ARTIFICIAL INTELLIGENCE AS A MEDIATION DEVICE: TOWARDS AN EPISTEMOLOGICAL REDEFINITION OF ACTIVE TEACHING THROUGH THE 5E MODEL

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ABSTRACT
The integration of Artificial Intelligence in educational settings challenges the epistemological status of teaching, requiring a redefinition of the relationship between normativity and practice. This contribution investigates AI as a transformative device capable of restructuring the teaching-learning relationship beyond mere technological enhancement. Specifically, it examines the BSCS 5E Instructional Model developed by Roger W. Bybee as an AI-mediated framework for stimulating dialogue and expressive creativity. Acting across the phases of exploration, explanation, and elaboration, AI supports active participation and metacognition, preventing technology from serving as an informational shortcut. The algorithm thus evolves into a dynamic co-designer of the lesson, capable of fostering curiosity and critical reflection. In this perspective, the teacher's mediation transforms the classroom into a generative environment, reaffirming the centrality of meaning-making processes and intersubjectivity in the digital transition.

KEYWORDS
Artificial Intelligence; 5E framework model; algorithmic mediation; epistemic literacy; dialogic teaching.

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1. Introduction

In 2003, the British Journal of Educational Technology, a leading international journal in the field of educational technology, dedicated a monographic issue to the role of technologies in formal education, highlighting how the relationship between school and innovation has always been permeated by a deep and polarising "rhetoric of optimism" (Nichol & Watson, 2003). The analysis of the contradictions inherent in technological innovation in education remains a heated debate in contemporary pedagogy, given the risk of instrumental overload as an end in itself, without adequate methodological reflection.

As Selwyn (2011) has already shown, educational settings are pervaded by a generic need to keep pace with the exponential rhythm of development, situating the educational system within a scenario perceived as constantly ineffective. In retrospect, the introduction of technologies in schools has frequently been accompanied by ambitious and systematically unfulfilled promises, which were supposed to trigger positive effects on teaching-learning processes and relational dynamics.

In this regard, Rushby and Seabrook (2008) outline an innovation adoption curve that traces a recurring circuit in the history of educational technologies, characterised by alternating enthusiasm, hope, and disillusionment, accompanied by transformative prophecies about the inevitability of change.

This circuit reproduces itself today with generative artificial intelligence, amplified by the speed at which this tool has spread into everyday life. It is necessary to recognise this pattern in order not to yield to the rhetoric of optimism and to adopt a critical and sceptical stance towards technologies, understood not as necessary solutions but as complex and never neutral devices.

As Neil Postman had already intuited in Technopoly (1992), in educational contexts the introduction of a new technology neither adds nor subtracts anything, but changes everything: every change restructures and redefines the frame of reference. Drawing on the construct of remediation from Bolter and Grusin (1999), it is possible to read artificial intelligence as a device that grafts itself onto a complex media system, inheriting its structures and reinterpreting them, thereby redefining environment, culture, and relationships. In this sense, AI re-mediates writing, image, sound, video, and even the peer tutor, producing a renewed cognitive ecology in which the boundaries between individual elaboration and algorithmic delegation become opaque. And yet the questions that fuel today’s debate on artificial intelligence have easily traceable historical

roots. Already in the Phaedrus, for example, Plato stages a provocation that resonates familiarly: by recounting the Egyptian myth of Theuth, he criticises the invention of writing, considering it a dangerous shortcut destined to weaken memory, atrophy reasoning, and produce the illusion of knowledge (Plato, ca. 370 BCE).

From writing to artificial intelligence, every new device has aroused analogous fears and specular enthusiasms: the camera was accused of imitating painting and impoverishing the gaze, cinema of diminishing the imagination, radio of manipulating consciences, television of creating passive viewers. Each of these technologies, from a McLuhanian perspective, is never neutral, as it is a structural part of the environment and produces cognitive, relational, and cultural effects regardless of the contents it conveys (McLuhan, 1964). In the elaboration developed by de Kerckhove (1997), every technology reveals itself as a cognitive prosthesis that redefines our thought processes. Similarly, Clark and Chalmers (1998) consider the system of artefacts with which human beings interact as an "extended mind" that amplifies individual and collective knowledge, competencies, and abilities.

