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TEACHER EDUCATION FOR AI WITH ELEMENTARY SCHOOL STUDENTS: CRITICAL MEDIATION, ETHICS AND PEDAGOGICAL INTENTIONALITY

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ABSTRACT

The growing presence of artificial intelligence in educational platforms and everyday digital services is reshaping teaching and learning in elementary schooling, demanding teacher education that goes beyond technical training. Grounded in a narrative literature review, this chapter discusses teacher education for pedagogical work with AI with children and early adolescents, articulating three interdependent dimensions: intentional pedagogical mediation, sociotechnical ethics, and algorithmic criticality. The discussion mobilizes Selwyn, Williamson, Holmes and Tuomi, Rojo, Lankshear and Knobel, Papert, Floridi, Noble, Benjamin, Zuboff and international guidelines, particularly UNESCO. It argues that educating teachers for AI requires understanding the non-neutral nature of technologies, the risks of

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datafication and surveillance, the reproduction of bias and inequality, and the need for didactic practices that strengthen authorship, multiliteracies, inquiry and autonomy in digital environments. The chapter proposes that teacher education should integrate theoretical foundations, critical case analysis, pedagogical criteria for AI use, data protection and collaborative professional cultures. It concludes that the ethical and educational integration of AI in elementary schooling depends on structured policies for initial and continuing teacher education, data governance, and a commitment to cognitive justice and children's rights.

Keywords: Teacher education; Artificial Intelligence; Elementary Education; Ethics; Digital culture.

INTRODUCTION

Artificial intelligence has ceased to be a theme restricted to academic research and has come to operate as everyday infrastructure for navigation, search, recommendation, personalization, and automation. In schooling, this shift manifests itself both in tools explicitly designed for education and in services widely used by students and families, in which algorithms filter information, suggest content, organize workflows, and modulate practices of reading, writing, attention, and interaction. In elementary education—where foundations of literacy, scientific thinking, cultural repertoire, and school socialization are consolidated—the presence of AI imposes a specific formative challenge: the school must act before technology becomes an invisible curriculum, naturalized and governed by logics external to the educational project.

This scenario moves teacher education to a more demanding level. It is not merely about "learning to use" tools, but about understanding how they structure social practices and, consequently, learning practices. Selwyn (2016) warns that educational technologies carry discourses of efficiency and innovation that may obscure economic interests, governance models, and power asymmetries. Williamson (2020) adds that the datafication of education transforms pedagogical processes into metrics and profiles, altering the very way that performance, risk, and quality are defined. When this process permeates childhood and the initial stages of schooling, ethical and pedagogical consequences become more sensitive: digital rights, data protection, development of autonomy, and the very social purpose of schooling are at stake.

This chapter discusses teacher education for work with AI in elementary education from a formal and critical academic perspective. It argues that teacher preparation must integrate three interdependent dimensions: pedagogical intentionality, sociotechnical ethics, and algorithmic criticality. To support this thesis, the text is organized into six sections: the first delimits assumptions about teaching and digital culture; the second examines AI as educational infrastructure and the risks of uncritical adoption; the third proposes a model of teacher competencies for AI; the fourth discusses pathways for initial and continuing education; the fifth presents implications for public policy and governance; and, finally, conclusions and recommendations are synthesized.

In this sense, discussing teacher education for work with artificial intelligence in elementary schooling implies recognizing that technology does not add itself neutrally to preexisting school practices; rather, it reconfigures meanings, temporalities, languages, and pedagogical relationships. Teacher education thus becomes a strategic space of mediation between technological innovation and educational commitment, requiring a critical reading of digital infrastructures, an understanding of their sociocognitive impacts, and a conscious definition of pedagogical criteria. From this perspective, the

chapter articulates theoretical foundations, critical analysis, and formative propositions for an ethical and educational insertion of AI in basic schooling.

TEACHING, DIGITAL CULTURE, AND THE SHIFT BEYOND TECHNICAL COMPETENCE

Teacher education, in contexts of digital culture, has historically oscillated between two poles: instrumental training (focused on tools) and critical-pedagogical education (centered on educational aims. However, the expansion of AI intensifies the limits of instrumental training. Technology is no longer merely a "resource" attachable to a lesson, but a system that participates in text production, circulation of meanings, organization of attention, and selection of what is visible. This requires that teachers understand not only operational functioning but also the sociotechnical logics that underpin the environment.

