THE IRREDUCIBLE DIMENSION: TOWARD AN INTEGRATION OF AUTOMATED TUTORING AND MENTORING IN AI-SUPPORTED EDUCATION

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ABSTRACT

The growing proliferation of GenAI tutors is reshaping hybrid learning from secondary to higher education. This paper examines how new forms of e-tutoring are reconfiguring the distribution of educational roles, distinguishing tutoring from mentoring. As instructional tasks are automated, mentoring gains importance for reflection, motivation, relational support. We propose a framework for AI-tutors promoting digital well-being, arguing education's relational dimension is irreducible.

KEYWORDS
AI-tutoring, mentoring, digital wellbeing

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1. Introduction

The pervasive spread of Generative Artificial Intelligence (GenAI) tools is normalizing the use of chatbots and intelligent assistants to support study and is contributing to the reconfiguration of hybrid learning environments. Across Europe, despite estimates that are not always directly comparable, the phenomenon is clearly documented: according to the *Eurobarometer. Youth Survey 2024* survey (European Parliament, 2025), 57% of young Europeans between 16 and 30 report having used AI-based applications in the previous twelve months; among these, 36% used them for study and research and 28% for schoolwork, with Italy reaching 50% for study-related purposes. The *Eurostat 2025* survey (*European Commission*, 2025) confirms the trend: 63.8% of young people aged 16-24 use GenAI tools, 39.3% for formal education purposes, with Italy at 47.2% on overall use in the same age group. The most recent Eurostat survey on *Digitalization* records AI tool use by 65% of young people aged 16 to 24, with 10% usage, across the total population, in formal education contexts (European Commission, 2026). On the perception side, the *Flash Eurobarometer 564. Future Needs in Digital Education* report (European Commission, 2025) finds that 87% of European citizens are in favor of promoting digital technologies designed for learning; on AI specifically, positions are more nuanced: 54% recognize both its benefits and risks, 17% support experimenting with it without concern, and 22% would prefer to exclude it from classrooms. In Italy, the latest ISTAT reports do not offer specific data on AI use by students, but they record a general increase in digital technologies among the 15-24 age group, describing them as a *structural component of daily experience*; the use of AI tools is particularly widespread among younger people, with 51.2% of 14-19-year-olds and 43.1% of 20-24-year-olds (ISTAT, 2026).

Institutional guidelines and strategic investments are also driving the development of hybrid learning environments, in both secondary and university education. At the European level, first the Recommendation of the Council of the European Union (EU Council, 2021), partly in response to the pandemic experience, and subsequently, in particular, the *EENEE* report (Caplanova et al., 2024) attest to the progressive institutionalization of blended learning, confirmed by Eurostat: the share of users who took online courses rose from 21.4% in 2019 to 34.8% in 2025. In the Italian context, this transformation is reflected, in schools, in the investments of the Piano Scuola 4.0 (the Italian National Recovery and Resilience Plan, PNRR)

for *Next Generation Classrooms* (MIM, 2022) and, in higher education, in the sharp increase in enrollments at online universities.

The latest report from the Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR, 2026) records, over the last three years, an increase in enrollments in online degree programs large enough to describe this demand for education as *a structural and still-growing* phenomenon: of 316,160 students enrolled in predominantly or entirely online degree programs, 97.4% are at digital universities. And while traditional universities are working to expand their range of hybrid delivery modes as provided for by current regulations (Ministerial Decree 1835/2024), launching numerous new *mixed*, *mainly online*, and *fully online* courses, digital universities are seeing a shift in enrollments from entirely online courses to predominantly online courses: first-year enrollments in predominantly online programs have nearly doubled, rising from 351 to 634, an increase of 80.7%, while the number of first-year enrollments in entirely online programs has remained stable (around 370-380 students). The blended model thus appears to respond to a demand for distance education that is in the process of becoming normalized, one that integrates laboratory-based solutions with in-person experiences.