Artificial intelligence inscribes itself in this genealogy by simulating the thought process through operational autonomy and contextual adaptivity: it does not merely memorise, calculate, and search, but infers, selects, generates, evaluates, and constructs an output by interpreting the user's context and expectations. Such agentivity produces changes in the environment in which it operates, modifying beliefs, decisions, and behaviours. The illusion of the bidirectional interaction that artificial intelligence offers to the user's perception dangerously brings it closer to a human interlocutor who responds, relaunches, corrects, and proposes (Floridi, 2022).

Quattrociocchi and colleagues (2025) introduce the term "epistemia" to describe the structural condition that ensues: AI systems produce fluent, coherent, and convincing responses without instantiating the processes through which they are constructed. The user experiences the acquisition of an answer without having traversed the cognitive labour of critical reasoning, confusing the linguistic plausibility of the output with the epistemic solidity of the knowledge acquired. This is made possible by the way information is delivered: while search engines return documents, leaving the user the task of selecting and connecting informational nuclei, generative systems absorb the cost of epistemic verification (Quattrociocchi et al., 2025). This is an infrastructural condition that risks rendering superfluous the critical, creative, and personal contribution of everyone who learns, bringing to light the Platonic concern between knowledge and the illusion of knowledge. Recognising this

risk does not, however, mean abandoning the integration of AI in educational contexts, but rather redefining the conditions under which it can become a tool in the service of authentic, transformative, and meaningful learning (Ausubel, 1968).

As Laurillard (2014) observed, "knowledge technologies shape what is learnt, going on to change how it is learnt" (p. 17). For this reason, technological innovation does not diminish the teacher's role but makes it more complex and more necessary, since beyond assuming the role of mediator of articulated knowledge, the teacher is called upon to support students in organising their thinking and developing authentic competencies. The methodological integration of the digital and the didactic makes sense not because the future is inevitably algorithmic, but because the school has the task of forming people capable of critically inhabiting their own time — and our time is, among other things, the time of artificial intelligence (Di Padova & Lotti, 2024).

It is from these premises that this contribution adopts a theoretical-critical perspective to analyse the role of AI as a mediation device in teaching-learning processes, choosing as its interpretive framework the BSCS 5E model developed by Roger W. Bybee (2014). The model, articulated in the phases of engagement, exploration, explanation, elaboration, and evaluation, represents one of the most consolidated constructivist frameworks in the field of instructional design oriented towards active learning. Its sequential and cyclical structure, grounded in cognitive conflict and the progressive construction of knowledge, offers a fertile theoretical space for examining how artificial intelligence can be integrated not as an additive tool, but as a transformative agent capable of reconfiguring the dynamics of each phase, with the promises and risks that this entails (Bybee, 2015).

2. The 5E Model as a framework for algorithmic mediation

The BSCS 5E model was developed in the second half of the 1980s by Roger W. Bybee with a team of researchers from the BSCS — Biological Sciences Curriculum Study, a non-profit organisation dedicated to the dissemination of scientific curricula, which included scholars such as Nancy Landes, Jim Ellis, Janet Carlson, Deborah Muscella, and William Robertson. The model was initially piloted within primary school science programmes and draws inspiration from the Learning Cycle developed by Atkin and Karplus (1962) within the Science Curriculum Improvement Study programme at the Lawrence Hall of Science in Berkeley, integrated with research on cooperative learning within the constructivist perspective on learning (Johnson & Johnson, 1987).

The model aims to promote active learning through inquiry and the autonomous construction of knowledge, organising the teaching-learning process in a structured sequence of five phases — engagement, exploration, explanation, elaboration, and evaluation — with the objective of making students responsible for their own learning pathways, valuing prior knowledge, and activating an experiential continuum that moves from experience to abstraction (Bybee, 2015).