Literacy and multiliteracies studies provide a foundation for this shift. Rojo (2012) argues that contemporary language practices are multimodal, hybrid, and traversed by technical mediations, demanding from schools an expanded understanding of what it means to read and produce meaning. Lankshear and Knobel (2011) add that "new literacies" are not reducible to devices; they constitute social practices with their own values, norms, modes of participation, and regimes of visibility. When AI begins to intervene in these practices, teacher education must encompass discourse analysis, modes of authorship, information circulation, and criteria of credibility.

Within this context, it is essential to reaffirm that teaching is not substitutable by automation. Holmes and Tuomi (2022) argue that AI can support educational processes but should not be conceived as a substitute for pedagogical mediation. Teaching involves situated judgment, care, listening, contextual reading, and real-time ethical decision-making—dimensions that are not reducible to statistical patterns. Teacher education for AI, therefore, should strengthen teaching as critical and intentional mediation, rather than weaken it through technological dependency.

ARTIFICIAL INTELLIGENCE IN ELEMENTARY EDUCATION: INFRASTRUCTURE, PROMISES, AND AMBIVALENCES

To understand the formative demands placed upon the elementary teacher, it is necessary to analyze how artificial intelligence presents itself concretely in everyday schooling. More than a technological abstraction, AI today constitutes a diffuse infrastructure that permeates didactic materials, educational platforms, family practices, and students' cultural habits, producing direct effects on ways of learning, teaching, and assessment.

AI reaches elementary education through multiple avenues. It appears in adaptive platforms that promise personalization; in recommendation systems for videos and exercises; in automated correctors; in

conversational assistants; in search engines; and in digital learning environments. The most recurrent promise is personalization—adjusting pace, pathways, and feedback based on student performance. Pedagogically, this promise may be enticing, especially in heterogeneous classes. Nevertheless, algorithmic personalization requires critical examination: what is "adapted," based on which data, according to which criteria, and with what long-term effects?

Selwyn (2016) warns that the innovation narrative tends to shift the debate from educational aims to operational efficiency. This may lead schools to adopt AI as a quick response to structural problems such as insufficient planning time, large class sizes, and scarcity of pedagogical support. Williamson (2020) shows that when systems collect data continuously, they begin to classify students and guide decisions, instituting forms of governance via indicators. In elementary education, the risk is to transform child development and learning trajectories into performance profiles, reducing the complexity of learning.

There is also the dimension of algorithmic bias. Noble (2018) evidences how search and classification systems can reproduce stereotypes and inequalities, especially when training data reflect social asymmetries. Benjamin (2019) expands this by showing that technologies can operate as "codes" of exclusion, reinforcing hierarchies under the guise of technical neutrality. In the school setting, this means that recommendations, automated assessments, and content filters may unequally affect students, particularly in contexts of social and cultural vulnerability.

Finally, datafication and surveillance constitute a central ethical problem. Zuboff (2019) describes how surveillance capitalism transforms personal data into the raw material of predictions and markets. In educational environments, this process can be aggravated by the sensitivity of children's data, by power asymmetries between schools and platforms, and by low transparency regarding secondary uses of information. Teacher education, therefore, must include data governance, privacy, and digital rights as a core component, not a mere addendum.

Faced with these ambivalences—between pedagogical promise and sociotechnical risk—it becomes evident that the focus of the discussion cannot rest solely on technology itself, but on the formative conditions of the subjects who pedagogically mediate it. It is at this point that teacher education emerges as the central axis for any responsible proposal to integrate AI into elementary schooling..

TEACHER EDUCATION FOR AI: DIMENSIONS, COMPETENCIES, AND FORMATIVE CRITERIA

Educating teachers for AI in elementary schooling entails consolidating a set of professional competencies that are not to be conflated with technical mastery. Here we propose an analytical model of three interrelated dimensions: the pedagogical-didactic dimension, the ethical-legal dimension, and the

critical-epistemological dimension. These dimensions are not isolated "modules," but knowledge domains that must operate jointly in the planning, execution, and evaluation of practices involving AI.

