

# FROM MOVEMENT TO MEANING: THE ROLE OF EMBODIED LEARNING IN EDUCATION

## DAL MOVIMENTO AL SIGNIFICATO: IL RUOLO DELL'EMBODIED LEARNING NELL'EDUCAZIONE



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### ABSTRACT

Embodied learning integrates physical activity, cognitive processes, and environmental interactions, challenging the mind-body dualism and promoting inclusive education. A thematic synthesis of 21 studies highlighted the role of movement in improving comprehension in STEM subjects, boosting motivation, and enhancing self-awareness and meaning-making. However, implementation and resource allocation challenges persist, underscoring the need for further research into its long-term effects.

L'embodied learning integra attività fisica, processi cognitivi e interazioni con l'ambiente, mettendo in discussione il dualismo mente-corpo e promuovendo un'educazione inclusiva. Una sintesi tematica di 21 studi ha evidenziato il ruolo del movimento nel migliorare la comprensione delle materie STEM, nell'aumentare la motivazione e nel potenziare la consapevolezza di sé e la costruzione di significato. Permangono sfide legate all'implementazione e all'allocation delle risorse, rendendo necessarie ulteriori ricerche sugli effetti a lungo termine.

### KEYWORDS

Embodiment, Embodied Cognition, Education, Movement, Inclusive Pedagogy

Embodiment, Embodied Cognition, Educazione, Movimento, Pedagogia Inclusiva

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## 1. Introduction

Over time, the understanding of the body has experienced substantial conceptual shifts, often resulting in ambiguity, reductive interpretations, or fragmented definitions (Fei, 2020). One persistent misconception frames the body as a self-contained mechanism, unimpacted by social or environmental influences. This isolated view, which envisions the body as detached from its relational and contextual fabric, overlooks its profound entwinement with broader social, cultural, and ecological dimensions (Digennaro & Iannaccone, 2023a, 2023b; Piccerillo et al., 2025). In contrast, contemporary thought increasingly recognizes the body not as an isolated element but as a complex, integrated system. It is both medium and message - a vessel through which individuals engage with reality, shape experiences, and relate to others. The body is a threshold where nature and culture converge, where individuality meets shared social narratives. It holds within it the tension between personal specificity and the collective frameworks in which it is inscribed (Digennaro, 2021; Digennaro & Iannaccone, 2023a). This reconceptualization aligns closely with phenomenological philosophy, which asserts the body's centrality in human experience. Phenomenology, rooted in the works of Edmund Husserl (1960), offers a framework in which the body is not merely observed but lived - a foundational site of consciousness and perception. Husserl's contributions reframed the body as the locus of intentionality, the means through which consciousness reaches out to and interprets the world. Building on this groundwork, figures such as Maurice Merleau-Ponty (1945) and Jean-Paul Sartre (1942) further advanced the discourse. Merleau-Ponty redefined embodiment by asserting that we are always already "being-in-the-world" - a condition in which bodily existence is interlaced with the environment and imbued with meaning. His *Phenomenology of Perception* (1945) disrupts Cartesian dualisms, emphasizing that the body is not a passive object but an active, perceiving, and meaning-making presence. Sartre, likewise, emphasized the body's role in constituting human reality, arguing that subjectivity and worldliness are inseparable from the bodily condition. This philosophical framework has resonated with practical fields, most notably in education. John Dewey (1998) was among the early thinkers to challenge the mind-body dichotomy in learning, advocating instead for an educational model that values experiential, embodied engagement. Dewey's legacy continues through contemporary theories of embodied cognition, which propose that mental processes are deeply shaped by the body's