The BSCS 5E presupposes that every student brings to class their own biographical and socio-cultural background, sometimes constituted also by naive conceptions and misconceptions that represent the indispensable starting point for any authentic learning. As Ausubel (2000) observes in a well-known citation, "if I had to reduce all of educational psychology to just one principle, I would say this: the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (p. vi). The objective, therefore, is not to correct these conceptions from the outside through the transmission of content the teacher considers correct, but rather to create the conditions for them to surface, to be put to the test by experience, and to be eventually deconstructed.

In this way, a gradual and personal construction of knowledge is fostered, since each phase depends structurally on the preceding one and prepares for the next, ensuring a coherent path that leads from concrete experience to formal conceptualisation, and from there to subjective and transferable re-elaboration.

The model is grounded in the design and implementation of teachable moments — that is, moments favourable to creativity, oriented towards curiosity, respectful of everyone’s intelligences and learning styles, aimed at creating the best cognitive and emotional conditions for self-expression. According to Bybee, this model fosters the development of transversal competencies such as critical thinking, problem-solving, collaboration, communication, and systemic thinking, because it is based on active inquiry, collaborative work, and metacognitive reflection (Bybee, 2015).

The sequential structure of the model is articulated in a rigorous protocol that defines, for each phase, the instructional action and the expected outcomes. Specifically, the first phase concerns engagement: the teacher introduces a cognitive trigger that can take the form of a discrepant event, a big question, or a real-world problem, with the objective of activating a conflict between students’ prior knowledge and the object of study, generating curiosity and readiness for exploration.

In the second phase, exploration, students conduct active inquiry by manipulating materials, consulting sources, and formulating hypotheses cooperatively, building a common base of concrete experience before accessing formal theory. In the explanation phase, the teacher systematises the explored concepts and introduces technical terms and formal patterns, while students present their provisional interpretations: this is the moment of dialogic negotiation of meaning, in which intersubjectivity is an indispensable condition for learning. In the elaboration phase, the student extends and deepens the acquired understanding by applying it to new contexts and constructing, preferably in a group, an output that concretely applies what has been learned. Finally, during the evaluation phase, teacher and students jointly verify the achievement of objectives through assessment, co-assessment, and self-assessment tools, and the student analyses the change in their own knowledge from the initial trigger to the conclusion of the pathway, activating a metacognitive reflection on their own learning process (Bybee, 2015).

For completeness, it should be noted that in 2022 the BSCS developed the AIL — Anchored Inquiry Learning framework, currently poorly documented, presented as the natural evolution of the 5E model, aimed at integrating the most recent research on the social, cultural, and emotional aspects of learning in order to respond to contemporary educational challenges (BSCS Science Learning, 2022).

According to the scientific literature (Joswick & Hulings, 2024; Polanin et al., 2024; Yanar & Ergene, 2025), the 5E model is indicated when the intention is to design active, progressive, student-centred learning in which knowledge is constructed through experience, reflection, and re-elaboration. Particularly in the scientific disciplines, it proves effective when the didactic objective involves deconstructing stereotypes and misconceptions, activating prior knowledge, and connecting information. In short, it works well in contexts of authentic inquiry, where the student is called upon to formulate hypotheses, collect data, and construct explanations autonomously and cooperatively. The model proves ineffective under conditions of limited time, heavy external cognitive load, and in contexts requiring a standardised assessment that leaves no room for shared exploration, since it presupposes organisational flexibility and tolerance for uncertainty (Joswick & Hulings, 2024).