These transformations make it necessary to rethink the concept of e-tutoring, which no longer refers merely to the electronic dimension or to distance, but to a tutoring function that is distributed and mediated within hybrid environments. The specialized literature, European policy directions, and Italian regulations confirm the strategic role of tutoring in online university contexts (Selmi & Martiniello, 2025) and the importance of support figures in secondary schools as well, such as digital facilitators, tutors, and guidance counselors (MIM, 2021). The development of GenAI also makes it useful to distinguish between AI for tutoring, in which AI supports the work of the human tutor through data analysis, alerts, and resource generation, and AI-tutoring, in which chatbots and automated systems directly take on functions of explanation, feedback, and personalization.

Such tools (AI-tutors, virtual tutors, digital humans, etc.) are already widely used in informal contexts and are progressively spreading into tertiary education as well, requiring a more precise definition of roles, competencies, and responsibilities. The automation of certain operational functions does not, in fact, reduce the need for human mediation; rather, it may increase the relevance of the relational, metacognitive, and motivational functions proper to tutoring and mentoring. There is also a risk that predominantly hyper-personalized use of AI may progressively isolate learning from the class group and the community (OECD, 2026).

This contribution is offered as a reflection on these evolving scenarios, suggesting the need to develop and test new frameworks for redistributing tutoring and mentoring functions in AI-supported learning contexts, with particular attention to the quality of educational relationships, student agency, and aspects of digital well-being. The following sections explore these implications, starting with the evolution of GenAI-supported *Intelligent Tutoring Systems* (ITS) (1), distinguishing between tutoring and mentoring functions (2), and then analyzing the educational relationship (3) and digital well-being (4) in contexts supported by generative AI.

2. The evolution of automated tutoring.

ITS represent one of the most widespread applications of AI in education: the first programs date back to the 1970s, and their evolution has been constant and progressive (Guo et al., 2021), up to the more recent integrations with GenAI tools. According to a traditional definition by Graesser (2005), which well expresses the interplay between education and technology, ITS are computerized learning environments that incorporate computational models from the cognitive sciences, the learning sciences, computational linguistics, artificial intelligence, mathematics, and other fields that develop intelligent systems specified in a rigorous computational way (Rossi & Fedeli, 2012). The wide adoption and growing effectiveness of ITS in certain disciplinary areas and for specific learning styles are documented in the international literature on the subject, especially regarding their applications in secondary and higher education, with a strong concentration in disciplines such as mathematics, languages, and science (Wang et al., 2023). The literature documents a rich variety of terms: *intelligent online tutors*, *intelligent software agents*, *intelligent assistant*, *virtual assistant*, *intelligent agent*, *intelligent helper*, and these identify the main functions of ITS as supporting the teaching of disciplinary content and facilitating collaboration among students (Zawacki-Richter et al., 2019; Crompton & Burke, 2023). Tutoring support is provided through exercises and quizzes for self-directed learning, chatbots for interaction on disciplinary content, immediate feedback on whether tasks have been completed correctly, general real-time feedback for self-assessment, guidance in carrying out exercises and activities, personalization of learning by recalibrating the difficulty level of exercises and activities, and flexibility in managing the time needed to complete them. The most advanced forms of automated tutoring simulate individual support that is increasingly similar to human support, also performing scaffolding functions and supporting motivation and engagement in collaborative activities (Liu et al., 2025). The GenAI revolution has driven experimentation with

new conversational agents, including the integration of *Large Languege Models* (LLMs) within advanced ITS: an increasingly thin line today separates these generalist agents from ITS designed according to explicit pedagogical criteria. This evolution of ITS does not propose replacing traditional tutoring architectures with generative language models, but rather seems to be moving toward hybrid systems in which the dialogic and generative capabilities of LLMs are integrated with explicit models of the domain and the learner, pedagogical strategies, verification mechanisms, and forms of human supervision. The frontier, therefore, is not represented by the generalist conversational tutor, but by multimodal, longitudinal, and pedagogically governed tutoring environments capable of adapting their intervention based on actual learning processes and outcomes (López-Goyez et al., 2026). A useful taxonomy for navigating AI integration in education is the one proposed by Mollick and Mollick (2023), who distinguish at least seven possible functions-including AI-tutor, AI-coach, and AI-mentor, each with specific pedagogical implications; an initial empirical comparative study has drawn specifically on this distinction between tutoring and mentoring (Marconi & Cabitza, 2025).