sensorimotor capacities and its interactions with the world (Varela et al., 1991). Embodied cognition thus represents a decisive departure from traditional cognitive theories. Rather than treating the mind as separate from the body, it affirms the body's role in shaping complex cognitive functions, from language and reasoning to social and emotional understanding (Baker & Morris, 2005). This integrative view has critical implications for how we think about teaching, learning, and the environments in which these occur. Phenomenology, in turn, provides a conceptual underpinning for these perspectives by emphasizing the learner as a situated, embodied subject. Educational experience is grounded in corporeal presence; it unfolds through action, sensation, and movement. As Digennaro (2023) observes, learning is not a disembodied process but a deeply physical one, emerging from the body's interactions with its surroundings and with others. Within this framework, Physical Education (PE) offers a particularly compelling site for inquiry. Its emphasis on bodily engagement and movement positions it as a natural ground for investigating the principles of embodied cognition and phenomenology in practice. Scholars such as Armour (1999), Connolly (1995), and Stolz (2013) have emphasized the potential of PE to support identity development, social connectedness, and holistic growth. Armour, for example, argued for a rethinking of PE that centers bodily identity and purpose. Connolly encouraged pedagogical practices that make space for reflection on lived bodily experiences, while Stolz advocated for an integrated model that honors physical, emotional, and cognitive dimensions of the learner. Therefore, the present review aims to explore how embodied learning in PE contributes to the cultivation of physical literacy, the construction of embodied identity, and interdisciplinary links with other educational domains. Beyond critical reflection and movement exploration, it also considers motivational dynamics, inclusive practices, and the influence of sociocultural context, age, and time. Through this analysis, it highlights how such approaches can foster deeper connections between learners and their environments, where the environment is understood in its broadest sense, encompassing cultural, social, physical, and institutional dimensions. In alignment with Whitehead's perspective (1990), this review reaffirms PE's unique contribution to holistic education, proposing that embodied engagement through movement is key to a fuller understanding of self and world.

## 2. Methods

This review aimed to map key concepts and identify knowledge gaps related to embodied learning within school-based PE. The literature search was conducted from January to November 2024, using three major academic databases: Web of Science, Scopus, and PubMed. In the preliminary phase, the search strategy included the basic keyword combination “embodiment” AND “physical education.” This was then expanded into a more comprehensive search string: (“embodiment” OR “embodied” OR “embodied learning” OR “embodied cognition”) AND (“physical education” OR “physical activity”) AND “school.” To ensure a systematic and thorough review process, clear inclusion and exclusion criteria were applied while evaluating titles, abstracts, and full texts. The inclusion criteria targeted empirical, peer-reviewed studies that explicitly addressed embodiment within the context of physical education, focusing particularly on embodied learning experiences from the perspective of researchers. Studies were excluded if they were review articles, meta-analyses, conceptual or theoretical papers, academic books, conference abstracts, grey literature, or if they did not discuss embodiment-related concepts or were not written in English or Italian (as detailed in Table 1). The screening process was done using the semi-automated tool Rayyan (Ouzzani et al., 2016). A hierarchical approach was followed, beginning with title screening, abstract review, and finally full-text assessment. Only studies that met all inclusion criteria were selected for data extraction. Data were extracted systematically to capture essential study characteristics, including author(s), year of publication, participant demographics, study aims, key topics (identified through thematic analysis), and methodological approaches. Special attention was given to the nature and outcomes of the embodied learning interventions, particularly in terms of the types of bodily experiences facilitated. All included articles were analyzed using thematic analysis. This process identified three overarching themes to synthesize the findings: Cognitive and Academic Development, Social-Emotional and Identity Formation, and Physical Competence and Engagement. These themes serve as the core dimensions through which the contributions of embodied learning in PE are understood and discussed.

| Inclusion Criteria                                                                                              | Exclusion Criteria                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Peer-reviewed articles                                                                                          | Grey Literature                                                                                                                                     |
| Includes search items in at least one of the following:<br>keywords, research questions, title, or body of text | Review Articles                                                                                                                                     |
| English or Italian Language                                                                                     | Academic Books                                                                                                                                      |
| Empirical studies (qualitative, quantitative, or mixed methods)                                                 | Academic Book Chapters                                                                                                                              |
| Focus on body as the core of the experience                                                                     | Conference Abstracts                                                                                                                                |
| School Setting                                                                                                  | Other Languages                                                                                                                                     |
| Physical Education Setting                                                                                      | Conceptual/Theoretical Studies                                                                                                                      |
| Studies that are based on the concept of embodiment (or related concepts)                                       | Studies that do not focus on body as the core of the experience                                                                                     |
| Scholars' perspective or Scholars as participants                                                               | Neither School nor Physical Education Setting                                                                                                       |
|                                                                                                                 | Studies that do not discuss embodiment (or related concepts) in at least one of the following: research questions, keywords, title, or body of text |
|                                                                                                                 | Other Perspectives or Participants (e.g. teachers, parents)                                                                                         |

Table 1. Inclusion and Exclusion Criteria

### 3. Results

Database searches identified a total of 642 records. After removing duplicates and filtering for relevant document types, 275 studies remained for screening. Of these, 213 studies were excluded based on title and abstract review. Following a full-text assessment, 21 studies were included in the final review.

