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TECHNOLOGY FOR TRAINING FUTURE COMPUTER SCIENCE TEACHERS FOR THE USE OF ARTIFICIAL INTELLIGENCE IN SOLVING FACILITATION TASKS

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ABSTRACT

This study presents a technology for preparing future informatics teachers to work in an educational environment integrated with artificial intelligence (AI). The central focus is on forming the intellectual polysubject—a multilayered subject configuration that encompasses cognitive, corporeal, ethical, and facilitative levels. We propose a four-phase model of pedagogical evolution: teloreflection, working with open-ended tasks, AI-didactics, and facilitation. This model fosters the development of empathy, AI literacy, and the capacity for subject-oriented interaction. Drawing on ACT-R theory, connectivism, and actor-network theory, we substantiate the interdisciplinary validity of the model. We have also developed tools for diagnosing subjective maturity and presented visual diagrams of the educational architecture. Special emphasis is placed on the applicability of the proposed technology for teacher retraining and professional development programs. The results of this study provide both methodological and practical foundations for updating the content of teacher education in the digital age.

KEYWORDS: Artificial Intelligence, Pedagogy, Facilitation, Subjectivity, Intellectual Polysubject, Teloreflection, Open-Ended Tasks, Pedagogical Technology.

1. INTRODUCTION

It is evident that contemporary education is entering an era where traditional models of teaching are losing relevance, giving way to more flexible, empathetic, and technologically enriched formats of learning. In particular, the transition to a digital educational environment necessitates a fundamental rethinking of the teacher's role—from a transmitter of knowledge to a facilitator of cognitive interaction who can leverage intelligent technologies as partners in colearning.

Our study is grounded in ontological humanism and constructivism: knowledge is not transmitted but rather constructed through dialog—including with nonanthropomorphic agents, particularly AI systems (Woodill, 2005; von Foerster, 2003). In this paradigm, the teacher becomes a mediator of meaning and a moderator of the digital environment rather than a controller of learning.

The core idea of our work is the creation of a developmental environment for a new type of subject—the intellectual polysubject—characterized by technological flexibility, empathetic facilitation, and cognitive adaptability. This subject does not compete with AI but learns to interact with it, delegating automatable functions while retaining zones of semantic, ethical, and embodied presence (Zawacki-Richter et al., 2019; Holmes et al., 2019).

In this context, we envision future teachers as facilitators of digital learning that combines three core roles:

1. Informatics specialists who are proficient in AI tools and knowledgeable in the algorithmic structure of educational technologies;
2. Facilitators, organizing developmental collaboration, group practices, and empathetic processes;
3. Media-technologists integrate digital resources into a dynamic, ethically managed learning environment.

To structure our inquiry, we also draw upon the concepts of open-ended task technologies (Herasymova et al., 2020) and embodied reflection as a means of restoring empathetic connections in digital learning (Kasper et al., 2024). We believe these practices form the foundation for the emergence of the intellectual polysubject—capable not only of solving but also of facilitating learning and professional tasks within a hybrid human–machine environment.

Accordingly, we identify three interrelated levels in our model:

- At the environmental level, where AI is not merely a tool but also a cognitive partner, it requires pedagogical literacy and reflective capacity;
- Task level, where open-ended tasks activate metacognition and collective thinking, in contrast to algorithmic templates;
- At the embodied level, bodily reflection and empathetic practices serve as means of emotional facilitation and digital alienation compensation.

These levels are naturally integrated into pedagogical training technology; wherein future informatics teachers undergo the following stages:

(1) Embodied-reflective awareness,
(2) Open-ended cognitive practices,
(3) AI-environment mastery,
(4) Group facilitation.

Overall, our research on teacher preparation involving AI practices adopts an interdisciplinary approach that combines pedagogical archaeology (Ayagan, 2001), digital didactics (Liu, 2020), constructivism and subjectivity (O'Loughlin, 1992), and methods of open education and neurosagogy (OECD, 2021).

We thus argue that the shift toward education based on flexible digital ecosystems makes it urgently necessary to develop a new pedagogical technology—one that prepares specialists capable of collaborating with AI, managing the dynamics of open-ended tasks, maintaining empathetic contact with learner groups, and sustaining a meta-level of bodily and ethical reflection. This is the key relevance of our research.

Furthermore, in the context of the digital divide, the ethical crisis of AI, and teacher overload, such preparation gains not only scientific but also strategic and practical significance.

2. LITERATURE REVIEW

The formation of a teacher's subjective position in the age of AI is impossible without addressing the ontology of knowledge, the nature of thinking, and meaning. Existentialism (Sartre, 1989) views the subject as a project and a bearer of responsibility—critically important in the context of AI-assisted learning, where the teacher loses the monopoly on knowledge but gains a new facilitative dimension (Sartre, 1989; Podlinyaev, 2012). According to Rozin, the shift from classical epistemology to a "situational epistemology" opens the way for modeling pedagogy as a distributed system of cognition, in which AI acts as a full-fledged cognitive agent (Rozin, 2012).

Constructivism, particularly in its radical form

(Glasersfeld, 1995; Foerster, 2003), posits that knowledge is not a reflection but a construction of meaning by the subject. This aligns with the approach of preparing informatics teachers for facilitating open-ended tasks, where the learner is not an object of instruction but an active constructor of meaning. The works of Fosnot (1996), Duffy (2000), and Steffe (1995) highlight the importance of the environment, uncertainty, and coauthorship in future pedagogy. Holstein and Gubrium (2008) emphasize the social constitution of knowledge, which is especially relevant in contexts involving AI interaction and collective facilitation.

The concept of the intellectual polysubject is closely linked to acmeology—the science of professional excellence. Derkach (2004) and Kuzmina (1990) present professional maturity as an integration of personal, reflective, and social components. Ananyev emphasized the importance of individual pathways and psychophysiological resources. Guilford (1967) and Ackerman (1997) describe the complex structure of intelligence, interest, and motivation, supplemented by self-assessment and meaning—crucial for training future educators as navigators of the digital world.