The effectiveness of ITS, at least in the short term, is broadly confirmed by recent studies (Cristea et al., 2025), which suggest appreciable results in content learning across various disciplinary areas; however, as we will see in more detail in Section 3, behavioral or emotional engagement does not necessarily coincide with greater depth of cognitive processing (Bai et al., 2025). The shift from e-tutoring to generative ITS therefore appears not as a simple technical evolution, but as a reconfiguration of educational support functions.

In Italy, experimentation with GenAI-based study support has seen, in the university sector, an initial guided integration of generalist models such as ChatGPT and Gemini, followed by the targeted development of dedicated educational chatbots (Triberti et al., 2024; Rega et al., 2024). One particular line of research also investigates the gamification of e-tutoring (Ramadhan et al., 2024; Rahman et al., 2026), but research in the field today is increasingly focused on the effectiveness, both qualitative and quantitative, of conversational chatbots for tutoring, and on comparing the learning effects of generalist GPTs with GenAI-integrated ITS. Initial results show that the latter, based on pedagogical models rooted in constructionism, achieve better performance, with more lasting outcomes over time, while also counteracting the risk of cognitive offloading and dependency among students (Barbieri et al., 2024; Liu et al., 2024; Filippone et al., 2025; Al-Abri, 2025).

3. Tutoring and mentoring: areas of overlap and difference.

The spread of GenAI-supported ITS also calls for pedagogical reflection on the relationship between tutoring and mentoring, in order to properly distribute support functions among automated assistance, the development of autonomy, and relational dynamics. The literature has long pointed to a definitional difficulty whereby mentoring, coaching, advising, counselling, and tutoring are often used interchangeably, risking unclear goals and evaluation criteria (Crisp & Cruz, 2009). This ambiguity is now heightened by the emergence of generative agents, which on the one hand may erode traditional functions (Selmi et al., 2024) and on the other hand enrich educational environments, disrupting linear learning processes. Functions such as cognitive and emotional scaffolding, which require educational intentionality and relational responsibility, aim to make students' activity progressively more autonomous, within a balance between excessive guidance and superficial assistance (Wood et al., 1976; van de Pol et al., 2015): tutoring and mentoring can find points of intersection here in support of motivation and engagement.

Mentoring, however, operates on a different level, taking the form of a developmental relationship oriented toward the growth of the person, the recognition of their resources, and the definition of educational trajectories. Traditionally, it integrates professional and psychosocial development dimensions, connected to trust and support during transitions (Kram, 1985); originating in organizational contexts, it has progressively been extended to educational settings, first in North American systems and later in Europe and Italy, where Investment 1.4 of Mission 4 of the PNRR allocated €1.5 billion to mentoring and tutoring initiatives to combat school dropout, with the goal of involving 820,000 students (Italian Ministry of Education, 2021). This is an important signal that encourages us to read mentoring not as a residual practice, but as part of a broader need for personalization and the prevention of academic failure. In education, it can be described as a formalized process in which a more experienced figure supports the mentee through academic, emotional, and guidance-related support (Nuis et al., 2023), distinguishing it from episodic help or the mere availability of an adult figure. In upper secondary school, it accompanies a phase in which students' relationship to knowledge intertwines with self-image and planning for the future.