The pedagogical-didactic dimension concerns intentionality of use. Papert (1980) already argued that technologies become educationally potent only when placed at the service of active construction, inquiry, and authorship. In AI, this means orienting use toward the production of questions, comparison of versions, review of arguments, exploration of multiple languages, and project construction. Teachers must distinguish activities in which AI supports learning from those in which it replaces the central cognitive effort, impoverishing the process. The criterion is not prohibition or blanket approval, but deciding when AI serves learning and when it undermines it.

The ethical-legal dimension involves privacy, data protection, and responsibility. Floridi (2018) argues that information ethics should guide practices in computerized societies because technical decisions produce human effects. In basic education, this entails understanding principles of data minimization, informed consent where applicable, credential security, limits on exposure of personal information, and care in the use of children's images and works. UNESCO guidelines (2021; 2023) emphasize transparency, equity, inclusion, and respect for human rights as parameters for integrating AI into education. For teachers, this translates into practical criteria: avoiding opaque tools, reducing data collection, guiding students regarding digital identity, and discussing the consequences of sharing information.

The critical-epistemological dimension concerns reading the world algorithmically. Generative AI produces plausible texts but does not guarantee truth, context, or accountability—requiring teacher education for assessing reliability, verifying sources, identifying bias, and understanding model limitations. Holmes and Tuomi (2022) insist that education for AI should include criticality regarding what AI can and cannot do. In elementary education, this converts into critical literacy practices appropriate to the age group: differentiating opinion from evidence, recognizing patterns of persuasion, comparing responses with curricular materials, and developing habits of checking.

Figure 1 – Dimensions of teacher education for the pedagogical use of artificial intelligence in elementary education

Formative Dimension	Main Focus	Implications for Teaching Practice
Pedagogical-Didactic Dimension	Intentional planning of AI use	Clear definition of learning objectives, use of AI to support investigation, authorship and critical review, avoiding substitution of the student's cognitive effort
Ethical-Legal Dimension	Protection of data and children's rights	Conscious selection of platforms, minimization of data collection, guidance on digital identity, privacy and responsible use of information
Critical-Epistemological Dimension	Algorithmic reading and evaluation of automated responses	Development of practices for comparing sources, verifying information, identifying biases and understanding the limitations of AI systems
Sociocultural Dimension	Impacts of AI on school relationships	Analysis of the effects of automation on interaction, participation, inequalities and school culture
Formative-Professional Dimension	Continuous teacher learning	Construction of communities of practice, collective reflection, pedagogical documentation and replanning of actions

Source: Created by the authors, 2025

INITIAL AND CONTINUING EDUCATION: A FORMATIVE ARCHITECTURE FOR ELEMENTARY SCHOOLING

If teacher education constitutes the structuring axis for a critical insertion of AI in basic schooling, it becomes essential to reflect on how this education can be organized institutionally. The distinction between initial and continuing education should not be understood as a rigid separation, but as a formative continuum that accompanies teachers throughout their professional trajectory.

Initial education, in teacher-training programs (licenciaturas), must integrate AI as a transversal and structuring theme, avoiding treatment as an optional subject disconnected from practice. A consistent pathway is to insert AI into components such as didactics, curriculum, assessment, and educational policy, articulating theory and practice. This enables future teachers to understand AI as a pedagogical and social issue, not as an isolated "technological innovation." At the same time, teacher preparation should promote concrete experiences of planning with AI, always focusing on learning objectives and ethical criteria.

Continuing education, in turn, should be conceived as institutional policy, not as a one-off initiative. Communities of practice, study groups, and teacher networks can sustain ongoing professional learning through case analysis, practice review, and construction of local pedagogical protocols. This format is especially relevant in elementary education, where the demands for literacy, multiliteracies, and holistic development require that technology not weaken essential human interactions, but rather support processes of authorship and participation.