A summary of the included studies is presented in Table 2.

| First Author/Year             | Country     | School Level           | Topic                                   |
|-------------------------------|-------------|------------------------|-----------------------------------------|
| Aartun et al., 2023           | Norway      | Upper Secondary School | Physical Competence and Engagement      |
| Almarcha et al., 2023         | Germany     | Primary School         | Cognitive and Academic Development      |
| Anderson & Wall, 2016         | USA         | Lower Secondary School | Cognitive and Academic Development      |
| Azzarito et al., 2016         | USA         | Upper Secondary School | Social-Emotional and Identity Formation |
| Bergentoft, 2020              | Sweden      | Upper Secondary School | Physical Competence and Engagement      |
| Bustamante et al., 2022       | USA         | Primary School         | Cognitive and Academic Development      |
| Damsgaard et al., 2022        | Denmark     | Primary School         | Cognitive and Academic Development      |
| Fairbrother et al., 2020      | UK          | Primary School         | Social-Emotional and Identity Formation |
| Farias et al., 2019           | Portugal    | Upper Secondary School | Social-Emotional and Identity Formation |
| Halliwell et al., 2018        | UK          | Primary School         | Social-Emotional and Identity Formation |
| Have et al., 2018             | Denmark     | Primary School         | Cognitive and Academic Development      |
| Kosmas et al., 2019           | Greece      | Primary School         | Cognitive and Academic Development      |
| Cámara-Martínez et al., 2022  | Spain       | Preschool School       | Cognitive and Academic Development      |
| McClelland et al., 2015       | UK          | Primary School         | Cognitive and Academic Development      |
| McIntosh-Dalmedo et al., 2023 | UK          | Upper Secondary School | Social-Emotional and Identity Formation |
| Mills et al., 2022            | Australia   | Primary School         | Physical Competence and Engagement      |
| Resaland et al., 2019         | Norway      | Primary School         | Physical Competence and Engagement      |
| Schubring et al., 2021        | Sweden      | Upper Secondary School | Social-Emotional and Identity Formation |
| Wehner et al., 2021           | Danmark     | Upper Secondary School | Physical Competence and Engagement      |
| Wienecke et al., 2021         | Denmark     | Primary School         | Cognitive and Academic Development      |
| Zhu et al., 2023              | Netherlands | Primary School         | Cognitive and Academic Development      |

Table 2. Summary of the Included Studies

### 3.1 Overview of Findings

The studies included in this review ( $n = 21$ ) were conducted across diverse educational settings, with the majority ( $n = 11$ ) focusing on interventions in elementary schools involving children aged 5 to 11. A smaller group of studies ( $n = 6$ ) targeted high school students (ages 14–19), while four were set in middle schools (ages 11–14). One study included a mixed sample of upper elementary and early middle school students (ages 10–12), and another focused on pre-school-aged children ( $M_{age} = 35.83$  months,  $SD_{age} = 2.57$  months). Two studies did not report participant age explicitly but provided school grade information. Sample sizes varied significantly from large-scale interventions involving over a thousand students (e.g., Resaland et al., 2019) to small, in-depth studies with fewer than a dozen participants (e.g., Wehner et al., 2021). Most of the research was conducted in Europe ( $n = 17$ ), with additional studies from the United States ( $n = 3$ ) and Australia ( $n = 1$ ). Nearly all studies included male and female participants ( $n = 20$ ), though one focused exclusively on female students. Notably, all studies adopted a binary gender framework, without inclusion of non-binary or gender-diverse identities. All selected studies framed their interventions within PE, using embodiment-related theories such as embodied cognition, embodied experience, or embodied learning as a foundational lens. The interventions were designed and led by scholars, whose perspectives shaped the conceptualization of the body as central to the learning experience. As such, the scholar-centered nature of the research was reflected both in the design of the activities and in the interpretation of the findings. Through thematic analysis of the selected studies, three interconnected thematic areas emerged, corresponding to the primary objectives of the interventions: cognitive and academic development, social-emotional and identity formation, physical competence and engagement. Despite the variety of target groups and educational contexts, the studies shared a common aim: to advance understanding of embodied learning and to investigate its pedagogical potential within PE. The longitudinal design adopted by all the studies allowed for observing gradual changes and longer-term impacts, contributing to a richer picture of how embodiment influences learning over time. The included studies, published between 2015 and 2023, employed different methodological approaches, including qualitative ( $n = 10$ ), quantitative ( $n = 9$ ), and mixed-methods ( $n = 2$ ) designs.