Building on the above, we can propose a distinction between tutoring and mentoring as a functional differentiation: tutoring tends to be more circumscribed

and performance-oriented, while mentoring works on the continuity of support, on reflection, and on decision-making autonomy. Designing mentoring models requires making roles, aims, and the duration of the relationship explicit, avoiding reducing it to a generic helping practice (Dawson, 2014): a distinction that is also crucial for AI-supported environments, because technology can support tutoring activities but cannot, on its own, define the pedagogical meaning of mentoring support.

In upper secondary school, mentoring could support students through delicate transitions (choices after graduation, motivational and performance difficulties, changes of course of study, supplementary educational activities, etc.), not as an intervention reserved for at-risk students alone, but as an ordinary mechanism for supporting growth. Evidence on youth mentoring suggests moderate but significant effects on academic, social, and emotional dimensions, especially when programs are designed and sustained through stable relationships (Raposa et al., 2019). In AI-supported contexts, this distinction appears even more relevant: AI-tutors can offer adaptive, personalized feedback, but they do not seem to exhaust the emotional, social, and guidance-related dimensions of mentoring support (Kasneci et al., 2023). As we will see in the next section, the more generative ITS become capable of responding and personalizing, the more necessary it becomes to help students question, choose, and attribute meaning to their educational experience.

4. The educational relationship in AI-supported contexts (AIED)

Having established the difference between tutoring and mentoring, the central question does not concern only which functions can be automated, but also what relational configuration emerges in educational contexts where artificial agents capable of simulating forms of tutorial presence are introduced. Generative AI does not simply introduce a new teaching tool; it changes the conditions of interaction, entering as an actor within a complex educational ecosystem. The *Community of Inquiry* framework, although formulated specifically for distance learning, still offers a useful analytical lens for the theme of presence, articulated across three core areas: *teaching presence*, *social presence*, and *cognitive presence* (Garrison et al., 2000). AI-tutors built on pedagogical models can certainly support some forms of cognitive presence, especially if they do not limit themselves to providing clarifications and feedback but also foster exploration: through probing questions, they can help students move from a descriptive level (exchange of

information) to an interpretive and applied one (connecting ideas, solving problems), guiding them toward deep learning (Hu et al., 2025). It is more complex to imagine a similarly effective contribution at the level of teaching presence and social presence, which in any case require human mediation. What remains decisive, in any case, is designing environments in which these cognitive tools also function as conscious relational interfaces.

Upper secondary school represents a particularly sensitive context for observing these dynamics. Students are not only consolidating disciplinary learning; they are also building a more autonomous relationship with knowledge, with choice, and with their own educational identity. In university settings as well, interaction with an AI-tutor can take on very different meanings: support for understanding, a shortcut for finishing an assignment, or a source of immediate reassurance. The tool's permanent availability can be a resource, but it can also encourage forms of excessive reliance. It is within this ambivalence that the pedagogical question of the human-machine relationship is situated: the AI-tutor is not neutral, because it shapes ways of asking questions and attitudes toward error.

Recent literature on generative-AI-supported ITS suggests that student engagement cannot be interpreted in a linear way; moreover, the categories of AIED tools and applications are highly varied (Agostini & Picasso, 2024). A student may, in fact, make heavy use of a tool and perceive it as useful, without this implying greater reflection or conceptual understanding: the quality of the interaction depends on the cognitive operations it prompts, not merely on its accessibility. The use of AI can support learning when it invites students to formulate hypotheses, compare strategies, verbalize steps, review errors, and explain their own reasoning. It can instead foster cognitive offloading when it is used mainly to obtain the solution, quickly validate an answer, or avoid engaging with uncertainty (Yusuf et al., 2026). This distinction recalls the principle of the zone of proximal development: effective support should be situated in the space between what the student can already do independently and what they can achieve with adequate guidance (Vygotsky, 1992). The comparison between generalist conversational systems and ITS designed according to pedagogical criteria suggests that the design of the interaction can affect the quality of cognitive processes: more structured environments seem to foster autonomy, verbalization, and reflection, while generalist systems may more readily support offloading practices (Filippone et al., 2025; Fakour & Imani, 2025). In upper secondary school, this point appears decisive, because autonomy cannot be assumed as an already-acquired prerequisite, but rather as an outcome that needs to be supported.

