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Educational practices in motion: a scoping review of embodied learning approaches in school

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Introduction: Embodied learning integrates physical activity, cognition, and environmental interaction within educational practices, challenging traditional dichotomies between mind and body. In the context of physical education (PE), embodied approaches are particularly promising for fostering physical literacy, embodied identity, and interdisciplinary learning, thereby promoting more inclusive and holistic pedagogical models.

Methods: A scoping review was conducted in accordance with the Joanna Briggs Institute guidelines and the PRISMA checklist. A systematic search across Web of Science, Scopus, and PubMed databases was performed from January to November 2024. Studies were included if they empirically explored embodied learning within school-based PE contexts. Twenty-one studies met the inclusion criteria and were analyzed thematically. The methodological quality of the studies was assessed using the Mixed Methods Appraisal Tool (MMAT).

Results: Three major thematic cores emerged: physical literacy, embodied identity, and multidisciplinary. Embodied learning interventions consistently enhanced student motivation, body awareness, cognitive engagement, and interdisciplinary integration, particularly in STEM-related areas. Furthermore, several studies reported improvements in students' self-perception, social competence, and critical engagement with body ideals. Despite these positive outcomes, limitations were noted, including cultural homogeneity of samples, age-related research gaps, and methodological inconsistencies across studies.

Discussion: Embodied learning holds substantial potential to enrich educational environments by bridging physical, cognitive, and emotional domains of student experience. It facilitates deeper engagement, inclusivity, and academic integration across disciplines. However, future research should focus on diversifying cultural contexts, including broader age ranges, and conducting longitudinal studies to explore the sustained impact of embodied learning interventions.

KEYWORDS

embodiment, embodied cognition, physical education, inclusive pedagogy, movement

1 Introduction

The concept of body has undergone profound transformations over time, often giving rise to misunderstandings, incomplete definitions, or oversimplifications (Fei, 2020). A recurring challenge lies in the notion of the body as an isolated entity—an autonomous mechanism capable of self-determination and transformation, independent of external influences. This perspective portrays the body as detached from the environment and society, operating in a vacuum devoid of relational and contextual factors. Such a view neglects the intricate and multifaceted reality of what the body represents (Digennaro and Iannaccone, 2023a, 2023b, Piccerillo et al., 2025).

Nevertheless, the concept should not be viewed as an isolated entity; rather, the body is a dense, interconnected weave of elements that transcend corporeality. It is not only the key to existence but also the window through which individuals perceive, interact with, and approach the world. Yet, existence itself cannot be reduced to mere corporeal presence. The body must be conceived as a junction—a dynamic link between nature and culture, individuality and collectivity, solidity and abstraction. It encapsulates the dualities of personal uniqueness and the inevitable adherence to social patterns (Digennaro, 2021; Digennaro and Iannaccone, 2023a; Digennaro and Iannaccone, 2025).

This nuanced understanding resonates with the central themes of phenomenology, a philosophical discourse that positions the body as fundamental to human existence. Phenomenology offers a robust framework for examining the body, not merely as an object of perception but as a lived and subjective entity intricately tied to the world. Philosophers such as Edmund Husserl (1960) pioneered this discourse, emphasizing the body's role in consciousness and lived experience. Husserl's groundbreaking work framed the body as a pivotal element in the intentionality of consciousness - the directedness of the mind toward objects and experiences in the external world.

Husserl's ideas inspired a lineage of thinkers, including Maurice Merleau-Ponty (1945) and Jean-Paul Sartre (1942), who expanded upon this foundation. Merleau-Ponty, in particular, revolutionized our understanding of embodiment, asserting that the body is not merely situated in the world but is fundamentally “being-in-the-world.” In his seminal work *Phenomenology of Perception* (1945), he articulated that human existence is inextricably interwoven with the world: “We are through and through compounded of relationships with the world.” This perspective challenges traditional Cartesian dualisms that separate mind and body, subject and object, by grounding human experience in the lived body.

For Merleau-Ponty, the world is not a neutral backdrop or passive background. Instead, it is the foundational ground of all human capacities and the source of meaning in life experiences. His work underscores that perception, cognition, and action are fundamentally embodied processes, rooted in the body's active engagement with its environment. Sartre echoed these sentiments, emphasizing that human existence is realized and sustained through the intimate relationships between the body and the world. Together, these philosophers redefined the body as an active participant in shaping consciousness and reality.

This philosophical reframing extends beyond theoretical exploration into practical domains such as education. Dewey (1998) was among the first to highlight the role of the body in learning, emphasizing that education involves not only cognitive processes but also physical, practical, and embodied actions. Dewey's work challenged traditional learning structures, advocating for an experiential approach that integrates mind and body. His insights laid the groundwork for embodied cognition, a theoretical framework that posits that cognitive processes are deeply intertwined with bodily interactions and the surrounding environment (Varela et al., 1991).

Embodied cognition rejects the Cartesian mind-body dualism (Baker and Morris, 2005) in favor of a holistic perspective that highlights the body's active role in shaping thought, emotion, and experience. Bodily systems, evolved for perception, action, and

emotion, contribute significantly to “higher” cognitive functions such as language comprehension, mathematical reasoning, and scientific thinking. This view not only enhances our understanding of cognition but also offers profound implications for education.

As a conceptual foundation for embodied cognition, phenomenology plays an equally significant role in the development of embodied studies, offering a richer understanding of human experience and valuable insights for rethinking educational practices.

From a phenomenological perspective, education can be understood as an embodied process in which the physical and subjective dimensions of the human being are integral to learning. The conscious experience of the learner is rooted in their corporeal existence, which mediates their relationship with the world (O'Loughlin, 1997). As Digennaro (2023) argues, education is made possible precisely because humans are embodied beings who engage with the world through their bodies. The educational relationship, in this sense, is grounded in the body's capacity to perceive, act, and connect with its environment.

In this context, physical Education (PE), represents a particularly fertile ground for exploring these theories. By its very nature, PE emphasizes the body's role in perception, movement, and interaction, making it a unique context for examining the practical implications of embodied cognition and phenomenology. Researchers such as Armour (1999), Connolly (1995), and Stolz (2013) highlighted the potential of PE to enrich students' understanding of their surroundings and their capacities as embodied beings. Indeed, Armour argued that focusing on body in education could help students build a stronger sense of identity and provide a clear purpose for PE within schools. Similarly, Connolly highlighted the importance of lived experiences in PE, encouraging both reflection and meaningful interaction with others. Stolz, on the other hand, pointed out that PE should address the whole person by combining physical, emotional, and mental development, stressing the value of movement in helping students connect with themselves and their surroundings.

Unlike previous reviews that focused primarily on pedagogies of embodiment in PE (e.g., Aartun et al., 2022), this scoping review expands the perspective by examining how embodied learning contributes to physical literacy, identity formation, and interdisciplinary connections within PE. While Aartun et al. explored critical reflection and movement exploration, this study highlights additional dimensions, including the role of embodied learning in fostering motivation, engagement, and inclusive practices. By synthesizing diverse approaches, this review uncovers new insights into the practical applications of embodied learning in PE, addressing gaps in cultural adaptation, age-related differences, and long-term impact.

In this perspective, by investigating the intersection of phenomenology, embodied cognition, and education, with a particular focus on PE, the present scoping review aims to highlight the role of embodied learning in fostering a deeper appreciation of the body's relationship with its environment, understood as the interplay between society, culture, learning processes, and the physical surroundings. It also examines its influence in shaping physical literacy, embodied identity, and interdisciplinary learning, while uncovering insights, common threads, and practical implications that can inform future educational approaches. As Whitehead's work suggests (Whitehead, 1990), PE has the potential to enhance our understanding of embodiment, guiding learners toward a more integrated and holistic engagement with themselves and their environment.