The open-ended task method forms the core of facilitative thinking technologies. Research by Gorev and Rychkova (2015), Kadirbayeva and Ospanov (2022), and Shuba et al. (2012) demonstrates the value of creative uncertainty, solution diversity, and group work. Particularly noteworthy is the Japanese "open approach" (Nohda, 2000), which emphasizes awareness and discussion of thinking processes rather than just outcomes. This allows AI to be integrated not as a replacement but as an amplifier of pedagogical interaction.

Open-ended task technology (Samsonova, 2022) is also seen as a conscious relation to one's presence, movements, and gestures—critical in facilitating open-ended learning. The work of Mullina and Amirbekuly (2023) on active and interactive learning highlights the need for bodily sensitivity and emotional intelligence as conditions for subjective maturity.

With respect to the most recent research, it is worth noting the growing number of interdisciplinary studies on the integration of AI into educational practices, especially in terms of pedagogical design, ethics, and cognitive personalization. Overall, the internet and digitalization have had a significant effect on higher education, as the export of high-tech products reflects both internet development and digitalization (Rosak-Szyrocka, 2024).

Panke (2024) explored the interaction between open educational resources (OERs) and artificial intelligence (AI), emphasizing their application in open pedagogy. Both course concepts provide hands-on experiences in designing and implementing student-centered reusable assignments through the integration of AI tools into open-access book projects.

In the review by Samala et al. (2024), ChatGPT was noted to have considerable potential for education. However, the authors stress the need for further research and careful analysis of potential risks and limitations. In particular, they highlight possible covert manipulations through instructions given to ChatGPT for answering educational questions, including the potential exploitation of vulnerabilities in AI-generated content detectors (AIGC) to commit academic misconduct (Pan, 2024). Overall, given these concerns, incorporating AI and machine learning into nontechnical educational programs, such as social science courses, presents a significant challenge (Sundberg, 2024).

Nonetheless, in the field of education, AI holds the promise of enhancing both teaching and learning (Lampou, 2023). It is intended to supplement, not replace, educators—making learning more engaging and effective. In this context, several ways are described in which students can use these tools to improve their learning outcomes, along with a set of guidelines that everyone should consider when using them in academic settings (Favero, 2024).

3. METHODOLOGY

The methodology of our study is based on an interdisciplinary integration of approaches from cognitive science, pedagogy, AI theory, and embodied subjectivity. The objective is to construct a holistic model for preparing future informatics teachers for facilitative roles in AI-enriched educational environments.

The core concept of the intellectual polysubject draws on the adaptive control of thought–rational (ACT-R) cognitive architecture, which models the interaction of working memory, declarative, and procedural knowledge in learning contexts (Anderson, 1996). This allows us to consider how structured knowledge and automated pedagogical responses are formed in future teachers within AI-mediated environments.

Connectivism serves as the ontological foundation of subjectivity in digital contexts, positing that knowledge is distributed across networks of agents (Siemens, 2005). Accordingly, the teacher is not the sole bearer of knowledge but a navigator and facilitator of networked flows.

Actor-network theory (ANT) enables us to conceptualize the interactions between teachers, learners, AI systems, digital platforms, and institutional structures as a symmetrical network of actors (Whittle, 2008), positioning the facilitator as a mediating link in this distributed educational dynamic.

A central role is also played by theories of embodied cognition and enactivism, which suggest that learning and understanding emerge through sensorimotor engagement, teloreflection, and the embodiment of thought (Varela et al., 1992).

The research stages included the following:

- Theoretical analysis of the concepts "teacher-facilitator," "intellectual polysubject," and "AI pedagogy";
- Modeling a four-phase trajectory of teacher preparation;
- Development of diagnostic tools for assessing subjective maturity.

Methodological validity is achieved through theoretical depth and interdisciplinary synthesis, alignment with modern embodiment-learning concepts, relevance to real challenges in digital pedagogy, and the justification of multilayered subjectivity via visual-phase models and diagnostic instruments.

4. RESULTS

We interpret our concept of teacher-facilitator preparation in the form of a block-hierarchical diagram (Figure 1), which outlines the key elements of preparing a new type of teacher facilitator.

