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Human-Technology Co-Mediation in AI supported Education: A Conceptual Framework for Inclusion, Engagement, and Learner Agency

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Abstract: The integration of artificial intelligence into education raises questions about how to promote inclusion and engagement while preserving students' cognitive effort. This paper proposes a conceptual framework connecting teacher mediation, technological resources and learner participation. Drawing on Vygotsky's sociocultural perspective, Feuerstein's Mediated Learning Experience, inclusive design and research on AI in education, it develops human–technology co-mediation as the intentional coordination of teacher guidance, AI-supported resources and learner activity. Pedagogical responsibility and the interpretation of educational processes remain with human participants. Intentionality, reciprocity and transcendence provide criteria for guiding content adaptation, feedback and support regulation. Ontogenetic co-mediation articulates the framework's developmental dimension, examining how assistance can respond to individual developmental trajectories and evolving support needs across the life span. The framework distinguishes technological interaction from meaningful engagement, engagement from learning, and assisted performance from learning demonstrated independently. It situates AI's educational value within the pedagogical conditions governing its use. The proposal requires further operationalisation and empirical testing to examine its implications for accessibility, self-regulation and learning transfer.

Keywords: Artificial intelligence; Human–technology co-mediation; Inclusive instructional design; Student engagement; Self-regulated learning.

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1. Introduction

The rapid expansion of artificial intelligence (AI) in education is changing the way knowledge is accessed and learning activities are designed, as well as the way feedback is provided and student progress is interpreted. Generative AI, intelligent

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tutoring systems, learning analytics and adaptive technologies offer different forms of assistance to teachers and learners . However, the mere availability of these functions does not ensure that students will develop a deeper understanding or participate more meaningfully. Recent evidence suggests that AI can improve performance in immediate tasks without necessarily facilitating long-term learning, especially when it replaces rather than supports cognitive effort (OECD, 2026).

The pedagogical relevance of AI therefore depends on the educational purposes that guide its use, the quality of the interactions it enables, and the extent to which it contributes to learners' understanding, reflection, autonomy, and responsibility. AI can support learning when integrated according to clear pedagogical principles (OECD, 2026).

This issue is particularly apparent in relation to student engagement. In educational technology research, engagement is often presented as an expected benefit of digital innovation. Increased access to a platform, frequent interaction with educational resources, rapid task completion or continuous responses to automated prompts are often interpreted as indicators of successful participation. However, these observable behaviours cannot be considered equivalent to meaningful cognitive, metacognitive, motivational and relational involvement. For example, a student may interact extensively with a digital system while remaining dependent on its suggestions, engaging only superficially with the content or failing to understand the strategies required to solve a problem independently. Therefore, engagement must be distinguished from activity: the former concerns the quality and meaning of participation, whereas the latter simply indicates that an interaction has occurred.

Against this background, this paper adopts the concept of engaging education as a lens through which to reconsider the relationship between learners, teachers, and digital technologies. The expression is used here to describe intentionally designed educational experiences that support meaningful participation, understanding, and learner agency. It does not identify engagement as an intrinsic property of a device, platform, or AI system, rather it recognises engagement as an emergent quality of educational experiences. From this perspective, meaningful engagement develops when learners are enabled to formulate hypotheses, explore alternatives, make decisions, encounter productive difficulty, interpret feedback, reflect on their strategies and progressively take responsibility for regulating their own learning. While technology can expand the opportunities for these processes, it cannot produce them independently of the pedagogical, social and relational conditions in which it is embedded.

This interpretation necessitates shifting from a tool-centred to a mediation-centred perspective. Digital artefacts influence how information is represented, how learners participate, which actions become possible, and how knowledge is constructed and evaluated, rather than simply being channels through which educational content is transmitted. Consequently, their educational effects are neither neutral nor predetermined. These effects depend on the relationships established among learners, teachers, tasks, signs, cultural practices and technological environments. Therefore, the central question is not whether AI is educationally beneficial or harmful in itself, but rather, under what conditions it can contribute to experiences that are cognitively meaningful, relationally responsive and oriented towards learner agency.

