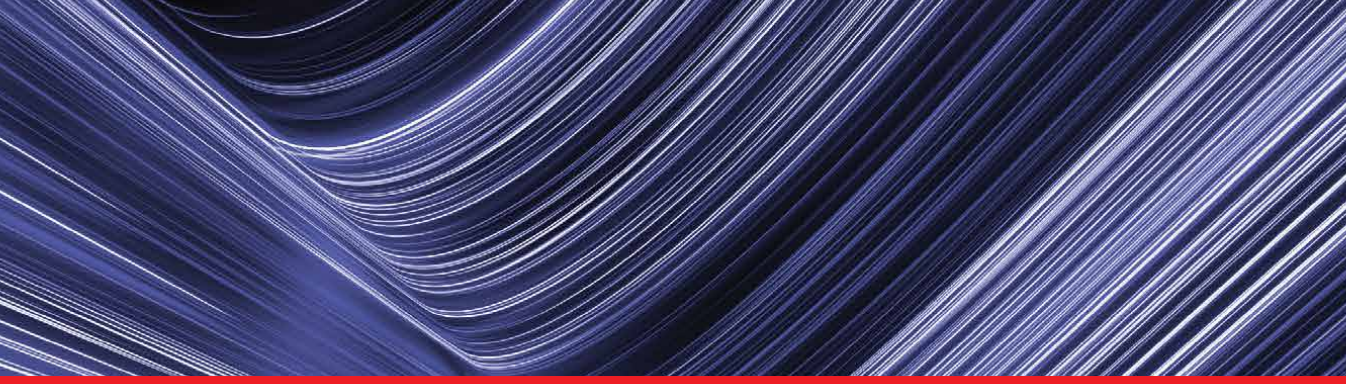

IntechOpen

IntechOpen Series
Education and Human Development,
Volume 37

Teacher Training and Student Learning

Past Values, Present Uncertainties and Future Prospects

Edited by Filippo Gomez Paloma, Pio Alfredo di Tore and Giuseppina Rita Jose Mangione

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Published in London, United Kingdom

Teacher Training and Student Learning – Past Values, Present Uncertainties and Future Prospects
http://dx.doi.org/10.5772/intechopen.1005967
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First published in London, United Kingdom, 2025 by IntechOpen
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 167-169 Great Portland Street, London, W1W 5PF, United Kingdom

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British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Teacher Training and Student Learning – Past Values, Present Uncertainties and Future Prospects
Edited by Filippo Gomez Paloma, Pio Alfredo di Tore and Giuseppina Rita Jose Mangione
p. cm.

This title is part of the Education and Human Development Book Series, Volume 37
Topic: Education
Series Editor: Katherine Meltzoff
Topic Editors: Delfín Ortega-Sánchez and Carlos Pérez-González

Print ISBN 978-1-83634-818-4
Online ISBN 978-1-83634-817-7
eBook (PDF) ISBN 978-1-83634-819-1
ISSN 2755-9513

IntechOpen Book Series

Education and Human Development

Volume 37

Aims and Scope of the Series

Education and Human Development is an interdisciplinary research area that aims to shed light on topics related to both learning and development. This Series is intended for researchers, practitioners, and students who are interested in understanding more about these fields and their applications.

Meet the Series Editor

Katherine Meltzoff received her BA in Psychology from Trinity College, in Connecticut, USA and her Ph.D. in Experimental Psychology from the University of California, San Diego. She completed her postdoctoral work at the Yale Child Study Center with Dr. James McPartland. Dr. Meltzoff' doctoral dissertation explored neural correlates of reward anticipation to social versus nonsocial stimuli in children with and without autism spectrum disorders (ASD). She has been a faculty member at the University of California, Riverside in the School of Education since 2016. Her research focuses on translational studies to explore the reward system in ASD, as well as how anxiety contributes to social challenges in ASD. She also investigates how behavioral interventions affect neural activity, behavior, and school performance in children with ASD. She is also involved in the diagnosis of children with ASD and is a licensed clinical psychologist in California. She is the Assistant Director of the SEARCH Center at UCR and is a faculty member in the Graduate Program in Neuroscience.

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Contents

Preface

With great enthusiasm and deep personal engagement, I am pleased to present this volume, "Teacher Training and Student Learning – Past Values, Present Uncertainties and Future Prospects", the result of a collective effort born from a strong and shared conviction: teacher education is today more than ever a dynamic and evolving field, traversed by complex challenges and extraordinary opportunities. In recent years, it has undergone radical transformations, driven by technological innovation, global socio-political shifts, and the continuous evolution of educational paradigms.

