Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno 6 n. 4 (2026)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

AI tutoring and mentoring between proto- and deutero-learning: habits, internal feedback, and assessment anxiety

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Abstract: AI tutoring is used to explain concepts, generate exercises, provide feedback, and offer low-threshold support. This contribution examines whether such support can also participate in the formation of the learner. The article proposes a theoretical-conceptual analysis of AI tutoring and mentoring through the Batesonian distinction between proto-learning and deutero-learning. Proto-learning is understood as first-order learning, concerning content, procedures, strategies, and task performance; deutero-learning, by contrast, concerns the way students learn how to learn, interpret outcomes, attribute causes, use feedback, regulate the affective dimension, and build agency. The central argument is that AI tutoring primarily supports proto-learning and may foster some self-regulatory habits when it is pedagogically designed through explicit criteria, reasoning prompts, revision, comparison with human feedback, and opportunities for transfer. This transition is not automatic: the same system may support reflection or intensify delegation and dependency. Mentoring therefore remains crucial for deutero-learning, since, within the educational relationship, it makes cognitive, affective, motivational, relational, and ethical-social postures open to discussion. The article concludes that educational AI should be evaluated not only in terms of efficiency, personalization, and immediacy, but also in relation to the habits, forms of participation, and relationships with feedback and assessment that it helps to cultivate.

Keywords: AI tutoring; mentoring; deutero-learning; internal feedback; assessment anxiety

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1. Introduction

An AI tutor can explain, correct, suggest, and respond continuously, offering students a space perceived as more private in which to practise and ask questions. However, the pedagogical issue does not concern only task support, but also what students come to understand about the task, feedback, and themselves as learning subjects. The distance between operational assistance and the formation of the learner thus becomes a central issue in the relationship between educational technologies and formative mediation.

This tension is connected to the agenda of *Engaging Education*, since engagement cannot be reduced merely to frequency of use or time on task, but also includes the meaning attributed to study, a sense of competence, agency, and participation in shared practices (Fredricks et al., 2004; Kahu, 2013). AI tutoring may foster accessibility and personalization, but, if it is not pedagogically designed, it may also

support cognitive delegation, avoidance of confrontation, or the search for reassurance.

The article analyses the relationship between AI tutoring and mentoring through the Batesonian distinction between proto-learning and deutero-learning (Bateson, 1972, 1979; Visser, 2003). Proto-learning concerns content, procedures, and strategies functional to performance; deutero-learning, by contrast, concerns the way students learn how to learn, interpret outcomes, use feedback, seek help, regulate the affective dimension, and build autonomy.

The aim is to connect this distinction with studies on *self-regulated learning*, *feedback literacy*, strategic competences, and educational well-being, examining whether and under what conditions AI tutoring can contribute not only to first-order learning, but also to the formation of some self-regulatory habits. The article therefore proposes a non-binary proto-deutero framework, in which AI tutoring and mentoring are understood as potentially integrable forms of mediation.

The guiding question is: what kind of learning does AI tutoring support, and under what conditions can it contribute to habit formation? The hypothesis is that it mainly supports task-oriented learning, but may contribute to some self-regulatory habits when embedded in intentional pedagogical design. Mentoring, instead, retains a specific function in deutero-learning, by offering a relational space in which reflective, affective, motivational, relational, and ethical-social postures can be discussed.

2. Levels of Learning in Bateson

Bateson's theory distinguishes between changes that occur within a given set of expectations and changes that concern the way those expectations are formed. Proto-learning, corresponding to *Learning I*, refers to the acquisition of a procedure, a rule, or a strategy in relation to a recognizable situation. Deutero-learning, corresponding to *Learning II*, instead concerns the learning of the contexts of learning and the formation of habits of attention, categorization, classification, attribution, and interpretation of the relationship between action and consequence (Bateson, 1972). In *Mind and Nature*, Bateson (1979) also recalls the relational dimension of learning, understood as the organization of differences and patterns of meaning.

This distinction helps to interpret educational technologies. AI tutors seem particularly suited to supporting first-order adaptations: varying examples, providing suggestions, generating alternative explanations, and responding in real time. Such *affordances* may guide the student's action within the task, but they do not necessarily modify the way the student interprets feedback, seeks help, or attributes the causes of their own performance. It is therefore possible to become more effective in producing correct answers without having developed a more autonomous disposition toward understanding and regulating one's own learning.