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To bring these dimensions together, this paper proposes human–technology co-mediation as a conceptual framework for engaging education, grounded in Mediated Learning Experience (MLE). The following sections articulate the framework, examine its implications for inclusion and engagement, and consider how support can respond to learners' developmental trajectories. Although the broader discussion concerns AI in education, the applications examined focus primarily on generative AI. The proposal provides a basis for further operationalisation and empirical investigation.

2. From mediated learning to human–technology co-mediation

The theoretical basis for this argument lies in the sociocultural theory of learning developed by Vygotsky. According to this perspective, higher psychological functions do not emerge exclusively from the learner's direct interaction with an external environment. Instead, they develop through participation in socially organised activities and the internalisation of cultural signs and tools, including language and systems of representation (Vygotsky, 1978). These tools facilitate more than just an existing mental activity; they contribute to its qualitative reorganisation, enabling new forms of attention, memory, planning, problem solving and voluntary regulation. Learning is therefore inseparable from the social, cultural and semiotic processes through which experience is interpreted and transformed.

Within this framework, digital technologies can be considered contemporary cultural and semiotic artefacts that can influence the organisation of individual and collective activities. However, their capacity to modify participation does not automatically make them pedagogical mediators. A digital system can organise information, provide a response, identify an error or suggest an action, but these functions do not in themselves ensure that learners understand the significance of the experience or transfer what they have learnt to a different situation. Technological interaction becomes educationally meaningful when situated within an ecology of dialogue, interpretation, reflection and shared sense-making.

Feuerstein's theory of Mediated Learning Experience (MLE) offers a complementary perspective for examining the relational and intentional qualities through which experience acquires educational value. Mediated learning cannot be reduced to the mere transmission of information from a knowledgeable source to a learner. It involves the purposeful selection, organisation, interpretation and transformation of experience, enabling learners to develop new cognitive strategies, become aware of their own learning processes and apply their knowledge in different situations. Through mediation, learners are supported in not only completing a task, but also understanding how and why particular strategies are effective, and when they can be transferred to other contexts (Feuerstein & Lewin-Benham, 2012).

Intentionality and reciprocity, together with transcendence, are among the criteria associated with Mediated Learning Experience that are especially relevant to the analysis of AI-supported education. Intentionality refers to the purposeful organisation of the educational experience in relation to explicit and meaningful learning objectives. Reciprocity concerns learners' active and responsive participation in the mediational relationship rather than their passive reception of information or instructions. Transcendence extends the educational value of an activity beyond solving the immediate task by connecting a specific experience to

broader concepts, strategies, dispositions and future situations (Feuerstein & Lewin-Benham, 2012).

These criteria enable technological practices to be evaluated without directly attributing human qualities or pedagogical intentionality to AI. From an intentionality perspective, the key question is whether the use of AI is driven by a clearly defined educational purpose or merely by the availability of the technology.

From a reciprocity perspective, attention must be given to whether students can question AI-generated outputs, express alternative interpretations, explain their choices and participate in determining how the technology is used. From a transcendence perspective, it is necessary to examine whether interaction with AI promotes transferable understanding or remains confined to the rapid completion of a specific task. In this sense, these criteria operate simultaneously as principles for designing educational activities and as questions for examining the quality of technology-enhanced learning.

The relationship between AI and mediation has recently become an important area of pedagogical inquiry. Niari (2026) emphasises AI's possible contribution to orchestrating interaction, epistemic sense-making and regulatory processes in collaborative learning, highlighting questions about the distribution of agency, responsibility and authority. Similarly, research on initial teacher education reports participants' perceptions of AI as a resource for collaborative work and critical reflection, while emphasising the importance of human dialogue for contextualisation, ethical judgement and the interpretation of complex educational situations (Ortí-Martínez et al., 2026).