The human-machine relationship also affects peer dynamics. Within a class group, the introduction of artificial agents does not produce uniform effects: some students may use AI as a tool for deeper exploration, others as compensation in case of difficulty, others as a facilitating substitute, and others may reject it or use it inconsistently and ineffectively. Differentiation in learning practices therefore concerns not only digital competencies, but more broadly involves self-regulation processes (Zimmerman, 2002) and, more broadly, what Pellerey calls *strategic competences* (Pellerey, 2006) such as self-efficay and stress management. The perception of the role of teachers, tutors, and educational mentors is also affected: authority may be attributed not only to traditional educational figures, but also to artificial agents perceived as available, fast, and reliable. If students can obtain effective and rapid support interventions from a conversational system, educators are called upon to redefine their own contribution, in order not to lose their central role and authority. The pedagogical regulation of the learning environment becomes, in this scenario, absolutely crucial; it involves guiding students' reflection on the responses they receive, facilitating a critical interpretation of the interactions they engage in, articulating validity criteria, and supporting the formulation of questions; in short, it means problematizing the use of AI and discussing the limits of the solutions it generates, in order to learn *how* to correctly use what we now have available (Ranieri, 2024).

The challenge, then, becomes that of designing hybrid environments in which AI supports the educational relationship while preserving relational quality against forms of offloading, dependency, or isolation. It becomes necessary to imagine AI agents as cognitive mediators within systems in which the relational workload is distributed among AI-tutors, human mentors, teachers, and the student group. In short, the relationship between the various tutoring and mentoring figures and artificial agents needs to be rethought according to a logic of complementarity, in which educational relationships also take on a regulatory function with respect to technological innovation. European and international guidelines on AIED pay particular attention to these aspects, in order to safeguard the quality of learning and promote the dignity of individuals and their educational paths (European Commission, 2022). The digital competencies involved in using these new technologies must necessarily include a metacognitive dimension, so that students develop stable *habitus*, such as questioning the cognitive postures they adopt during interactions with AI-tutors. Asking for a solution, an explanation, a check, a counterexample, or help in reflecting are not equivalent operations. A significant part of self-regulation plays out in this very difference.

The more the machine becomes capable of interacting with students and supporting them effectively, the more the educational relationship is called upon to strengthen its interventions at the level of the meaningful construction of knowledge, the sense of learning, and the strategic competencies that can support and develop it (Pellerey, 2006).

In light of the above, it becomes essential to experiment with frameworks and operational models capable of distributing the relational workload in a balanced way among AI agents, teaching staff (teachers, tutors, mentors), and the student group, without neglecting the digital well-being component. Between *human-in-the-loop* models, in which AI manages the primary interactions and the human supervises, and *human-at-the-helm* models, in which the human remains at the center of the educational relationship and AI provides support and resources that the educator integrates into their own response, the framework proposed here is positioned in the second direction: not an AI that replaces tutoring and mentoring functions, but an ecosystem in which the various competencies (cognitive, relational, motivational, guidance-related) are consciously distributed between human and artificial actors, according to design principles made explicit and shared by the educational community.

5. Digital well-being: essential dimensions for building new frameworks.

The proliferation of models, designs, and experimental approaches along the lines of human-AI integration (Holstein & Aleven, 2022; OECD, 2026) makes careful mapping of this trend advisable. The integration of AI-tutors in educational contexts cannot be assessed solely in terms of accessibility, personalization, and effectiveness: it also becomes necessary to ask about the digital well-being conditions under which these systems are used. Digital well-being does not coincide with the simple reduction of technology-related risks, but with the possibility of maintaining a balanced, intentional, and sustainable relationship with digital environments, so that technology supports learning without reducing autonomy, discernment, and the quality of the educational experience.