A consistent formative proposal includes at least four axes of continuous work. The first is the foundations axis, in which teachers study AI concepts, limitations, biases, and social implications. The

second is the didactic axis, in which pedagogical use is planned based on objectives, authorship criteria, and assessment. The third is the ethical axis, concerning data governance, child protection, and discussions of responsibility. The fourth is the assessment and teacher research axis, in which teachers document, analyze, and replan practices, treating the classroom as a space of pedagogical inquiry.

Teacher education for work with artificial intelligence in elementary schooling must also consider the specificities of child development and learning processes characteristic of this stage. Unlike later levels, elementary education is marked by the consolidation of basic skills in reading, writing, logical thinking, social interaction, and construction of intellectual autonomy. In this context, the use of automated systems can both broaden formative experiences and compromise essential processes if it replaces practices mediated by human interaction, language, and the pedagogical time required for meaningful learning. Thus, teacher education should emphasize that AI must not operate as a cognitive shortcut but as a resource carefully integrated into practices that respect students' rhythms, needs, and individuality.

Another central aspect concerns the relationship between artificial intelligence and assessment of learning. Automated systems for correction, performance monitoring, and report generation have been incorporated into educational platforms with the promise of objectivity and efficiency. However, as Williamson (2020) argues, such systems tend to reduce the complexity of the educational process to quantifiable indicators, shifting assessment from a formative process to a logic of continuous measurement. In elementary education, this risk is particularly sensitive, as assessment exerts a strong influence on the construction of self-esteem, motivation, and the child's relationship with learning. Teacher education must therefore prepare teachers to interpret critically the data generated by AI, avoiding automatic pedagogical decisions and preserving assessment as a reflective, contextualized practice oriented toward development.

The relational dimension of teaching also assumes heightened relevance in light of the increasing presence of AI in basic schooling. Learning in elementary education is profoundly shaped by affective bonds, trust, listening, and recognition—elements that cannot be automated. Santaella (2018) highlights that in a culture marked by technical mediation, there is a risk of impoverishment of symbolic relations when technologies take the place of human encounters. In this sense, educating teachers for AI entails reinforcing the centrality of the pedagogical relationship, ensuring that the use of technologies does not weaken the teacher's role as an intellectual, ethical, and affective reference for students. AI should support teaching practice and never replace the pedagogical presence that sustains the educational process.

Moreover, teacher education for AI should foster the understanding that intelligent technologies produce distinct effects depending on the sociocultural context in which they are used. Schools located in

territories with fewer resources, unstable connectivity, or institutional fragilities tend to experience the introduction of AI unevenly, which may widen educational asymmetries. Selwyn (2016) warns that technologies often reproduce existing inequalities when implemented without equity policies and adequate formative support. Preparing teachers for the pedagogical use of AI thus also involves developing sensitivity to local contexts, enabling pedagogical choices that consider students' real conditions and avoid naturalizing homogeneous and exclusionary technological models.

Finally, it is essential to understand teacher education for AI as an ethical-political process, not merely a pedagogical one. The decision to use or not use certain technologies; to trust or question automated responses; to protect data or accept indiscriminate collection—constitutes an exercise of professional and civic responsibility. Floridi (2018) asserts that in computerized societies every technical decision is also a moral decision. In elementary schooling, this responsibility is amplified by the fact that children lack full capacity to consent or to comprehend the implications of data and algorithm use. Thus, teacher education for AI should strengthen teaching as an instance of protection, ethical mediation, and defense of children's rights, reaffirming the school as a space of humanization amid growing processes of automation.

PEDAGOGICAL PRACTICES WITH AI IN ELEMENTARY EDUCATION: PRINCIPLES FOR DIDACTIC DESIGN

To prevent the chapter from becoming a manual of tools, we propose discussing didactic design principles applicable to different realities. The first principle is the centrality of questioning: practices with AI should strengthen problem formulation, curiosity, and inquiry. Rather than soliciting "answers," teachers can guide the construction of better questions, the comparison of responses from different sources, and the identification of gaps.

The second principle is guided authorship. AI can support revisions, rewritings, and reorganization of ideas, but authorship must be maintained as a human process of choice, justification, and responsibility. Rojo (2012) and Lankshear and Knobel (2011) argue that multiliteracies involve participation and meaning production in different languages; in this scenario, AI should broaden repertoires without erasing the student's voice.