Building on these perspectives, the present paper proposes the concept of human–technology co-mediation. This does not imply an equivalence between human and artificial agents, nor does it suggest that technological systems possess the same intentionality, responsibility or contextual sensitivity as teachers. Instead, co-mediation refers to an educational configuration in which technological affordances are integrated into a system intentionally designed around human relationships, cultural tools, learning activities and reflective practices. The proposed framework connects three contributions within particular tasks and educational contexts: teachers establish educational purposes and regulate support; AI systems expand the resources available for representation, exploration, feedback and interaction; learners interpret, question and rework these resources. Content, curricular objectives and contextual conditions shape how these contributions are coordinated. The MLE criteria orient their relationships: intentionality guides the selection and organisation of assistance, reciprocity foregrounds learners' contribution to the experience, and transcendence directs attention to understanding and strategies that extend beyond the immediate activity. This articulation constitutes the conceptual proposal advanced in this paper and requires further operationalisation and empirical examination.

Human–technology co-mediation therefore extends the teacher's mediational function to the technological environment itself. Teachers evaluate technological and regulate assistance in relation to educational purposes and learners' responses. This human-centred approach preserves teachers' professional autonomy and judgement (OECD, 2026). Learner agency is equally constitutive: students need opportunities to question and justify how they incorporate technological support into their work.

The following sections develop three interconnected dimensions of this framework. The inclusive dimension examines whether adaptations reduce barriers while preserving access to meaningful content and shared participation. The engagement dimension concerns the quality of learners' involvement in interpreting and using AI-supported resources. The developmental dimension considers how guidance and assistance should respond to learners' prior knowledge, evolving capacities and opportunities for self-regulation. Together, these dimensions clarify how the proposed coordination can be examined in educational design, without assuming that technological assistance automatically produces inclusive or engaging experiences.

3. The inclusive potential of the teacher's mediation in adapting personalised content

Within the human–technology co-mediation framework outlined above, inclusion concerns the conditions that enable each learner to access knowledge and participate meaningfully in educational activities. The teacher's pedagogical mediation is a fundamental aspect of inclusive educational and pedagogical planning, as it enables subject content to be transformed into learning opportunities that are accessible, meaningful and consistent with the diversity of students' functional profiles.

This perspective moves beyond a conception of inclusion centred exclusively on the individual characteristics of the student, and focuses on barriers and facilitators within the educational context, in line with the bio-psycho-social model of the *International Classification of Functioning, Disability and Health* (World Health Organisation, 2001). In this regard, the teacher assumes the role of mediator between curricular objectives, learners' characteristics and the opportunities offered by the context, promoting a dynamic balance between accessibility, personalisation and participation. Educational mediation is manifested, first and foremost, in the ability to select, reorganise and present content through different languages, communicative codes and modes of representation, without compromising its meaning. Simplified texts, concept maps, graphic organisers, images, structured and unstructured materials, digital resources and multimodal aids can facilitate understanding when incorporated into a deliberate design. Their inclusive relevance depends on how they enable students to engage with disciplinary content and contribute to shared activities.

The reference to *Universal Design for Learning* (UDL) reinforces this approach: the CAST (2024) guidelines propose providing multiple means of engagement, representation, action and expression, in order to anticipate learner diversity and reduce barriers to learning. Content adaptation thus acquires an inclusive significance both when it responds to an identified need and when it stems from proactive planning capable of offering flexible alternatives to the learning community. Within co-mediation, this orientation informs the purposes for which technological resources are selected and the criteria used to assess their relevance. Accessibility must be considered alongside opportunities for meaningful challenge, expression and participation.