The *digital flourishing* framework proposed by the Digital Wellness Institute offers a useful heuristic reference, provided it is integrated with more established scientific models: its value lies in invoking a multidimensional conception of the relationship with the digital, in which physical health, mental well-being, and intentional use are components of a single educational experience (Digital Wellness Institute, 2025), particularly relevant in secondary school, where students are still

building study habitus and decision-making skills. A recent qualitative study on university students' recommendations confirms that digital well-being specifically linked to generative AI remains a largely unexplored paradigm compared to the more established literature on digital well-being in general, and links its understanding to AI literacy as well (Černý, 2025). The most recent systematic reviews confirm this fragmentation (Klimova & Pikhart, 2025; Kundu & Bej, 2025): a gap that certainly needs to be filled.

Cognitive load theory distinguishes between load that is useful for building mental schemas and extraneous load produced by ineffective design (Sweller et al., 2011): AI-tutors can ease certain operations through explanations and personalized pathways, but the relevant question is not how much load is reduced, rather what type of load is transformed, since lightening it is not necessarily beneficial if it deprives students of opportunities for processing and metacognitive monitoring. This connects to the risk of cognitive offloading, which becomes critical when external tools are used to reduce mental effort in processes that should instead be internalized (Risko & Gilbert, 2016; Kasneci et al., 2023). Digital well-being, in this sense, is not only about feeling good but about remaining an active subject of one's own learning.

Students' digital balance is also subject to forms of pressure that depend both on time spent online and on the quality of the demands posed by technological environments, which can generate attentional fragmentation and difficulty disconnecting. The *technostress trifecta* perspective helps avoid an exclusively negative reading: technostress can take the form of techno-distress, when technology is perceived as a threat, but also of techno-eustress, when its demands are interpreted as manageable and generative challenges (Tarafdar et al., 2019). AI-tutors therefore do not automatically produce well-being or distress: their effect depends on how they are designed, introduced, and discussed within the educational relationship.

Digital well-being also involves the bodily dimension of learning, which is not always given due weight when it comes to educational AI. The perspectives of embodied cognition and embodied simulation have, in fact, contributed to overcoming a purely mentalistic conception of cognitive processes, showing how perception, action, emotion, relationship, and sensorimotor systems take part in the construction of meaning and knowledge. Learning is therefore an embodied and situated experience, one that takes shape in the interaction between brain, body, environment, and other subjects. From this perspective, awareness of one's own bodily states - posture, movement, fatigue, tension, breathing, and level of

activation - is not an accessory element, but can support the regulation of attention, emotions, and cognitive load, contributing to metacognition and to the self-regulation of learning. The design of AI-supported educational environments should therefore avoid reducing the educational experience to a disembodied relationship with the screen, and should preserve opportunities for movement, interaction, presence, and somatic awareness (Rivoltella, 2018; Gallese & Morelli, 2024; Gallese et al., 2025). Elements of physical well-being that should certainly be taken into account include eye strain and prolonged static posture. The literature on *digital eye strain*, for example, shows that prolonged use of digital devices can be associated with ocular and visual symptoms, with a prevalence of 50% or higher among computer users (Sheppard & Wolffsohn, 2018): a finding that does not justify alarmism, but does call for considering the body as part of the learning experience, with breaks, posture, and ergonomics as pedagogical components of the sustainable use of AI-tutors.