### **3.2 Cognitive and Academic Development**

The cognitive and academic development domain within embodied learning emphasizes how physical activity, movement, and sensorimotor experiences can enhance mental functions and support academic growth. Rather than treating physical engagement as separate from intellectual tasks, this perspective suggests that movement-based learning environments can improve attention, memory, self-regulation, and conceptual understanding - core components of effective cognition. Several studies reviewed highlight the potential of integrating physical activity into academic instruction, particularly for students who may struggle in conventional learning environments. For example, McClelland et al. (2015) evaluated the Move4Words program, a multisensory intervention combining movement with literacy activities for students at risk of underperformance. Over 12 weeks, participants showed marked gains in national assessments, particularly in reading, writing, and math. Teachers also observed improvements in students' classroom focus and behavioral regulation - outcomes directly linked to executive functions like inhibition and sustained attention. Other research reinforces these findings with subject-specific applications. Have et al. (2018) introduced physical exercises to support mathematical learning. Students who physically enacted math problems outperformed those in traditional settings, demonstrating improved math performance and enhanced executive functioning. These benefits were especially pronounced for boys, suggesting that embodied methods may address gender-based learning disparities by accommodating different cognitive engagement styles. A growing body of work also explores how embodied learning supports comprehending abstract scientific ideas. For instance, Almarcha et al. (2023) implemented a kinesthetic protocol for teaching physics and dynamic systems theory. Students acted out phenomena like phase transitions or equilibrium states using coordinated physical tasks like balance and acroport. This hands-on engagement deepened students' conceptual understanding and nurtured transferable cognitive abilities like pattern recognition and analogical thinking. Importantly, this approach was grounded in developmental theory, ensuring that activities aligned with learners' cognitive readiness. Technology-enhanced learning environments have further expanded the possibilities for embodied cognition. Studies by Kosmas et al. (2019) and Anderson & Wall (2016) examined how motion-capture devices like the Xbox Kinect can be used to teach physics principles such as motion and force. While Kosmas et al. reported gains in memory and conceptual

retention, Anderson and Wall pointed to challenges with interpreting noisy data and the need for strong instructional scaffolding. These findings underline the importance of designing tech-based activities with clear cognitive objectives and age-appropriate complexity to prevent cognitive overload. Play-based and game-oriented learning approaches also featured prominently in this domain. For example, Bustamante et al. (2022) developed Fraction Ball, a hybrid of basketball and math instruction that used the court's geometry to teach fractions. Students made progress in arithmetic tasks directly tied to the game mechanics, though gains in broader math skills, such as estimation, were more limited. This illustrates how embodied learning may be especially effective for foundational concepts, while more advanced skills might require a blended instructional approach. Similarly, Wienecke et al. (2021) incorporated math problems into basketball drills, which significantly boosted students' motivation and sense of agency. These interventions not only improved skill acquisition but also strengthened emotional and cognitive engagement with the learning material, highlighting how movement can foster a sense of autonomy and competence. Language development studies echo this potential. Cámara-Martínez et al. (2022) found that movement-based vocabulary and narrative games in early childhood education led to significant improvements in comprehension, suggesting that embodied learning can support literacy alongside motivation and enjoyment. Foundational skill development, particularly in early education, also benefits from motor involvement. Damsgaard et al. (2022) explored how whole-body movements and fine motor tasks supported letter-sound recognition in young children. While gains in phonemic awareness were clear, the study also indicated that broader reading abilities may require additional literacy-specific instruction, suggesting a complementary rather than standalone role for embodied methods. Finally, creative applications such as data physicalization (Zhu et al., 2023) offer an innovative means to teach abstract data concepts. Students enhanced their spatial reasoning and better understood data visualizations by manipulating physical objects to represent numerical information. However, practical barriers - such as time and materials - limit the scalability of the intervention, highlighting the need for a balance between creativity and feasibility in embodied curriculum design. These studies illustrate how embodied learning contributes to cognitive development by integrating physical experience into academic tasks. It enhances focus, comprehension, and problem-solving, particularly when activities are contextually relevant, developmentally aligned, and thoughtfully scaffolded. While challenges remain, particularly regarding