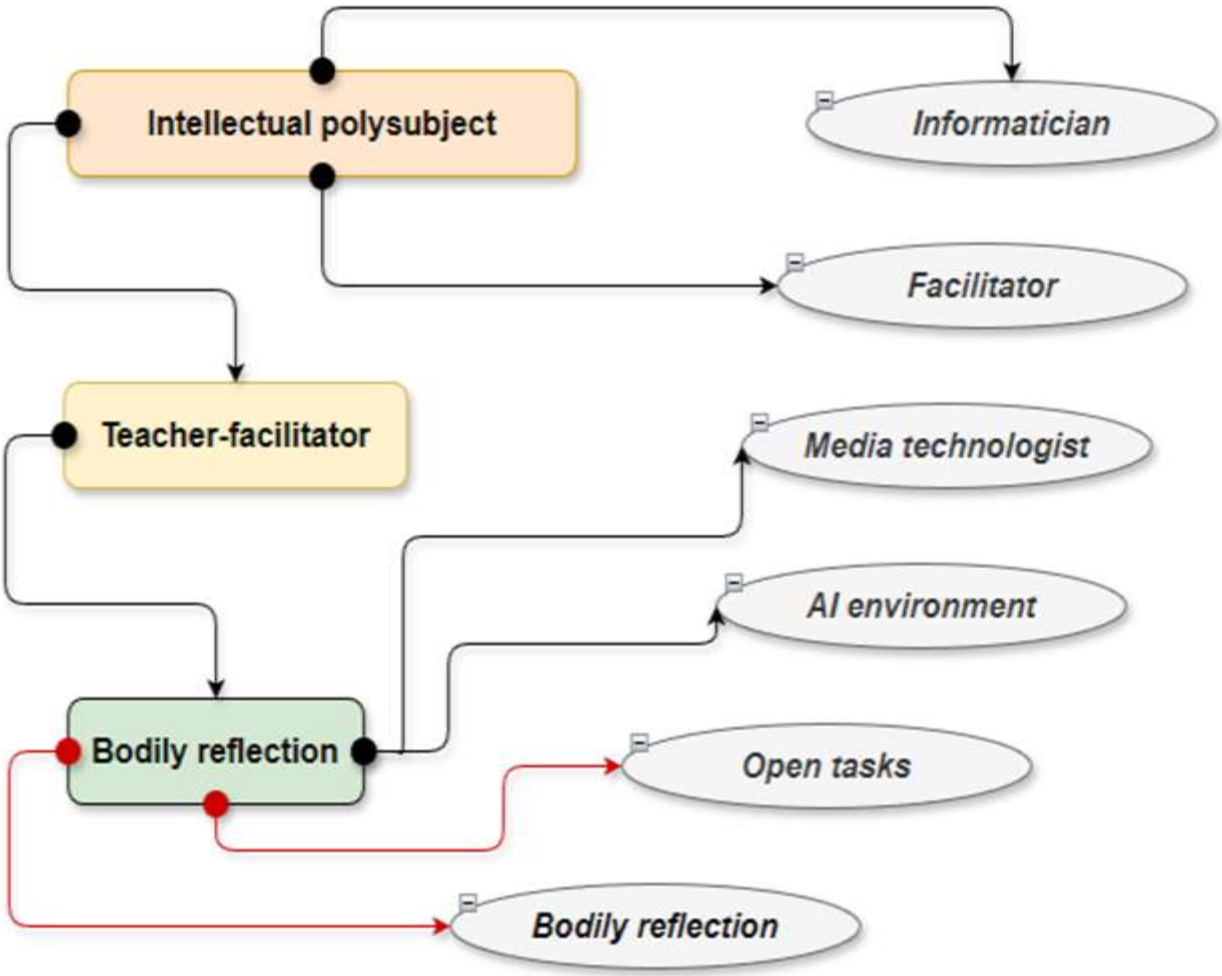

Figure 1: Conceptual Model of Teacher-Facilitator Preparation.

The conceptual structure is organized into four foundational layers:

- Philosophical foundations (bottom layer): radical constructivism, subjectivity, and the ontology of human–AI interaction;
- Methodological components: open-ended tasks, bodily reflection, and cognitive facilitation practices;
- Educational modules: teloreflection, AI literacy, and group facilitation;

- Outcomes and target competencies: the teacher as an intellectual polysubject—an integrator of thinking, empathy, and technology.

The central element of our concept is the intellectual polysubject. In a first approximation, this term synthesizes and localizes a multiplicity of competencies: embodied-empathic, cognitively open, digitally algorithmic, and group-organizational. In this sense, we describe a new type of educational subject capable of operating in unstable, postclassical, and digital environments (see Fromm, 2010; Foerster, 2003).

Each module in our model is not isolated but directly corresponds to a target competency, as reflected by directional arrows. For example, the "AI literacy" module directly supports the development of the AI navigator role. "Teloreflection" strengthens the facilitator's empathic resilience. These align with modern competency-based design approaches in EdTech (Zawacki-Richter et al., 2019).

A distinctive feature of our model is the integration of embodied reflection as a full-fledged educational layer. Traditional digital pedagogy often neglects the body as a cognitive agent. Here, embodiment is not a peripheral aspect but the core of facilitation and empathy, which is especially relevant in online interactions (see Halprin, 2021). A distinctive feature of our model is the integration of embodied reflection as a full-fledged educational layer. Traditional digital pedagogy often neglects the body as a cognitive agent. Here, embodiment is not a peripheral aspect but the core of facilitation and empathy, which is especially relevant in online interactions (see Halprin, 2021).

In summary, our visualization of teacher-facilitator preparation presents a holistic architecture, encompassing philosophical, methodological, technological, and pedagogical layers. The target model depicts the teacher not only as an AI-literate specialist but also as a synthesis of meta-, soft-, and hard competencies.

The model is fully applicable to real retraining programs: each module may serve as a training unit, including both embodied and cognitive diagnostics.

We believe that the visual logic of the model effectively conveys the transformation of the teacher—from an AI user to a facilitator of meaning-making spaces, where AI acts as a partner in the educational process rather than a replacement.

4.1. The Intellectual Polysubject

The concept of the intellectual polysubject is a philosophical and pedagogical construct that reflects the transformation of subjectivity under conditions of digitalization and cognitive decentralization. In classical ontology, the subject is understood as a center of autonomy, consciousness, and agency. However, in the age of AI—when activity, knowledge, and coordination are increasingly distributed among humans and intelligent agents—it becomes necessary to rethink subjectivity not as individual and closed but as relational and distributed.

Polysubjectivity (from the Greek πολὺς — "many") in this context refers not only to the multiplicity of participants but also to a distributed, synergistic form of subjectivity arising from the joint resolution of tasks by humans, digital tools, and algorithms. This is not a solitary subject but one organized through facilitation, mediation, and cognitive interaction, where AI acts as a cognitive partner rather than an object of manipulation.

Thus, in our framework, the intellectual polysubject is a new type of teacher—one who thinks within conditions of distributed cognitive load, consciously integrates AI agents into the educational process as participants in cognitive activity, develops collective thinking through open-ended tasks and facilitative practices, and maintains an embodied-empathic presence, critically retaining the human component.

Ontologically, this is not a subject as a closed "I" but a node in a dynamic network of meanings, bodies, and interfaces. Such a subject requires a unique form of pedagogical preparation—one that combines digital and AI literacy and facilitates soft skills, bodily and ethical reflection, and the capacity for meta-level thinking.

Hence, the notion of the intellectual polysubject clearly transcends both the humanistic and technocratic models of education, offering a new ontology of subjectivity in postclassical digital pedagogy. That is, we are speaking of a subject capable of mediating meaning, ethics, and embodiment between people and algorithms in contexts of uncertainty and cognitive overload.

This prompts a necessary question about the nature of the differences between the classical educational subject and the intellectual polysubject. We interpret this distinction in the form of the following differential table:

Table 1: Comparison of the Classical Educational Subject and the Intellectual Polysubject.