Deutero-learning does not simply indicate "deeper" learning, but a different logical level of experience. In proto-learning, the student acquires a response, a procedure, or a strategy useful for addressing a specific task. In deutero-learning, by contrast, the student learns to recognize the conditions under which that procedure is appropriate, to transfer it to different contexts, to interpret unexpected outcomes, and to modify not only the action plan, but also the way in which action plans are constructed. The difference, therefore, does not concern only the quantity or

complexity of what is learned, but the object of learning itself: in the first case, one learns *what to do* in a situation; in the second, one learns *how to orient oneself* among situations, criteria, errors, and possibilities for revision. The two levels remain interdependent: deutero-learning requires concrete tasks to interpret, while proto-learning may be strengthened when students progressively regulate their activity beyond the single task.

2.1 Habits as Strategic, Affective, and Relational Dispositions

The reference to habits makes it possible to connect the different levels of learning. In pedagogical terms, a habit does not coincide with an automatic routine, but may be understood as a relatively stable disposition to perceive a situation, choose a course of action, and interpret its consequences. Dewey highlights the situated nature of habits as patterns that connect attention, emotion, action, and environment (Dewey, 1922, 1938), and that are formed through recurrent participation in meaningful situations.

Pellerey (2013) interprets strategic competences as "habits" that support the capacity to direct oneself in study and work. They include goal setting, planning, monitoring, self-assessment, persistence, and the reorientation of action, together with motivational and ethical dimensions. In a convergent way, models of *self-regulated learning* describe regulation as a cyclical process involving forethought, performance, monitoring, and self-reflection (Panadero, 2017; Zimmerman, 2002).

This perspective avoids a reductive reading of AI-supported self-regulation. An AI system may help students define a sub-goal or check an answer; the question is whether such actions become part of a more stable disposition to plan, monitor, interpret, and revise. Habits also have a relational dimension: seeking help may express curiosity, avoidance, dependency, solidarity, or responsibility toward a shared task. Deutero-learning therefore also includes the way students inhabit educational relationships.

3. The *Affordances* of AI Tutoring

AI tutoring is understood here as systems capable of interacting with students to explain, ask questions, provide feedback, recommend resources, or adapt practice activities. The category may include both intelligent tutoring systems and generative tools, despite relevant differences in terms of reliability, transparency, and pedagogical configuration. Their common feature is the possibility of offering responsive mediation at the moment of need.

At the level of proto-learning, AI tutoring may support personalized explanations, additional practice, indications on errors, adaptive repetition, and forms of guided self-assessment. Reviews on AI-enhanced self-regulated learning indicate that such *affordances* may foster goal setting, monitoring, and reflection, especially when they are integrated into designed learning activities and not used as shortcuts for producing answers (Lan & Zhou, 2025). Consistently, Chiu (2024) stresses the need to distinguish uses of GenAI according to the forms of regulation and agency they elicit. From this perspective, AI tutoring offers resources for self-regulation, but it does not produce it automatically: it may replace a cognitive operation or make it more visible and practicable. The difference depends on how the system is embedded in the task and on the pedagogical purposes that guide its use (Collins et al., 1991; Holmes et al., 2019; Kasneci et al., 2023).

3.1 Conditions for the Formation of Habits

For AI tutoring to contribute to the formation of self-regulatory habits, some pedagogical conditions appear relevant. First, students should be prompted to make their reasons explicit, not only their results. Explanatory prompts and requests for justification help make the criteria used more visible. Moreover, feedback should be referred to clear standards: without shared criteria, the AI response may appear plausible but weakly grounded; with explicit criteria, students can compare, discuss, and reformulate feedback (Hattie & Timperley, 2007; Nicol & Macfarlane-Dick, 2006).

Revision, transfer, and comparison with human feedback are also relevant. Feedback acquires educational value when it is used to improve a subsequent performance, not only when it is received (Boud & Molloy, 2013; Carless & Boud, 2018). Similarly, correcting an answer with the help of the tutor does not in itself imply the acquisition of a general strategy: tasks are needed that require both repetition and application in new contexts. Dialogue with teachers, peers, or mentors reduces the risk that AI becomes the student's only epistemic reference.