This volume brings together 24 contributions that, like voices in a harmonious choir, offer a rich, multifaceted, and deeply human perspective on the new directions of teacher education. Each chapter is an invitation to explore, reflect, and imagine: from theoretical frameworks to practical field experiences, the contributions present innovative approaches, emerging methodologies, and reflective strategies designed to support teachers—both in training and in service—as they navigate increasingly dynamic, complex, and demanding learning environments.

The pages of this book resonate with lived experiences and diverse perspectives, shared by researchers and professionals working in varied educational and cultural contexts. The issues addressed are of critical importance: digital transformation, sustainability, inclusion, linguistic and cultural diversity, and the redefinition of the teacher's professional identity. Through experiential narratives, critical reflections, and theoretical tools, the authors sketch a vision of teacher education that remains firmly grounded in the realities of today's schools, while keeping an eye on the future.

Despite the diversity of viewpoints, several key themes emerge with clarity and strength: the centrality of reflective practice, the value of autonomy and agency in teachers' professional development, and the urgent need for educational practices that can effectively respond to both global challenges and local needs.

This volume does not claim to offer definitive answers. On the contrary, it aims to be an open space for dialogue, experimentation and shared thinking. It embraces the complexity of the present and transforms it into fertile ground for meaningful change.

It is an invitation extended to teacher educators, researchers, policymakers, and, above all, to those who live and breathe the school environment with passion

and dedication: teachers. To them, this volume offers inspiration, tools for reflection, and authentic opportunities for renewal.

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Chapter 2

Perspective Chapter: Embodied AI and the Educational Turn – From Cognition to Situated Presence

Giuseppina Rita Jose Mangione, Pio Alfredo Di Tore and Filippo Gomez Paloma

Abstract

This chapter explores the transformative potential of embodied artificial intelligence (Embodied AI) in education, focusing on fragile learning ecologies such as rural schools and homebound instruction. Grounded in the theoretical framework of embodied cognition, the work critically reframes educational technology by emphasizing the bodily, relational, and emotional dimensions of learning. Drawing on international literature and Italian case studies—particularly those involving small schools and domiciliary education—it articulates three key axes of analysis: teachers' professional reflection in isolated contexts, embodied educational leadership, and student support in conditions of isolation. Rather than positioning Embodied Conversational Agents (ECAs) as replacements for human actors, the chapter presents them as relational infrastructures capable of sustaining presence and promoting situated learning. It argues for a participatory and co-designed approach to educational AI—one that is sensitive to the somatic, cultural, and territorial specificities of each educational context—and envisions AI not as a tool of automation, but as a technology of attention, care, and educational justice.

Keywords: embodied artificial intelligence, situated learning, educational equity, rural and homebound education, educational neuroscience

1. Introduction

In recent years, artificial intelligence has emerged as a central vector of transformation across educational landscapes, catalyzing new forms of instructional delivery, assessment, and administrative governance. From large-scale learning analytics systems to adaptive tutoring platforms and generative conversational agents, AI is often heralded as a solution to inefficiencies and inequities within contemporary schooling systems. However, a growing body of critical research underscores the risks of aligning AI exclusively with computational metaphors of the mind—models that reduce cognition to abstract processing and learning to the acquisition of discrete content units [1]. This orientation privileges metrics over

meaning, automation over relation, and generalizability over situatedness—reinforcing technocratic logics that risk eroding the relational, ethical, and embodied dimensions of educational practice.

Such technocentric framings overlook a fundamental insight that has gained traction across cognitive science, educational theory, and the learning sciences: cognition is not disembodied. Far from being an activity confined to the brain, learning emerges as a deeply situated, sensorimotor, and affective process. The paradigm of embodied cognition, rooted in the work of Varela, Thompson, and Rosch [2] and later developed by scholars such as Barsalou [3] and Wilson [4], asserts that knowledge is not abstracted from the body but co-constituted through it. Perception, gesture, movement, emotion, and spatial awareness are not incidental to thought—they are its very condition of possibility. As Gallagher [5] and Shapiro [6] argue, the mind is not separate from the world but enacted within it: cognition is "in the wild," shaped by bodily experience, environmental affordances, and social interaction.

In the educational sphere, this shift has prompted a revaluation of traditional didactic models, moving from content delivery to participatory and embodied pedagogies. Researchers such as Abrahamson [7] and Shapiro [6] have called for learning environments that leverage the body's expressive and perceptual capacities—foregrounding rhythm, posture, gaze, and gesture as generative elements of understanding. In mathematics education, for example, embodied design has been shown to support conceptual development through structured movement and tactile manipulation. In inclusive education, somatically grounded strategies have been deployed to foster engagement among neurodiverse learners, emphasizing emotional co-regulation and sensorimotor feedback [8].

