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ECO-EMBODIED PEDAGOGY FOR INCLUSIVE LEARNING IN ELEMENTARY SCHOOL-A SYSTEMATIC LITERATURE REVIEW

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Abstract

Achieving quality, ¹inclusive education for elementary students with special needs remains constrained in practice, despite longstanding international commitments such as the 1994 Salamanca Statement. Physical education (PE) may be uniquely positioned to advance this goal because it is organized around bodily movement rather than verbal-symbolic instruction, offering a natural, comparatively equal setting for students with differing sensory, motor, and behavioral profiles. Yet the pedagogical function of movement itself is often treated as incidental to nature-based or technology-based interventions rather than as their central mechanism. This study addresses that gap by systematically reviewing eco-embodied pedagogy, the integration of movement-based (embodied) learning with nature-based (eco) learning, with explicit ¹attention to how bodily movement functions as the core pedagogical mechanism supporting learning for students with special needs (SSN) in elementary school. A Systematic Literature Review (SLR) was conducted following the PRISMA 2020 guidelines, searching Scopus, ERIC, ScienceDirect, SpringerLink, Google Scholar, Garuda, and SINTA using three layers of search terms spanning general embodiment/nature-based concepts, disability- and intervention-specific terms, and physical-education-specific terms. Seventeen studies published between 2015 and 2025, spanning eight countries including Indonesia, met the inclusion criteria and were thematically synthesized. The findings show that movement functions as the core mechanism through which eco-embodied pedagogy supports sensorimotor and behavioral regulation, autism-specific engagement and well-being, and adapted physical education practice, while its benefits remain conditional on teacher preparedness rather than environmental access alone; Indonesian adapted physical education studies corroborate this pattern, identifying teacher competency, not infrastructure, as the primary implementation barrier. This review concludes that fundamental movement skills theory and embodied cognition theory converge to position eco-embodied pedagogy as a natural extension of adapted physical education, and recommends that PE curricula and teacher training in Indonesia explicitly adopt movement-centered, nature-integrated pedagogical strategies to strengthen inclusive elementary education.

Keywords: Eco-Embodied Pedagogy; Movement-Based Learning; Students with Special Needs; Elementary School; Systematic Literature Review

INTRODUCTION

Inclusive education is a mandate to reach the goal of quality education. This concept ¹gained international legal support during the World Congress on Special Education held in Salamanca (Spain) (UNESCO, 1994). However, this potential is not automatically realized. In Indonesia, data from the Ministry of Education, Culture, Research, and Technológ indicie that as of December 2023, 40,164 schools had students with special needs enrolled, while only 5,956 schools, or about 14.83

percent, employed a special education support teacher (Kompas.com, 2024). One root cause of persistent challenges ¹ in the implementation of inclusive education is the dominance of verbal-symbolic, seat-based instructional models, which historically rooted in the Cartesian dualist view that separates mind from body (Johnson & Lakoff, 2002).

For students with special needs (SSN), many of whom have sensory, motor, or behavioral regulation profiles that differ from their typically developing peers, learning approaches that accommodate bodily movement and multisensory experience are potentially far more relevant learning pathways than verbal instruction alone (Johnson-Glenberg et al., 2014). One of the subjects that may lead to effective inclusive education is Physical Education (PE). PE occupies a distinctive position within elementary schooling. Unlike most academic subjects, it is organized explicitly around bodily movement, making it a natural setting in which students with different sensory, motor, and behavioral profiles can participate on comparatively equal footing. Within PE specifically, field studies of adaptive PE implementation in Indonesian inclusive elementary schools report that although schools and PE teachers often show a basic willingness to adapt instruction, actual readiness remains suboptimal; constrained by limited teacher competency in adaptive methods, inadequate equipment, and insufficient structured planning for lesson adaptation (Forestry et al., 2019; Oktaviane, 2026). This suggests that the barrier to inclusive PE is not the absence of movement-based opportunity itself, but the lack of a coherent pedagogical framework for structuring that movement to serve students with special needs (SSN).