The systematic review and meta-analysis conducted by Polanin and colleagues in 2024 confirmed the empirical robustness of the model, revealing a significant positive effect on learning outcomes in the scientific disciplines (Polanin et al., 2024). Furthermore, a study by Yanar and Ergene (2025), conducted with twenty-one pre-service mathematics teachers, analysed interactions with

ChatGPT during the design of lesson plans structured according to the 5E model, identifying fourteen purposes of use distributed across the five phases. The results show that ChatGPT was used predominantly for two purposes: the generation of instructional ideas, including engaging examples, real-life applications, and exploratory activities, and the development of learning tools, including concept maps, differentiated materials, and assessment instruments. The most intensive use was concentrated in the explanation phase, where the system's ability to suggest activities using dynamic geometry software and to generate alternative visual and conceptual representations responded to a specific need for support in comprehension. Participants recognised among the main advantages temporal efficiency and the stimulation of design creativity, while noting as a limitation the system's tendency to produce generic or repetitive responses in the absence of sufficiently articulated prompts, confirming that the quality of the algorithmic output depends to a decisive extent on the pedagogical competence of those who formulate the request (Yanar & Ergene, 2025).

The 5E model currently proves to be one of the most promising frameworks for experimenting with the integration of AI in the classroom, for reasons that are not contingent but structural. The first concerns the protection of the cognitive process: the principal risk of AI in teaching is that it provides answers before the student has constructed their own questions, short-circuiting the heuristic moment that is a necessary condition for authentic learning. The sequence of the five phases defines precisely when it is pedagogically legitimate to introduce an explanation and when, instead, productive uncertainty must be preserved. For this reason, using AI within the 5E framework means having a pedagogical container that guides and constrains the use of the tool, transforming a potentially substitutive technology into a selective amplifier of the process.

The second reason concerns the centrality of the teacher's didactic direction. The 5E model does not merely organise content in sequence but assigns the teacher an active and differentiated role in each phase: designing the trigger, defining the times of exploration, deciding when to introduce conceptual systematisation, and structuring metacognitive assessment. Integrating AI into this framework obliges the teacher to ask not only "what" the algorithmic tool does, but "when" it intervenes in the didactic process and with what function. This question is an act of conscious design that prevents drift towards an improvised and uncritical use of AI, restoring to the teacher the epistemic responsibility of the process and preventing technology from substituting their function as critical mediator. Thirdly, as documented by the most recent experiments, AI does not have the same utility in all phases of the model,

proving more valuable in explanation and elaboration and riskier in exploration, where its intervention risks substituting the student's inferential process (Yanar & Ergene, 2025). Ultimately, the 5E model habituates students to distinguish between hypothesis and conclusion, between observation and interpretation, between personal elaboration and passive reception, calling upon the competencies necessary to navigate consciously in a digital educational ecosystem, developing what Quattrociocchi (2025) would define as epistemic literacy. Using the 5E as a framework for AI integration means, therefore, not only teaching with AI, but teaching how to think critically through and despite AI.

At a time when many proposals for AI integration in teaching are still speculative or anecdotal, anchoring experimentation to a framework with decades of empirical research provides a solid and verifiable methodological foundation. It is, in substance, a matter of integrating artificial intelligence into a model whose conditions of effectiveness and structural limits are known. Recognising this empirical robustness and the potential of the model in the algorithmic era does not, however, exhaust the central question of this contribution, which concerns the conditions under which AI can become a mediating device without the algorithmic delegation eroding the constructivist processes that constitute its core. Answering this question requires shifting the gaze from the systematic application of the framework to the people who operate within it, redesigning above all the role of the teacher and the relationship with the student in an iterative and dialogic dynamic mediated by the digital.

3. Artificial Intelligence as a mediation device between creativity and dialogic negotiation

In Ethics of Artificial Intelligence (2022), Floridi reflects on the opaque nature of algorithmic systems, identifying in the inscrutability of the texts produced by artificial intelligence one of the principal ethical challenges of the contemporary era. The processes that generate an algorithmic output are inaccessible to the user, making it impossible to reconstruct the inferential pathway that leads from question to response.