Against this backdrop, a novel and promising frontier is emerging: embodied artificial intelligence. Rather than viewing AI systems as disembodied cognitive engines, the embodied AI perspective imagines them as agents capable of participating in the affective and sensorimotor life of educational contexts. This includes Embodied Conversational Agents (ECAs) designed to engage learners through multimodal interaction—gaze alignment, facial expression, intonation, and gesture—mimicking the rhythms of human communication and providing scaffolding that is not merely cognitive, but relational and somatic [9, 10].

This reframing of AI opens critical and urgent possibilities—particularly in fragile or peripheral educational ecologies, such as rural schools, homebound education, and inclusive classrooms—where the experience of disconnection is not merely technological but existential. In these contexts, the absence of embodied co-presence can translate into motivational decline, epistemic marginalization, and emotional desynchronization. Here, embodied AI holds the potential to function not as a replacement for the teacher or peer, but as a relational prosthesis—an interface that simulates presence, sustains attention, and affirms the learner's position within a meaningful, interactive field.

Crucially, this turn from abstraction to embodiment is not simply a technological innovation, but a paradigmatic reorientation: one that challenges reductive notions of intelligence and recovers the ethical, affective, and situated nature of learning. As educational theorists increasingly contend with the limits of standardization and automation, embodied AI invites a deeper inquiry: Can technology be made to dwell—rhythmically, attentively, and responsively—within the embodied life of education? Not to mechanize it, but to extend, amplify, and resonate with its relational core.

2. Reframing educational technology through embodied AI: A situated response to fragile school ecosystem

In the global educational landscape, AI is increasingly positioned as a transformative force for innovation, equity, and personalization. From adaptive learning systems and data-driven assessment tools to conversational agents and virtual tutors, AI technologies promise to enhance learning pathways and foster inclusive access to education. Yet critical scholarship has warned that many of these tools are rooted in narrow cognitivist assumptions that reduce learning to information processing and pedagogy to content delivery. This instrumental vision fails to capture the complexity of human cognition as embodied, affective, and socially situated—thus risking the reinforcement of educational inequalities, particularly in fragile, peripheral, or "non-standard" learning contexts [11, 12].

The paradigm of embodied cognition, emerging at the crossroads of neuroscience, phenomenology, and educational theory [13], offers a compelling alternative. It posits that learning is not a disembodied mental computation but rather a dynamic engagement of the mind, body, and environment—where perception, movement, emotion, and relational dynamics are co-constitutive of understanding [3, 4]. Educational design models grounded in this view—such as Abrahamson's [7] embodied design framework or Shapiro and Stolz's [6] somatic pedagogy—call for environments in which sensorimotor activity, postural orientation, and bodily resonance are not ancillary, but foundational to the construction of meaning.

This embodied turn becomes particularly urgent when applied to two critical educational ecologies: rural small schools and homebound or domiciliary education. In both cases, fragility manifests not only through infrastructural and logistical constraints but also in terms of epistemic discontinuities, relational deprivation, and pedagogical invisibility. Rural schools across Europe and globally are frequently characterized by teacher shortages, professional isolation, and limited access to peer networks or institutional support [14, 15]. Similarly, homebound education—whether due to chronic illness, environmental risk, or geographic remoteness—places students outside of the social and embodied life of schooling, threatening their motivation, affective stability, and developmental continuity [16–18].

Italy presents a particularly salient case. The national network of small and rural schools has developed over the years as a laboratory of pedagogical resilience, experimenting with flexible, community-anchored, and multimodal practices. These were especially evident during the COVID-19 pandemic, which revealed the importance of affective anchoring, spatial modulation, and embodied communication in sustaining educational continuity ([19, 20], 2023). Moreover, the country's domiciliary education system—serving students in isolated locations or under environmental constraint—has pioneered relational and somatic pedagogies that privilege affective co-presence, bodily rhythm, and shared spatial imagination [18].

In these contexts, Embodied Conversational Agents (ECAs)—AI systems capable of multimodal interaction through gaze behavior, gesture, voice modulation, and turn-taking rhythm—offer a promising avenue for bridging relational and pedagogical gaps. When grounded in somatic design principles, such agents may function not merely as digital assistants, but as relational infrastructures capable of sustaining teacher reflection, student motivation, and distributed school leadership, even under conditions of geographic isolation and material fragility.

This chapter therefore poses the following research question:

How can embodied AI be co-designed and integrated to promote equitable, affectively grounded, and contextually responsive education in rural and homebound schooling?

In addressing this question, we aim to shift the discourse on educational technology from efficiency and automation toward a paradigm of relational embodiment, pedagogical co-presence, and epistemic justice. Rather than viewing AI as a generic tool for content delivery, we propose framing it as a co-constructed epistemic partner, shaped in dialog with local cultures, teacher agency, and student bodies.

