

Body, Cognition, and Neuropedagogy: an epistemological exploration of Biopedagogy, Neuroactivation and Motor Didactics

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Abstract: Recent advances in neuroscience, embodied cognition, and educational research have questioned traditional dualistic conceptions of learning, emphasizing the inseparable relationship between body, mind, and environment. This paper explores the epistemological connections among Biopedagogy, Neuroactivation, Neuropedagogy, and Motor Didactics, proposing an integrated framework for understanding human development and learning processes. The study adopts a theoretical and interdisciplinary approach, drawing on the contributions of Merleau-Ponty's phenomenology, Embodied Cognition, executive function research, cerebellar neuroscience, and contemporary pedagogical theories. The analysis highlights Neuroactivation as a dynamic process through which cognitive, motor, perceptual, emotional, and relational functions progressively emerge and reorganize through experience and educational interaction. Within this perspective, Motor Didactics represents the methodological expression of Neuroactivation, while Biopedagogy provides the interpretative lens for understanding adaptive development. The proposed framework offers a holistic perspective on learning, supporting current debates on inclusive education, precision pedagogy, and quality of life, and contributes to redefining educational intervention as an embodied and adaptive process.

Keywords: Neuroactivation; Biopedagogy; Embodiment; Motodidactics; Neuropedagogy



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1. Introduction

Over the last decades, findings from neuroscience, cognitive science, developmental biology, and complexity studies have profoundly reconceptualized learning as a constructive, emergent, situated, and relational process that takes shape through the continuous interaction among organism, environment, and culture (Barsalou, 2008; Shapiro, 2011).

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Merleau-Ponty (1945) anticipated this theoretical shift by arguing that the flow of information from the sensory organs and the constant interaction with the environment shape the way the brain develops and organizes itself (p. 177). The brain thus reveals its fundamental capacity for continuous adaptation and modification through experience, movement, and interaction with the environment.

Within this theoretical framework, Embodied Cognition and Enactivism have significantly contributed to redefining the relationship between body and knowledge. Building upon Piagetian interactionism, Varela, Thompson, and Rosch (1991) argue that cognition emerges from the continuous coupling between organism and environment. Thompson (2007) further emphasizes that knowing is inseparable from lived experience and embodied action. Similarly, Barsalou (2008) demonstrates that higher cognitive processes are grounded in perceptual and motor systems actively involved in meaning construction. From this perspective, learning is understood as the progressive organization of increasingly sophisticated ways of engaging with the world rather than the accumulation of abstract representations.

These reflections are further supported by contemporary research on executive function development. Pearce and Miller (2025) show that working memory, inhibitory control, cognitive flexibility, and planning emerge progressively through the interaction of cognitive and motor systems. Their findings suggest that executive functions cannot be fully understood independently of bodily experiences and the opportunities for action provided by the environment.

An even more radical perspective is proposed by Koziol et al., (2011), who argue that the nervous system evolved primarily to support action control and environmental adaptation, whereas higher cognitive functions emerged as later developments of originally motor mechanisms. Within this framework, the cerebellum assumes a central role in planning, prediction, regulation, and executive control processes (Edelman, 1992).

This evolution of international scholarship shows significant convergence with the Italian biopedagogical tradition developed by Frauenfelder and colleagues (2011, 2018), which progressively elaborated a conception of human development grounded in the interaction among biological, cognitive, emotional, social, and cultural dimensions. Within this perspective, Clinical Pedagogy is conceived as a science of adaptation and human development (Crispiani, 2001), interpreting the person as a bio-psycho-operative system in continuous transformation, in which biological potentials are expressed through educational, relational, and experiential processes that guide individual development.

More recent contributions by Pellegrini (2024) and Pellegrini et al. (2025) further extend this framework through the concept of bioexperience. According to this perspective, educational experience represents a transformative process capable of progressively modifying the functional organization of the individual. Learning thus becomes a form of complex adaptation involving body, cognition, emotion, relationships, and technology simultaneously. Education is consequently conceived as an adaptive ecosystem in which the quality of experiences contributes to the construction of increasingly articulated and functional developmental patterns.