This opacity is an infrastructural condition that has direct consequences also in the educational domain. A student who interacts with a chatbot does not have the tools to evaluate the epistemic grounding of the information received, to trace back to sources, or to identify the implicit assumptions that guided the response. The fluency and coherence of the output thus become a risk, as they feed what Petrucci and Ranieri (2025) define as epistemic overconfidence —

that is, the user's tendency to overestimate their own understanding simply because they have received a plausible response, confusing the rhetorical quality of the output with the solidity of the knowledge acquired.

Inscribing AI within the 5E model means situating it within a constructivist framework that, by its very nature, restores the complexity between communicative plausibility and authentic comprehension. Each phase, in fact, requires the teacher to design the architecture of the formative experience, to decide when to introduce algorithmic mediation and with what specific function, and to safeguard the epistemic quality of the process. It requires the student to produce, present, and negotiate their own understanding before receiving any form of theoretical systematisation and formative feedback.

To understand how artificial intelligence can fulfil this ambitious function, it is necessary to clarify what is meant by mediation device in an epistemological sense. In the tradition of hermeneutics, and particularly in Gadamer's reflection (1960), mediation does not identify a transmission of contents between an emitting and a receiving pole, but rather the space in which understanding is produced through the encounter of different horizons of meaning. On this point Ricoeur (1989) develops the idea that understanding is never a recognition of a prefabricated meaning: every mediation opens a symbolic space of interpretive possibilities that the individual traverses to appropriate meaning.

Considering these considerations, artificial intelligence integrated within the 5E model can configure itself as an effective didactic mediation device not for the quantity of information it conveys, but for the quality of the interpretive spaces it inaugurates.

Educating students in dialogue, comparison, and negotiation requires intentional instructional design that goes well beyond the simple organisation of moments of discussion in the classroom. As Vygotsky (1934) demonstrates, cognitive development is produced primarily in social interaction, since the zone of proximal development is activated precisely in dialogue with a more competent interlocutor, who does not transfer knowledge but creates the conditions for the subject to construct it autonomously through comparison. Developing this perspective in cultural terms, Bruner (1997) observed that the mind does not grow in isolation but is formed through participation in shared cultural practices, where language is the privileged tool through which meanings are constructed, negotiated, and collectively transformed. Learning, in this perspective, means entering an interpretive community and participating in its processes of meaning-making.

In the generative digital environment, the educational relationship redefines itself in a triadic key, where the student, the intelligent system, and the physical-digital context cohabit in a dynamic network of interactions (Lizio et al., 2025). The educational relationship is enriched by a semiotic and operational dimension that profoundly redesigns the roles and responsibilities of each subject involved. The interaction between student and AI becomes mediated co-construction in which the subject maintains the function of regulator of meaning, while the teacher safeguards the pedagogical intentionality of the process. In this triadic configuration, the teacher is called upon to monitor and critically orient the algorithmic determinisms, amplifying the critical thresholds of students and restoring sense to the formative process. The effectiveness of the student-AI-environment triad depends to a decisive extent on the quality of the instructional design and the epistemological coherence of the tools adopted: in the absence of conscious educational direction, technologies risk producing cognitive fragmentation, rendering subjectivity invisible, and impoverishing the educational relationship (Lizio et al., 2025).

Within the 5E model, the teacher can use artificial intelligence as a co-designer, with the objective of designing triggers, generating resources, differentiating content, and providing formative feedback in real time. The student can learn to use AI as a genuine thought partner, testing hypotheses, comparing their discoveries with sources, generating resources, and initiating processes of self-assessment and metacognitive reflection.

In the engagement phase, the teacher can use AI to generate contextualised cognitive triggers, discrepant events calibrated to the class profile, and problematic scenarios capable of connecting to students' prior knowledge. In the exploration phase, the teacher can broaden the space of inquiry by introducing alternative disciplinary perspectives and provocative data that fuel cognitive conflict and peer discussion. In the elaboration phase, AI lowers the technical barriers that often obstruct the realisation of ideas, allowing those with good intuitions but executive difficulties to produce outputs commensurate with their creativity, restoring centrality to the student's ownership of their own work. In the evaluation phase, AI delivers formative feedback in real time in accordance with the teacher's guidelines. In all these cases, AI enriches the design, differentiating materials and multiplying the possibilities for the personalisation of pathways.