implementation logistics and transfer to complex cognitive domains, the evidence supports embodied learning as a valuable approach to promoting both academic achievement and cognitive engagement.

### **3.3 Social-Emotional and Identity Formation**

Embodied learning is crucial in shaping how young people understand themselves and relate to others. The body is a vessel for action and sensation and a site of identity, emotion, and social negotiation. In educational contexts, embodied experiences can support the development of emotional literacy, interpersonal skills, and a sense of belonging, while also providing opportunities to critically engage with societal norms related to gender, race, and ability. This section explores how movement-based and physical learning environments influence the formation of self-concept, emotional well-being, and social identity. The concept of the lived body - central to phenomenological perspectives - highlights how identity is experienced and expressed through physical presence and social interaction (Schultze, 2014). As such, the classroom becomes a space where students do more than learn academic content; they also encounter and construct who they are in relation to others. This includes navigating powerful cultural narratives about bodies and worth, often shaped by media and reinforced through institutional practices. A prominent example of critical embodied pedagogy comes from Azzarito et al. (2016), whose Body Curriculum invited secondary school students to reflect on body ideals through a sociocultural lens. Lessons focused on media representations, gender and racial dynamics, and personal body image. Through discussions and journaling, students became aware of how cultural narratives influence self-perception, particularly around size, shape, and muscularity. While some students resisted stereotypical ideals, many still internalized narrow standards, illustrating the tension between critical awareness and lived experience in a media-saturated environment (Evans et al., 2008). Embodied practices can also foster emotional regulation and body appreciation, as seen in Halliwell et al. (2018). Their 4-week school-based yoga intervention aimed to enhance body esteem and mood in pre-adolescents. Although both the yoga and control groups (who participated in regular PE) showed improvements, no significant differences were observed between them. This suggests that well-structured PE programs may offer similar psychosocial benefits to more targeted interventions. However, gendered patterns remained: girls continued to report lower body satisfaction and higher

negative affect, underlining the need for gender-sensitive approaches to embodiment and well-being. Simple policy changes can also yield meaningful shifts in how students experience their bodies at school. McIntosh-Dalmedo et al. (2023) evaluated the impact of allowing students to choose their own PE attire. This small but significant intervention improved scores on several dimensions of body esteem, especially concerning weight and appearance. However, perceived judgments from others (BES-attribution) remained low, indicating that external social pressures continue to influence body image even in more flexible environments. These findings resonate with broader concerns about how institutional norms around uniforms and appearance can impact self-concept, especially for adolescent girls (Juli, 2017; Miranda et al., 2021). Building on critical pedagogy, Schubring et al. (2021) implemented a Lesson Study intervention in Swedish schools to address cultural constructions of the “ideal body” within PE. Students are engaged with narrative case studies and reflective activities to examine how media and peer norms shape their views. The outcomes were mixed: while some students demonstrated critical engagement and challenged gender stereotypes, others reinforced prevailing norms. These results reflect the difficulties in translating theoretical insights into personal transformation and underscore the importance of contextual sensitivity in designing embodied interventions. Although not included, Sánchez-Hernández et al. (2018) developed a cooperative learning model in PE using football as a medium to confront gender inequality. The intervention created space for both boys and girls to question traditional roles by embedding critical discussions within a familiar and engaging activity. Although not all students welcomed the shift from performance to inclusion, the intervention opened productive tensions and new ways of thinking about participation and equity. In health education, embodied approaches have also proven effective, though not without complexity. The Love Life, Smokefree Sports program, evaluated by Fairbrother et al. (2020), used physical activity to communicate anti-smoking messages to primary school children. The most successful components involved multisensory, interactive tasks that aligned closely with the intended message. However, when the physical experience felt disconnected from the lesson's purpose, students struggled to internalize the health messaging. This highlights the need for coherence between physical engagement and pedagogical intent, an insight echoed across embodied learning literature. Long-term engagement also appears critical for meaningful identity development. Farias et al. (2019) examined the lasting impact of a Sport Education curriculum on students' personal growth