Parameter	Classical Educational Subject	Intellectual Polysubject
Ontology	Individualism: the subject as autonomous self	Distributed subjectivity: a node in a human–technology–group cognitive network
Educational focus	Knowledge transmission from teacher to student	Coconstruction of knowledge through facilitation, AI, and open-endedness
Cognitive center	Individual consciousness	Collective thinking, algorithmic patterns, embodied coparticipation
Role of AI	Tool subordinated to the teacher	Partner in cognitive interaction and source of alternative thinking patterns
Role of the body	Mediated and secondary	Full-fledged cognitive module: teloreflection, embodied cognition
Task type	Closed, with fixed answers	Open-ended, facilitated, with multiple solution trajectories
Communication	Vertical: teacher to student	Horizontal: facilitator – AI – group – bodily signals
Thinking mode	Linear-analytical	Meta-, systemic, stochastic, integrative
Teacher's role	Knowledge transmitter, controller	Facilitator, mediator, designer of learning environments
Learner's role	Object of pedagogical influence	Coauthor of the process, bearer of a fragment of distributed intelligence
Educational goal	Knowledge and competence	Meaning-making, navigation through uncertainty, ethical positioning in a techno-environment

This table demonstrates the ontological and functional shift in 21st-century pedagogy, driven by the growth of algorithmic environments, the need to address complex unstructured tasks, and renewed attention to bodily and ethical aspects of education. Figure 2 shows a diagram of subjectivity in education.

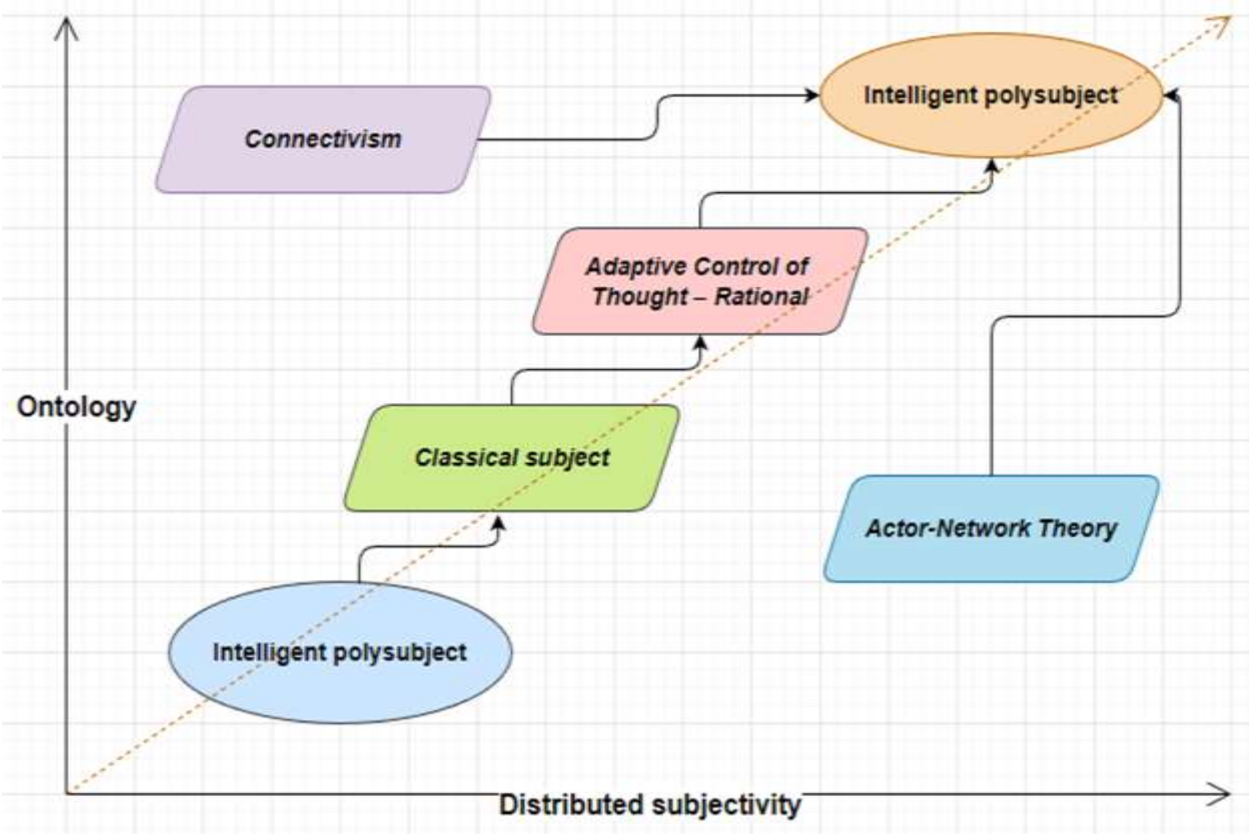

Figure 1: Diagram Of Subjectivity in Education.

The diagram presents causal relationships and a comparison with the ACT-R, connectivism, and actor-network theories. It depicts an evolutionary trajectory of teacher subjectivity through five key stages: teacher-transmitter, teacher-organizer, coach, facilitator, and intellectual polysubject. This visual model traces increasing levels of subjective engagement, openness of cognitive environments, and technological mediation.

The key stages of the dynamics of subjectivity in education can be interpreted in Table 2.

Table 2: Key Stages in The Dynamics of Subjectivity.

Stage	Characteristics	Limitations
Transmitter	Transfers knowledge, relies on authority	Minimal learner subjectivity
Organizer	Structures instruction, sets boundaries	"Plan → execution" logic, lacks depth of meaning
Coach	Stimulates development, uses guiding questions	AI and body not integrated
Facilitator	Creates space for group reflection	May underestimate digital environment
Intellectual Polysubject	Coauthor, mediator, integrator of AI, body, and group	Requires new preparation and ontology

We conclude that the polysubject model synthesizes the cognitive mechanisms of the ACT-R, the networked logic of connectivism, and the actor dependencies of ANT while adding embodied, ethical, and facilitative components. Overall, the model of the intellectual polysubject combines the strengths of classical and contemporary cognitive theories, enriched by the bodily ethical layer, which makes it fundamentally novel.

In Figure 2, we consider three models—the ACT-R, connectivism, and actor-network theories. We present a detailed comparison of the intellectual polysubject model with these three theoretical frameworks according to core criteria: subjectivity, structure, role of the environment, knowledge dynamics, and technology function.