The teacher's ability to formulate targeted and pedagogically grounded prompts represents, in this perspective, an advanced form of didactic mediation — an intentional and design act through which autonomy,

empowerment, and the development of critical thinking are promoted (De Mutiis, 2024). The teacher assumes a function that goes well beyond the technical management of tools, orientating algorithmic action within pedagogically grounded frameworks, problematising automatic responses, and providing feedback that broadens and decentres the student's vision. From an epistemic standpoint, the teacher remains the guarantor of the meaningfulness of learning and the custodian of the affective and metacognitive dimensions that naturally elude computational logics (Di Padova & Lotti, 2024).

The convergence of algorithmic mediation and educational direction can produce, under the conditions outlined thus far, a generative learning environment that multiplies the explorative and creative possibilities of students. AI becomes a partner in human-machine co-creativity — a scenario in which technology broadens human creative capacities rather than replacing them, exploring with the student new expressive and design possibilities (Haase & Pokutta, 2024; Ivcevic & Grandinetti, 2024). Dialogic negotiation and expressive creativity are interdependent processes: it is in comparison with others that creativity develops and takes root. Artificial intelligence, correctly integrated within the 5E model, can amplify both dimensions without substituting either of them, configuring itself as a selective amplifier of students' cognitive and expressive potential, whose effectiveness depends entirely on the quality of the instructional design that contains and orients it (Lecce & Di Tore, 2025).

In this perspective, it is necessary to specify that the personalisation of pathways operated by AI is never the result of an authentic understanding of the student's needs, but of an algorithmic elaboration of data and patterns (Minerva & Fornasari, 2025). Intelligent Adaptive Learning systems analyse the digital traces left by students to predict performance and correlate these predictions with different cognitive styles, offering a scalable and granular personalisation of content. However, such personalisation remains instrumental and does not replace the observation of the cognitive processes of the class, the reading of the affective and relational dimensions, and the capacity to provide formative feedback that takes account of the whole person. AI as co-designer, therefore, does not relieve the teacher of the educational task, but frees up time and cognitive resources to dedicate to activities of higher pedagogical value: individual interaction, the construction of meaningful relationships, and the metacognitive support that no adaptive system can replicate (Minerva & Fornasari, 2025).

4. Discussion

The recurring circuit of enthusiasm, hope, and disillusionment that has historically characterised the relationship between technologies and learning (Rushby & Seabrook, 2008) compels us to avoid polarising positions and to problematise the role of AI in the contemporary educational ecosystem, reflecting on advantages, limits, and paradoxes.

As noted earlier, the more effective AI is in personalising, differentiating, and amplifying the didactic process, the more it risks rendering the teacher's direction invisible and normalising algorithmic delegation as an ordinary mode of learning. The structure of the 5E model offers a partial protection against this risk, since it defines when and how algorithmic mediation can intervene without substituting the constructivist process. However, as Floridi (2022) reminds us, AI acts without educational intentionality, and its presence in the didactic process produces effects regardless of the degree to which the teacher is aware of them. The most subtle epistemic risk is not that AI substitutes the teacher, but that its technical effectiveness progressively erodes the space of pedagogical reflection, normalising efficiency as the sole criterion for evaluating the educational experience.

To this first tension is added a second, structural in nature, concerning the condition of epistemia, described by Quattrociocchi et al. (2025) as the regime in which linguistic plausibility substitutes epistemic evaluation. In a didactic context in which AI is integrated in the phases of the 5E model, this risk does not concern only the student who interacts with a chatbot autonomously, but the entire learning environment. If AI provides cognitive triggers, alternative explanations, evaluative feedback, and differentiated resources, the boundary between personal elaboration and passive reception becomes structurally more difficult to safeguard. The 5E model, with its emphasis on cognitive conflict and the intersubjective negotiation of meaning, is a pedagogical response to this drift, but it is not sufficient without specific teacher training capable of recognising the signs of epistemia and intervening to restore the conditions for learning grounded in the student's epistemic judgement.