This review argues that the missing framework can be found by foregrounding the function of bodily movement as a pedagogical mechanism, not merely a physical outcome. Two complementary bodies of theory support this claim. First, motor development theory, most influentially articulated through the fundamental movement skills (FMS) framework (Gallahue et al., 2012), establishes that locomotor, object-control, and stability skills form the developmental foundation upon which children's broader physical, cognitive, and social competence is built. Within adapted physical education (APE), movement is

therefore not incidental to learning but constitutes its primary medium, particularly for children whose access to verbal-symbolic instruction is constrained by their disability profile. Second, embodied cognition theory (Varela et al., 1991; Lakoff & Johnson, 1999) provides the cognitive-scientific rationale for why movement functions this way: thinking and learning are not abstract mental processes detached from the body, but are shaped through sensorimotor interaction between the body and its environment. Read together, these frameworks imply that when movement occurs within natural, exploratory outdoor settings, it does not merely deliver a nature-related side benefit, but it also activates the same sensorimotor mechanisms through which cognitive, behavioral, and social development take place, a claim consistent with Vygotsky's (1978) sociocultural view that active bodily engagement with the environment, mediated socially by teachers and peers, is a primary developmental pathway.

A growing body of international research supports this movement-centered reading, even when the studies themselves are not always framed around physical education. Motion-based technologies such as Kinect games have been shown to improve motor, cognitive, and academic outcomes for ⁵ elementary students with special needs in mainstream classrooms precisely because they require sustained physical movement to function (⁵ Kosmas et al., 2018; Kourakli et al., 2017). Outdoor environmental education programs, which necessarily involve locomotor movement across natural, uneven terrain, have ⁷ improved attention and reduced disruptive behavior among students with emotional, cognitive, and behavioral disabilities without compromising academic achievement (Szczytko et al., 2018). For autistic children, nature-based movement activities such as Forest School have been associated with increased well-being, autonomy, and social engagement, contingent on the movement opportunities being scaffolded by well-prepared adults (Bradley & Male, 2017; Friedman et al., 2022; Odame-Asante et al., 2025). Within physical education itself, technology-supported motor and sports activities have been shown to enhance participation for students with disabilities in inclusive school settings (Perla et al., 2023), and in the Indonesian context, an experimental creative-and-adaptive sports learning model significantly increased participation

and social-emotional outcomes among elementary students with special needs (Saputra et al., 2024).

Although this evidence base is growing, most reviews of embodied or nature-based learning for children with disabilities treat movement as an ancillary feature of the intervention setting rather than as the pedagogical core to be optimized. It is a framing gap that matters directly for the field of physical education and sports pedagogy, since it obscures PE's potential role as the primary curricular vehicle for eco-embodied practice. Moreover, syntheses that explicitly connect this literature to adapted physical education (APE) theory and to the practical readiness of PE teachers in developing-country contexts such as Indonesia remain scarce. Based on the above, this study aims to: (1) map the characteristics and trends of research on eco-embodied pedagogy ¹for students with special needs in elementary school, with explicit attention to the movement/motor component of each intervention; (2) synthesize the mechanisms through which movement-based, nature-integrated pedagogy supports sensorimotor, behavioral, social, and academic development across different disability profiles; and (3) identify the implications of this evidence for adapted physical education practice and PE teacher preparation, particularly in Indonesia.

METHOD

²This study employs a Systematic Literature Review (SLR) conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The SLR approach was chosen because it allows for the systematic and transparent identification, critical appraisal, and synthesis of evidence from previously published primary studies, resulting in a comprehensive knowledge map of eco-embodied pedagogy and its movement-based mechanisms in inclusive elementary physical education.

The literature search was conducted across the academic databases Scopus, ERIC, ScienceDirect, and SpringerLink, as well as Google Scholar, along with the national portals Garuda and SINTA to capture relevant Indonesian-language literature. The search was structured in three layers. The first layer combined general embodiment and nature-based terms: ("embodied learning") AND

("outdoor education") AND ("inclusive education") AND ("elementary school"). The second layer cross-referenced specific disability categories (autism, ADHD, intellectual disability, motor impairment) and specific intervention types (sensory garden, Forest School, Kinect/motion-based games). The third layer, added specifically for this revision, targeted physical-education-specific terms: ("adapted physical education" OR "inclusive physical education" OR "fundamental movement skills" OR "motor development") AND ("special needs" OR disability) AND ("elementary" OR "sekolah dasar"), including Indonesian-language equivalents ("pendidikan jasmani adaptif", "penjas adaptif"). The search was limited to publications from 2015–2025, except for foundational theoretical references on embodied cognition, motor development, and inclusive education, whose original sources predate this period.

The inclusion and exclusion criteria used during the article screening process ³ are presented in Table 1.