In this process, teaching professionalism is demonstrated through the ability to interpret educational needs without reducing a student's identity to a diagnosis or a manifest difficulty, whilst valuing their resources, interests, prior skills and potential

for development. Ianes and Cramerotti (2013), in addressing the personalisation and individualisation of learning, highlight the importance of devising educational responses consistent with the heterogeneity of the class and with different learning conditions. For the purposes of this discussion, individualisation can be understood as the differentiation of strategies, timings and tools aimed at achieving common objectives, whilst personalisation places greater emphasis on the characteristics, interests and developmental trajectories of the individual student (Ianes & Cramerotti, 2013). These two dimensions can be integrated into a flexible planning approach in which the teacher adjusts the level of support, the complexity of tasks, the sequence of activities and the ways in which learning is demonstrated, while progressively monitoring the effectiveness of these choices (Dell'Anna & Marsili, 2025; Tomlinson, 2001). As Tomlinson (2001) highlights, differentiated teaching requires consideration of students' readiness, interests and learning profiles, tailoring educational provision to individual variation. Observation, formative assessment and the review of interventions are therefore essential to ensure that adaptations expand learning opportunities. Personalisation should diversify access to knowledge while preserving opportunities for shared learning within the class group.

A further defining feature concerns the relational and collaborative dimension of teaching mediation. The teacher fosters participation through the negotiation of meanings, guiding questions, the recognition of errors as learning opportunities, and the facilitation of peer tutoring and cooperative learning. These practices support students in progressively developing autonomy and assuming responsibility. They also give concrete expression to reciprocity within the proposed framework: students' questions, interpretations and responses help shape the educational experience and inform the revision of support. The relevance of an adaptation is consequently examined through how learners use it and contribute to the activity.

The UDL approach, particularly in version 3.0, emphasises the need to promote learners' agency, recognising the value of participation, self-determination and opportunities to express knowledge through different means (CAST, 2024). The inclusive scope of adaptation must therefore be considered through several dimensions: actual accessibility of the task, quality of participation, opportunities to demonstrate understanding and the progressive development of autonomy. In relation to transcendence, attention also extends to whether students can use the concepts and strategies developed through adapted activities in subsequent tasks and contexts. These questions connect the immediate usefulness of support with its contribution to further learning.

The teacher's mediation thus combines equity and differentiation by removing barriers while preserving conceptual integrity and opportunities for collective knowledge construction.

4. Mediation, Engagement and Artificial Intelligence

Within the framework outlined above, AI can support inclusive participation by expanding the resources available for adapting content, guiding learning activities and providing feedback. Content generation, dialogic support and alternative explanations create opportunities to respond to diverse educational needs (Lo, 2023). Their integration requires an ethical and pedagogical framework that preserves teachers' professional judgement, students' autonomy and a critical understanding of content (Ranieri, 2024; Miao & Holmes, 2023).

AI can extend teachers' capacity to transform subject knowledge into accessible and meaningful resources. The ability to generate reformulations, examples, guiding questions and differentiated materials enables teachers to explore multiple ways of presenting the same content (Lo, 2023). Teacher mediation connects the generated resources to students' prior knowledge, difficulties and potential, checking that transformations preserve disciplinary meaning. The TPACK framework situates this competence at the intersection of technological, pedagogical and content knowledge: the quality of technology integration depends on understanding their relationships within the specific teaching context (Mishra & Koehler, 2006).

This process can be understood through Carroll's (2004) concept of technology appropriation: users adapt tools to their practices, contributing to the completion of the design process through use. In the case of AI, teachers interpret and reshape the system's possibilities in relation to learning objectives, subject content and students. Appropriation thus takes on a critical dimension when it includes evaluating the proposed transformations and the opportunities for participation they enable. Within co-mediation, this process gives practical expression to intentionality by connecting technological possibilities to explicit educational purposes.

