

NATURE AS A COGNITIVE EXTENSION: EMBODIED PERSPECTIVES FOR EDUCATION

LA NATURA COME ESTENSIONE COGNITIVA: PROSPETTIVE *EMBODIED* PER L'EDUCAZIONE

Rossana Pia Laccone

University of International Studies of Rome

rossana.lacone@unint.eu

0009-0001-6100-3470



Silvia Artusi

University of International Studies of Rome

silvia.artusi@unint.eu

0009-0003-1721-0186



Double Blind Peer Review

Lacone, P. R., Artusi, S. (2025). Nature as a cognitive extension: embodied perspectives for education. Italian Journal of Health Education, Sports and Inclusive Didactics, 9(3).

Doi: <https://doi.org/10.32043/gsd.v9i3.1589>

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gsdjournal.it

ISSN: 2532-3296

ISBN: 978-88-6022-522-1

ABSTRACT

The paper examines embodied cognition as an educational paradigm integrating body, mind, and environment. Nature is interpreted as a cognitive device that provides affordances, regulates attention and emotions, and generates situated learning. Pedagogical, methodological, and inclusive implications are discussed, focusing on the teacher's role and on transforming nature into a neuro-didactic laboratory.

Il contributo analizza la cognizione incarnata come paradigma educativo che integra corpo, mente e ambiente. La natura è interpretata come dispositivo cognitivo capace di offrire affordances, regolare attenzione ed emozioni e generare apprendimento situato. Vengono discusse implicazioni pedagogiche, metodologiche e inclusive, con particolare attenzione al ruolo del docente e alla trasformazione della natura in laboratorio neurodidattico.

KEYWORDS

Cognizione incarnata; educazione all'aperto; natura; inclusione; neurodidattica

Embodied cognition; outdoor education; nature; inclusion; neuro-didactics

Received 19/09/2025

Accepted 28/10/2025

Published 07/11/2025

1. Introduction¹

The paradigm of embodied cognition emerged as a critical alternative to the computational model of the mind, which dominated much of the twentieth century. The cognitivist tradition conceived mental processes as internal symbolic operations, comparable to those of a computer manipulating abstract representations, detached from both body and environment (Stanford Encyclopedia of Philosophy, 2021). In contrast, research on embodied cognition has emphasized that the body, its actions, and its interactions with the context are not merely “external supports” but integral components of cognitive processes themselves. The mind is no longer viewed as a separate locus of abstract calculations but as a distributed system shaped through perceptions, emotions, and movements rooted in situated reality (Kosmas & Zaphiris, 2018).

This shift has led to the development of broader theoretical frameworks, such as the perspective of 4E cognition, which conceives mental processes as embodied, embedded, enactive, and extended (Schilhab & Groth, 2024). In particular, the enactivism proposed by Varela, Thompson, and Rosch opened a decisive field of inquiry: to know does not mean to represent a pre-given world but to “enact” it through sensorimotor practices and interactions with the environment that construct experience (Varela, Thompson, & Rosch, 1991). Within this view, cognition cannot be separated from the material and relational context in which it unfolds.

Contemporary pedagogy has begun to engage with these insights, recognizing that education cannot be reduced to the abstract transmission of content but must integrate corporeality, affectivity, and the relationship with the environment. International literature highlights how embodied experiences enhance learning quality by strengthening motivation, memory, and critical thinking (Kosmas & Zaphiris, 2018; Schilhab & Groth, 2024). Italian scholarship on the relationship between education and nature moves in the same direction: the volume *Educazione e natura. Fondamenti, prospettive, possibilità* stresses the need to move beyond reductionist and sectoral approaches, advocating for a collective understanding of outdoor education as a field capable of integrating anthropological, pedagogical, psychological, and ethical perspectives (Antonietti, Bertolino, Guerra, & Schenetti, 2022).

Within this framework, nature emerges as a privileged context for activating embodied processes. Several studies have shown that outdoor bodily experience

¹ The introduction is the result of a common commitment on the part of the authors, the second paragraph is to be attributed to R. P. Laccone, and the third paragraph to S. Artusi.

fosters the construction of body schema, multisensory perception, and situated memory, directly linking emotion and learning (Federici, 2019; Valentini, Guerra, Troiano, & Federici, 2019). The natural environment is not simply a backdrop but an educational actor that offers affordances—opportunities for action and meaning-making—stimulating spatial orientation, attentional regulation, and sensory integration.

The reduction in time spent outdoors has produced a veritable “environmental deficit,” depriving younger generations of the educational potential of nature and weakening their connection to the natural world (Oliva, 2022). This is not a new concern: the tradition of outdoor education had already emphasized the benefits of direct contact with the natural environment, both in terms of psycho-physical well-being and meaningful learning (Valentini, Guerra, Troiano, & Federici, 2019). Recent research confirms that nature not only reduces extraneous cognitive load and supports emotional regulation but also functions as an extended cognitive context, capable of amplifying intrinsic motivation and generating integrated learning experiences.