The analysis proceeds through three interrelated dimensions. It first examines how embodied AI can support teachers' professional reflection in small and isolated schools—enhancing design thinking, emotional regulation, and retention in conditions of chronic marginalization. It then explores the role of school leadership, considering how principals operating in fragile school ecologies might rely on somatic AI agents to sustain distributed, care-oriented governance and overcome the solitude of administrative roles. Finally, it addresses the student experience of educational isolation, showing how ECAs can reinforce motivation, participation, and identity formation in homebound, digitally mediated, or multigrade settings—thus responding to a broader vision of educational justice [21, 22].

By integrating insights from the international research literature—including perspectives from OECD countries [23], rural education reforms [14, 24], and European comparative studies [12]—this contribution seeks to redefine educational AI not as scalable automation, but as embodied co-presence, attentive to the lived realities of learners and educators in fragile educational ecologies.

2.1 Teachers' professional reflection in isolated settings

In fragile educational contexts—such as small rural schools or homebound learning environments—teachers often operate in conditions of chronic professional solitude and structural marginalization. The absence of structured peer dialog, sustained mentorship, and tailored professional development opportunities weakens reflective capacity and limits innovation over time [15]. This professional isolation not only affects morale but also undermines retention, as teachers experience a lack of pedagogical companionship and epistemic recognition. Within these ecologies, the integration of Embodied Conversational Agents (ECAs)—AI systems designed according to the principles of somatic pedagogy [7]—may offer a novel form of relational infrastructure, acting as epistemic and affective partners in sustaining professional agency.

As highlighted in recent studies [25], teacher retention in rural areas is deeply tied to the availability of emotionally sustainable, supportive, and dialogic professional environments. Yet conventional technologies tend to frame professional development as cognitive upskilling, overlooking the embodied and affective dimensions of pedagogical knowledge. In contrast, ECAs—through multimodal engagement involving gaze, vocal rhythm, gesture, and spatial sensitivity—can simulate the presence of a reflective other, offering teachers a dialogic interface for ideation, emotional regulation, and continuous reflection.

Research conducted by reference studies [19, 26] demonstrates that teachers in rural and remote Italian schools often engage in highly creative, embodied forms of reasoning grounded in the arrangement of physical space, sensitivity to proxemics, and responsiveness to affective cues. These practices—which include using bodily orientation to manage multigrade classrooms, structuring attention through movement,

and modulating relational energy in real time—constitute an ecology of tacit professional expertise that is rarely formalized in teacher education, yet foundational to effective practice.

Rather than introducing embodiment, somatically informed ECAs can amplify and scaffold what is already present in these teachers' work: the rhythms, tensions, and spatial logics of classroom life. Such agents can engage educators in reflective conversations that integrate both cognitive and bodily awareness, allowing them to name and analyze their own gestural, emotional, and spatial strategies. In this way, ECAs may support the externalization of tacit pedagogical knowledge, helping teachers gain clarity and intentionality about choices that are typically made intuitively and under pressure [6, 27].

Importantly, these technologies may also contribute to teacher retention in geographically and relationally isolated systems. By creating a stable, responsive environment for dialogic reflection—free from judgment or institutional constraint—ECAs offer teachers an always-accessible space for professional companionship, supporting both their emotional well-being and their capacity for pedagogical innovation. They can be particularly effective in promoting metacognitive stance and emotional regulation, key conditions for maintaining motivation and resilience in under-resourced or non-standard teaching settings.

Ultimately, the value of ECAs in these contexts lies not in delivering content or evaluating performance, but in their capacity to simulate pedagogical presence: to mirror the teacher's rhythm, tone, and intentionality; to co-construct meaning through embodied dialog; and to sustain the ethical and epistemological depth of teaching in peripheral educational ecologies. By anchoring AI in situated, affectively attuned interaction, we move toward a vision of professional development that is not only scalable but also just, relational, and somatically grounded.

2.2 Embodied leadership and the challenges of rural school management

Educational leadership in rural and peripheral contexts requires more than managerial competence: it demands an ethically grounded and somatically enacted praxis that is deeply rooted in the lived complexity of local ecologies. Principals and middle managers in these territories often preside over archipelagos of small school sites, physically dispersed across mountainous, island, or infrastructurally marginal regions, where the continuity of pedagogical vision must be preserved across distance, difference, and fragmentation. These leaders operate within an ecology of structural precarity, contending with chronic staff shortages, high turnover, inadequate infrastructures, and the pressures of multitasking across geographically and administratively fragmented school networks [15].

In such contexts, leadership is rarely reducible to administrative rationality. It unfolds instead as a pedagogy of presence [19], in which authority is exercised not through distant abstraction but through corporeal and affective immediacy. Walking through corridors, greeting students by name, modulating tone in a staff meeting, or sitting beside a teacher during a moment of crisis—these are not incidental gestures, but somatic vectors of governance, anchoring the school in rhythms of care, recognition, and relational accountability. Leadership, here, is not only strategic; it is deeply atmospheric, emergent from a meshwork of embodied practices and tacit knowledges.