These conditions are consistent with the idea of AI as a possible co-regulator, rather than as an autonomous producer of learning (Lan & Zhou, 2025; Xia et al., 2026). They also help contain the risk of over-reliance on dialogic systems, which may foster cognitive shortcuts and reduce opportunities for autonomous reasoning (Zhai et al., 2024). In terms of *self-determination theory*, supporting autonomy does not mean eliminating structure, but offering meaningful choices and conditions in which students can recognize themselves as authors of their own activity (Ryan & Deci, 2020).

3.2 From External Feedback to Internal Feedback

The notion of internal feedback makes it possible to clarify the transition from first-order assistance to the possible formation of more stable habits. External feedback is the information provided by a person or a system about the relationship between performance and criteria; internal feedback, by contrast, concerns the student's evaluative activity while carrying out or revising a task: recognizing a discrepancy, hypothesizing its cause, and deciding how to proceed.

An AI tutor can support this process when it invites students to anticipate an outcome, classify an error, formulate a criterion, or estimate the degree of confidence in their own response. Such practices may make calibration and metacognitive monitoring more visible. However, the internalization of feedback is not an automatic transfer from the screen to the mind: it depends on prior knowledge, motivation, trust in the criteria, and the possibility of discussing ambiguous cases (Carless & Boud, 2018; Nicol & Macfarlane-Dick, 2006).

4. Mentoring as a Developmental Relationship

Mentoring is often described as a developmental relationship in which a more experienced person supports another person's growth through guidance, modelling, *advocacy*, and psychosocial support (Kram, 1985). In educational contexts, it has been linked to academic integration, persistence, identity development, and access to

institutional resources (Crisp & Cruz, 2009; Jacobi, 1991). These functions are not limited to the transmission of strategies, but may help students interpret their experiences within a broader formative trajectory.

From this perspective, mentoring can be understood as a form of second-order educational mediation. The mentor does not intervene only in task completion, but may prompt reflection on how students learn, seek help, interpret their own abilities, and assume responsibility for their choices. This kind of dialogue may bring to light postures that are not always detectable from correct or incorrect answers: avoidance, the search for reassurance, fear of judgement, attribution to fixed abilities, or the progressive assumption of *ownership*.

The relational dimension appears relevant because learning also involves participation in practices grounded in explanation, reciprocity, trust, and responsibility. The mentor may offer models for discussing feedback, recognizing uncertainty, reworking an error, and using support without relinquishing personal judgement. In this sense, mentoring may also contribute to the ethical-social dimension of deutero-learning.

4.1 Mentoring and Self-Regulated Learning

The relationship between mentoring and self-regulated learning has been progressively discussed in the literature. Tise et al. (2023) suggest that *self-regulated learning* strategies may constitute a relevant link between mentor support and educational success, especially for students with unequal access to academic norms and resources. Mentoring may therefore help students acquire a language for defining goals, monitoring their pathway, seeking help, and reflecting on their own strategies.

From this point of view, mentoring differs from merely adaptive personalization. Personalization may modify the pace, difficulty, or format of content; mentoring may instead help interpret the meaning of such adaptations for a specific student and for their future choices. It may also make repeated requests for reassurance, assessment-related fears, or forms of apparent autonomy that conceal feedback avoidance open to discussion.

However, mentoring should not be idealized: relationships may take paternalistic, intrusive, or dependent forms, and may reproduce institutional norms that are insufficiently problematized. The point is not to oppose human and technological mediation, but to recognize that deutero-learning requires spaces in which assumptions, responsibilities, and meanings can be discussed in relation to the student's context and history. Such spaces may include digital tools, but they seem difficult to guarantee through personalization alone.

5. AI Tutoring as a Protected but Limited Space

Assessment anxiety concerns cognitive, affective, and physiological responses that may emerge when a performance is evaluated or perceived as such. It may interfere with attention, working memory, self-confidence, and performance, also in relation to students' beliefs about their own abilities and the consequences of failure (Hembree, 1988; Zeidner, 1998). In this context, the AI tutor may offer a low-exposure space, useful for practising, trying again, and asking questions without the immediate public pressure of judgement.