In this sense, to speak of embodied cognition in education means to consider nature as a living laboratory in which perception-action, emotion, and knowledge construction are intertwined. The central question guiding this contribution is therefore: why, and to what extent, can the natural environment be considered a cognitive extension capable of amplifying educational processes?

2. Nature as a Cognitive Device

The concept of affordance, introduced by Gibson, describes the possibilities for action that the environment offers to the individual, in a complementary relationship between subject and context (Gibson, 1979; Antonacci, 2022; Guerra, 2022). These are not static properties of the environment but opportunities emerging from the dynamic interaction with its inhabitants (Chemero, 2003). From an educational perspective, this means recognizing that natural environments are not neutral backdrops but devices that stimulate perception and action, generating embodied experiences and situated knowledge (Heft, 1997; Toccafondi, 2016). The literature shows how nature constitutes a privileged context for spatial orientation and topographical memory: a forest, a garden, or an open space become places where children explore and construct sensorimotor schemas, while at the same time developing spatial and bodily awareness (Federici, 2015; Valentini & Donatiello, 2019). In this sense, spatial perception is always embodied: as Merleau-Ponty reminds us, space does not exist independently of the body that inhabits it but takes shape through its exploration (Merleau-Ponty, 1965). The natural environment also acts as an attentional and emotional regulator. Several studies

have documented that contact with green spaces reduces cognitive fatigue, lowers stress levels, and alleviates ADHD symptoms, with more significant effects than built environments (Kuo & Taylor, 2004; Bowler et al., 2010). In school contexts, the presence of greenery fosters diversified play, increases spontaneous physical activity, and supports peer cooperation (Dyment & Bell, 2008; Wells et al., 2014). A meta-analysis confirmed that prolonged experiences in nature generate psycho-emotional benefits such as reduced anxiety, increased perceived energy, and improved mood (Bowler et al., 2010). Due to the richness of its stimuli, nature is also a privileged environment for multisensory integration: sight, hearing, touch, and movement all contribute to building deep cognitive experiences. Research on embodied cognition highlights that learning is not rooted in abstract representations but in perceptual-motor practices and internalized sensorimotor routines (Barsalou, 2010; Glenberg, 2015; Schilhab, 2021). From this perspective, the natural environment functions as a “cognitive technology” that enhances learning through processes of cognitive offloading, namely the use of the environment itself to lighten mental load and support memory and attention (Wilson, 2002; Shapiro & Stolz, 2019). A central aspect concerns the link between bodily experience, emotion, and meaningful learning. Embodied Education emphasizes how the body, in movement and in relation to the environment, integrates perception, action, and cognition into a unified educational expression, making learning more inclusive and accessible (Maggi et al., 2025). Some contributions further show that immersive experiences in natural and informal environments, characterized by unpredictability and complexity, invite participants to engage in first-person: in such contexts, bodily, social, emotional, and cognitive dimensions intertwine seamlessly, stimulating the capacity to face uncertainty and to transfer the skills acquired to other domains of life (Tarantino, Del Gottardo, & Patera, 2023). In this sense, nature functions as a neurodidactic amplifier: it not only reduces extraneous cognitive load and increases intrinsic motivation but also fosters reflection through direct experience and the challenge of the unexpected (Pouw et al., 2014; Schilhab, 2021). Outdoor activities, when pedagogically designed with intentionality, promote not only the learning of disciplinary content but also ecological awareness, collaborative problem solving, and emotional regulation (Fjørtoft, 2001; Dahlgren & Szczepanski, 1998). In summary, the natural environment acts as a true cognitive device: it offers affordances for action and thought, regulates attention and emotions, integrates sensory channels, and generates embodied and transformative learning. The literature clearly shows that immersive experiences in nature constitute cognitive and emotional laboratories in which knowledge and meaning are constructed through the living interaction between body and environment. This perspective finds significant confirmation in phenomenological reflections on Embodied Education, which place the body at the center as an active subject in the construction of cognition through interaction with