Table 1. Article Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication year	2015–2025 (except foundational theoretical sources)	Before 2015 (for empirical studies)
Topic	Movement-based/embodied learning, adapted or inclusive physical education, eco/outdoor/nature-based physical activity, sensory gardens/Forest School, or motion-based digital learning, applied to children with disabilities/special needs	Does not address bodily movement/motor function, nature, or disability/special needs; addresses disability policy with no movement or physical education component
Population / level	Children with special needs/disabilities in early childhood–elementary school (ages 4–12), or studies whose findings are explicitly generalizable to that level	Adults, or secondary/higher education populations with no relevance to elementary school
Publication type	Peer-reviewed journal articles, indexed conference proceedings, or academic book chapters	Magazine articles, blogs, advocacy pages, or other non-peer-reviewed sources
Language	English and Indonesian	Languages other than the above
Text access	Full text accessible for data extraction	Abstract only available

⁴ The article selection process followed the four stages of the PRISMA flow: ⁴ identification, screening, eligibility, and included. During the identification stage, all search results across 17 structured search sessions were compiled and duplicate

or non-peer-reviewed records were removed. During the screening stage, the title and abstract of each remaining record were checked for relevance to the research topic, with particular attention to whether the intervention involved an explicit movement or motor component. Records that passed this stage were then assessed for eligibility through full-text reading, based on the criteria in Table 1. Records meeting all criteria then had their data extracted, including author name, year, country, population/type of special need, research design, and the movement-based mechanism of the intervention. A summary of the screening process is presented in Table 1a.

Table 2. Summary of the Article Screening Process

PRISMA Stage	Description	n
Identification	Unique candidate records retrieved across 17 structured search sessions covering disability-specific terms (autism, ADHD, intellectual disability, motor impairment), intervention-specific terms (embodied learning, outdoor/nature-based learning, sensory gardens, Forest School, motion-based digital games), and physical-education-specific terms (adapted physical education, fundamental movement skills, inclusive PE, motor development)	77
Duplicates / grey literature removed	Duplicate records and non-peer-reviewed sources (magazine articles, advocacy blogs) removed prior to screening	31
Screening (title/abstract)	Records screened for topical relevance (movement/embodiment/nature + disability, or adapted PE)	46
Excluded at screening	Excluded for wrong population/level, no movement/embodiment or nature-based component, or being secondary citations without retrievable full text	16
Full-text eligibility assessment	Records assessed in full text against Table 1 criteria	30
Excluded at eligibility	Excluded for insufficient methodological detail, non-elementary focus, or lacking an explicit special-needs population (e.g., junior-high-level adapted PE management studies used only as contextual evidence)	13
Included in synthesis	Primary studies and reviews retained for thematic synthesis (Table 2)	17

The methodological quality of the articles that passed selection was assessed narratively, considering the clarity of research objectives, the appropriateness of the design relative to the research questions, transparency of data collection procedures, and the credibility of the publication source (journals indexed in Scopus, Web of Science, or SINTA 1–4). Data analysis was conducted using a thematic synthesis

approach following the stages of Braun and Clarke (2006), including familiarization, ⁴ initial coding, theme searching, theme review, and final theme definition and naming, with the coding process deliberately structured to surface the specific movement/motor mechanism reported in each study.

RESULT AND DISCUSSION

Seventeen studies met the inclusion criteria and were retained for thematic synthesis (Table 2). The included studies span autism spectrum disorder (five studies), ADHD and learning disabilities, motor impairment, and general/mixed special educational needs, across the United Kingdom, the United States, Spain, Italy, Greece, Cyprus, Türkiye, and Indonesia. The complete ³ characteristics of the seventeen included studies are presented in Table 2.

Table 3. Characteristics of Included Studies (N = 17)