Particularly relevant is the contribution of Italian Neuropedagogy and, more specifically, the theoretical work of Crispiani (2019). Through the Praxic-Motor Theory, the Pedagogical Hippocrates paradigm, and Cognitive Motor Training (Crispiani&Palmieri, 2017), he proposes an interpretation of development centered on

the organization of executive functions, spatiotemporal coordination, executive fluency, and adaptive capacities. Within this perspective, many learning difficulties and neurodevelopmental conditions are understood as expressions of functional disorganization that can be addressed through intentional educational interventions.

It is precisely within this theoretical framework that the concept of Neuroactivation emerges, understood as an educational process aimed at the progressive organization of cognitive, motor, linguistic, perceptual, and emotional functions. Evidence from Embodied Cognition, cerebellar research, executive function studies, and Biopedagogy converges in suggesting that learning and development depend on the individual's ability to integrate perception, movement, cognition, and relationships within complex adaptive systems (Koziol et al., 2011; Pearce & Miller, 2025; Crispiani & Mancini, 2021).

This contribution aims to develop an epistemological exploration intended to elaborate an integrated theoretical framework capable of interpreting human development as an emergent phenomenon arising from the interaction among body, cognition, experience, and environment. In doing so, it seeks to contribute to the definition of new educational paradigms oriented toward inclusion, personalization, and the promotion of quality of life.

2. Neuroactivation Between Body and Cognition

Among the most original contributions of contemporary Italian pedagogy, a central position is occupied by the epistemological metaphor of the *Pedagogical Hippocrates* proposed by Crispiani (2019). Within this framework, pedagogy recovers its original vocation for educational care, conceived as a planned and intentional process grounded in the analysis of the developmental trajectories expressed by individuals and observed in their bodily, psychological, and behavioral integrity.

The primary aim is to identify and foster those human potentials that can be further developed through processes of functional activation and capability enhancement. Pedagogy thus becomes a science of adaptation and quality of life, oriented toward the promotion of human flourishing. Within this model, movement represents the privileged medium through which executive functions are organized, refined, and stabilized. Learning difficulties, dyspraxia, and several neurodevelopmental conditions are interpreted as manifestations of executive disorganization involving planning, fluency, coordination, and spatiotemporal orientation (Crispiani, 2019).

Neuroactivation constitutes the generative principle of this framework and is promoted through intensive cognitive-motor exercise, cross-lateral motor patterns, functional synesthetic activities, intentional motor engagement, and practices aimed at enhancing executive fluency. These interventions support individuals in achieving progressively higher levels of cognitive and behavioral organization. It is therefore not surprising that Cognitive Motor Training identifies fluency as a core construct, reflecting the organism's capacity to integrate diverse processes into a coherent and functional whole.

These reflections reveal remarkable convergences with the theories of Embodied Cognition and Enactivism. While Varela and colleagues (1991) argue that mind emerges through embodied action, Crispiani demonstrates how the quality of action directly shapes the organization of cognitive functions. Likewise, the notion that

knowledge is constructed through movement and lived experience is highly consistent with contemporary research on neural plasticity and sensorimotor learning.

The most recent development of this theoretical framework is represented by the convergence of Biopedagogy, Artificial Intelligence, and Precision Pedagogy. Pellegrini (2024) and Pellegrini, Cuccaro, Gentilozzi, and Sebastiani (2026) argue that educational processes can be understood as complex adaptive ecosystems in which data, experience, embodiment, and relationships continuously interact. The convergence of Biopedagogy, Neuroactivation, Cognitive Motor Training, Embodied Cognition, and Enactivism therefore delineates a new epistemological horizon for educational sciences, offering an integrated perspective on human development, learning, and educational intervention.