and social attitudes. Through interviews and memory retrieval exercises, participants reported increased empathy, inclusivity, and motivation, skills and dispositions that extended beyond school settings. These findings illustrate the potential of sustained embodied practice to improve immediate outcomes like engagement and self-esteem and to contribute to lifelong dispositions toward equity and participation. Rather than positioning the body as a neutral vehicle for learning, these interventions foreground it as a site of meaning-making, vulnerability, and resistance. Whether through yoga, critical pedagogy, clothing autonomy, or physically active discussions on health and identity, the reviewed studies reveal how bodily experiences in school settings can either reinforce or disrupt social norms. Crucially, the emotional and social dimensions of embodied learning are not incidental outcomes. They are central to how students relate to themselves and others. Effective embodied practices in this domain appear to hinge on context-sensitive design, gender responsiveness, and the capacity to engage students in movement and reflection. In this way, embodiment becomes both a pedagogical strategy and a medium through which identity and empathy are negotiated, contested, and reimagined.

### **3.4 Physical Competence and Engagement**

This domain centers on the development of motor skills, body awareness, and confidence in physical expression, alongside a motivation to engage in movement as part of a fulfilling and active life. It encompasses both technical proficiency and expressive embodiment, emphasizing how students cultivate movement literacy through play, reflection, and meaningful engagement with their environment. Aartun et al. (2023), drawing on sensory ethnography and phenomenological methods, explored how students experience movement through play in PE. Their research revealed that playful modifications of structured tasks, such as in parkour, biking, or swimming, often enhanced enjoyment and fostered a sense of agency. These playful experiences generated sensations of physical exhilaration and psychological flow, which in turn supported the integration of social, physical, and creative skills. Sensory ethnography, with its attention to gesture, posture, and affective cues, offered insight into how embodied learning takes shape beyond verbal instruction (Pink, 2015). Building on this focus on bodily perception, Bergentoft (2020) employed Variation Theory to examine how students reflect on the sensory experience of running. By structuring lessons around variations in

posture and sensation, students learned to attend to their internal bodily cues, identifying what felt unfamiliar or effortful, and experimenting with new ways of moving. This pedagogical emphasis on lived bodily experience reinforced a central theme in embodied learning: awareness and refinement arise through repetition and attunement to sensation and change. Technology also played a role in expanding the possibilities of embodied engagement. Mills et al. (2022) examined how virtual reality tools like Google Tilt Brush™ can foster full-body participation in artistic creation. Students used gross and fine motor movements - walking, reaching, and gesturing - to paint immersive 3D environments. Unlike traditional screen-based learning, these multimodal experiences foregrounded spatial awareness, coordination, and tactile interaction, revealing how digital tools can support embodied meaning-making when physical engagement is prioritized. Several studies extended the inquiry into how physical activity contributes to well-being. The ASK Study (Resaland et al., 2019) evaluated a school-wide physical activity intervention aimed at improving academic performance and health-related quality of life (HRQoL). Although the intervention did not produce significant gains in HRQoL, it highlighted the need to consider individual differences and the quality, not just quantity, of movement experiences. Similarly, Wehner et al. (2021), part of the Danish Healthy High School Study, examined how everyday movement, such as informal walking or stretching, supported students' emotional balance and peer relationships. Movement was a reprieve from academic demands and a quiet strategy for navigating them, revealing the subtle yet powerful role of embodied rhythms in daily life. Challenging dominant notions of ability in PE, Nyberg et al. (2020) proposed a shift from performance-based standards to inclusive, exploratory approaches. Using juggling as a non-competitive activity, they examined how students developed movement competence through pattern recognition, rhythm, anticipation, and spatial positioning. Rather than focusing on technical mastery (e.g., juggling three balls), the study emphasized a broader definition of movement ability grounded in embodied awareness, adaptability, and process-oriented engagement. This perspective advocates for a richer understanding of competence that recognizes the body's capacity to know, feel, and create meaning through movement. These studies illustrate that physical competence is not merely an outcome of skill acquisition, but a dynamic process shaped by curiosity, bodily awareness, and diverse forms of participation. When movement is approached as an open-ended and meaningful activity, rather than a performance to perfect, students are more likely to develop sustained interest,