Table 3: Comparison Of the Intellectual Polysubject Model with the ACT-R, Connectivism, And ANT.

Criterion	Intellectual Polysubject	ACT-R (Anderson, 1996)	Connectivism (Siemens, Downes)	Actor-Network Theory (Latour, Callon)
Type of subjectivity	Distributed, multiple, includes AI, group, and body (polysubject)	Individual cognitive architecture with modular structure	Networked subject as a node in a knowledge web	Subject as the effect of network action among human and nonhuman agents
Ontology of knowledge	Integrative, embodied, meaning-making in dialog with algorithms	Declarative and procedural memory governed by rules	Distributed knowledge emerging from connections	Knowledge as a product of translation and mobilization of actors
Role of AI and digital agents	Equal cognitive agents in thinking and facilitation	External support tools for cognition	Key nodes in learning networks	Actors equal to humans and objects
Role of body and empathy	Central cognitive component (teloreflection, empathic facilitation)	Not included	Partially considered but poorly formalized	Mostly ignored
Task and environment type	Open-ended, facilitated, unstable tasks with high uncertainty	Stable problem-solving in controlled environments	Constantly shifting, distributed digital environments	Environment as a stage for actor interplay, not fully controllable
Communication	Horizontal: human – AI – group – body (meta-communication)	Internal information processing, external context secondary	Communication between nodes as information flow	Mediation among various types of actors
Educational goal	Development of subjective maturity, facilitation of meaning, empathy, and critical AI thinking	Effective cognitive task-solving and thinking simulation	Ensuring networked access to knowledge	Tracing how truths, technologies, and networks are shaped
Novelty	Combines and extends all three models with embodiment, empathy, open-endedness, and subject ontology	Specialized cognitive processing architecture	Sociodigital learning theory	Sociotechnical interaction theory

The ACT-R is a sophisticated cognitive architecture that models many aspects of human thinking. However, it excludes embodiment, empathy, and social facilitation—all of which are critical for teacher preparation in the AI era. The polysubject, by contrast, is constructed as an expanded consciousness incorporating body and digital agents.

Connectivism sees learning as the creation and navigation of distributed networks of knowledge. This is close to the logic of the polysubject, yet it insufficiently accounts for empathic and facilitative dimensions. The intellectual polysubject builds not only a cognitive network but also a bodily and meaning-oriented network.

ANT is strong in describing how an action is distributed among humans, things, and ideas. The polysubject inherits ANT's notion of multiple agents but augments it with agency, goal orientation, and pedagogical responsibility—dimensions largely absent in ANT.

Thus, we interpret the intellectual polysubject model as a meta-theoretical construct capable of synthesizing and expanding cognitive, networked, and actor–mediator approaches. It proposes a new ontology of pedagogical subjectivity that incorporates the body, AI, emotion, group dynamics, and meaning facilitation. For pedagogy and teacher preparation, this represents an evolutionary leap—from cognitive trainers and network mediators to facilitators of meaningful, embodied digital environments.

In practice, this model can be operationalized through a diagnostic tool for assessing teacher subjectivity in AI-mediated environments. The structure of this tool is presented in the table below.

Table 4: Structure Of the Teacher Subjectivity Rubric.

№	Criterion of Teacher Subjectivity	Description	Skill Type	Score (1–5)
1	AI Literacy	Ability to understand and apply AI as a partner in educational tasks	Hard	
2	Meaning Facilitation	Ability to organize group interaction and support collective thinking	Meta	
3	Embodied Reflection	Conscious use of body, gestures, facial expressions, and embodiment in pedagogy	Soft	
4	Digital Empathy	Ability to recognize emotional states in digital communication and build trust	Soft	
5	Openness to Uncertainty	Readiness for change, creativity in instability, acceptance of ambiguity	Meta	
6	Ethical Coagency	Ability to build responsible interaction with AI (without blind dependence or fear)	Meta	
7	Open-ended Task Work	Skills in designing, facilitating, and assessing open ("wicked") educational tasks	Hard/Meta	
8	Subjective Reflection	Awareness of one's role, boundaries, responsibility, and impact in the learning system	Meta	

Interpretation of scores:

- 8–16 points: Low level of subjectivity; the teacher acts as a transmitter, with limited use of AI or embodiment.
- 17–28 points: Medium level; the teacher integrates some elements of facilitation and AI but remains within conventional structures.
- 29–40 points: High level: the teacher functions as an intellectual polysubject capable of facilitating digital thinking, ethically mediating AI, and embodying meta-competencies.

This diagnostic rubric for teacher subjectivity in AI contexts can serve as a dynamic monitoring tool in educational practice. It can be implemented in teacher training institutions and professional development courses. We believe this tabular visualization clearly illustrates the shift in the paradigm of subjectivity—from transmission to cocreation.

4.2. Facilitator Development Roadmap

We interpret the step-by-step trajectory of becoming a teacher facilitator through four sequential stages:

- Stage 1: Personal sensitivity and teloreflection

Goal: Develop bodily awareness, emotional empathy, and reflective capacity;

- Stage 2: Working with open-ended tasks

Goal: Developing creative, critical, and cross-disciplinary thinking;

- Stage 3: AI-Didactics

Goal: Master basic and advanced skills for integrating AI into the educational process.

- Stage 4: Group Facilitation + Collective Reflection

Goal: Develop a facilitative teaching style, manage group dynamics, and organize collaborative thinking.

On the basis of this progression, the facilitator development roadmap in the AI era—including goals, key skills, methods, and performance indicators—is presented as follows (see Table 5)

Table 5: Facilitator Development Roadmap.