This protective function, however, remains ambivalent. The reduction of immediate discomfort does not necessarily imply a transformation in the student's relationship with assessment. If used to avoid human feedback or to seek continuous reassurance, the AI tutor may displace anxiety rather than help elaborate it. The pedagogical issue therefore concerns what students learn about assessment: an opportunity for revision and growth, or a space from which to protect themselves.

5.1 Feedback, Anxiety, and Educational Well-Being

Educational well-being does not coincide with the absence of discomfort, but concerns the quality of the formative experience: perceived competence, belonging, meaning, and participation. Botta (2025) emphasizes the importance of listening to students' narratives about school well-being. AI may contribute to such well-being when it makes understandable pathways and opportunities to try again more accessible; it may instead weaken it when it fosters dependency, opacity of criteria, or uncertainty about standards.

It is therefore useful to distinguish between formative feedback, summative assessment, and internal feedback: the first guides learning, the second produces an institutional judgement, and the third concerns the evaluative activity that students develop in relation to their own work. AI tutoring may support *feedback literacy* if students are guided to interpret its responses critically (Carless & Boud, 2018). Since AI-generated feedback may be inconsistent or not aligned with actual criteria, explicit norms are needed to check, discuss, and triangulate it. The aim is not to distrust AI, but to build reliance proportionate to transparency, relevance, and verifiability.

6. Proto-Deutero Framework for AI Tutoring and Mentoring

The framework distinguishes, in heuristic form, two communicating levels. AI tutoring seems to support primarily proto-learning, by fostering explanation, practice, feedback, and task regulation. Mentoring appears more oriented toward deutero-learning, since it helps students interpret recurring patterns, affective and motivational aspects, agency, responsibility, and participation. The two levels are not separate: AI can contribute to reflective processes if intentionally designed, while mentoring can also support the understanding of the task and of strategies.

Table 1. Proto-deutero framework for integrating AI tutoring and mentoring

Dimension	AI Tutoring	Mentoring	Pedagogical mediation
Task and feedback	Explains, provides practice, signals errors.	Connects feedback, criteria, and pathway.	Make criteria explicit and compare human feedback.
Internal feedback	Prompts prediction, revision, self-assessment.	Helps recognize recurring patterns.	Require explanation and transfer.
Anxiety and agency	Offers protected practice and options.	Reintegrates assessment dialogue and responsibility.	Use AI as a bridge, not a substitute.

Ethical-social habits	May foster collaborative language.	Discusses reciprocity, equity, and care.	Connect AI, peers, and shared norms.

Table 1 should not be read as a diagnostic scale, but as a design-oriented guide. The transition from performance to the student's relationship with performance is fostered when the use of AI is accompanied by explanation, revision, transfer, and dialogue; it is weakened when the system becomes the sole source of answers or a substitute for the educational relationship.

7. Conclusions

AI tutoring should not be evaluated only in terms of efficiency, personalization, or immediacy, but also in relation to the kinds of learning and habits it may foster. At the level of proto-learning, it may support explanation, practice, feedback, and task regulation; however, the transition toward self-regulatory habits requires explicit criteria, reflective prompts, revision, transfer, and comparison with human feedback.

Deutero-learning concerns the way students interpret outcomes, attribute causes, seek help, face assessment, regulate the affective dimension, and participate responsibly. From this perspective, mentoring retains a specific function, because it offers a relational space in which such postures can be made visible, discussed, and reworked. AI tutoring and mentoring should therefore not be opposed, but integrated as different and connected forms of mediation.

For *Engaging Education*, engagement cannot be reduced to frequency of use, persistence, or completion of activities. It should include meaning-making, agency, responsibility, relational participation, and the capacity to remain within uncertainty without depending on immediate reassurance (Fredricks et al., 2004; Kahu, 2013). AI may facilitate access to the task, but it should prepare students to re-enter cooperative, evaluative, and dialogic contexts.

At the design level, AI tutoring should be embedded in activities that require prediction, justification, revision, and transfer. Criteria should be explicit, and AI feedback should be compared, when possible, with feedback from teachers, peers, or mentors. Ultimately, the educational quality of AI depends not only on the answers it helps produce, but on the habits of attention, critical use of feedback, autonomy, and responsibility that it may make possible.

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