Author (Year)	Country	Population	Design	Key Finding
Martínez-Monés et al. (2020)	Spain	General SEN (pre-school & elementary, inclusive)	Multi-classroom pilot study	Teachers' adoption of embodied movement-based digital games in inclusive classrooms.
Kosmas, Ioannou, & Retalis (2018)	Cyprus	Mixed SEN incl. motor impairment, mainstream elementary	5-month intervention study (n = 31)	Motion-based (Kinect) games improved short-term memory, motor engagement, and emotional state.
Kourakli et al. (2017)	Greece	SEN, elementary	Intervention study	Motion-based games improved cognitive, motor, and academic skills.
Szczytko, Carrier, & Stevenson (2018)	United States	Emotional, cognitive & behavioral disabilities (ECBD)	Quasi-experiment	Outdoor movement-based environmental education increased attention, reduced disruptive behavior.
Natalini (2024)	Italy	ADHD & learning disabilities	Systematic review	Outdoor physical activity supports sensory-motor integration and inclusion processes.
Di Palma, Gravino, Scala, Castellano, & Tafuri (2023)	Italy	General inclusive classroom	Experimental study	Embodied education via sports activities improved school well-being and collaboration.
Bradley & Male (2017)	United Kingdom	Autism spectrum disorder	Qualitative (multi-informant)	Forest School movement and exploration foster friendship, risk-taking, and success.
Friedman, Gibson, Jones, & Hughes (2022)	United Kingdom	Autism spectrum disorder (specialist school)	Case study	Outdoor movement activities promote autonomy and competence, contingent on adult attitudes.

Author (Year)	Country	Population	Design	Key Finding
Odame-Asante, Ani, & Mura (2025)	United Kingdom	Autism spectrum disorder	Systematic review	Nature-based movement learning supports emotional health and behavioral outcomes.
Pouya, Bayındır, & Pouya (2024)	Turkey	Autism spectrum disorder	Design-based case study	Sensory garden design guides movement and sensory-motor exploration.
Hussein (2020)	United Kingdom	Mixed disabilities, special schools	Qualitative design study	Sensory gardens support physical mobility, communication, and well-being.
Godwin, Jarvis, & Gattis (2025)	United Kingdom	SEND	Qualitative case study	UDL-informed outdoor movement programs improved accessibility and belonging.
Özdemir Sarılioğlu & Karal (2025)	Türkiye (global scope, 2013–2023)	Mixed SEN incl. ASD	Systematic review	Maps growth of technology-enhanced embodied/movement learning for special needs.
Perla, Amati, Agrati, & Ascione (2023)	Italy	Mixed disabilities, school-age	Ongoing case study	Technology-supported motor and sports activities enhance participation in inclusive PE.
Saputra, Fantiro, Herviani, Muzakki, & Akbar (2024)	Indonesia	SEN, inclusive elementary school (n = 30)	Quantitative experimental	Creative, adaptive sports learning model significantly increased participation and social-emotional outcomes.
Oktaviane (2026)	Indonesia	Inclusive elementary school (school-level)	Qualitative descriptive	Schools show basic readiness for adaptive PE, but teacher competency and facilities remain suboptimal.
Forestry, Kristiyanto, & Legowo (2019)	Indonesia	SEN, inclusive elementary school	Qualitative case study	Adaptive physical education implementation was underway but required further methodological support.

Notably, there are three Indonesian studies included above. The pattern shown indicates that research on eco-embodied learning for SSN remains concentrated in developed countries with relatively established inclusive education support systems, while studies from developing-country contexts such as Indonesia, which face different challenges in terms of special education teacher ratios, facilities, and policy (Kompas.com, 2024; World Bank, 2024), remain very limited in number. Furthermore, the three studies (Forestry et al., 2019; Saputra et al., 2024; Oktaviane, 2026) are situated specifically within physical education rather than general classroom instruction, suggesting that PE is already, in practice, the starting point through which movement-based inclusive pedagogy is being explored in Indonesian elementary schools, even though this has not yet been explicitly framed

as eco-embodied pedagogy. This reinforces the relevance of the present synthesis for the physical education and sports science field specifically.

Movement as the Core Mechanism for Sensorimotor and Behavioral Regulation

⁷ Szczytko et al. (2018) reported that engagement of students with emotional, cognitive, and behavioral disabilities (ECBD) in outdoor environmental education programs, which required sustained locomotor movement across natural terrain, significantly increased attention span and reduced teacher-reported disruptive behavior. Natalini's (2024) systematic review similarly concluded that the physical, exploratory movement inherent to outdoor education offers structured sensory-motor integration opportunities for children with ADHD and learning disabilities. In digitally mediated settings, Kosmas et al. (2018) found that a five-month Kinect-based motion-game intervention, in which full-body movement was the operative mechanism of the intervention, not an incidental feature, improved short-term memory and emotional state among ⁵ 31 elementary students with special educational needs in mainstream classrooms, while Kourakli et al. (2017) reported gains in cognitive, motor, and academic skills using comparable motion-based games. Considered together as fundamental movement skills in action—locomotor movement across terrain, and object-control/stability demands of motion-game interfaces (Gallahue et al., 2012) these studies indicate that structured, repeated bodily movement, whether outdoors or technologically mediated, is the shared active ingredient supporting self-regulation.