Stage	Name	Key skills and competencies	Methods and tools	Achievement indicators
Stage 1	Personal sensitivity and body reflexivity	- Conscious perception of body signals - Emotional self-observation skills - Acceptance of other people's positions	- Exercises of body reflection - Psychodrama, body practices - Analysis of video feedback - Diary of sensations	The participant consciously uses body language. Has skills of body regulation. Able to recognize emotional states in a group

Stage 2	Working with open tasks	- Ability to formulate open questions - Generation of hypotheses and alternatives - Collective thinking	- Open-ended task method - Project and problem-based learning - Case analysis - Modeling and discussion of real pedagogical situations	The student creates his own open-ended problems Participates in discussions Shows growth in cognitive flexibility and reasoning
Stage 3	AI-didactics	- AI literacy (ChatGPT, Copilot, LMS-AI) - Ethical attitude toward AI - Designing lessons with AI	- Modules on working with AI - Analysis and creation of educational tasks with AI - Essay on the topic of the boundaries of AI - Role-playing simulations (teacher-AI-student)	Applies AI in didactics Develops AI-integrated lessons Able to critically reflect on the risks/opportunities of AI
Stage 4	Group facilitation and collective reflection	- Group management skills - Empathic listening and engagement - Conducting collective reflection	Facilitated activity scenarios - Games, debates, facilitation sessions - Reflective circles - Use of body language and feedback	Leads independently facilitated session Participants show increased cooperation Conscious "we-thinking" (polysubjectivity) appears

We summarize the logic and synergy of the stages as follows:

- Stage 1 forms the emotional and somatic foundation; without teloreflection, empathic interaction is impossible.
- In Stage 2, cognitive tools for navigating uncertainty, creativity, and critical thinking are developed.
- Stage 3 provides technological fluency, transforming the teacher into a digital moderator.
- Stage 4 integrates all the elements into facilitative practice: the teacher becomes a reflective, ethical, technologically savvy facilitator working with the group as an intellectual polysubject.

This dynamic may also be implemented cyclically—for example, repeating the stages each semester with increasing complexity. Each stage can conclude with an assessment.

Contemporary education demands not only the training of new teachers but also the retraining and upskilling of current educators—especially during digital transformation and AI integration. Our model, which is based on teloreflection, open-ended tasks, and AI integration, is highly adaptable and suitable for short-term or intensive professional development.

We further suggest a modular adaptation for educational courses. Each of the four stages may be delivered as an independent short module (16–24 hours):

- Module 1: Teloreflection and pedagogical empathy—a training program for overcoming communicative barriers and developing nonverbal professional behavior.
- Module 2: Designing and applying open-ended tasks—a practicum for rethinking curriculum through open didactics.
- Module 3: Rapid AI literacy for educators—intensive training in the use of neural tools, with a focus on ethics and effectiveness.
- Module 4: Facilitation and Group Dynamics in Education – an interactive workshop on group management, facilitation techniques, and reflective practices.

Each module may function independently, enabling a "pedagogical assembly" model tailored to teachers' needs.

Our model also enables a multilevel certification system for educators. For example:

- Level 1: "Basic Facilitator" – trained in open-ended tasks and foundational facilitation.
- Level 2: "AI Navigator in Education" – capable of integrating AI into teaching and training others.
- Level 3: "Polysubjective educator" – proficient in teloreflection, group facilitation, and critical AI interaction.

Such a certification system may become a national standard for 21st-century competencies and be embedded in accredited training programs.

In summary, our facilitator preparation model can be applied not only in universities but also in large-scale retraining programs. Its modular design, practical focus, emphasis on key pedagogical transformations (AI, facilitation, awareness), and flexible learning formats make it highly effective.

We believe that this model can serve as the foundation for a new architecture of future teacher education: fast, deep, value-oriented, and digitally literate.

4.3. Architecture Of Future Teacher Education

Figure 3 illustrates the architecture of future teacher education.