2 Methods

2.1 Search strategies

The present scoping review was conducted by following the guidelines for scoping reviews developed by the Joanna Briggs Institute (Peters et al., 2020) and the PRISMA checklist (Tricco et al., 2018) to identify key concepts and gaps in contemporary knowledge regarding embodied learning.

The literature research was conducted between January and November 2024, across the scientific databases of Web of Science, Scopus, and PubMed. In the initial phase, the search strategy included a combination of the keywords “embodiment” AND “physical education.” Subsequently, a more complex search string was employed: (“embodiment” OR “embodied” OR “embodied learning” OR “embodied cognition”) AND (“physical education” OR “physical activity”) AND “school.”

To ensure a comprehensive examination of the available material, specific inclusion and exclusion criteria were established for evaluating titles, abstracts, and full-text content of all identified records. Inclusion criteria were designed to collect empirical peer-reviewed studies incorporating both the concept of embodiment and the PE setting. These studies focused on the body as the core of the embodied learning experience, uniquely from scholars’ perspectives. Exclusion criteria filtered out review articles, meta-analyses, academic books, conference abstracts, grey literature, conceptual or theoretical works, studies that do not discuss embodiment or related concepts, and studies not written in English or Italian (as detailed in Table 1). The screening process was meticulously conducted using the semi-automated tool Rayyan (Ouzzani et al., 2016), following a hierarchical approach based on the inclusion and exclusion criteria, starting with titles, then abstracts, and finally full texts. Studies were included in the review only if they met the specified inclusion criteria.

TABLE 1 Inclusion and exclusion criteria.

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

The data extraction process captured critical information such as author(s), publication year, sample characteristics, objectives, topics (identified through thematic analysis), and methodological details. Particular emphasis was placed on the intervention outcomes, including the types of bodily experiences proposed. All included articles were analyzed in full text using thematic analysis. The findings were synthesized into three main themes: Embodied Identity, Physical Literacy, and Multidisciplinarity.

2.2 Quality assessment

The Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018) was employed to assess the quality of evaluation procedures. The MMAT process encompassed several stages: (1) addressing screening questions that evaluate the clarity and efficacy of the research inquiries; (2) classifying the research design; (3) filling out a checklist for each research design category to assess pertinent quality attributes. Each criterion was scored as 1 for presence and 0 for absence. Discrepancies in quality assessments between reviewers, particularly regarding the influence of researchers on findings and the sampling strategy of quantitative data, were resolved through consensus. Subsequently, a quality score for each article was calculated by dividing the total points scored by the total points possible. Each article was categorized based on the quality score as follows: weak (≤ 0.50), moderate-weak (0.51 to 0.65), moderate-strong (0.66 to 0.79), or strong (≥ 0.80).

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 (Figure 1).

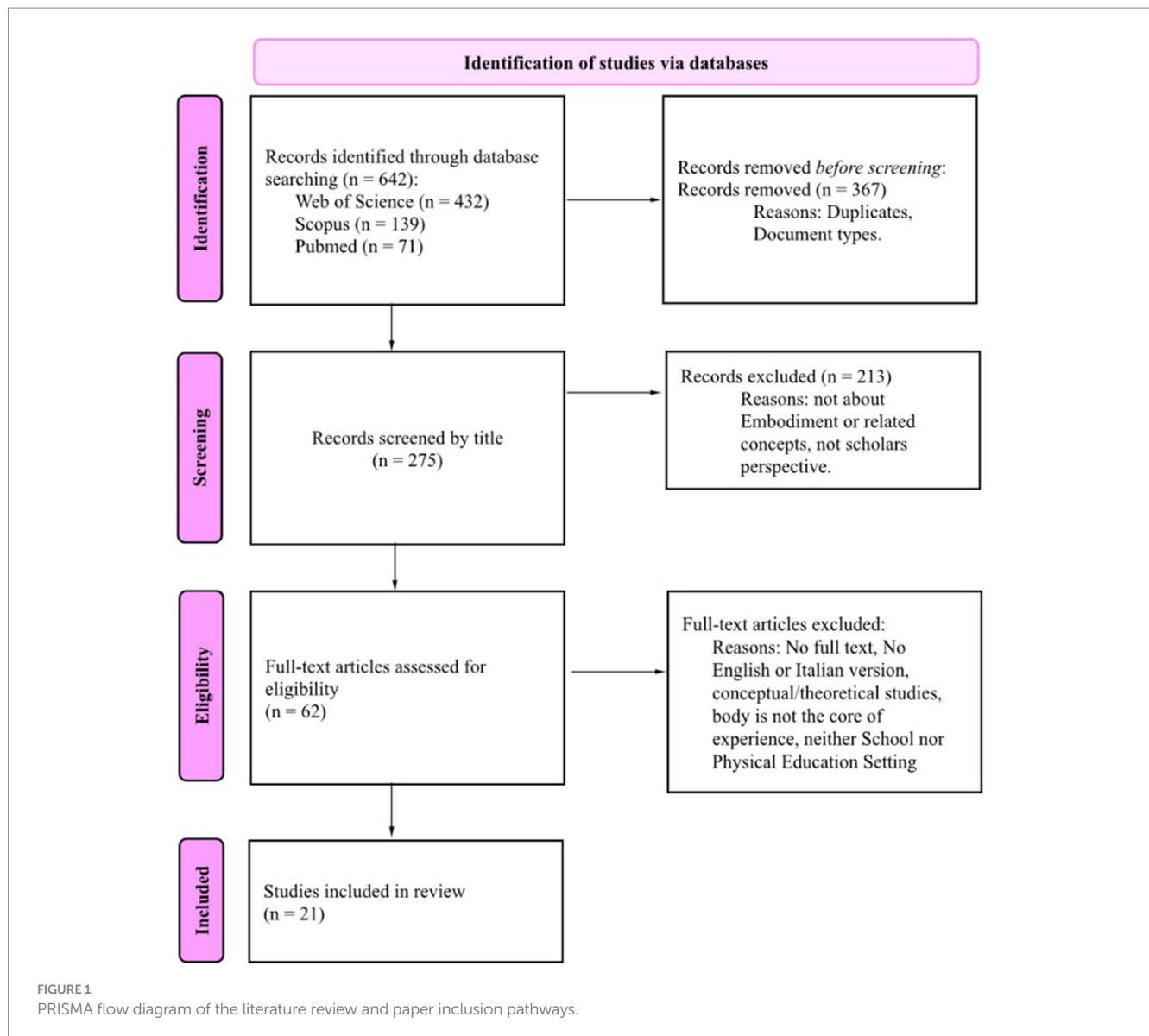
A summary of the included studies is presented in Table 2.

3.1 Qualitative assessment

The MMAT (Hong et al., 2018) classified all the included studies as high quality for each research type: quantitative randomized studies (Table 3), quantitative non-randomized studies (Table 4), qualitative studies (Table 5), mixed methods studies (Table 6). Overall, the selected studies clearly articulated their research aims and methodologies. Data were gathered from participants aged 5–23 years. Most studies provided a clear statement of their findings and addressed factors related to limitations.

3.2 Overview of findings

The majority of studies ($n = 11$) focused on interventions conducted in elementary schools, with participants ranging in age from 5 to 11 years. A significant portion ($n = 6$) targeted high school students, aged 14–19 years, while a smaller number ($n = 4$) involved middle school students, aged 11–14 years. Among these, one study included a mixed sample of both elementary and middle school



students (ages 10–12 years). Only one study focused on pre-school children (Mage = 35.83 months, SDage = 2.57 months). Of the 21 studies, two did not report information on sample age but only about school grade. Sample sizes ranged from 1,229 (Resaland et al., 2019) to 10 (Wehner et al., 2021). The majority of study sample was from Europe ($n = 17$), with a few from the USA ($n = 3$) and Australia ($n = 1$). Most studies included both male and female participants ($n = 20$), although one study focused exclusively on female participants. All of the studies employed traditional gender binary classifications, excluding non-binary and gender-fluid individuals.