3. From Neuroactivation to Motor Didactics: Towards a Pedagogy of Movement

A robust process of epistemological and scientific renewal has characterized the evolution of pedagogy from the second half of the twentieth century to the present day, culminating in the recent incorporation of concepts and knowledge derived from neuroscience. This development has progressively influenced not only educational theory but also professional practice, shaping educational and teaching interventions (Damiano, 2013). Significant antecedents of this transformation include the Neapolitan School of Biopedagogy (Frauenfelder & Santoianni, 2002), the perspective of the *Clinic of Formation* (Massa, 1992), and Clinical Pedagogy (Crispiani, 2001).

On the one hand, pedagogy has experienced what may be defined as a *neuro-incursion*, namely the increasing integration of neuroscientific perspectives into educational knowledge. On the other hand, pedagogy has moved toward a more conscious dialogue with the behavioral sciences while maintaining its primary commitment to education and human development.

The neuro-incursion into pedagogical domains is still in its early stages, yet it has already generated promising theoretical developments and conceptual innovations. It has opened new avenues for investigating the neurophysiological processes underlying human behavior and development (Oliverio, 2015). Evidence of this trend can be found both in the growing body of research examining the neural foundations of human action and in the gradual emergence of a distinct epistemological framework now recognized as Neuropedagogy (Crispiani, 2019).

At the same time, the concept of education has undergone substantial expansion, extending beyond traditional teaching to encompass prevention, assessment, training, habilitation, rehabilitation, mentoring, and guidance. This evolution reflects a broader trend toward the professionalization of educational practice (Schön, 1983; Damiano, 2013). Within this context, the increasing scientific grounding of Special Education has progressively shifted attention from educational settings alone to the functional processes that support learning and development, highlighting the importance of motor and neuroactive dimensions of human experience.

Among the key concepts emerging from this perspective is the praxic-motor nature of many neurodevelopmental conditions, including dyspraxia, specific learning disorders, Fragile X syndrome, and autism spectrum disorders (Crispiani, 2019). Across these conditions, recurrent characteristics include delayed initiation, reduced execution speed, spatial and temporal disorganization, and coordination difficulties.

Challenges in functional synesthesia—namely multitasking and dual-task performance—are also frequently observed (Ajuriaguerra, 1974; Crispiani, 2020).

Adopting a bodily perspective, or what may be termed the culture of Embodied Education, means recognizing several fundamental principles: the integrity of the person and their ecological dimension (Morin, 2020); the central role of praxic-motor activity in learning and development (Gallagher, 2017); the distinction between deficit and disorder (Ianes & Cramerotti, 2021); and the need for deeper diagnostic and developmental assessment processes (Crispiani, 2018).

Embodied Cognitive Science (Shapiro & Stolz, 2019), which considers the body an essential component of cognition, is strongly aligned with Cognitive Motor Training (Crispiani, 2019), an educational model grounded in the centrality of action and movement within learning and developmental processes. Two key indicators of this perspective are neuroactivation and functional enhancement, understood as processes aimed at stimulating, strengthening, and consolidating cognitive, executive, and praxic functions. This convergence finds practical application in Motor Didactics, which emerges as both a conceptual framework and a professional practice based on the integration of cognitive and motor processes through dual-task and multitasking activities (Crispiani, 2020).

4. Discussion

The relationship between body, cognition, and learning represents a central issue in contemporary educational sciences. The perspectives examined converge in recognizing embodied experience as the primary locus of knowledge construction. In this regard, the theories of Embodied Cognition (Barsalou, 2008; Shapiro, 2011) and Enactivism (Varela et al., 1991; Thompson, 2007) reveal significant affinities with the Italian pedagogical traditions of Biopedagogy and Clinical Pedagogy.

A first point of discussion concerns the role of Biopedagogy as an interpretative framework capable of integrating biological development, educational experience, and human adaptation. As emphasized by Frauenfelder (2011, 2018), education cannot be fully understood without considering the biological dimension of the individual. However, this dimension should not be interpreted in deterministic terms; rather, it functions as a dynamic component within complex systems of relationships and meaning-making. In this sense, Biopedagogy occupies an intermediate position between educational neuroscience and humanistic pedagogical approaches, offering an ecological and systemic understanding of development.