confidence, and a sense of ownership in how they move. This underscores the importance of designing learning environments that invite experimentation, value subjective experiences, and affirm multiple expressions of physicality.

## **4. Discussions**

This review underscores the evolving relevance of embodied learning within PE, offering a nuanced understanding of how bodily engagement contributes to holistic development. Three intersecting domains were identified as central to this process: cognitive and academic development, social-emotional and identity formation, and physical competence and engagement. These dimensions emphasize that learning is not merely a mental endeavor, but a dynamic, multisensory experience shaped by context, culture, and community. Drawing on contemporary literature, this discussion explores how embodiment shapes educational outcomes and how pedagogical practices can evolve to embrace this perspective.

### **4.1 Rethinking Learning through Embodiment**

Embodied learning challenges traditional models of education that prioritize abstract reasoning over experiential engagement. By foregrounding the body as a site of knowing, this approach invites educators to consider how movement, sensation, and spatial awareness shape cognitive processes (Kosmas et al., 2019; Lambert, 2018). The studies reviewed confirm that learning is often most effective when it involves more than just symbolic representation. When students physically enact, feel, or reflect on their learning, their understanding deepens. The concept of physical literacy exemplifies this shift. Far from being a narrow focus on technical skills, it encompasses emotional, social, and motivational elements that contribute to lifelong movement competence (Whitehead, 2019). Practices like embodied reflection, exploratory movement, and sensory-based learning cultivate a more integrated learner, capable of adapting to various physical, cognitive, and social demands (Aartun et al., 2023; Bergentoft, 2020). Moreover, embodied learning supports attentional and memory processes. When learners physically participate in constructing knowledge, for example, by using gestures or manipulating objects, the resulting neural pathways tend to be stronger and more durable (Johnson-Glenberg et al., 2016). This reinforces short-term engagement and strengthens long-term retention and problem-solving capabilities. To scale these benefits,

however, educators must integrate embodied learning with curriculum standards to preserve academic rigor and student agency. Doing so requires reimagining teaching not as transmission but as facilitation of embodied inquiry a shift that carries important implications for teacher training and educational design.

## **4.2 Embodiment, Identity, and Equity**

Embodiment does not occur in a vacuum; it is inherently social, relational, and shaped by power dynamics. Educational environments can reproduce or disrupt normative assumptions about gender, ability, body type, race, and class. The research reviewed signals an urgent need to move beyond standardized benchmarks of physical performance toward a more inclusive and responsive understanding of what it means to be capable. Approaches like Nyberg et al.'s (2020) "embodied exploration" give students room to engage with movement in personally meaningful ways, fostering competence and a sense of authentic belonging. Similarly, Azzarito et al. (2016) highlight how critical pedagogies interrogating media, beauty standards, and body ideals empower students to resist harmful stereotypes and affirm their bodily identities. Attention to gendered experiences also emerges as a critical concern. Girls in particular face social pressures that can restrict their comfort and participation in PE. Interventions such as yoga (Halliwell et al., 2018) or clothing autonomy (McIntosh-Dalmedo et al., 2023) may seem minor. However, they can significantly improve emotional safety and body image, enabling fuller engagement in movement-based activities. Intersectionality further complicates the picture. Students' embodied experiences are not only gendered but also racialized, classed, and culturally inflected. Embodied pedagogies that ignore these dynamics risk reinforcing systemic inequities. Teachers must be equipped to recognize and validate diverse bodily expressions, foster critical dialogue, and create spaces where multiple identities can coexist and thrive. Ultimately, inclusive embodiment means valuing the full range of human movement as a mode of physical expression and a vehicle for personal growth, social connection, and cultural meaning.