AI also contributes to the conditions under which this mediation can be exercised. Support for resource preparation can reduce some of the work required to develop instructional alternatives. A randomised trial involving 259 science teachers in England found a 31% reduction in the time spent preparing lessons and resources among teachers who used ChatGPT alongside implementation guidance (Education Endowment Foundation, 2024). This finding suggests the possibility of freeing time for observation, dialogue and the revision of teaching interventions. However, translating operational time savings into stronger educational relationships depends on teachers' decisions and organisational conditions: it is an opportunity to pursue rather than an automatic consequence of technology adoption.

Alongside material production, dialogic interaction provides a resource for supporting students' activity. The opportunity to ask questions, request clarification and receive further explanations can extend the support available for understanding (Lo, 2023). Teachers can design interactions in which the system provides hints, recalls relevant knowledge or invites students to make their reasoning explicit. Such assistance can contribute to scaffolding when it makes aspects of a task initially beyond the learner's capabilities manageable and is adjusted as learning progresses (Wood et al., 1976). Its educational relevance depends on how it sustains learners' participation without routinely anticipating every choice and every step.

The potential of these supports is reflected in Pardos and Bhandari's (2024) study involving 274 participants working on specific mathematical skills. ChatGPT-generated help, checked before use, produced learning gains compared with the no-help condition, with no statistically significant differences from help prepared by human tutors. This evidence supports the possibility of using AI to expand the resources available for instructional support. At the same time, it limits the interpretation of the finding: the usefulness of a resource in a specific task does not amount to an ability to interpret the entire educational situation.

Feedback provides a further opportunity to connect assistance with learners' active responses. Hattie and Timperley (2007) distinguish feedback concerning the task, learning processes and self-regulation, showing that its value depends on its focus and use. AI can contribute to preparing comments and questions that

highlight aspects requiring further exploration and strategies needing revision. Teachers assess their relevance and support their interpretation so that students can use the guidance to inform subsequent activity. Reciprocity becomes visible when students explain how they interpret the feedback, question its relevance and justify their revisions. Transcendence directs attention to whether they can subsequently use the strategies developed through this exchange in other tasks.

The relationship between AI and engagement develops within this organisation of the learning experience. Fredricks, Blumenfeld and Paris (2004) distinguish behavioural, emotional and cognitive dimensions of engagement, highlighting their responsiveness to contextual conditions. Adaptation can facilitate initial participation in a task, make content more relevant to students' interests and support investment in understanding. These possibilities require examination through the quality of learners' activity: whether they sustain participation, find meaning in the task, compare explanations, identify inconsistencies and justify their choices. Interaction frequency and speed of completion provide only partial information about these processes.

The level and form of assistance must also respond to learners' prior knowledge and capacity to regulate their activity. The following section develops this developmental dimension, considering how support can be calibrated to sustain active involvement and progressively independent reasoning.

5. Developmental Trajectories in Human–Technology Co-mediation

A developmental account of human–technology co-mediation should examine how learning, self-regulation, and support needs change across ontogeny and across the life span. Development is multidirectional: gains, maintenance, and losses may occur concurrently, and their expression depends on interactions among individual characteristics, experience, and environmental demands (Baltes, 1987). Drawing on this perspective, the developmental dimension of the human–technology co-mediation framework examines how educator guidance, AI-supported resources and learner activity can be coordinated in relation to individual developmental trajectories and educational goals (Vygotsky, 1978; Wood et al., 1976; Niari, 2026). The term ontogenetic co-mediation is used here to identify this developmental dimension rather than a separate framework. It extends the preceding discussion of inclusion and engagement by considering how learners' changing capacities and support needs inform the organisation of educational activities. This perspective does not imply a uniform sequence of age-based stages. Rather, it directs attention to the ways in which prior knowledge, goals, learning opportunities, and current developmental conditions shape participation in educational activities.