The third principle is verification as a habit. From the early grades, it is possible to teach checking practices at appropriate levels: "Where does this information appear in the textbook?" "What evidence supports this claim?" "Is there another source that confirms it?" This principle responds directly to the risk of informational superficiality and to the undue authority attributed to automated systems.

The fourth principle is care with data and with childhood. In pedagogical practice, this implies avoiding exposure of personal information, guiding the use of fictitious names in public activities,

discussing privacy in accessible terms, and selecting tools with attention to terms of use. Here, UNESCO guidelines (2023) are a reference for institutional and pedagogical decisions, as they emphasize protection of rights, inclusion, and responsibility.

IMPLICATIONS FOR EDUCATIONAL POLICY AND SCHOOL GOVERNANCE

The pedagogical reflections developed throughout the chapter show that teacher education for AI cannot be addressed solely within the scope of individual practice or isolated school initiatives. On the contrary, it is a structural issue requiring articulated educational policies capable of sustaining institutional, normative, and ethical conditions for pedagogical work with intelligent technologies.

Teacher education for AI cannot depend exclusively on individual initiative. It requires policies that articulate curriculum, teacher education, infrastructure, planning time, and data governance. Selwyn (2016) observes that technologies tend to be implemented top-down under modernization discourses without teacher participation. To reduce resistance and avoid uncritical adoption, policies should be built with schools, taking into account contexts and inequalities.

Williamson (2020) highlights that governance by data alters pedagogical and administrative decisions. Therefore, school systems must establish criteria for acquisition and use of tools, privacy protocols, transparency regarding data collection and processing, and auditing mechanisms. In basic education, this point is decisive: children must not be converted into exploitable profiles by platforms. The role of the State and educational institutions is to protect childhood and to ensure that technologies serve the educational project, not the reverse.

FINAL CONSIDERATIONS

Teacher education for work with artificial intelligence with elementary school students constitutes a formative, ethical, and political imperative of the present. As discussed throughout the chapter, AI no longer occupies a peripheral place in educational practices; it operates as infrastructure of information, language, and visibility, directly interfering with ways of reading, writing, researching, communicating, and learning. This shift, announced in the introduction, requires schools to take an active stance toward technologies, recognizing that they not only support pedagogical practices but also reorganize meanings, temporalities, and educational relationships.

In light of this scenario, educating teachers solely for instrumental use of tools proves insufficient and, in certain contexts, dangerous. Uncritical adoption of AI can intensify processes of cognitive dependency, widen educational inequalities, and legitimize forms of surveillance and datafication incompatible with the principles of basic education. As argued throughout the text, teacher education must move from an operational logic to a perspective of critical mediation capable of interrogating the

intentionalities inscribed in algorithmic systems and of defining clear pedagogical criteria for their insertion into daily schooling.

The chapter maintains that consistent teacher education for AI in elementary schooling must articulate three inseparable dimensions: pedagogical intentionality, which orients technology use via explicit formative objectives; sociotechnical ethics, which regulates decisions related to privacy, data protection, and children's rights; and algorithmic criticality, which enables understanding of limits, biases, and social effects of intelligent systems. These dimensions, anchored in robust theoretical foundations and international guidelines, constitute the core of a teaching practice capable of acting responsibly in complex digital environments.

Furthermore, it has been evidenced that the educational insertion of AI depends on consolidating collaborative professional cultures in which teachers can reflect collectively on practices, share usage criteria, and build situated pedagogical knowledge. When conceived as an articulated, institutionally supported process, initial and continuing teacher education strengthens teacher autonomy and prevents technology decisions from being imposed vertically or decontextualized. In this sense, educational policies and data governance structures become central elements to ensure ethical and pedagogical working conditions with AI in basic schooling.

It is concluded, therefore, that artificial intelligence will only contribute effectively to elementary education when subordinated to a pedagogical project committed to cognitive justice, democracy, and holistic formation. Schools must ensure that students learn not only with technology but about the technology that organizes the world they live in, developing capacities for critical interpretation, responsible authorship, and conscious participation. Thus is reaffirmed the role of teaching as indispensable human mediation in times of automation, ensuring that technological innovation does not obscure but strengthens fundamental educational principles.

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