), allows on one hand to calibrate didactic intervention in real-time based on the individual characteristics of students, favoring a high degree of personalization, and on the other, platforms that integrate the presence of artificial agents promote peer interaction dynamics and human-machine interactions oriented toward the development of both disciplinary and transversal competencies. The effectiveness and significance of digital-educational intervention seems to reside, therefore, in the ability to organically integrate technologies into didactic practices, orchestrating meaningful experiences through the coordinated stimulation of the cognitive, relational, and emotional dimensions of the subject. In this context, Emotional Technologies seem to be able to play a key role in favoring multidimensional involvement and supporting student motivation and engagement (Muscarà et al., 2024). In this framework, GAI assumes the role of catalyst for didactic action, not only to reconfigure practices but also to open new theoretical, design, and research horizons (Mancini & Sebastiani, 2024) in a hybrid space where physical interaction and algorithmic mediation coexist and co-act in the construction of knowledge.

For this innovative process to be truly generative, renewed teaching professionalism is required, aware of complexity and capable of maintaining firm agency. The sustainability of the new educational-technological ecosystem will therefore depend on the ability to preserve pedagogical intentionality within hybrid environments, in which the human and digital dimensions intertwine in a complementary way (Atzei et al., 2024).

It is therefore urgent to promote deep pedagogical reflection on the human-machine binomial, to prevent GAI from being perceived as a threat to the teaching

function itself rather than as an epistemic and professional ally, and to "dismantle the false alternative between the pole of technophobes and that of naive techno-optimists, suggesting that the real conflict is not between human being and technology but between worldviews" (Gallese et al., 2025, p. 179).

2. Reconfiguring teacher professionalism between agency, metacognition and algorithms

Critically and structurally analyzing the potential of GAI represents an essential condition for fully understanding its transformative value in the educational field (Fiorucci & Bevilacqua, 2025): it is within the daily operations of didactic practice that such potentialities assume tangible and observable contours, especially in relation to the inclusive opportunities that GAI is able to generate. The possibility of constructing personalized content in real-time, adapted to the specific cognitive, emotional, and cultural characteristics of students, of optimizing the time and resources invested by teachers in didactic planning, opens unprecedented didactic scenarios with promising additional strengths, potentially capable of freeing up energies to be devoted to relational and reflective work.

However, alongside these captivating and engaging perspectives, some non-negligible risks may also arise for teachers: on one hand, the extreme ease of use and immediacy in generating output could induce a progressive dependence on algorithmic infrastructures, with the danger of de-responsibilization regarding one's pedagogical choices and the reduction of the degree of critical awareness with which they are formulated; on the other hand, a sort of defensive rigidity could occur, a form of ideological rejection of innovation, generated by the fear that AI is an antagonistic entity, a threat to professional autonomy and to safeguarding the human dimension of teaching.

Both are drifts - that of blind delegation and that of defensive closure - that can compromise the quality of the relationship between the teacher and the innovation process, which, on the contrary, requires a conscious and critical approach. Instead, it is about building an authentic dialogue between the human and algorithmic agent, based on a vision of education in which technology is a tool and never an end, plays the role of ally and never surrogate of the teacher.

To educate in the uncertain territories of digital (Iavarone, 2023), the concept of AI Literacy (Cuomo et al., 2022) becomes central, a foundational competence for fully

and consciously accessing the new educational ecosystem, also to redefine the professional identity of teachers, called to assume a role of competent and reflective mediators, professionals capable of designing dialogic, inclusive, technologically advanced learning environments and exercising a new form of agency that includes daily confrontation with non-human epistemic partners (Moriggi & Pireddu, 2024).

It is the school 4.0 in which a new balance between human presence and algorithmic mediation must be redesigned, a new distributed cognitive architecture in which knowledge is generated by the synergistic interaction between natural and artificial intelligence (Clark, 2000). The teacher is required to have a new educational responsibility, while AI is assigned a function of cognitive empowerment, of force multiplier capable of amplifying professional competencies (Mollick & Mollick, 2023a).

As an "orchestrator of didactic experiences" (Luckin et al., 2016), the teacher assumes multiple postures to observe with a critical gaze, design authentic experiences, evaluate processes and products, build dynamic and inclusive environments, harmoniously integrate relational and digital dimensions.

It is in this context that the concept of technological self takes shape (Santoianni, 2025): a holistic, dynamic, and relational dimension that the teacher constructs in continuous exchange with the digital environment, accompanied by an articulated set of specific competencies related to intentional design, prompt design capability, critical evaluation of algorithmic outputs.

It is a "metacognitive" teacher capable of reflecting on their own didactic action, of readapting strategies, of developing awareness, resilience and critical spirit, maintaining the guidance and control of the educational process (Cottini, 2006). The use of AI can be configured as a sort of zone of proximal development (Vygotsky, 1978; Iannella, 2023): a learning environment that initiates paths of continuous professional improvement through the adoption of reflection-in-action and reflection-on-action practices (Schön, 1993), which allow the teacher to act as a reflective researcher, to maintain firm their role as educational guide, avoiding being overwhelmed by the fascination of automation.

It is about redefining Teacher Agency (Aiello et al., 2016) in light of new literacies that enrich the profile and making one's own an adaptive AI mindset, which recalls, enhancing it, the digital mindset proposed by Padua (2024). The adaptive AI

Mindset could represent, in this sense, an integrated configuration of cognitive dispositions, reflective attitudes, and educational-didactic and technological competencies that characterize the teacher capable of integrating AI into educational processes in a conscious, critical, and intentional way. As Rivoltella (2024) indeed emphasizes, for the human-machine dialogue to be fruitful and pedagogically oriented, it is necessary to equip oneself with a new conceptual and operational arsenal, capable of inhabiting the complexity of the present.

Conclusions

The use of Generative Artificial Intelligence in the educational context raises not only technical or methodological questions but calls into question the very idea of school, the teacher's responsibility, and the profound meaning of educational-didactic action. As previously mentioned, GAI is not a simple operational support: it is a co-actor that can transform and redefine teaching and learning practices, affecting the forms of knowledge and reshaping the educational relationship.

In this new scenario characterized by increasingly accelerated evolution, the teacher is called upon to renegotiate their role, to establish a reflective and intentional relationship with GAI, serving as a critical safeguard of the innovation process to avoid drifts toward passive adaptation, closure, or fascination with automation. It is urgent to redefine a new professional identity for teachers capable of governing the complexity of contemporaneity within a distributed cognitive ecosystem in which technology represents the opportunity "to rethink cognitive, educational, and cultural processes," as suggested by Gallese, Moriggi, and Rivoltella in the Manifesto of the Beyond-Technophobe. For a Conscious Relationship with Digital Technology (2025, p.181), so that the future can be decided with responsibility and critical spirit without fear of renouncing the human.

Author contributions

Marinella Muscarà was responsible for the "Introduction" paragraph.
Alessandra Brafa was responsible for the paragraph "1. GAI as epistemic partner: cognitive and educational implications."
Antonio Giannone was responsible for the paragraph "2. Reconfiguring teacher professionalism between agency, metacognition and algorithms."
The conclusions were written jointly by all three authors.

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