Movement-Based Nature Interventions for Autistic Students

Looking at the five of the included studies, physical movement within natural settings specifically could benefit autistic children. Bradley and Male's (2017) qualitative study of Forest School participation found that the freedom to move, climb, and physically explore fostered friendships, risk-taking, and success experiences among young autistic children. Friedman et al. (2022) similarly documented that outdoor movement activities promoted autonomy, relatedness, and competence for autistic students, though these benefits were contingent on the child's state on a given day and on the movement-supportive attitudes of accompanying adults. Odame-Asante et al.'s (2025) systematic review corroborated

these findings at a broader scale, concluding that nature-based movement learning supports the emotional health and behavioral outcomes of autistic children. Complementing these process-oriented studies, environmental design research by Hussein (2020) and Pouya et al. (2024) demonstrated that purpose-built sensory gardens are explicitly designed to structure and invite physical movement and exploration, such as walking varied terrain, reaching for textured plants, navigating winding paths, may become mechanism for supporting sensory integration and physical mobility, rather than as passive sensory exposure alone.

Eco-Embodied Pedagogy as Adapted Physical Education Practice

A movement-based and nature-integrated pedagogy is a form of adapted physical education (APE). Martínez-Monés et al. (2020) found that teachers' successful adoption of embodied movement-based digital games in inclusive classrooms depended on aligning activity design with students' movement and sensory abilities, echoing core APE principles of individualized motor-task adaptation. Godwin et al. (2025) showed that ⁶the Universal Design for Learning (UDL) framework (Meyer et al., 2014) can be applied to outdoor movement activities to structure diverse, multi-modal pathways of physical engagement. Özdemir Sarıalioğlu and Karal's (2025) systematic review of technology-enhanced embodied learning for special needs (2013–2023) found a growing evidence base predominantly concentrated at the elementary level, largely organized around motor tasks. Perla et al. (2023) documented an ongoing Italian initiative in which technology-supported motor and sports activities were used to enhance the participation of students with disabilities directly within physical education lessons in an inclusive school. In the Indonesian context, three studies converge on this theme: Saputra et al. (2024) found that an experimental creative-and-adaptive sports learning model significantly increased participation (mean post-intervention score of 86.94) and produced positive social-emotional outcomes among 30 elementary students with special needs; Oktaviane (2026) found that inclusive elementary schools demonstrate basic conceptual readiness for adaptive PE and that PE teachers actively attempt to adapt instructional methods to student characteristics, but that overall readiness remains suboptimal due to gaps in teacher competency;

and Forestry et al. (2019) similarly documented an adaptive PE program already underway in an Indonesian inclusive elementary school, though requiring stronger methodological structuring. Together, these seven studies indicate that eco-embodied pedagogy is not a departure from adapted physical education but a natural extension of it.

Movement, Social Participation, and Barriers to Inclusive Eco-Embodied Environment

Di Palma et al.'s (2023) experimental study found that embodied education through sports activities improved school well-being and student collaboration, indicating that movement-based PE activities can double as social-inclusion mechanisms. Godwin et al. (2025) documented that movement-rich outdoor programs fostered a sense of belonging for children with SEND, while Friedman et al. (2022) cautioned that these benefits are not automatic, because untrained support staff and their discomfort with unstructured movement settings can represent a greater barrier than the physical environment itself. This caution is proved through the evidence of Oktaviane (2026)'s who found that PE teacher competency in adapting movement tasks was the primary constraint on inclusive PE readiness. Meanwhile, Forestry et al. (2019) similarly pointed to the need for more structured methodological support for teachers delivering adaptive PE. These findings collectively suggest that the central barrier to eco-embodied pedagogy in Indonesian elementary schools is pedagogical and professional (teacher preparation in movement adaptation) rather than purely infrastructural, a distinction with direct implications for PE teacher education policy.