spaces, objects, and people in the here-and-now of experience (Ceciliani, 2018). Bodily intentionality, observable already in young children when they interact with the environment to grasp, move, or manipulate objects, demonstrates that intelligent behavior can never be reduced to abstract mental processes but arises from an integrated network of motivations, emotions, and sensorimotor actions (Ceciliani, 2016). In this sense, cognition is not only online—that is, situated in concrete action—but also offline: even in mental simulation activities, such as motor anticipation or mental rotation, the body and past experiences provide the basis for cognitive elaboration (Rizzolatti, Fogassi, & Gallese, 2001; Jansen & Lehmann, 2013). The contribution of Embodied Education lies in showing how bodily and motor experiences—whether games, physical activities, or explorations in nature—constitute an intrinsically embodied educational framework, where cognition, emotion, and sociality are intertwined. This translates into educational opportunities that not only stimulate executive functions—such as attention, working memory, and planning—but also foster self-awareness and the ability to cope with new and unpredictable situations (Pesce et al., 2016; Diamond, 2015). Within this framework, the natural environment appears as the most favorable ground for giving concreteness to the embodied paradigm: ecological affordances become motivating stimuli, bodily experiences are rooted in situated memories, and cognitive processes take living form in the present moment (Francesconi & Tarozzi, 2012; Mortari, 2002).

3. Pedagogical Implications and Methodological Perspectives

Translating the theoretical framework of embodied cognition and the evidence on the effectiveness of natural environments into concrete teaching practices means radically rethinking educational design. The embodied perspective suggests that learning can no longer be understood as the mere acquisition of abstractly transmitted content, but rather as the situated construction of knowledge and competences that arise from the interaction between body, mind, and environment (Ceciliani, 2018; Pouw, van Gog, & Zwaan, 2014). In this sense, the task of the school becomes that of organizing experiences that allow students to engage firsthand in integrated motor and reflective activities capable of stimulating both cognitive and socio-emotional dimensions.

A first methodological area concerns motor activities intertwined with moments of reflection and re-elaboration. The so-called “argumentative walks,” in which students discuss while moving, or outdoor dramatizations, demonstrate how corporeality becomes a catalyst for processes of critical thinking and conceptual reworking (Ceciliani, 2018). Such practices make it possible to intertwine action and reflection, fostering a form of learning that does not separate doing from thinking but connects them in a virtuous cycle. The narration of bodily experience also

represents a powerful device for integrating memory, language, and emotional experiences, thereby fostering metacognitive awareness (Maggi, Dallari, & Gelati, 2021). From this perspective, the teacher is no longer a transmitter of knowledge but a facilitator of embodied experiences in nature. Their role is to design learning contexts rich in affordances, to guide students in observing and interpreting their experiences, and to support the integration of bodily and reflective dimensions (Buccino & Mezzadri, 2013). This posture also requires a rethinking of assessment, which can no longer be limited to verifying abstract knowledge but must instead value situated competence—that is, the ability to mobilize cognitive, bodily, and emotional resources in real contexts (Guerra, 2022).

Another crucial element is the targeted use of “lightweight” technologies as learning supports. Photographs, audio recordings, digital maps, or simple multimedia diaries can serve as tools for documenting and sharing bodily experience without replacing it (Antonacci, 2022). Technology, in this perspective, should not invade the experience but act as a reflective device that allows learners to revisit, represent, and re-elaborate what they have lived. This situates itself within a vision of teaching enhanced by nature, where natural environments and technological tools intertwine to expand the formative potential of embodied experiences.

The inclusive perspective represents an additional layer of exploration. Corporeality, in fact, constitutes a privileged entry point to learning for students with different cognitive styles or special educational needs (Maggi, Dallari, & Gelati, 2021). Embodied activities allow barriers linked to abstract codes and overly distant disciplinary languages to be bypassed, offering everyone the opportunity to participate through their body and emotions. Outdoor and nature-based education also generate less standardized and more flexible contexts, in which diversity is not perceived as deficit but as a resource for interaction and collective growth (Natural Learning Initiative, 2013; Feduc, 2021).

From the perspective of formative outcomes, embodied experiences in nature prove particularly effective in developing transversal competences such as critical thinking, problem-solving skills, and emotional regulation. Several studies have shown that activities based on direct interaction with the natural environment foster the capacity to analyze complex situations, to develop creative problem-solving strategies, and to manage emotions in uncertain contexts (Pouw, van Gog, & Zwaan, 2014; Tarantino, Del Gottardo, & Patera, 2023). In particular, immersive and metaphorical experiences—such as those that reproduce the unpredictability of the sea—train resilience and self-regulation, transforming uncertainty into opportunities for growth (Tarantino, Del Gottardo, & Patera, 2023).

The neurodidactic horizon provides further confirmation. Recent studies show that bodily experiences in nature reduce extraneous cognitive load and increase intrinsic motivation, thereby optimizing the conditions for deep learning (Pouw, van Gog, & Zwaan, 2014; Guerra, 2022). Nature acts as a neurodidactic laboratory in which sensory integration, attentional regulation, and emotional stimulation combine to make the construction of meaning more effective.