The permanent availability of the AI-tutor can also affect the emotional dimension of the relationship with learning: a system that is always accessible, patient, and non-judgmental can reduce certain barriers, especially for students who fear making mistakes or being judged by peers, but this same availability could give rise to forms of functional reliance that are difficult to recognize and to distinguish from genuine educational support. The emotional availability of the system is therefore not, in itself, sufficient to guarantee the quality of its effects (Nyakhar & Wang, 2025): the relationship with the artificial agent supports learning only if it fosters exploration and reflection, and becomes problematic if it progressively replaces engagement with the teacher, with peers, and with the effort of independent thinking. The issue of self-regulation brings these elements back together, since the intentional use of AI-tutors implies the ability to set goals, monitor one's own behavior, and adjust one's path when necessary (Zimmerman, 2002).

Given its emerging relevance, the issue of digital well-being should not be treated as a matter of isolated individual responsibility, but should be taken on as an essential criterion for educational and relational design: shared criteria and teacher training are needed to promote the intentional use of AI-based tools, applications, and agents, as well as self-regulation, as also indicated by UNESCO's most recent recommendations on the topic (UNESCO 2023; 2024, 2025).

Conclusions

Technological evolution brings some important functional and relational discontinuities that call for changes in educational roles and postures. For this reason, it is desirable to formulate new models that must meet certain essential criteria: 1) the participation of the various components of the teaching staff (teachers, tutors, instructional designers, mentors, etc.) in the design of AI-supported learning environments; 2) the participation of diverse professional expertise in the development of AI-based tools, applications, platforms, and agents to be incorporated into hybrid learning contexts; 3) the introduction of shared indicators across the various areas of digital well-being, as elements to be assessed on an ongoing basis; 4) constant monitoring not only of students' performance and the quality of their learning, but also of their perceptions and needs.

A first, necessarily provisional, translation of these criteria into observable dimensions is proposed in Table 1. The indicators suggested are not intended as validated metrics, but as a starting point for the participatory design processes referred to above; they must be discussed, tested, and revised together with teaching staff, students, and AI-tool designers, adapting them to the contexts of upper secondary education and blended/online tertiary education.

Within these models, still to be developed and tested, the dimension we consider irreducible remains the ability to guide students in attributing meaning, value, and direction to their own learning experience: an ability that requires mutual recognition, relational responsibility, and care, and that we believe no artificial system, however sophisticated, is able to offer on its own.

Table 1: CARE-D Framework. Cognitive, Affective, Relational, Embodied-Distribution framework.

Dimension	**What to observe**	**Who is involved**	**Illustrative guiding question**
Functional distribution	How tutoring, mentoring, and AI-tutor functions are allocated and overlap within a given course/program	Teaching staff, instructional designers, AI-tutor developers	Which functions are explicitly assigned to the AI-tutor, and which are reserved for human tutors/mentors?
Cognitive posture	The type of request students address to the AI-tutor (solution-seeking vs. reflection-seeking)	Students, AI-tutor logs, tutors	Are students mostly asking for answers, or for help in reasoning through a problem?
Self-regulation	Students' ability to set goals, monitor their own	Students, mentors	Can students describe why they turned to the

	use of AI-tools, and adjust their strategies		AI-tutor for a given task, rather than to a peer or teacher?
Relational continuity	Whether mentoring relationships remain stable and traceable over time, independent of AI-tutor availability	Mentors, institutional coordinators	Does the student have a stable human reference point beyond the AI-tutor's session-by-session support?
Digital well-being (bodily & attentional)	Indicators of cognitive load, attentional fragmentation, posture/eye strain during AI-supported study sessions	Students, teachers, school/university health services	Are breaks, posture, and screen time considered part of the pedagogical design of AI-tutor use?
Perceived authority & trust	To whom students attribute authority/credibility for feedback (AI-tutor vs. human figures)	Students, teachers, mentors	When AI-tutor and teacher feedback diverge, which does the student trust, and why?
Social dimension (peer collaboration)	The impact of AI-tutors on group dynamics, peer collaboration, and peer mentoring practices	Students, peer mentors, teaching staff	Does reliance on the AI-tutor reduce, redirect, or enrich students' collaboration with peers and engagement in peer mentoring

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