Studies focused on the embodiment construct or related concepts (e.g., embodied cognition, embodied experience, embodied learning) as the theoretical framework for their intervention, which were all situated within PE. Each study adopted a scholar-centered approach, emphasizing the body as the core of the proposed experience. Additionally, scholars were the participants in every study, and their perspectives were consistently reported. Through thematic analysis, the studies included in this review were classified into three main thematic cores based on the purposes of the interventions: physical literacy, embodied identity, and

multidisciplinarity. While the majority of studies ($n = 15$) focused on a single thematic core, a minority ($n = 6$) spanned multiple cores due to their interventions having multiple purposes. Despite the varied purposes of these interventions, all of the studies aimed to enhance the understanding of embodiment theory—particularly embodied learning—and its influence on pedagogies within the school and PE settings. All the studies included in this review employed a longitudinal research framework, which was essential for understanding the effects of embodied learning interventions over time. Additionally, the studies were not distributed between those primarily based on qualitative data ($n = 10$) and those focusing on quantitative data ($n = 9$). A smaller subset ($n = 2$) utilized a mixed-methods approach, integrating both qualitative and quantitative data.

3.3 Theme 1: physical literacy

Physical literacy (PL) can be described as the disposition to fully leverage our embodied capabilities, wherein an individual possesses the motivation, confidence, physical competence, knowledge, and

TABLE 2 Summary of the included studies.

References	Country	Participants	Age	Topic	Embodied experience	Main findings	Major Outcomes
Aartun et al. (2023)	Norway	23 (15 Females, 8 Males)	14–16 years old	Physical Literacy	Playfulness within PE setting to promote embodied learning.	Playfulness in physical education settings enabled pupils to create pleasurable and meaningful experiences. These experiences enhanced embodied and emplaced learning and supported physical, social, and creative competencies.	n/a
Almarcha et al. (2023)	Germany	48 (22 Females, 26 Males)	$M_{\text{age}} = 10.2$ $SD_{\text{age}} = 0.82$	Multidisciplinarity	Embodied Experiences to teach concepts of Dynamic Systems Theory (DST) and Statistical Physics (SP).	Teaching DST and SP through embodied learning enhanced STEM integration in 5th-graders, despite some variability. Students grasped complex concepts like phase transitions and order parameters, showing improved far-transfer competencies.	Effect of the intervention on students' knowledge and transfer abilities: - pre-intervention mean rank = 1.28; mode = 1 - post-intervention mean rank = 4.06; mode 4 - $Z = -5.98$; $p < 0.0001$
Anderson and Wall (2016)	USA	692	Middle School Students (11–14 years old)	Multidisciplinarity	3D Xbox Kinect simulations to support the teaching of Newton's laws of motion.	Kinect technology helped students better understand kinematics concepts by linking physical movements to abstract data. However, visual data required additional support, and the reduced group interaction highlighted the need for collaborative scaffolding.	n/a
Azzarito et al. (2016)	USA	11 (4 Females, 7 Males)	15–16 years old	Embodied Identity	Body Curriculum to help young people critically engage with the media narratives of perfect bodies.	The Body Curriculum in PE helped students critically engage with media-driven body ideals and stereotypes. While they resisted some media narratives, they struggled to detach from these ideals, reflecting a persistent, narrow view of body appearance and attractiveness.	n/a
Bergentoft (2020)	Sweden	72	16–19 years old	Physical Literacy	Exploration of Body awareness in running.	Students enhanced their body awareness by analyzing sensations during running, facilitated by Variation Theory. Awareness of critical movement aspects and internal sensations was linked to discovering new ways to move.	n/a
Bustamante et al. (2022)	USA	69 (45% Females)	10–12 years old	Multidisciplinarity	Fraction Ball (basketball-based game) to engage children in Math learning (fractions and decimals).	Fraction Ball significantly boosted students' abilities in fraction and decimal conversions but showed limited impact on advanced arithmetic and far-transfer skills. Game refinements and added instructional support improved outcomes in subsequent tests.	Post-test Composite Score (Full Sample not missing 90% of post untimed test): $N = 153$; $b = 0.40$; $SE = 0.11$; $p < 0.001$
Damsgaard et al. (2022)	Denmark	149 (76 Females, 73 Males)	$M_{\text{age}} = 6.2$ years $SD_{\text{age}} = 0.4$ years	Multidisciplinarity	Whole-body and hand motor movements to impact on reading-related skills, specifically letter-sound knowledge and word reading.	Both whole-body (WM) and hand motor (HM) movement interventions improved letter-sound knowledge, with the whole-body group showing long-term retention advantages. No immediate effects on word reading skills were observed.	Improvement from pre (T1) to post test (T2) for Conditional Letter-Sounds: - CON: 1.0 ± 0.2 (+500%) - HM: 2.1 ± 0.3 ; $d = 0.5$ $p < 0.01$ (+700%) - WM: 2.2 ± 0.3 ; $d = 0.7$ $p < 0.01$ (+1,050%)

(Continued)

TABLE 2 (Continued)

References	Country	Participants	Age	Topic	Embodied experience	Main findings	Major Outcomes
Fairbrother et al. (2020)	UK	25 (16 Females, 9 Males)	10–11 years old	Physical Literacy	Love Life, Smokefree Sports, Program (sports and PA lessons) to convey smokefree messages.	The “Love Life, Smokefree Sports” program effectively conveyed smokefree messages when interactive and embodied experiences aligned with the intervention’s goals. However, some children struggled to connect these messages to their daily lives.	n/a
Farias et al. (2019)	Portugal	24 (9 Females, 15 Males)	12–14 years old	Physical Literacy	Sport Education curricular experience to develop physical literacy.	Participation in a year-long Sport Education curriculum significantly enhanced students’ physical literacy dispositions, promoting lifelong engagement with a healthy sport culture and equitable participation in PE and sport.	n/a
Halliwel et al. (2018)	UK	344 (54.4% Females)	$M_{age} = 9.34$ $SD_{age} = 0.69$	Physical Literacy Embodied Identity	Yoga lessons to influence body image (including body appreciation, body esteem, and body surveillance) and mood (positive and negative affect).	Both yoga and regular PE classes improved body appreciation, body esteem, and positive mood among pre-adolescents, with no significant differences between the groups. Gender differences were noted, with girls reporting lower body esteem and higher self-objectification than boys.	Effects on Body Image: - Body esteem increased significantly over time in both intervention ($p = 0.01$, $\eta^2 p = 0.03$) and control ($p < 0.001$, $\eta^2 p = 0.10$) groups. Effects on Mood: - Positive mood increased ($p < 0.001$, $\eta^2 p = 0.05$) post-intervention and follow-up. - Negative mood decreased ($p = 0.01$, $\eta^2 p = 0.02$), especially from baseline to follow-up.
Have et al. (2018)	Denmark	505 (49,55% Males)	$M_{age} = 7.2$ $SD_{age} = 0.3$	Multidisciplinarity	Task-relevant physical activity in math teaching.	Task-relevant physical activity led to a significant increase in math achievement. No effects were found on BMI, fitness, or executive function, suggesting benefits were linked to movement integration rather than physical intensity.	Mathematics Score (Active Math vs. Control): Points (SE) = 1.2(0.4) $p = 0.002$; $d = 0.38$
Kosmas et al. (2019)	Greece	52	7–10 years old	Multidisciplinarity	Xbox Kinect motion-based games to impact children’s cognitive skills and academic performance (linguistic development and vocabulary acquisition).	Kinect games supported embodied learning, enhancing memory and vocabulary skills. The integration of these games in classrooms showed improvements in cognitive and academic outcomes, validated by teacher observations.	Memory Skills: - PretestMean = 15.04 - PosttestMean = 19.00 - $p < 0.001$; $d = 1.01$ Expressive Vocabulary: - PretestMean = 17.40 - PosttestMean = 19.92 - $p < 0.001$; $d = 0.28$

(Continued)