On the research front, a rich agenda opens. It is necessary to empirically test hypotheses related to the impact of natural environments on attentional processes, situated memory, and learning motivation. Some contributions have already highlighted the relevance of bodily movement in the formation of linguistic and scientific concepts (Buccino & Mezzadri, 2013), while others stress the importance of exploring to what extent embodied experiences can influence the construction of personal and social identity (Antonacci, 2022). Learning cannot be separated from the emotional sphere: without solid emotional competence, no real knowledge construction is possible. Further studies should investigate the role of emotions as mediators of learning processes in nature, examining how the affective dimension intertwines with the cognitive to generate meaningful knowledge (Maggi, Dallari, & Gelati, 2021). Moreover, future research should address the methodological criteria that allow embodied experiences in nature to be made accessible to all. The challenge lies in building educational pathways that are inclusive not only in principle but also in daily practice, valuing the diversity of bodies, languages, and cognitive styles. In this sense, nature constitutes a privileged laboratory because it provides non-standardized contexts open to plurality, while at the same time requiring careful and conscious pedagogical design (Ceciliani, 2018; Feduc, 2021).

In summary, the embodied perspective calls for transforming nature into an accessible and inclusive neurodidactic laboratory. The teacher becomes the director of integrated experiences in which corporeality, emotion, and cognition intertwine to generate meaningful and lasting learning. Technology acts as a discreet and reflective support, while the natural environment offers optimal conditions for activating processes of perception-action and situated memory. The research agenda, finally, calls for rigorously testing these insights to consolidate an educational paradigm capable of responding to contemporary challenges with innovative, inclusive tools deeply rooted in human experience.

A further crucial aspect concerns the inclusive value of experiences in nature. Research shows that outdoor environments foster forms of active and participatory learning that also support children with special educational needs or from socially marginalized contexts. Active outdoor education, for instance, has been described as a path of social inclusion that values the body as a universal medium and nature

as a democratic, accessible, and shared space (Bortolotti, 2021). In these contexts, diversity becomes a resource, since corporeality, with its rhythms and expressive modes, opens multiple pathways to learning, making possible a pedagogy that respects heterogeneous cognitive styles and promotes more egalitarian peer relations.

In parallel, it has been emphasized that exploration represents not only a natural disposition of children but also an educational posture that can be adopted by teachers and educators. Understood as an inquiring approach, exploration transforms learning into a shared inquiry, stimulating reflective and emotional processes that take root in memory and orient the development of ecological awareness (Guerra, 2023). In this sense, the act of exploring becomes both a method for building knowledge through direct contact with the environment and a practice that nurtures curiosity, creativity, and the capacity to pose open questions—qualities decisive for critical and responsible education.

Reflections on outdoor education have also highlighted the historical continuity of a pedagogical tradition that, from Rousseau to Dewey, from Montessori to Baden-Powell, has always regarded the external environment as an antidote to rote learning and the fragmentation of knowledge (Giorda & Rosmo, 2021). Today these insights find confirmation in neuroscience, which attests to the psychophysical and cognitive benefits of time spent in nature, from increased executive functions to emotional regulation and the promotion of ecological citizenship competences (Giorda & Rosmo, 2021). The geographical-educational perspective, in particular, emphasizes how direct observation and place-based learning foster in children not only cognitive abilities but also a sense of belonging to places and responsibility toward the community (Giorda & Puttilli, 2019).

In line with these perspectives, bodily experience is reinterpreted as an essential space for rethinking contemporary schooling. Several analyses have highlighted the need to overcome the body–mind divide that still characterizes many formal educational contexts, where the body remains invisible and movement relegated to curricular margins (Borelli, 2025). In this sense, outdoor education can be seen as an “untimely” practice (Borelli, 2025), but precisely for this reason innovative and necessary.

An emerging strand of the literature also highlights the importance of metaphors as pedagogical devices capable of generating profound learning. The model of “Metaphorical Experiential and Emotional Learning” (MEEL) interprets the educational environment as a network of embodied metaphors, in which emotions function as devices of openness and relationships are structured as transformative dynamics (Tarsi, Tarantino, & Del Gottardo, 2024). Through this model, nature and

the body are understood as sites of experience that, transposed metaphorically, foster inclusive processes and the integral development of the person.

Finally, the privileged relationship between childhood and nature deserves specific reflection. As recent literature emphasizes, contact with the natural environment allows children to build a sense of familiarity and care toward ecosystems, to train the capacity for sustained attention, and to develop situated memory that supports school learning (Bertolino, 2022). Direct encounters with trees, rocks, streams, or small animals are not only occasions for scientific knowledge but also integral experiences involving emotions, imagination, and sociality, strengthening the link between cognition and everyday life.

A school that aspires to be inclusive and meaningful must restore centrality to the body as a site of experience, self-expression, and relational construction, overcoming transmissive models that immobilize students and devalue the affective and experiential dimension.

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