The distinction between biological neural plasticity and the adaptive behaviour of AI systems is central. Human neural plasticity refers to changes in the nervous system associated with experience and learning. By contrast, a language model's ability to respond differently to a prompt or to the preceding conversation should not be described as "synaptic plasticity": in ordinary use, the model can adapt its output to the current context without necessarily changing its underlying parameters. These processes operate at different explanatory levels and should not be treated as equivalent. The relevant question is how educators can use the system's contextual responsiveness to support learners' development and learning goals.

Prompt design can be understood as one part of educational mediation. A carefully constructed prompt can define a learning objective, identify relevant prior knowledge, specify the type and amount of support, and request a progression from explanation to guided practice and independent application. These instructions guide the system's output; the resulting assistance can function as scaffolding insofar as it supports learners' participation without doing the essential thinking for them (Wood et al., 1976). Prompts can also draw on familiar classroom routines or "scripts"—for example, recalling what the learner already knows, presenting an example, inviting an attempt, and asking the learner to explain or check the answer (Nelson, 1986). These routines provide a design rationale; they should not be presented as a universally optimal sequence for every learner.

A pilot study of a ChatGPT-based science-learning tool with secondary students illustrates how AI may be structured to support planning, monitoring, and reflection; its findings are specific to that study context and do not establish effectiveness across age groups (Ng et al., 2024). Learners' responses to such support can inform ongoing adjustments to its form and intensity.

Research on experience-dependent development provides a background for these design considerations. A systematic review of training studies in young people identified associations between some training experiences and changes in brain structure or function, while also reporting variation across studies. Methodological work further stresses the difficulty of separating learning-related change from maturation and other influences (Tymofiyeva & Gaschler, 2021; van Duijvenvoorde et al., 2022). Research on adult cognitive plasticity similarly considers interactions between individual capacities and environmental demands (Lövdén et al., 2010). These findings concern learning and development generally and do not establish specific neurocognitive effects of generative AI.

The concept of cognitive offloading offers a more precise way to discuss the possible consequences of delegating parts of a task to technology. Digital externalisation can change which operations learners perform themselves and which they rely on tools to complete; the consequences for learning depend on the task and on what learners continue to retrieve, practise, and understand (Skulmowski, 2023). This literature is not specific to generative AI but supports examining whether an AI-supported activity leaves learners opportunities to recall information, make decisions, detect errors, and explain their reasoning.

In a high-school mathematics field experiment, general-purpose AI assistance improved performance while available but was associated with lower performance on a later unaided test; teacher-informed hints reduced this disadvantage (Bastani et al., 2025). Considered alongside the study by Pardos and Bhandari(2024), discussed in Section 4, this finding highlights the importance of distinguishing performance with AI support from learning demonstrated independently.

A developmental approach also requires care when discussing childhood, adulthood, and later life. During childhood and adolescence, educators may need to make task goals and support sequences explicit while preserving opportunities for active problem-solving. For adult learners, design may allow greater choice and self-regulation when aligned with their prior knowledge, purposes, and circumstances. In later adulthood, accessibility, familiarity with technology, and opportunities to draw on existing knowledge may be relevant design considerations. These are developmentally informed questions for educational design, not established age-

specific effects of AI. The life-span perspective therefore guides the questions for educators and researchers, while empirical studies must determine the answers. Across these contexts, the educator's role is to regulate the conditions of interaction: selecting suitable tasks, calibrating assistance, checking outputs, and deciding when support should be reduced. Learners should be asked to question, compare, contextualise, and revise AI-generated responses rather than accept them as authoritative. Such activities can support metacognitive monitoring and epistemic vigilance by making learners responsible for evaluating the source and relevance of information. They can also preserve "desirable difficulty"—the effort required to retrieve, apply, and reorganise knowledge—provided that challenge is matched to the learner and accompanied by appropriate support. Ontogenetic co-mediation thus articulates the developmental dimension of human–technology co-mediation: AI may expand the resources available for learning, while educators regulate assistance in relation to learners' trajectories and educational purposes. This dimension complements the preceding analyses of inclusion and engagement by examining how support can remain responsive to changing needs while strengthening learners' capacity to monitor and direct their own learning.