Moreover, in these fragile educational ecologies, school leaders function as translators and mediators—negotiating between ministerial mandates and the sociocultural

textures of local life. They must reconcile policy imperatives with lived constraints, often without structured peer support or participatory decision-making frameworks. This position requires not only organizational intelligence but also emotional literacy, narrative tact, and ethical imagination. It is a form of leadership that resists automation, precisely because it is irreducibly relational and contextually improvised.

It is within this terrain that ECAs offer a compelling, though still underexplored, resource. When designed through the lens of somatic pedagogy and embodied cognition [6], ECAs become more than tools: they are epistemic companions, capable of mirroring affect, simulating dialogic encounters, and sustaining meta-reflection in settings where solitude is structural. Principals may engage with ECAs to rehearse difficult conversations, model inclusive staff development strategies, or map coordination between distant sites—all within an emotionally modulated, temporally flexible space that supports embodied reasoning.

These systems are designed not to issue directives, but to offer reflective scaffolds that adapt to the user's tempo, proxemic sensitivity, and communicative posture. Their value lies in supporting the integrity of relational labor under conditions of temporal pressure and organizational fragility—extending the leader's capacity to maintain coherence, attunement, and ethical discernment across an otherwise disjointed landscape.

Crucially, such support intersects with the challenge of teacher retention, a well-documented crisis in rural and remote schools. Numerous studies [15, 25] underscore the decisive role of school leaders in shaping institutional climates that either nourish or erode professional commitment. Where leadership fosters trust, recognition, and dialogic engagement, teachers are more likely to remain—not because external conditions are optimal, but because the relational fabric of the institution sustains meaning, belonging, and pedagogical purpose. ECAs can contribute to this ecology of retention, not by enforcing compliance, but by amplifying the leader's capacity to listen, to reflect, and to co-regulate the emotional life of the school.

This perspective aligns with international policy frameworks that advocate for a rethinking of educational technology not as an efficiency instrument, but as a partner in equity, care, and human development [23, 24]. In Italy, the experience of school leadership during the COVID-19 crisis has demonstrated that resilience in rural schools depends not only on digital connectivity but also on embodied communicative strategies, shared rituals, and affective anchoring—forms of leadership that ECAs, if co-designed with attention to cultural and pedagogical nuance, can meaningfully support [27].

Ultimately, reframing educational leadership in rural contexts through the lens of embodiment and ethical situatedness challenges dominant techno-managerial paradigms. It opens the possibility of conceiving embodied AI as a technology of solidarity, one that honors the moral, spatial, and emotional complexities of leading from the margins. In this vision, ECAs are not substitutes for presence, but mediators of continuity, empathy, and reflective depth—extending the pedagogical body of leadership into territories where it is most needed, yet least supported.

2.3 Supporting students in situations of isolation: Embodied AI as relational and cognitive infrastructure

Students in fragile educational contexts—such as those located in remote rural areas, archipelagic communities, hospital settings, or domiciliary schooling under environmental constraint—frequently experience a form of pedagogical

disconnection that transcends physical separation. It entails relational fragmentation, exclusion from classroom rituals, limited peer interaction, and a diminished sense of embodied participation in the intersubjective rhythms of learning [17, 28]. These conditions risk compromising not only academic achievement but also the student's capacity for motivation, self-recognition, and identity formation—dimensions fundamentally rooted in bodily presence and affective resonance [8].

In these contexts, ECAs—AI systems capable of multimodal interaction through gaze, gesture, vocal modulation, and turn-taking rhythm—offer a compelling technological response. Far from being mere content delivery systems, ECAs can function as relational and cognitive infrastructures, capable of restoring some of the lost vectors of pedagogical presence. Their ability to simulate co-presence and attuned interaction enables them to foster motivation, guide emotional regulation, and scaffold reflective engagement, even in highly constrained digital settings [29, 30].

For students in multigrade classroom, homebound learners due to health or environmental hazards, or those attending digital learning hubs in infrastructurally marginal regions, ECAs can act as dialogic companions. By mirroring gestures, posing contextualized questions, and modulating emotional feedback, these agents contribute to sustaining the learner's sense of being-seen and being-in-dialog—critical conditions for both cognitive development and affective well [20, 21, 27]. Such presence is especially vital in small rural schools, where individualized teacher attention is often constrained by multigrade dynamics and administrative overload.

Moreover, the somatic responsiveness of ECAs—if grounded in principles of embodied design—allows for differentiated interaction based on learners' neurocognitive profiles and affective states. Informed by real-time bodily feedback (e.g., facial expression, movement, and latency), ECAs can adapt the tempo, tone, and form of their communication, offering a tailored pedagogical rhythm that resonates with the learner's internal states. This dynamic supports students who may otherwise disengage in static or over-standardized environments, including neurodiverse, highly sensitive, or gifted learners in isolated conditions [8].