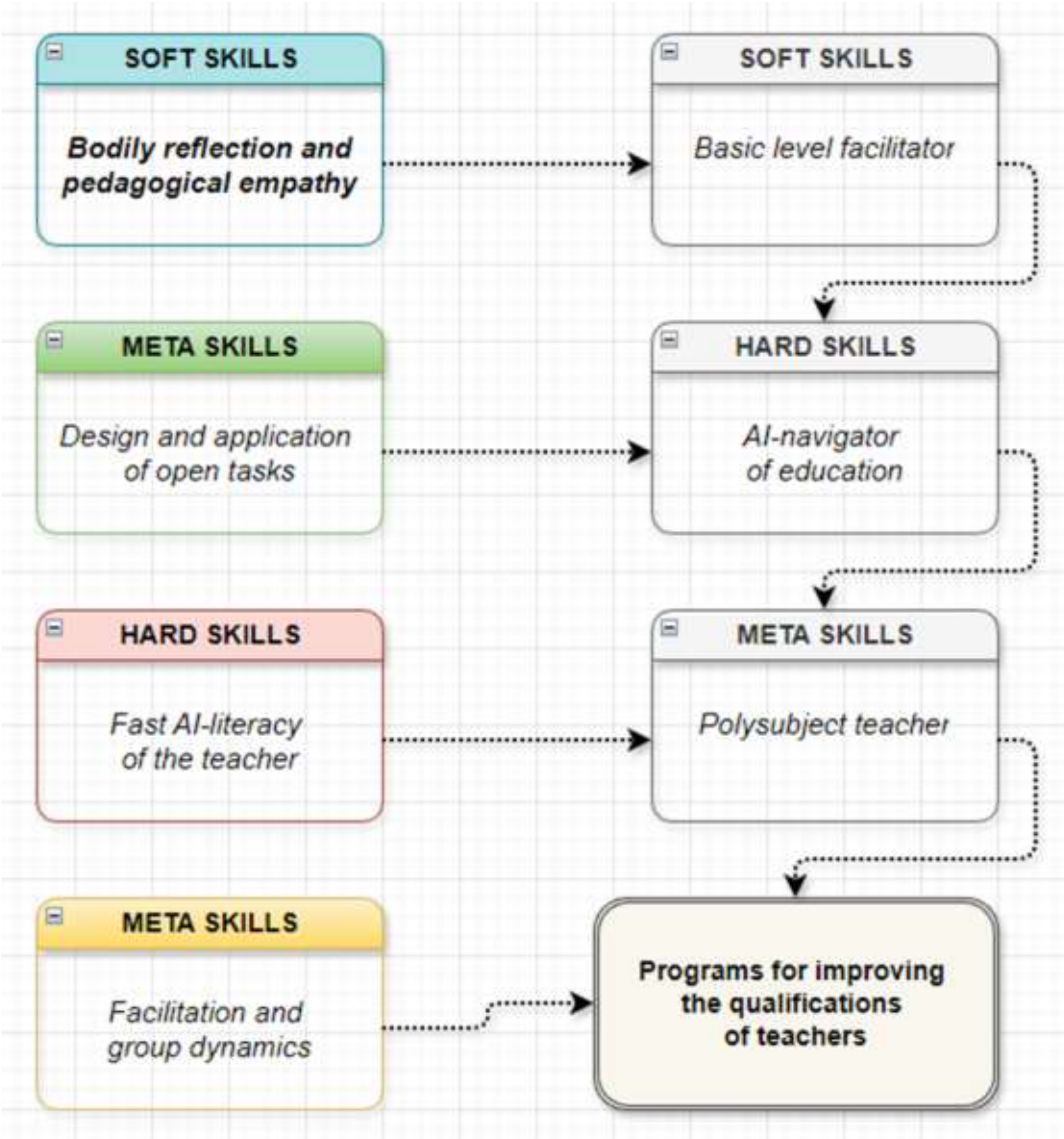

Figure 3: Architecture Of Future Teacher Education.

The visualization is designed as a two-column modular architecture, which represents two interrelated pillars:

- Left side: a sequence of short-term modules representing the step-by-step development of key components of facilitative pedagogy.
- Right side: the corresponding multilevel certification system resulting from module completion.

Both pillars converge at the base into a common implementation field: "Teacher Professional Development Programs", highlighting the model's compatibility with formal continuing education (see Table 6).

Table 6: Training Modules.

Module	Focus	Skill Type
Teloreflection and Pedagogical Empathy	Emotional and nonverbal sensitivity	Soft skills, embodied cognition
Designing and Applying Open-Ended Tasks	Creativity, critical thinking	Cross-disciplinary, cognitive
Rapid AI Literacy for Educators	AI competencies	Technical and methodological
Facilitation and Group Dynamics	Group management, community engagement	Communicative, reflective

Each module follows a logical progression—from inner awareness to technological and social influence in the learning environment.

Table 7: Certification Levels.

Certificate	Competencies	Equivalent
Basic Facilitator	Empathy, nonverbal interaction	Entry-level soft-skills module
AI Navigator in Education	Conscious AI integration, methodological flexibility	Technological maturity
Polysubjective Educator	Synthesis of empathy, technology, facilitation	Highest level, teacher of the future

This tabular visualization serves as a framework for the digital–humanistic profile of the 21st-century teacher.

We emphasize the pedagogical relevance of this model. The modular format supports implementation in time-constrained environments. Certification enables integration into official training programs and standards (see Table 7).

The architecture is grounded in a profound pedagogical idea: the evolution of the teacher from a transmitter to a cocreative facilitator. The vertical structure reflects the increase in complexity and responsibility, which is consistent with a cognitive development ladder.

This visualization effectively conveys the philosophy and structure of the facilitator preparation program. It unifies personal growth, pedagogical reflection, AI literacy, and facilitation into a holistic model. The design is scalable, the modules are reusable, and the certification path supports career and professional growth.

5. DISCUSSION

The technology for training future informatics teachers presented in our article reflects a qualitatively new approach to shaping professional subjectivity in the context of education's digital transformation. A key contribution of this study is the integration of three core dimensions—facilitation, artificial intelligence (AI), and bodily reflection—into a unified pedagogical framework, enabling a systemic and nonlinear model of teacher preparation.

First, we emphasize the shift from a reproductive paradigm to a facilitative paradigm. In the traditional system, the teacher is positioned as a knowledge transmitter. In contrast, the model described here positions the teacher as a moderator of meaning, a designer of learning environments, and a mediator between AI and the learner. This aligns with modern pedagogical transformations rooted in connectivism and distributed cognition theory, where knowledge is coconstructed within a network of agents, including digital ones.

Second, the development of a stepwise pedagogical roadmap (TCR model: teloreflection – open-ended tasks – AI-didactics – facilitation) constitutes an important methodological advance. It not only enables instruction but also allows for the determination of the future teacher's subjective maturity. Positioning teloreflection as the initial phase emphasizes embodied cognition—learning through bodily awareness and internal consciousness.

Third, the comparison of the intellectual polysubject model with the ACT-R cognitive architecture, connectivism, and actor-network theory (ANT) demonstrates the interdisciplinary and integrative validity of the approach. In AI-enriched environments, subjectivity is no longer a static trait of the individual but rather a dynamically evolving configuration of meaning, embodied involvement, cognitive flexibility, and technological fluency.

Fourth, the diagnostic tool we developed to assess the level of teacher subjectivity in AI settings (including questionnaires, rubrics, and tiered profiles) shows strong applicability in teacher education and retraining practices. This is especially relevant in the face of accelerated digital transformation, where limited time demands fast and adaptive assimilation of new professional roles.

Finally, the visual model of multilayered subjectivity presented in our study (from the sensory to the ethical level), along with the diagram of pedagogical subjectivity evolution, not only reflects the developmental logic of future educators but also provides a foundation for designing adaptive learning trajectories, including AI-assisted systems.

We therefore argue that the proposed model may serve not only as a pedagogical technology but also as a methodological foundation for rethinking the very role of the teacher in the age of artificial intelligence. It opens pathways for future empirical research, validation of the proposed tools, and scalable implementation in professional development systems.

The modular model we propose, composed of four interconnected blocks (tele reflection, open tasks, AI-didactics, and facilitation), offers high flexibility in both duration and format. In our view, each module should be designed for 16–24 academic hours and can be implemented in various modes:

- as an intensive format (e.g., 3–4 consecutive days),
- in remote or blended mode (e.g., 2 hours per week for a month),

- as an embedded section in professional development programs, master's programs, or pedagogical residencies.

Importantly, owing to the independence of the modules, they can be combined to meet the objectives of specific programs while preserving the overall trajectory of development—from personal awareness to facilitation mastery. If desired, an educational institution may implement the model in stages, for instance, starting with one or two modules (such as "open tasks" and "AI literacy") and gradually increasing complexity.