TABLE 2 (Continued)

References	Country	Participants	Age	Topic	Embodied experience	Main findings	Major Outcomes
Cámara-Martínez et al. (2022)	Spain	92 (45.7% Females)	$M_{\text{age}} = 35.83$ months $SD_{\text{age}} = 2.57$ months	Multidisciplinarity	Active-Lessons based on playfulness to improve childrens' vocabulary and narrative comprehension.	Active lessons significantly improved preschoolers' vocabulary and narrative comprehension. This approach engaged children more effectively, showing consistent benefits across gender and age groups.	Vocabulary Improvement - Experimental: 49.89 ± 8.54 - Control: 31.96 ± 6.70 - $p < 0.001$, $d = 0.759$ Narrative Comprehension - Experimental: 29.20 ± 2.8 - Control: 23.41 ± 2.93 - $p < 0.001$, $d = 0.710$
McClelland et al. (2015)	UK	Study 1: 235 Study 2: 113 Study 3: 51	Study 1: 10–11 years old Study 2: 8–10 years old Study 3: 8–10 years old	Multidisciplinarity Embodied Identity	Physical activity (PA) intervention based on embodied learning (Move4Words program) to improve academic performance.	The Move4words intervention led to significant and sustained academic improvements, particularly for the lowest achieving 20% of students. Teachers noted better focus, attention, and behavior in the classroom.	Study 1 - Increased average percentage of pupils reaching Level 4 or more in English and Maths. Average (SD) = +20.25(10.73) $t = 5.340$; $p = 0.124$ Study 2 - Progress in Reading, Writing, and Math. Overall Combined Score (SD): - pre = 2.82(1.34) - post = 4.32(1.91) - $t = 5.970$; $p < 0.001$ $g = 0.91$ Study 3 – Increased Reading Scores in Year 4 and 5: - Year 4 scores 3.4 points higher ($p = 0.006$; $g = 0.94$). - Year 5 scores 2.8 points higher, significant at 90% CI ($p = 0.069$; $g = 0.64$)
McIntosh-Dalmedo et al. (2023)	UK	110 Females	$M_{\text{age}} = 14.9$ $SD_{\text{age}} = 0.68$	Embodied Identity	Free choice of Physical Education (PE) clothing to influence body esteem.	Allowing students to choose their PE clothing improved body esteem during PE. The highest body esteem scores were associated with wearing the preferred PE kit. Despite this, BE-attribution scores remained low, highlighting continued concerns about others' evaluations of their appearance.	Highest mean body esteem scores found for post-intervention data when wearing PE kit across all three subscales of the BES vs. wearing the uniform: - PE Kit, Mean (SD) = 14.46 (0.55); $p < 0.001$ - Uniform, Mean (SD) = 13.44 (2.65); $p < 0.001$

(Continued)

TABLE 2 (Continued)

References	Country	Participants	Age	Topic	Embodied experience	Main findings	Major Outcomes
Mills et al. (2022)	Australia	47	10–11 years old	Multidisciplinarity Physical Literacy	Virtual Reality (VR) technology as influencing factor for multimodal communication and embodied meaning-making.	VR technology using Google Tilt Brush™ engaged students in embodied multimodal communication, enhancing creative processes through extensive bodily movement and integration of visual, auditory, and tactile senses.	n/a
Resaland et al. (2019)	Norway	1,129 (47.9% Females)	$M_{age} = 10.2$ $SD_{age} = 0.3$	Physical Literacy Multidisciplinarity	Physical Activity (ASK Study Intervention) to promote physical literacy and academic performance.	The physical activity intervention had no significant impact on Health-Related Quality of Life (HRQoL) for 10-year-olds. The study suggests further research on the effectiveness of quality and quantity of physical activity interventions on HRQoL in relatively healthy children.	Group Differences: - Physical Well-Being: Mean (95% CI) = -0.2 ($-1.8, 1.4$); $p = 0.789$ - Psychological Well-Being: Mean (95% CI) = -0.3 ($-1.7, 1.1$); $p = 0.682$
Schubring et al. (2021)	Sweden	School A: 15 (8 Females, 7 Males) School B: 56 (39 Females, 17 Males)	16–17 years old	Embodied Identity Physical Literacy	Physical Education (PE) classes to teach on body ideals.	Teaching about body ideals using storied cases was meaningful for students but presented didactic challenges, especially in addressing the gendered nature of body ideals. Engagement varied with personal background and school context. The intervention had mixed success in challenging stereotypical discourses.	n/a
Wehner et al. (2021)	Danmark	10 (7 Females, 3 Males)	16–17 years old	Physical Literacy	Physical Activity to promote well-being and increase overall movement throughout the school day.	Movement in everyday life is perceived by high school students as a balance between activity and stillness. It serves as both a break from and a means to manage daily obligations, impacting well-being and social relations through a range of bodily sensations.	n/a
Wienecke et al. (2021)	Denmark	459	$M_{age} = 10.36$ years $SD_{age} = 0.40$ years	Multidisciplinarity	Basketball games mixed with math to enhance children's motivation for mathematics.	Integrating basketball with math increased students' perceived autonomy, competence, and intrinsic motivation, sustaining their engagement in math. Academic performance was not measured, but motivational benefits suggest potential academic gains.	Increased Perceived Autonomy in the intervention group: Mean (SD) = 2.48(0.81) %DIFF = +14.25 $p < 0.0001$ Increased Competencies in the intervention group: Mean (SD) = 3.26(0.67) %DIFF = +6.33 $p < 0.0001$ Increased Intrinsic Motivation in the intervention group: Mean (SD) = 3.29(0.63) %DIFF = +16.09 $p < 0.0001$

(Continued)

TABLE 2 (Continued)

References	Country	Participants	Age	Topic	Embodied experience	Main findings	Major Outcomes
Zhu et al. (2023)	Netherlands	37 (18 Females 19 Males)	11–12 years old	Multidisciplinarity	Lessons based on spatial thinking to enhance the process of data physicalization.	Data physicalization enhanced spatial thinking as children effectively used tangible objects to represent numerical data. This hands-on approach improved data comprehension, though some faced challenges in creating tangible forms due to practical limitations.	n/a
Further studies							
Johnson-Glenberg et al. (2016)	USA	109 (32% Females)	High School and College Students	Multidisciplinarity	Lessons based on embodied learning to teach of Centripetal Force (CF) and overcome common misconceptions.	High-embodiment lessons facilitated better delayed retention, particularly in generative tasks. Platform differences had no significant effect, emphasizing the role of embodiment in long-term learning gains.	
Nyberg et al. (2020)	Sweden	No data available	Secondary School Students	Physical Literacy	Embodied exploration of juggling movement to enhance students' abilities.	The study expanded the understanding of movement capability in PE, focusing on juggling as an embodied exploration. It highlighted broader aspects of movement capability beyond traditional sport performance, such as understanding patterns, rhythm, and spatial awareness.	
Sánchez-Hernández et al. (2018)	Spain	Mixed Group No further data available	High School Students	Embodied Identity	Combination of cooperative learning and critical pretexts to encourage critical reflection on the gendered nature of sport and its impact on the engagement and learning in Physical Education (PE).	Combining cooperative learning with critical pretexts in a football context led to increased student engagement and a more inclusive environment. It helped girls feel more valued, though some skilled boys criticized the approach for lacking focus on football skills.	

TABLE 3 Mixed methods appraisal tool – quantitative randomized studies (1 = meet criteria; 0 = did not meet criteria).

Quantitative randomized					
References	Randomization appropriately performed	Groups comparable at baseline	Complete outcome data	Provided outcome assessors blinded to the intervention	Participants adhered to the assigned intervention
Bustamante et al. (2022)	1	1	1	1	1
Damsgaard et al. (2022)	1	1	1	1	1
Halliwel et al. (2018)	1	1	1	1	1
Have et al. (2018)	1	1	1	1	1
Cámara-Martínez et al. (2022)	1	1	1	1	1
McClelland et al. (2015)	1	1	1	1	1
Resaland et al. (2019)	1	1	1	1	1
Wienecke et al. (2021)	1	1	1	1	1

TABLE 4 Mixed methods appraisal tool – quantitative non-randomized studies (1 = meet criteria; 0 = did not meet criteria).