A second important aspect concerns the contribution of Piero Crispiani through the constructs of the *Pedagogical Hippocrates* and the Praxic-Motor Theory. Within this framework, pedagogical assessment is directed toward identifying developmental potential and opportunities for human capability enhancement (Crispiani, 2019). The metaphor of the *Pedagogical Hippocrates* evokes a pedagogy of care in which observation, interpretation, and educational guidance become foundational categories of professional practice. Development is therefore viewed not as a static condition but as a dynamic process that can be intentionally supported through educational intervention.

Particularly significant is the concept of Neuroactivation, which emerges as a theoretical bridge between biological development and educational design. Unlike approaches that interpret development exclusively through neurophysiological mechanisms, Neuroactivation is understood here as an intentional educational process

aimed at organizing executive, cognitive, motor, linguistic, and relational functions (Crispiani, 2019). It therefore represents an interpretative category capable of connecting neural plasticity, learning, participation, and quality of life within a unified framework.

Motor Didactics may be considered the most concrete operational translation of these theoretical assumptions. If Neuroactivation describes the developmental process, Motor Didactics represents its methodological expression. Within this perspective, movement is not conceived as ancillary to learning but rather as one of its structural conditions. This position is supported by a growing body of research demonstrating the contribution of motor activity to the development of attention, working memory, emotional regulation, and executive functions (Howard-Jones, 2014). Learning is thus understood as an embodied process in which cognition emerges through action, interaction, and engagement with the environment.

A further area of reflection concerns the increasing convergence among Biopedagogy, Artificial Intelligence, and Precision Pedagogy. Recent contributions by Pellegrini (2024, 2025) suggest that the integration of educational data, intelligent technologies, and pedagogical observation may support increasingly personalized and inclusive learning pathways. Nevertheless, these developments also require careful ethical consideration. Personalization should continue to be grounded in educational relationships, professional responsibility, and respect for human dignity, avoiding reductive or purely algorithmic interpretations of learning and development.

In light of these considerations, the present work proposes an interactive and integrated vision of human development in which biological processes, embodied experience, cognition, and educational action continuously influence one another. Future research should empirically investigate the effects of Neuroactivation and Motor Didactics across different educational settings, while also examining how intelligent technologies can contribute to the creation of genuinely inclusive learning environments oriented toward participation, flourishing, and quality of life.

5. Conclusions

The reflections developed in this contribution suggest that the relationship between body, cognition, and learning has become one of the central epistemological challenges within contemporary educational sciences. Through the dialogue among Biopedagogy, Neuropedagogy, Neuroactivation, Motor Didactics, Embodied Cognition (Gómez Paloma & Damiani, 2021), and Enactivism, a vision emerges of the human being as a complex and adaptive system whose development unfolds through the continuous interaction of biological, cognitive, emotional, relational, and cultural processes.

The theoretical analysis highlights the potential of Biopedagogy as an interpretative framework capable of integrating these dimensions within a unified perspective. Within this context, Neuroactivation assumes the role of an organizing principle underlying developmental and learning processes, while Motor Didactics represents its methodological translation into educational practice. Movement is therefore no longer conceived as a mere support for learning but as one of the foundational conditions through which knowledge is generated and transformed.

The originality of the proposed framework lies in the convergence of the Italian biopedagogical tradition with the international theories of Embodied Cognition and Enactivism, as well as the more recent perspectives of Precision Pedagogy and

Educational Artificial Intelligence. This convergence contributes to the development of a pedagogical paradigm oriented toward quality of life, inclusion, and the personalization of educational pathways.

In conclusion, this contribution suggests that the future of educational sciences will require theoretical models increasingly capable of integrating embodiment, cognition, care, and technology. From this perspective, Biopedagogy and Motor Didactics should be regarded as genuine epistemological frameworks for rethinking inclusive education and human development in contemporary societies.

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