Ghimire [16] underscores the importance of affective scaffolding in blended and rural learning environments, where the absence of embodied feedback loops often leads to emotional disorientation and reduced executive functioning. ECAs, by modulating presence through bodily cues, can restore a temporal and emotional architecture to the learning experience, allowing students to structure their time not as a flat sequence of digital tasks but as a lived, affectively modulated process.

Crucially, this approach aligns with an equity-based redefinition of educational adequacy, which posits that the right to education entails not only access to content but also access to relational continuity, co-presence, and participatory resonance [17, 23]. In this sense, embodied AI technologies must be conceived not as neutral tools, but as epistemic and ethical companions, co-constructing a pedagogical dialog where the learner's body, emotion, and environment are central to meaning-making.

The Italian context offers instructive insights in this regard. The national system of domiciliary education, developed to serve students in chronic medical care or living under environmental risk, has historically advanced pedagogical approaches that privilege relational proximity, affective pacing, and bodily attunement [20]. During the COVID-19 pandemic, these practices were further refined through the use of multimodal digital strategies that preserved emotional presence under physical constraints [19, 31]. In such settings, ECAs may act as extensions of these pedagogical grammars, amplifying their scope while respecting their somatic core.

In conclusion, ECAs do not aim to replace teachers or peers but rather to mediate presence where absence would otherwise prevail. By enabling continuity, recognition, and mutual responsiveness in nonstandard contexts, they contribute to a vision of educational justice in which embodiment is reinscribed not as a privilege of in-person schooling but as a right to be reconfigured through responsible, somatically grounded technology.

3. Toward a participatory and situated AI for education

Reimagining the role of AI in education—particularly in fragile, rural, and homebound ecologies—demands a conceptual shift: from automation to relation, from standardization to situatedness, from instrumental efficiency to epistemic reciprocity. If educational intelligence is to be augmented through technological means, it must first be reframed as a deeply embodied, contextual, and participatory phenomenon.

This entails moving beyond the logic of delivery—whether of content, support, or oversight—and toward a paradigm where AI systems function as co-participants in pedagogical life. As suggested by Shusterman [32] and more recently by Di Domenico [33], the body is not a medium to be bypassed by cognition, but a site of knowledge, a sensorium of meaning, and a relational threshold. In this view, educational spaces—particularly those shaped by marginality—must be read not as deficits to be overcome through technological substitution, but as ecosystems of embodied intelligence in their own right.

In light of this, ECAs represent not just a technical innovation but a philosophical and pedagogical provocation. Their potential lies not in mimicking human interaction per se, but in structuring new relational grammars—rhythms of listening, gesture, emotional pacing, and shared attention—that can sustain presence where it is otherwise threatened. In doing so, ECAs may help counterbalance the affective asymmetries and spatial inequities that fragment the educational experiences of isolated teachers and learners.

However, such potential can only be realized if ECAs are not designed "for" schools, but with and within school communities. As proposed in recent interdisciplinary work on somatic and participatory AI [34, 35], co-design must become an epistemic condition of legitimacy—embedding local values, ethical deliberation, and narrative intelligibility into every layer of the system. This means respecting the rhythms of rural schools, the embodied imagination of homebound students, and the tacit expertise of educators navigating everyday fragility.

Participatory design also entails embracing territoriality as an educational actor. As the Italian network of small and domiciliary schools has shown, the school is never just a building, but a relational infrastructure rooted in community histories, spatial memory, and somatic rituals [20]. A truly situated AI must therefore be capable of inhabiting space—not abstractly, but through a poetics of proximity, resonance, and attunement.

From a policy standpoint, this implies a reorientation of digital agendas away from mere scalability and toward digital justice—a framework attentive to ecological specificities, relational ethics, and epistemic diversity [23, 24]. Embodied AI must not deepen the rift between central systems and peripheral schools, but rather amplify the pedagogical sovereignty of those working at the margins: teachers who improvise with care, leaders who govern through presence, and learners who construct meaning through gesture, silence, and breath.

In this sense, the challenge is not how to make AI more "human," but how to make it more educationally humane. That is, capable of entering the classroom not as a panoptic observer or instructional automaton, but as a rhythmically attuned interlocutor, contributing to the plural, affective, and place-based intelligence that makes learning possible.

Thus, toward a future of participatory, embodied, and situated AI, the question is not whether machines can teach, but how technology can learn to dwell in the fragile yet resilient ecologies of human education.