Quantitative non-randomized					
References	Participants representative of the target population	Measurements appropriate regarding both the outcome and intervention	Complete outcome data	Confounders accounted for in the design and analysis	Intervention administered as intended
McIntosh-Dalmedo et al. (2023)	1	1	1	1	1

TABLE 5 Mixed methods appraisal tool – qualitative studies (1 = meet criteria; 0 = did not meet criteria).

Qualitative					
References	Qualitative approach appropriate to answer the research question	Qualitative data collection methods adequate to address the research question	Findings adequately derived from the data	Interpretation of results sufficiently substantiated by data	Coherence between qualitative data sources, collection, analysis and interpretation
Aartun et al. (2023)	1	1	1	1	1
Anderson and Wall (2016)	1	1	1	1	1
Azzarito et al. (2016)	1	1	1	1	1
Bergentoft (2020)	1	1	1	1	1
Fairbrother et al. (2020)	1	1	1	1	1
Farias et al. (2019)	1	1	1	1	1
Mills et al. (2022)	1	1	1	1	1
Schubring et al. (2021)	1	1	1	1	1
Wehner et al. (2021)	1	1	1	1	1
Zhu et al. (2023)	1	1	1	1	1

understanding to value and take responsibility for engaging in purposeful physical activities throughout the lifespan (Whitehead, 2010). Consequently, this thematic core focused on studies that promoted the adoption of active and healthy lifestyles through bodily experiences, as well as those that explored methodologies aimed at enhancing the key elements of PL.

The reviewed studies collectively illuminate the multifaceted nature of embodied learning in school settings, exploring how physical engagement, sensory experiences, and reflective practices contribute to meaningful educational outcomes.

Aartun et al. (2023) adopted sensory ethnography, grounded in phenomenology, to investigate pupils' embodied experiences in

TABLE 6 Mixed methods appraisal tool – mixed methods studies (1 = meet criteria; 0 = did not meet criteria).

Mixed-methods					
References	Adequate rationale for using a mixed methods design to address the research question	Different components of the study effectively integrated to answer the research question	Outputs of the integration of qualitative and quantitative components adequately interpreted	Divergences and inconsistencies between quantitative and qualitative results adequately addressed	Different components of the study adhere to the quality criteria of each tradition of the methods involved
Almarcha et al. (2023)	1	1	1	1	1
Kosmas et al. (2019)	1	1	1	1	1

PE. Their research aimed to understand how playfulness could serve as a strategy for creating pleasurable and meaningful experiences that support embodied learning. Sensory ethnography emphasizes the multisensory aspects of perception and interaction, considering not just verbal expressions but also non-verbal cues like body language and sensory reactions (Pink, 2015; Pink et al., 2013). Through three illustrative episodes - parkour training, a bicycle trip, and swimming lessons - the study demonstrated how pupils tended to modify teacher-assigned tasks playfully. This playfulness acted as a lens through which they perceived activities as enjoyable, fostering openness to possibilities presented by their environments. The resulting pleasurable experiences, characterized by physical thrill and psychological flow, facilitated the integration of physical, social, and creative competencies.

Similarly, Bergentoft (2020) explored how students develop body awareness in running, focusing on their ability to analyze sensations and feelings associated with movement. The study employed Variation Theory (VT) as an instructional framework, which emphasizes critical aspects, variation, and contrasts to enhance learning. In this context, the “object of learning” was running posture, with lesson design intentionally structured to help students reflect on and identify critical aspects of movement. The findings revealed that when students were encouraged to focus on their lived body experiences, they could discern what felt “strange” and explore new ways of moving. The emphasis on internal sensations aligns with Aartun et al.’s attention to non-verbal and sensory cues, illustrating how embodied learning is facilitated through deliberate pedagogical strategies (Mehling et al., 2011).

Expanding on the role of embodied experiences in health education, Fairbrother et al. (2020) qualitatively evaluated the Love Life, Smokefree Sports program, which used sports and physical activity to convey smoke-free messages in primary schools. The study found that children responded positively to the program, particularly when interactive and sensory-rich activities supported the intervention’s objectives. However, challenges emerged when the embodied experiences did not align with the smoke-free messages, leading to difficulties in recall and application to daily life. These findings underscore the importance of coherence between embodied learning activities and intended messages, resonating with Aartun et al.’s emphasis on playfulness and meaningful engagement.

Farias et al. (2019) provided a retrospective view by examining the long-term impact of a Sport Education curriculum on students’ PL. Through augmented memory retrieval, surveys, and interviews, the study highlighted transformations in motivation, attitudes, and dispositions toward PE and sport. The findings revealed that students developed empathetic attitudes, resilience against discriminatory practices, and a commitment to equitable participation. These embodied competencies extended beyond school settings,

contributing to lifelong PL. The study aligns with Bergentoft’s findings on the importance of reflection and Aartun et al.’s emphasis on social and creative skills, suggesting that prolonged and meaningful engagement is pivotal to fostering embodied learning.

The potential of technology to enhance embodied learning was explored by Mills et al. (2022), who investigated the use of virtual reality (VR) in education. Using the Google Tilt Brush™ program, students engaged in extensive bodily movement, including fine and gross motor skills, to create virtual paintings. This physical engagement contrasted with traditional digital media tasks, which typically involve limited interaction. The study emphasized the importance of haptic feedback and bodily movement, such as walking and turning, in creating and interacting with three-dimensional virtual texts. These multimodal experiences enriched students’ sensory engagement and contributed to their embodied meaning-making.

Resaland et al. (2019), part of the ASK Study, evaluated the effects of a school-based physical activity intervention on academic performance and Health-Related Quality of Life (HRQoL) among children (Resaland et al., 2015, 2016). While no significant effects were observed on HRQoL domains, the study raised critical questions about the balance between quantity and quality of physical activity interventions. It also emphasized the importance of tailoring interventions to meet the needs of students with varying baseline HRQoL levels. These findings resonate with Wehner et al. (2021), who examined the role of movement in everyday life as part of the Danish Healthy High School Study (Bonnesen et al., 2020). Wehner’s study highlighted how lighter movement activities, distinct from traditional sports, promoted well-being and peer relations. By employing existential phenomenology, the study explored how students navigated the spectrum of bodily sensations, balancing activity and stillness. Movement was experienced both as a reprieve from daily obligations and as a means of progressing through them, highlighting its dual role in supporting social and individual well-being.

Although not included in the core review, Nyberg et al. (2020) present a compelling contribution to the discourse on embodied learning in PE. Their study challenges the prevailing performance-centered paradigm of movement capability, which often prioritizes technical proficiency, by advocating for a broader, more inclusive perspective. Through an “embodied exploration” approach, the authors investigated how PE can enhance students’ movement abilities, using juggling as a focal activity. Juggling was intentionally selected to level the playing field, avoiding disadvantages for students lacking traditional sporting backgrounds. The findings revealed four critical dimensions of how students engaged with the activity: (1) understanding patterns, (2) discerning rhythms, (3) preparing for subsequent throws and catches, and (4) positioning and navigating

movements. These insights demonstrate that movement capability extends beyond technique, encompassing spatial awareness, rhythmic understanding, and adaptive decision-making. Researchers challenge the traditional notion of ability as merely achieving specific technical outcomes, such as juggling three balls. Instead, they highlight the importance of fostering embodied “knowing,” emphasizing the development of students’ capacity to engage with movement in diverse and meaningful ways. This approach aligns with broader themes in embodied learning, focusing on inclusivity, exploration, and the holistic development of physical and cognitive competencies.