The third tension, perhaps the most urgent on an operational level, concerns teacher training. No proposal for AI integration in teaching is sustainable without addressing the problem of professional preparation. The teacher as critical mediator does not emerge spontaneously: it requires specific competencies in AI literacy, conscious instructional design, and epistemological reflection that current educational systems still struggle to guarantee systematically. The review of the available literature shows that the training offering for teachers on AI is still predominantly fragmentary, centred on

introductory or merely instrumental aspects, and lacking a coherent theoretical-pedagogical framework (Dicataldo et al., 2025). The distinction between professional updating and critical-pedagogical formation is in this sense indispensable: the task is not to teach teachers how to use algorithmic tools, but to train them to interrogate the epistemologies underlying these tools and to design learning environments in which technology remains in the service of the educational relationship rather than taking its place. The integration of disciplinary competencies, technological mastery, and pedagogical reflexivity constitutes the fulcrum of a new alliance between the human and the artificial that requires structured and lasting formative investments (Gülbay et al., 2024).

This theoretical reflection naturally requires validation through field experimentation, in different disciplinary contexts and with measurement instruments capable of assessing not only learning outcomes, but the quality of meaning-making processes and dialogic mediation. The most promising future research directions concern the development of observational protocols for evaluating the quality of algorithmic mediation in the classroom, the design of teacher training pathways oriented towards critical AI literacy, and the empirical experimentation of the proposed model in real school contexts.

5. Conclusions

The argumentative pathway developed in this contribution has assumed as its central object the question of the conditions under which artificial intelligence can configure itself as a mediation device in the teaching-learning process.

First, the BSCS 5E model, reread considering algorithmic mediation, does not lose its constructivist validity but radicalises it. The sequential structure of the five phases defines precisely the conditions under which algorithmic mediation is pedagogically legitimate, preserving cognitive conflict, the intersubjective negotiation of meaning, and metacognitive reflection as necessary conditions of deep learning. The task is not to add AI to any practice, but to inscribe it within a framework whose conditions of effectiveness and structural limits are known (Polanin et al., 2024).

Second, the teacher as critical mediator is not a residual figure in the algorithmic era, but a necessary condition for AI integration to produce generative learning environments. In a profoundly transformed educational triad, composed of student, intelligent system, and physical-digital context, it is the teacher who must hold together the plurality of dimensions involved, restoring sense to the formative process and safeguarding the affective and metacognitive dimensions that still today elude computational logics (Lizio et

al., 2025). Finally, the centrality of meaning-making processes and intersubjectivity is not a nostalgic inheritance of pre-digital pedagogy, but a structural condition of learning that no algorithmic system, however sophisticated, can replicate. The dialogic negotiation of meaning and expressive creativity, as research on human-machine co-creativity has shown, are irreducibly human processes that AI can amplify but not surrogate (Haase & Pokutta, 2024; Ivcevic & Grandinetti, 2024).

In an information ecosystem saturated with instant and plausible responses, the 5E model configures itself as an act of pedagogical resistance — the deliberate choice to preserve the slow time of questioning, doubt, and shared construction of knowledge as an indispensable space for human formation. A demanding choice in relation to technology, which asks AI to be equal to a teaching oriented towards the formation of a subject capable of producing, defending, and calling into question their own knowledge. As Plato had intuited in the Phaedrus, the difference between those who know and those who possess only the appearance of knowledge is measured by the quality of the pathway that has led to knowledge, and not by the quality of the output that results from it. This intuition, twenty-five centuries later, remains the most reliable compass for orienting the integration of artificial intelligence in a teaching practice that wishes to be, even in the algorithmic era, authentically educational.

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