## **4.3 Connecting Movement with Academic Disciplines**

Beyond physical literacy and social identity, embodied learning also holds a substantial promise for academic achievement. When students move while they learn, they do not just stay engaged; they often understand complex ideas more

fully. This review identified several studies demonstrating how embodied strategies enhance memory, attention, and concept mastery across subjects (Almarcha et al., 2023; McClelland et al., 2015). This is particularly relevant in STEM education. For instance, Jha and Price (2022) show how motion-based activities—like modeling centripetal force with spinning or acting out molecular transitions—enable students to internalize abstract phenomena through physical metaphor. These approaches bring the invisible into felt experience, offering a level of comprehension that textbooks alone rarely achieve. Equally important is the level of embodiment used. Johnson-Glenberg et al. (2016) found that higher degrees of physical engagement, such as full-body participation, lead to better retention and knowledge transfer, especially in tasks requiring generative thinking. This suggests that the depth of bodily involvement is not just a stylistic choice but a key determinant of learning efficacy. Still, multidisciplinary integration is not without its challenges. Designing tasks that maintain an appropriate cognitive load and serve meaningful learning objectives requires thoughtful planning. Educators must carefully align a lesson's symbolic and somatic aspects so that movement reinforces, rather than distracts from, conceptual understanding. Future directions should include more longitudinal studies that assess academic outcomes and creativity, curiosity, and cross-domain thinking, traits increasingly valued in 21st-century education.

#### **4.4 Emerging Technologies and the Evolving Role of Educators**

Technological advances have expanded the possibilities for embodied learning, particularly through tools like virtual reality, motion capture, and interactive gaming. These technologies offer immersive environments where learners can engage in simulated movement scenarios that would otherwise be inaccessible (Kosmas et al., 2019). However, the pedagogical success of such tools hinges on their design, equity, and cultural sensitivity. Mills et al. (2022) and Digennaro and Iannaccone (2023a) note that the body is culturally constructed. Technologies must avoid promoting biased body standards or privileging certain types of movement while excluding others. In this context, ethical design includes ensuring access, acknowledging diversity, and minimizing passive consumption. Teachers are central to these efforts. Effective implementation of embodied pedagogies - digital or analog - requires educators to develop new literacies around movement, identity, and inclusive design. Professional learning communities, such as lesson study

groups, offer promising models for building this capacity through peer collaboration and reflective experimentation (Dudley, 2014; Hiebert et al., 2002). Student participation is another essential pillar. When learners are invited to co-create activities, set personal goals, and reflect on their embodied experiences, they are likelier to feel ownership, engagement, and empowerment (Schubring et al., 2021). This co-design approach also supports the development of metacognitive skills and intrinsic motivation. Finally, embodied learning creates opportunities for schools to engage students in critical inquiry around body politics, gender norms, and cultural values. These are not peripheral issues but central to forming ethical, empathetic, and self-aware individuals. Teachers who create space for these conversations play a vital role in shaping informative and transformative education (Fisette, 2011; O'Sullivan & MacPhail, 2010).

## **5. Conclusions**

Embodied learning redefines conventional educational paradigms by emphasizing the dynamic interplay between mind, body, and environment. This approach encourages learners to engage physically and socially, facilitating deeper cognitive and emotional connections to content. The findings of this review underscore embodied learning's potential to cultivate more inclusive and responsive educational practices. Ongoing research and pedagogical experimentation are essential to unlocking its transformative power, ensuring its relevance in addressing contemporary education's evolving challenges and opportunities.

## **Author contributions**

SD: Supervision, Conceptualization, Writing review & editing. AI: Methodology, Writing – original draft, writing – review & editing PF: Data curation, Writing—original draft, writing – review & editing.

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