3.4 Theme 2: embodied identity

Bodies are central to identity, making individuals present and manifesting their existence to the world. They carry significant identity markers, such as gender, race, and (dis)abilities, which both enable and constrain our potential. Furthermore, lived bodies function as sites of social experience, emotion, and cognition, with the sense of self-being experienced as embodied (Schultze, 2014). This section, titled Embodied Identity, focuses on identity as shaped by interactions with the world through the body. It explores methodologies that investigate the multifaceted nature of the body, examining deeply ingrained perceptions such as body image and ideals, as well as critical aspects like emotional literacy, self-awareness, natural body perception, and gender dynamics.

Azzarito et al. (2016) provide a compelling example of how embodied learning can challenge dominant narratives about body ideals. Their Body Curriculum - implemented in secondary school (PE)-encouraged students to critically engage with media portrayals of “perfect bodies.” The intervention, informed by sociocultural and critical perspectives, comprised thematic lessons on the cultural body, gender and race dynamics, and the influence of media. Through class discussions and personal journals, students reflected on how these ideals shaped their perceptions of body size, shape, and muscularity. While students demonstrated resistance to stereotypical body ideals, they acknowledged the pervasive impact of media, particularly on girls. This highlights the complex tension between critical awareness and participation in media-driven cultures of performativity (Evans et al., 2008). Despite engaging critically, many students continued evaluating themselves against narrow standards of physical appearance, underscoring the challenges of navigating societal pressures.

Building on the theme of embodied interventions, Halliwell et al. (2018) examined the effects of a 4-week yoga program on pre-adolescents’ body image and mood. Yoga, as an embodying activity, fosters body appreciation, body awareness, and self-regulation (Butzer et al., 2016; Impett et al., 2006; Neumark-Sztainer, 2014; Piran, 2015). It was hypothesized to reduce self-objectification and enhance body esteem. Interestingly, both the yoga and control groups—who participated in regular PE classes—showed improvements in body appreciation, body esteem, and mood, with no significant differences. This suggests that thoughtfully structured PE classes can also positively influence body image. However, gender differences persisted, with girls reporting greater body image concerns and negative affect than boys. These findings emphasize the importance of tailored strategies to address gender-specific issues in interventions.

Continuing with PE as a focal point, McIntosh-Dalmedo et al. (2023) explored a novel intervention allowing students to choose their PE clothing, challenging rigid norms of mandatory PE kits. This

low-cost, easy-to-implement adjustment resulted in improved body esteem in PE settings, particularly regarding appearance and weight-related self-perceptions. Improvements were observed across three subscales of the body esteem scale (BES): BES-appearance (general appearance), BES-weight (weight-related feelings), and BES-attribution (external evaluations of one’s body). However, BES-attribution remained consistently low, reflecting ongoing challenges with external judgments. These findings align with broader discussions on societal pressures contributing to body image dissatisfaction, particularly among adolescent females, as highlighted in studies by Juli (2017) and Miranda et al. (2021).

Expanding on pedagogical strategies, Schubring et al. (2021) adopted a collaborative Lesson Study approach in Swedish upper secondary schools to address body ideals in PE. By incorporating storied cases, the intervention encouraged students to reflect on cultural messages about body acceptance. While many students engaged meaningfully, personal backgrounds, school context, and lesson design influenced their participation. Some students successfully deconstructed gender norms, while others inadvertently reinforced stereotypes. This highlights the complexities of fostering critical health literacy and connecting theoretical discussions about body ideals to students’ lived experiences. These findings parallel the challenges identified by Azzarito et al. (2016), where students grappled with balancing critical awareness and societal pressures.

Finally, although not included in the primary review, Sánchez-Hernández et al. (2018) offer an insightful perspective worth noting. Their intervention combined cooperative learning with critical pedagogy, using football as a context to challenge traditional gender norms in PE. By creating a safe and inclusive environment, the study fostered discussions on sexism and encouraged greater engagement, particularly among girls. Boys gained new perspectives, although some resisted the focus on inclusivity over skill development. This echoes themes seen in the work of Azzarito et al. (2016) and Schubring et al. (2021), emphasizing the balance between critical engagement and inclusivity in PE settings.

3.5 Theme 3: multidisciplinary

Multidisciplinary education has garnered significant interest in recent years, but the terms used to describe it vary widely. The literature refers to concepts such as multidisciplinary, interdisciplinary, curriculum integration, integrated teaching, and cross-curricular education. Broadly speaking, multidisciplinary education encompasses any approach where two or more subjects are interconnected. The term “multidisciplinarity” highlights the importance of understanding individual disciplinary perspectives as foundational elements in integrated teaching practices (Mård and Hilli, 2022). Consequently, this thematic focus on Multidisciplinarity emphasizes the connections between disciplinary content and skills, while fostering meaningful, student-centered, and collaborative experiences in PE settings.

The thematic analysis of the reviewed studies reveals a comprehensive and multi-dimensional view of embodied learning’s potential to reshape traditional educational approaches. These interventions, rooted in integrating physical activity with cognitive and academic content, demonstrate diverse and far-reaching impacts across cognitive, academic, and motivational domains, reinforcing the multifaceted nature of embodied learning and its ability to address a wide range of learning needs.

A major theme in the analysis was the role of physical activity in enhancing academic performance and cognitive function, specifically in areas such as attention, memory, and executive function. McClelland et al. (2015) conducted a thorough investigation into the Move4words program, a 12-week intervention designed to improve children's physical, visual, and auditory processing skills. The program targeted underperforming students, using a combination of movement and language exercises. The results showed a significant improvement in students' scores on national Key Stage 2 SATs at age 11, specifically in core subjects such as reading, writing, and mathematics. Teachers reported that students demonstrated better classroom engagement, improved behavior, and a noticeable increase in focus during lessons. These findings suggest that physical activity in the classroom catalyzes greater cognitive engagement, helping underperforming students catch up academically.

Similarly, Have et al. (2018) explored how task-relevant physical activity, such as movement exercises, could enhance math skills. Their study showed that students who engaged in movement-based math tasks experienced a 24.7% improvement in their mathematical performance, compared to a 17.5% gain in a control group. The improvements were not limited to mathematical skills alone but extended to executive function tasks, particularly those involving cognitive control, such as the Flanker test. These findings highlight the role of embodied learning in strengthening cognitive processes—particularly executive functions like attention and inhibition—suggesting that physical movement can enhance self-regulation and cognitive control in certain students, especially boys who seemed to benefit more from such interventions.

A significant advancement in embodied learning is its application within STEM (Science, Technology, Engineering, and Mathematics) disciplines, aiming not only to enhance specific subject knowledge but also to foster far-transfer skills: the ability to apply learned knowledge and skills in novel contexts. Almarcha et al. (2023) introduced an innovative protocol for teaching Dynamic Systems Theory (DST) and Statistical Physics (SP) through embodied activities. In this study, students balanced on a bench to demonstrate the concept of order parameters and engaged in acroport to represent phase transitions in physics. These embodied activities enabled students to physically connect with abstract concepts, providing a tangible way to engage with theoretical frameworks. This kinesthetic approach not only facilitated understanding of difficult concepts but also supported the development of higher-order thinking skills, such as pattern recognition and critical analysis. The study also emphasized the importance of developmental alignment, drawing on Piaget's stages of cognitive development (Piaget, 1952), to ensure that the activities were age-appropriate and cognitively engaging.

Similarly, Anderson and Wall (2016), and Kosmas et al. (2019) explored how digital tools like Xbox Kinect could be utilized to teach physics concepts, such as motion, force, and velocity. Anderson and Wall highlighted challenges in interpreting messy datasets from Kinect, which could confuse students without proper guidance. However, they acknowledged the positive impact of these tools in increasing student engagement and providing a more immersive learning experience. Kosmas et al. (2019) found that the use of Kinect technology enhanced short-term memory and concept retention, particularly for students who were more hands-on learners. The findings from these studies underline the potential of combining digital technology with physical engagement to create dynamic

learning environments, although they also stress the need for careful task structuring to prevent cognitive overload and ensure the activities' educational value.