4. Looking ahead: The future of embodied AI in education

The development of embodied and contextually responsive artificial intelligence in education remains, for now, in a nascent and exploratory phase. Yet the experiences discussed—ranging from the solitude of rural teachers to the adaptive leadership of small school principals, and the vulnerable positioning of homebound students—already point toward the emergence of a new paradigm. Embodied AI, especially when instantiated through somatically attuned ECAs, reveals a unique potential to sustain those dimensions of educational life that are most often threatened by distance, fragmentation, or marginalization. These systems are not simply interactive technologies; they are becoming, when appropriately designed and situated, infrastructures of presence—capable of supporting relational continuity, reflective dialog, and affective anchoring within fragile educational ecologies.

The road ahead demands a profound rethinking of how such systems are conceived and integrated. Embodied AI must not be imagined as an external solution imposed upon schools, but rather as an evolving partner shaped within and through educational communities. Its legitimacy and efficacy depend on participatory processes of design that center the lived experiences, values, and bodily knowledge of those who teach and learn. Co-design, in this sense, becomes not only a methodological strategy but also an epistemological stance—one that affirms education as a relational, cultural, and situated practice. When AI systems are built with teachers, students, and local communities—as opposed to for them—they are more likely to embody the textures of meaning that make pedagogical interaction both ethical and transformative.

This relational vision also carries with it significant ethical and regulatory implications. As embodied AI systems increasingly interact with the emotional, somatic, and cognitive rhythms of learners and educators, questions arise about the interpretation of bodily data, the emotional modulation of agents, and the boundaries between support and surveillance. Ensuring privacy, consent, and transparency is not enough; what is needed is a new ethical grammar that is capable of attending to the intercorporeal and affective dynamics of educational space. The intimacy of pedagogical relationships—particularly in contexts of vulnerability—demands that AI systems respond with sensitivity and restraint, honoring the asymmetries and responsibilities embedded in any act of care.

Moreover, the integration of embodied AI should not be seen as a substitution for human presence, but rather as a form of augmentation—a way of enriching hybrid ecologies where human and non-human agents co-construct learning environments grounded in attention, rhythm, and mutual recognition. In such ecosystems, AI becomes part of the choreography of education, not through automation, but through resonance: helping to sustain the micro-gestures of attunement, the pauses of reflection, and the embodied synchrony that defines meaningful pedagogical encounters.

To realize this potential, the professional formation of educators must evolve. Teachers and school leaders need opportunities not only to develop digital fluency but also to cultivate somatic awareness, emotional literacy, and reflective capacity in their engagement with technology. Training programs that foreground the embodied dimensions of teaching can equip educators to navigate the complexities of working alongside intelligent systems—not as passive users, but as informed interlocutors who understand how AI mediates attention, emotion, and power in the classroom.

Ultimately, the future of artificial intelligence in education does not lie in perfecting the logics of automation or scalability. It lies, rather, in cultivating technologies that are capable of listening—rhythmically, affectively, and culturally—to the needs of those they serve. Embodied AI, if rooted in dialogical and ethical co-design, may allow us to move from an educational paradigm based on the transmission of information to one grounded in intersomatic resonance, where knowledge is not merely delivered, but co-enacted through gesture, gaze, rhythm, and relation. In such a vision, learning is no longer an abstract process detached from the body—it becomes a shared movement, a choreography of understanding that unfolds between human beings and the systems they shape, together.

Notes

The article is the result of collaborative research by the authors. Specifically, Filippo Gomez Paloma edited chapter 1, Giuseppina Rita Mangione edited chapters 2 and 3, Pio Alfredo Di Tore edited chapter 4.

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References

[1] Luckin et al. Intelligence Unleashed: An Argument for AI in Education. London, UK: Pearson; 2016

[2] Varela FJ, Thompson ET, Rosch E. The Embodied Mind: Cognitive Science and Human Experience. Cambridge, MA: MIT Press; 1992

[3] Barsalou L. Grounded cognition. Annual Review of Psychology. 2008;**59**:617-645

[4] Wilson M. Six views of embodied cognition. Psychonomic Bulletin and Review. 2002;**9**:625-636

[5] Gallagher S. How the Body Shapes the Mind. Oxford, UK: Oxford University Press; 2005

[6] Shapiro et al. Embodied cognition and its implications for education. Theory and Research in Education. 2019;**17**(1):19-38

[7] Abrahamson D. Building educational activities for understanding: An embodied design framework. Educational Designer. 2014;**2**(7):1-20

[8] Job et al. The neurodiverse classroom: Engagement and embodied interaction. Journal of Educational Psychology and Neuroscience. 2022;**1**:67-83

[9] Russell C, Veletsianos G. Conversational agents in virtual worlds: Bridging disciplines. In: Gregersen T, Hurd S, editors. Landmarks in CALL. CALICO; 2013. pp. 123-140

[10] Zhou C et al. Computers and Education. 2022. p. 104528

[11] Gottschalk F, Weise C. Digital equity and inclusion in education. OECD Education Working Papers. 2023;**299**:1-75