DISCUSSION

Bodily movement is not an incidental feature of eco-embodied learning but its operative pedagogical mechanism, and this reframing carries specific implications for physical education and adapted physical education (APE) practice. Fundamental movement skills (FMS) theory (Gallahue et al., 2012) holds that locomotor skills (e.g., walking on uneven terrain, running, climbing), object-control skills (e.g., manipulating natural materials, operating motion-sensing technology), and stability skills (e.g., balancing on natural or designed surfaces) form the developmental substrate for children's broader physical, cognitive, and social

competence. Read through this lens, the outdoor, sensory-garden, and motion-technology interventions are not simply nature-based or technology-based interventions that happen to involve movement; they are, functionally, structured FMS practice environments, each emphasizing a different combination of locomotor, object-control, and stability demands suited to different disability profiles.

This movement-centered reading also clarifies why the benefits identified in this review are consistently reported as conditional rather than automatic. Embodied cognition theory (Varela et al., 1991; Lakoff & Johnson, 1999) holds that cognitive and emotional regulation emerge through sensorimotor interaction with the environment, but this interaction must be structured and scaffolded to be developmentally productive, which is precisely the professional function of a trained PE or APE teacher. Friedman et al. (2022) and Oktaviane (2026) converge on this point from very different contexts (UK Forest School and Indonesian elementary PE, respectively), whereas the presence of a natural or movement-rich setting does not by itself guarantee benefit. It is the adult's capacity to adapt, scaffold, and structure the movement task (which is consistent with Vygotsky's (1978) sociocultural emphasis on mediated engagement) and this determines whether eco-embodied pedagogy succeeds. This positions teacher preparation, not environmental access, as the primary lever for improving inclusive PE outcomes.

For Indonesia specifically, this review's findings suggest a clear and specific pathway forward to establish an inclusive eco-embodied based pedagogy in school or classroom. First, pre-service and in-service teacher training should explicitly incorporate eco-embodied pedagogy as an extension of existing education coursework. Teaching teachers may analyze any nature-based or motion-technology activity in terms of its locomotor, object-control, and stability demands (Gallahue et al., 2012) and to match these demands to individual students' disability profiles, addressing the competency gap identified by Oktaviane (2026) and Forestry et al. (2019). Second, given that Indonesian schools already possess outdoor space that can be structured into eco-embodied FMS stations at low infrastructural cost, PE curricula can integrate outdoor movement circuits and

adapted sports stations of the kind piloted by Saputra et al. (2024), whose creative-and-adaptive sports model produced measurable participation gains without requiring specialized equipment. Third, the international sensory-garden design literature (Hussein, 2020; Pouya et al., 2024) offers transferable principles—varied terrain, textured materials, calming and stimulating zones—that Indonesian schools could adapt at modest cost to support movement-based sensory regulation, provided that PE teachers, not only facility planners, are involved in translating these principles into actual lesson activities.

CONCLUSION

This study demonstrates that bodily movement functions as the central pedagogical mechanism, not merely an ancillary feature, through which eco-embodied learning supports children with special needs in elementary school—a reframing with direct significance for the field of physical education and adapted physical education. Evidence from seventeen studies spanning autism, ADHD, motor impairment, and mixed special educational needs populations across eight countries, including Indonesia, consistently shows that structured movement, whether through outdoor locomotor activity, sensory-garden exploration, motion-based digital games, or adapted sports instruction, drives sensorimotor regulation, autism-specific engagement and well-being, and social participation, while its benefits remain conditional on teacher preparation and pedagogical scaffolding. In answer to the research questions guiding, the literature shows that research explicitly foregrounding movement as the pedagogical mechanism of eco-embodied learning remains an emerging field, with Indonesian evidence concentrated specifically within physical education rather than general classroom instruction; the movement-related mechanisms driving benefit are best understood through the convergence of fundamental movement skills theory and embodied cognition theory; and the primary implication for adapted physical education practice, particularly in Indonesia, is that teacher preparation in movement-task adaptation is the critical lever for realizing eco-embodied pedagogy's potential.

In the future, teachers may need to note that advancing eco-embodied pedagogy will depend on how they can integrate fundamental-movement-skills-

based lesson design into adapted teacher training, leveraging existing outdoor school spaces as low-cost movement-learning environments, and building on the demonstrated success of locally piloted adaptive sports models. For researchers and PE practitioners, this may lead further to Indonesian classroom-action-research or quasi-experimental studies that explicitly test eco-embodied, movement-centered curricula for elementary students with special needs. Such efforts would strengthen the evidence base needed to establish eco-embodied pedagogy as a recognized, evidence-based strand within adapted physical education and sports pedagogy in Indonesia.

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