The role of play and physical activity in fostering active learning environments emerged as a recurring theme. Bustamante et al. (2022) evaluated Fraction Ball, a game that combined basketball with math learning. The game used modified court lines to teach fractions and decimals, providing an interactive and physically engaging way to learn mathematical concepts. The results indicated significant improvements in students' performance on arithmetic tasks directly related to the game's content, but the transfer of skills to more advanced mathematical concepts, such as number line estimation, was limited. This finding suggests that while playful and active learning can be highly effective for introducing foundational concepts, its ability to foster more complex mathematical thinking may require additional instructional strategies or follow-up activities.

In a similar vein, Wienecke et al. (2021) incorporated math problems into basketball drills, finding that the intervention had a profound impact on students' intrinsic motivation, perceived autonomy, and competence. The students who participated in this physical math lesson showed greater engagement with the material and demonstrated an increased sense of ownership over their learning. These findings align with Cámara-Martínez et al. (2022), who used playful, active lessons to improve vocabulary acquisition and narrative comprehension in preschool children. In their study, both boys and girls showed marked improvements in language skills, reinforcing the idea that playful, movement-based learning environments can enhance motivation and lead to significant academic gains. Collectively, these studies emphasize the motivational benefits of embodied learning and highlight the importance of designing playful, contextually relevant activities that resonate with students' interests and developmental needs.

Embodied learning has also shown promise in helping students develop specific educational skills, especially those foundational to later academic success. Damsgaard et al. (2022) investigated the use of motor activities, such as whole-body and hand movements, to support early literacy development in Danish children. The results showed significant, long-term improvements in letter-sound knowledge, which is a critical element of early reading skills. However, the study found no measurable gains in broader word reading abilities, suggesting that while embodied learning is effective in fostering specific aspects of literacy, it may need to be supplemented with other teaching methods to ensure comprehensive skill development.

Zhu et al. (2023) explored the use of data physicalization, where students manipulated physical objects to represent numerical data. This approach aimed to improve spatial reasoning and conceptual understanding by making abstract data more tangible. The study found that students engaged in this embodied activity demonstrated enhanced spatial reasoning abilities, particularly in understanding complex graphs and data visualizations. However, the study also highlighted challenges in terms of crafting the physical objects and managing time constraints, which limited the broader implementation of the intervention. This underscores the need to consider practical issues, such as resource availability and time management, when designing embodied learning activities. Despite these challenges, the study indicates that data physicalization can foster creativity

and deeper understanding, encouraging students to engage with data in a more meaningful and interactive way.

4 Discussion

This scoping review highlights the transformative potential of embodied learning approaches in school settings, particularly within PE. The findings were synthesized into three overarching themes: physical literacy, embodied identity, and multidisciplinary. These themes illuminate critical insights into the role of embodied pedagogies in fostering meaningful educational experiences that integrate mind, body, and environment. By systematically analyzing how embodied learning enhances student engagement, motivation, and cognitive development, this review extends existing knowledge by demonstrating the specific contributions of PE-based embodied learning to broader educational goals. Unlike studies that explore embodiment in isolated cognitive or technological contexts, this review positions PE as a unique and dynamic platform where embodied cognition naturally unfolds through movement-based experiences. Additionally, by identifying key gaps - such as the need for more inclusive pedagogical strategies and cross-disciplinary applications - this review provides a roadmap for future research and practice. The discussion explores the broader implications of these findings, addresses existing challenges, and outlines potential future directions for research and practice.

4.1 Embodied learning as a comprehensive approach to education

Embodied learning fundamentally challenges Cartesian dualisms that separate the mind and body, emphasizing that cognition is deeply rooted in the body's interactions with the world. This perspective, grounded in phenomenology, reframes the body not merely as a vessel for physical activity but as a dynamic site of meaning-making and subjective experience (Aartun et al., 2023; Kosmas et al., 2019; Lambert, 2018). This theoretical underpinning is reflected in the reviewed studies, which consistently demonstrate that embodied learning enhances engagement, understanding, and retention across diverse contexts.

A core outcome of this review is the emphasis on PL as a transformative goal. PL transcends technical skill acquisition, encompassing motivation, confidence, and the ability to value and engage in physical activities throughout life (Abate Daga et al., 2024; Whitehead, 2019). Studies such as Aartun et al. (2023) illustrate how sensory and reflective pedagogies foster deeper connections between students and their physical environments. For instance, playful approaches to movement - as seen in parkour and swimming lessons - cultivate openness to experiential learning, promoting physical, social, and emotional competencies. Similarly, Bergentoft (2020) highlights how reflective practices, such as analyzing sensations during running, enhance body awareness and self-regulation, key elements of PL.

Furthermore, embodied learning emphasizes experiential engagement, where knowledge is constructed through direct interaction with the environment. Sensorimotor engagement, such as deliberate focus on bodily sensations or gestures, has been shown to

strengthen learning signals and improve retention of complex concepts (Johnson-Glenberg et al., 2016; Kosmas et al., 2019). These insights suggest that embodied pedagogies, by integrating movement and cognition, provide students with richer and more meaningful learning experiences.

However, significant challenges remain in translating embodied learning principles into practice. For instance, interventions must align embodied experiences with broader educational objectives to avoid fragmentation. This requires teachers to adopt flexible, student-centered approaches that integrate sensorimotor experiences into cognitive and academic goals. Additionally, research is needed to explore how these pedagogies can be scaled for diverse educational contexts, particularly in schools with limited resources or rigid curricula (Azzarito et al., 2016).

4.2 Challenging normative constructs and promoting inclusivity

Traditional PE practices often reinforce normative constructs of ability and body ideals, marginalizing students who lack sport-related physical capital or do not conform to societal expectations. This review underscores the importance of redefining the ability to include diverse movement capabilities and embodied experiences, emphasizing adaptability and creativity over technical proficiency.

For example, Nyberg et al. (2020) propose an "embodied exploration" approach that fosters inclusivity and empowers students to develop a holistic understanding of movement. The intersection of bodily experiences and self-perception, as highlighted by Azzarito et al. (2016), underscores the need to create environments where students can critically engage with societal narratives about body ideals. Visual methods and sensory ethnography have proven effective tools for enabling nuanced reflection and self-awareness.

Addressing gender dynamics is equally essential. Embodied activities like yoga, shown by Halliwell et al. (2018) to enhance body appreciation and mood, underscore the potential of targeted interventions to address these issues, particularly among girls who, as highlighted in a recent systematic review (Digennaro and Tescione, 2024), often experience greater body image concerns. Similarly, McIntosh-Dalmedo et al. (2023) demonstrate how granting students' autonomy in choosing their PE outfits can bolster body esteem and challenge rigid norms. These small, context-sensitive adjustments can significantly impact students' sense of belonging and self-worth.

Furthermore, the intersectionality of embodied identity - encompassing race, socio-economic status, and cultural background - requires deeper exploration. Educators must recognize and address systemic inequalities through critical pedagogical approaches that foster inclusive spaces for discussion and exploration. This includes training teachers to acknowledge implicit biases and support diverse student needs. Centering inclusivity lays the foundation for a transformative discourse on embodied learning in education.

Studies like Azzarito et al. (2016) reveal how interventions can challenge dominant narratives around body ideals by encouraging critical reflection on media representations. Despite these efforts, many students continue to internalize conflicting messages about

body image, reflecting the complexity of these issues. Creating supportive environments where students feel safe to critique societal norms without fear of judgment is essential. The use of visual methods and sensory ethnography has proven valuable in helping students engage critically with stereotypes and develop a more nuanced understanding of their embodied experiences.