[12] Fargas Malet M, Bagley C. Is small beautiful? A scoping review of 21st century research on small rural schools in Europe. European Educational Research Journal. 2022;**21**(5):822-844

[13] Gomez Paloma F, Ianes D, Tafuri D. Embodied Cognition. New York: Nova Science Publishers; 2017

[14] Cheung AC. How should education in rural areas be reformed? Science Insights Education Frontiers. 2021;**9**(1):1113

[15] Ingersoll RM, Tran H. The rural teacher shortage. Phi Delta Kappan. 2023;**105**(3):36-41

[16] Ghimire B. Embodied Cognition. 2022

[17] Malhoit GC. Providing Rural Students with a High Quality Education: The Rural Perspective on the Concept of Educational Adequacy. Arlington, VA: Rural School and Community Trust; 2005

[18] Dalla Mutta E, Benigno V, Fante C, Mangione G. Educational and technological solutions to support" small schools". In: Distance Learning Settings: Evidence from the Italian Context. Edulearn 22 Proceedings. Palma, Spain: IATED Academy; 2022. pp. 6959-6967

[19] Mangione GRJ, Cannella G. Small school, smart schools: Distance education in remoteness conditions. Technology, Knowledge and Learning. 2021;**26**(4):845-865

[20] Mangione et al. Exploring educational practices for non-standard

didactic situations in small schools. In: Handbook of Research on Establishing Digital Competencies in the Pursuit of Online Learning. 2023. pp. 50-72

[21] Wood RM. A review of education differences in urban and rural areas. International Research Journal of Educational Research. 2023;**14**(2):1-3

[22] Leichty R. Online learning for rural students. State Education Standard. 2021;**21**(1):12-17

[23] Gottschalk F, Weise C. Digital equity and inclusion in education: An overview of practice and policy in OECD countries. OECD Education Working Papers. 2023;**299**:1-75

[24] Govender S, Ajani OA, Ndaba NH, Ngema T. Making in-service professional development effective in a rural context. Contextualising rural education in South African schools. 2023;**3**:78

[25] Seelig JL, McCabe KM. Why teachers stay: Shaping a new narrative on rural teacher retention. Journal of Research in Rural Education. 2021;**37**(8)

[26] Mangione GR, Fante C, Dalla Mutta E, Benigno V. Exploring Educational Practices for Non-Standard Didactic Situations in Small Schools. 2023. pp. 50-72

[27] Mangione GRJ, De Santis F. Intelligenza Artificiale nei contesti educativi non standard: i risultati di una" riflessione parlata" sulle piccole scuole. Scholé: rivista di educazione e studi culturali. 2024;**LXII**(1):146-165

[28] Ghimire B. Blended learning in rural and remote schools: Challenges and opportunities. International Journal of Technology in Education. 2022;**5**(1):88-96

[29] Veletsianos G, Russell. Conversational agents in virtual worlds: Bridging disciplines. British Journal of Educational Technology. 2010:123-140

[30] Zhou C et al. Embodied interactions and AI tutoring systems. Computers and Education. 2022;**186**:104528

[31] Mangione GRJ, Pieri M, De Santis F. Revitalizing education in rural and small schools: The role of AI in teachers' professional development. Italian Journal of Educational Technology. 2024;**32**(1):21-35

[32] Shusterman R. Body Consciousness: A Philosophy of Mindfulness and Somaesthetics. 2008

[33] Di Domenico M, Mangione GR, Bruni EM. No black box: Promoting inclusion and democracy in the age of artificial intelligence. Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva. 2024;**8**(2)

[34] Schiavo F, Mangione GRJ, Di Domenico M, Di Tore PA. Towards a somatic pedagogy of artificial intelligence: Interdisciplinary reflections between embodied cognition and educational design. Journal of Inclusive Methodology and Technology in Learning and Teaching. 2025;**5**(2)

[35] Di Tore PA. È possibile un'intelligenza senza corpo? Corpo, Società, Educazione. 2024;**1**(0)

Edited by Filippo Gomez Paloma, Pio Alfredo di Tore and Giuseppina Rita Jose Mangione

The contributions in this volume provide a comprehensive picture of the challenges and opportunities facing teacher training today. There is a growing awareness of the importance of holistic, culturally sensitive, ethically oriented and pedagogically innovative approaches. The teaching figure emerges as a reflective agent, a promoter of equity, a facilitator of learning, and a professional in a state of constant evolution. Rather than offering a single model, this volume invites the comparison of experiences, the exploration of complexity, and the construction of training courses capable of responding to the needs of schools in the present and the future.

Katherine Meltzoff,
Education and Human Development Series Editor

ISSN 2755-9513
ISBN 978-1-83634-819-1
9 781836 348191

Published in London, UK

IntechOpen