From the outset, we designed the model to be scalable. This is achieved through its modular architecture (each block as an independent learning segment with its own outcomes), a tiered certification system (levels from "Basic Facilitator" to "Polysubjective Educator"), cyclic re-engagement (the same instructor can return to the modules after six months or a year with increased complexity), and its compatibility with current formats of training and retraining.

We also believe that, at the university level, integration is possible within master's programs in education, EdTech curricula, and mentorship tracks. Within continuous education systems, this model may serve as a core for a new architecture of accelerated acquisition of AI tools, project-based formats, and facilitation skills. Special attention in our model is given to feedback mechanisms: reflective journals in which educators reflect on their own transformation and track the dynamics of their pedagogical stance; peer analysis of educational tasks and lessons; professional transformation rubrics that track the shift from traditional teaching to facilitation; and student feedback that reflects changes in the classroom atmosphere, engagement, and trust levels. We believe that this system not only ensures educators' conscious engagement in the learning process but also allows institutional administrators to monitor the program's impact on teaching practices, engagement, and readiness for AI integration. Thus, the modular structure of our model is not an abstract set of theoretical elements but a practical, operationalized, and adaptive architecture that can be implemented across educational institutions of various levels—from departments to national professional development programs. We emphasize that this structure combines cost efficiency, short-term effectiveness, and long-term pedagogical transformation.

6. CONCLUSION

In the context of the rapid development of artificial intelligence and the transformation of the teacher's role in digital society, the need arises for preparing a new type of specialist—the teacher-facilitator—capable of integrating AI tools into the learning process, managing open educational scenarios, and sustaining learners' subjectivity. The training model we present for future informatics teachers is built upon the synthesis of cognitive, bodily, and facilitative practices, forming what we refer to as the intellectual polysubject—a pedagogical figure of a new type.

The key outcomes of our study include the following:

- the conceptualization of pedagogical subjectivity in AI environments through a multilayered architecture (cognitive, reflective, ethical, and embodied levels),
- the development of a four-phase facilitator trajectory (teloreflection – open-ended tasks – AI-didactics – facilitation),
- the creation of assessment and self-assessment tools (TCR questionnaire, competency rubric, subject-evolution matrix),
- and theoretical comparisons with the ACT-R, connectivism, and actor-network theories, confirming the interdisciplinary coherence of the approach.

This training model is scalable, flexible, and applicable not only in teacher training universities but also in professional development courses, mentorship programs, and broader digital transformation efforts in education. Its implementation supports the development of teachers who can guide students through uncertainty, work with AI as a partner, and establish educational practices on the basis of meaning, coauthorship, and subjective reflection.

Thus, the proposed model contributes to the advancement of contemporary pedagogical science in response to the challenges of the postdigital era. It lays the groundwork for further empirical research, testing, and adaptation across educational contexts.

The technology for preparing future informatics teachers to use AI in facilitative tasks enables a rethinking of not only the content and methods of teacher education but also the very ontology of subjectivity in the age of digital thinking.

The model of the intellectual polysubject, which underpins this technology, demonstrates a high degree of integration across bodily reflection, facilitating, and AI competence, forming a holistic, multilayered pedagogical subject with adaptability, empathy, agency, and technological embeddedness.

On the basis of our findings, we offer the following

development forecast:

- There is a growing demand for educators capable of organizing collective meaning-making, dialogical thinking, and collaborative open-ended problem solving.
- There is increasing emphasis on embodied and mindful pedagogical practices, particularly in response to burnout and digital stress.
- Future teachers will combine the roles of mentors, mediators, AI navigation coordinators, and digital architects in the learning environment.
- Practices for measuring subjectivity (based on teloreflection, facilitation, AI literacy, etc.) will be integrated into certification and accreditation systems.

On the basis of the results, we propose the following policy and educational recommendations for practical implementation of our model:

- Integrate AI-facilitation competencies into national educational standards for teacher training (both university and professional development programs);
- Develop a national professional development programme on AI pedagogy and facilitative strategies, including online and blended learning modules;
- Establish practitioner-oriented workshops on teloreflection, open-ended task design, and AI-didactics, especially in rural and remote schools;
- Institutionalize diagnostic tools for pedagogical subjectivity, including questionnaires, cases, facilitation simulations, and AI-driven monitoring;
- Support research initiatives in cognitive pedagogy, embodied learning, digital facilitation, and human-centered AI teacher training;
- Flexible learning pathways and modules are designed on the basis of the TCR model, which is embedded in master's programs, residencies, and other qualification formats.

Thus, our study not only contributes to advancing the theory and practice of pedagogical facilitation but also lays the foundation for normative transformations in teacher education within the context of the emerging hybrid schools of the future.

Although this article has focused on the theoretical and architectural development of a modular model for teacher training in the context of AI transformation, the next critically important phase of development will be its empirical validation and pilot implementation.

In the upcoming academic years (2025–2026), we plan to carry out a structured pilot aimed at assessing the effectiveness of each of the four modules (tele reflection, open tasks, AI-didactics, facilitation), both individually and in a cohesive sequence.

This will allow us to empirically confirm that the completion of each module leads to measurable changes in the professional stance of educators. It will also enable us to identify the most significant effects of the model in terms of perceptions of AI, open didactic strategies, and facilitative thinking. Additionally, we assess implementability, user response, pedagogical safety, and institutional barriers. This foundation will support the scaling of the model into professional development and master's programs.

The planned supplementary study will take the form of a qualitative–quantitative pilot with elements of design-based research (DBR) conducted in real educational environments. We intend to use an intervention-oriented quasiexperimental format employing mixed methods.

We anticipate involving 3 to 5 cohorts of instructors (15–25 participants per cohort), representing various disciplines, including education, humanities, and technical fields.

This validation will not only confirm the real-world viability of the theoretical model but also generate a body of localized empirical data necessary for further publication, scaling, and adaptation to national teacher development programs. Moreover, it helps identify potential risks and limitations—whether institutional, technical, or cognitive—and converts them into opportunities for improvement in the next iteration of the model.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, X.X. and Y.Y.; methodology, X.X.; software, X.X.; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing—original draft preparation, X.X.; writing—review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript." Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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