4.3 Bridging disciplines through embodied multidisciplinary

Following the exploration of the broader paradigm, the potential of embodied learning to bridge physical activity with academic content emerges as a significant application. The theme of multidisciplinary highlights how movement-based pedagogies can enhance cognitive functions and foster deep, transferable understanding across disciplines.

For example, [McClelland et al. \(2015\)](#) demonstrate how programs like Move4Words improve attention, memory, and academic performance by integrating physical exercises with language learning tasks. Similarly, [Almarcha et al. \(2023\)](#) illustrate how embodied activities can make abstract concepts in physics and systems theory tangible and comprehensible.

This interdisciplinary approach extends to STEM education, where embodied learning can make abstract scientific concepts more accessible through hands-on experiences ([Jha and Price, 2022](#)). For instance, the use of motion-based activities to teach centripetal force or phase transitions has shown promising results, enabling students to connect theoretical knowledge with physical experiences. Moreover, the integration of playful elements, such as gamified learning activities, further supports engagement and fosters creative problem-solving.

Despite these benefits, the implementation of multidisciplinary approaches poses challenges. Effective task integration requires careful design to balance physical engagement with cognitive demands. Overly complex tasks can lead to cognitive overload, diminishing the educational value of the intervention. Although not included, studies such as [Johnson-Glenberg et al. \(2016\)](#) emphasize the importance of optimizing levels of embodiment—from simple gestures to full-body activities—to match the learning objectives and students' developmental stages. Indeed, the study found that the intensity of embodiment in learning activities represents another critical factor influencing their effectiveness. Comparing high-embodiment conditions (involving extensive physical movement) with low-embodiment conditions (involving simpler, less intense gestures), the researchers observed comparable immediate learning outcomes across both groups. However, long-term knowledge retention was significantly better among participants in the high-embodiment condition. Specifically, students who engaged in full-body activities retained their understanding for longer and performed better on generative tasks requiring the application of knowledge in novel contexts. These findings underscore the role of sustained physical engagement in promoting deep, lasting learning, suggesting that the intensity of physical interaction directly enhances knowledge retention and transfer.

Future research should explore how embodied learning can be systematically incorporated into diverse subjects, including STEM, arts, and humanities. This includes investigating the long-term impact

of such interventions on academic performance, creativity, and critical thinking. Additionally, longitudinal studies are needed to assess the sustainability of multidisciplinary embodied learning approaches and their influence on students' lifelong engagement with physical and intellectual pursuits.

4.4 Technological integration and implications for teacher development

The integration of technology, such as virtual reality (VR) and motion-based games, represents an exciting frontier for embodied learning. These tools offer unique affordances for creating immersive, interactive learning environments that engage the body and mind.

For example, [Kosmas et al. \(2019\)](#) demonstrate how motion-based games can enhance memory and language skills through sensorimotor engagement. However, the efficacy of these tools depends on thoughtful design that prioritizes active participation over passive consumption.

Ethical considerations are paramount when integrating technology into embodied learning. Ensuring equitable access to technological resources is critical to prevent exacerbating existing educational disparities. Additionally, developers and educators must be mindful of cultural sensitivities and the potential for unintended consequences, such as reinforcing stereotypes or promoting excessive screen time ([Johnson-Glenberg et al., 2016](#); [Mills et al., 2022](#)). The body, as a multidimensional construct, is deeply rooted in cultural contexts and carries significant social meaning. From a phenomenological perspective, the body serves as a link between nature and culture, the individual and society, and personal identity and collective belonging. Through bodily expression, individuals both reflect their unique personality and internalize social and cultural norms shaped by their environment. Consequently, how the body moves, interacts, and is perceived in educational settings is influenced by cultural frameworks and individuals' social competencies ([Digennaro and Iannaccone, 2023a](#)). Recognizing these cultural dimensions is crucial in the design and implementation of embodied learning experiences to ensure inclusivity and avoid imposing culturally biased perspectives.

Teacher expertise and student empowerment play a critical role in the successful implementation of embodied pedagogies. Professional development programs are essential to equip educators with the knowledge and skills required to integrate these innovative approaches effectively. Collaborative frameworks, such as lesson studies, have been identified as powerful tools for fostering innovation, enabling teachers to refine embodied pedagogies through iterative experimentation and partnerships with researchers and peers ([Dudley, 2014](#); [Hiebert et al., 2002](#)).

Empowering students to take an active role in shaping their learning experiences is equally crucial. Research, including [Schubring et al. \(2021\)](#) and [Sánchez-Hernández et al. \(2018\)](#), underscores the benefits of participatory approaches that allow students to co-design activities and assume leadership roles. These strategies align with broader educational trends emphasizing student agency and voice, fostering a deeper sense of ownership and engagement. For instance, involving students in curriculum design or enabling them to set their own learning goals cultivates intrinsic motivation and accountability ([Bergentoft, 2020](#); [Schubring et al., 2021](#)).

Teachers also play a pivotal role in facilitating critical discussions on sensitive topics such as body ideals, gender norms, and cultural influences on physical activity. Creating inclusive and reflective spaces where students feel comfortable exploring these issues is essential for promoting equity and fostering critical thinking (Fisette, 2011; O'Sullivan and MacPhail, 2010). Such environments not only support diverse learning needs but also empower students to challenge societal norms and develop a positive sense of self.

By addressing these factors, this section ties together the core themes of embodied learning, offering a roadmap for educators to create inclusive, transformative, and student-centered learning environments.

4.5 Limitations and future directions

Although this study offers significant insights into the role of embodied learning within PE, several limitations should be acknowledged. First, the scope of the review was limited to peer-reviewed studies published in English and Italian, potentially excluding relevant research in other languages. Additionally, the data predominantly represent European contexts, with limited representation from other regions, restricting the generalizability of findings to a global scale. Methodologically, most studies employed scholar-centered approaches, potentially introducing bias in interpreting participants' perspectives. Finally, while longitudinal frameworks provided valuable insights into the temporal impact of embodied learning, the emphasis on specific age groups left gaps in understanding its effects across the lifespan, particularly in early childhood and adult education contexts.

This review focused specifically on embodied learning within the context of PE. While numerous studies across various disciplines have adopted the embodied learning framework - manipulating or incorporating learners' body movements as a central aspect (e.g., Alibali et al., 1999; Glenberg et al., 2004; Johnson-Glenberg et al., 2016; Johnson-Glenberg and Megowan-Romanowicz, 2017) - only studies explicitly situated in PE settings were included. As a result, research exploring similar benefits of embodied learning in other subject areas may have been excluded, potentially limiting the broader generalizability of our findings. Future research could consider a cross-disciplinary perspective to better understand how embodied learning operates beyond PE. Furthermore, the selection of keywords in the article search may have constrained the scope of the review, potentially omitting relevant studies on embodied cognition and learning that share similar theoretical perspectives and implementations. Future research should consider refining search strategies to encompass a broader range of terminology associated with embodied learning.

To advance the field of embodied learning, future research should address several priorities. First, expanding the age range of participants to include early childhood, adolescence, and adulthood will provide a more comprehensive understanding of how embodied learning influences cognitive, social, and emotional development over time.

Second, considering the role of cultural and contextual factors is essential to ensure that embodied pedagogies are inclusive and representative of diverse student needs. Third, developing integrated approaches that combine embodied learning with interdisciplinary themes such as sustainability, digital literacy, and critical health education could yield innovative pedagogical models.

Finally, longitudinal studies are needed to evaluate the sustainability and long-term impact of embodied learning

interventions. These studies should investigate how these approaches influence not only academic outcomes but also broader competencies such as critical thinking, creativity, and social-emotional skills.

5 Conclusion

Embodied learning represents a paradigm shift in education, offering a holistic framework that integrates cognitive, physical, and social dimensions of human experience. By moving beyond traditional pedagogies, embodied approaches have the potential to create inclusive, engaging, and transformative learning environments. This review highlights the need for continued research and innovation to realize the full potential of embodied learning, ensuring it meets the diverse needs of students and educators in an ever-changing world.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

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

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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