6. Conclusions

This paper proposes human–technology co-mediation as a conceptual framework for examining the conditions under which artificial intelligence can contribute to inclusive and engaging educational experiences. Its contribution lies in connecting the MLE principles of intentionality, reciprocity and transcendence with the coordination of teacher guidance, technological resources and learner activity. This perspective shifts the focus from technological functionality to the quality of participation, and to the processes through which learners construct meaning, exercise judgement and progressively regulate their own learning.

A central implication concerns the distinction between technological activity and educational engagement. Frequent interaction with an AI system, rapid task completion and the production of accurate responses do not, in themselves, indicate meaningful learning. Instead, the proposed framework directs attention towards learners' opportunities to formulate hypotheses, justify decisions, interpret feedback, reconsider strategies, and apply their learning to new situations. Accordingly, AI-supported instructional design should be examined in terms of both the outputs it produces and the cognitive, metacognitive and relational processes it enables or constrains.

Within this configuration, teachers' pedagogical mediation remains constitutive rather than ancillary. Integrating AI extends the scope of professional responsibility to include selecting technological resources, evaluating generated content and calibrating assistance in relation to curricular aims and learner diversity. From an inclusive perspective, adaptation acquires educational value when it reduces barriers to participation while preserving conceptual integrity, providing appropriate challenges and creating opportunities for shared knowledge construction. Therefore, personalisation should not be equated with the fragmentation of learning into isolated pathways, nor should accessibility be pursued through an indiscriminate reduction in task complexity. The relevant design challenge is to differentiate the conditions of participation without unnecessarily limiting learners' educational opportunities.

The principles of intentionality, reciprocity, and transcendence provide a coherent basis for articulating this mediational responsibility. Intentionality situates the use of technology within explicit educational objectives, reciprocity emphasises learners' active contribution to interpreting and directing the experience, and transcendence connects local activities with broader strategies, concepts, and contexts of application. Together, they offer criteria for distinguishing between pedagogically meaningful assistance and technological substitution. Under these conditions, AI can increase the range of resources available for exploration, representation and feedback, while educational judgement and responsibility remain within the realm of human relationships.

The developmental dimension of the framework further emphasises the importance of calibrating support according to learners' evolving capacities, prior experiences, and opportunities for self-regulation. However, the relationship between computational adaptability and human neuroplasticity requires conceptual caution. These processes operate at distinct explanatory levels and should not be considered equivalent. Similarly, claims concerning the neurological consequences of AI-supported learning cannot be directly inferred from observed changes in engagement or task performance. Therefore, the pedagogical proposition advanced here is that co-mediation should preserve opportunities for cognitive effort, critical appraisal and independent reasoning. Whether particular instructional configurations produce specific neurocognitive effects remains an empirical question.

As a theoretical contribution, the framework requires further operationalisation and empirical examination. Future research should identify observable indicators of mediational quality and investigate how configurations involving teacher guidance, technological assistance and learner agency influence accessibility, participation, metacognitive regulation and transfer. An important methodological distinction concerns performance achieved in the presence of AI support versus learning subsequently demonstrated without it. Longitudinal and comparative research could clarify whether co-mediated experiences foster durable understanding and autonomy, and under which contextual and developmental conditions this occurs. Such research should also consider the possibility that adaptations intended to facilitate access may inadvertently generate dependence or restrict opportunities for productive challenge.

Ultimately, human–technology co-mediation situates the educational value of AI within an intentional, inclusive, and revisable pedagogical design. The value of AI lies not in maximising automation, but in organising technological assistance so that access to knowledge is expanded without displacing the interpretative and regulatory work through which learning develops. On this basis, the integration of AI can be understood as a pedagogical undertaking whose legitimacy depends on its contribution to meaningful participation, sustained understanding, and the progressive development of learner agency.

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