Bridging Physical Literacy: Multilateral Learning Methods in Physical Education to Enhance Motor Educability

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Abstract

Study purpose. This study aimed to investigate the impact of multilateral learning methods on the acceleration of motor educability in elementary school students, with an analytical focus on manipulative coordination and sensorimotor adaptability.

Materials and methods. Employing a quantitative approach with a pre-experimental one-group pretest-posttest design, this study involved 50 fifth-grade students selected via purposive sampling. The pedagogical intervention was implemented over a six-week period, integrating multilateral principles into the formal physical education curriculum through small sided games and fundamental movement circuits. Assessment instruments specifically tennis ball throwing and catching tests alongside basketball throwing tests were utilized to evaluate the efficacy of force control and the students' capacity for adaptive calibration to variability in object mass. Data were subsequently analyzed using a paired samples t-test at a 5% significance level to determine the statistical significance of the intervention's impact

Results. The results demonstrated a significant increase in motor performance across both measurement parameters; the mean score for the tennis ball throw significantly increased from 7.74 to 8.00 (t_observed = 2.768 > t_table = 2.009; p = 0.008). A more substantial significance was identified in the basketball instrument, where scores rose from 3.07 to 3.37 (t_observed = 9.440 > t_table = 2.009; p < 0.001). These findings provided empirical evidence that multilateral intervention effectively stimulated neuromuscular plasticity in students, enabling precise force calibration during transitions in object characteristics.

Conclusions. It was concluded that the implementation of multilateral learning based on equipment modification was a significant strategy for optimizing motor educability profiles while strengthening the foundation of physical literacy in children's developmental phases.

Introduction

For kids' development, physical education in elementary schools is essential. In addition to enhancing health, it promotes emotional, social, and cognitive development, all of which help students perform better academically (Li et al., 2023). Enhancing motivation, self-assurance, physical skill, and a profound comprehension of the significance of an active lifestyle throughout one's life are the goals of physical education. (Edwards et al., 2017) It is more than just engaging in physical activity. But reaching this all-encompassing objective mostly hinges on how well pupils are taught and how much movement they experience in their early years. According to empirical studies, educational approaches frequently center on helping students learn certain sport skills, also referred to as sport-specific talents. More significantly, if these efforts are not addressed, children' motor skills their innate capacity to pick up, adjust, and master new movement patterns may be neglected. Abilities are essential for predicting pupils' future mobility and levels of physical activity. A focus on motor skills and basic movement abilities is necessary to develop into an independent and adaptive motor learner (Bardid, 2016; Veldman et al., 2018).

Enhancing students' mobility and independence is a key component of contemporary physical education programs since it lays the groundwork for long-term active engagement (Taylor & MacLeod, 2024). An inclusive, gamification-based, and collaborative approach that improves emotional intelligence and stakeholder involvement is the optimal way to accomplish this (Rice et al., 2025). Additionally, this progressive paradigm includes non-traditional exploratory activities like parkour, which have been demonstrated to improve perceived competence and motor inventiveness (Yolcu et al., 2024). Despite recent empirical research indicating that collaborative, game-based approaches are substantially more effective, there is a significant implementation gap in the field, where rigid, conventional methods still dominate education. A stark contrast between dynamic curriculum expectations and static learning realities is created by the conventional learning approach's underutilization of key pedagogical components, such as verbal encouragement and feedback, which have been shown to impair students' technical and physical performance (Longakit et al., 2024).

The deterioration of motor educability and the stagnation of basic movement competencies are systemic effects of this pedagogical gap. It has been empirically demonstrated that play-based approaches are more effective than rigid drill methods at motivating students to learn and master techniques (Yulianti et al., 2025). Even while recent research highlights the need of technology-supported formative assessment in tracking continuous motor development, this problem is made worse by the lack of adaptable evaluation techniques (Müller & Wagner, 2025). Given that traditional learning models frequently fall short in stimulating higher-level cognitive aspects, the need for this transformation in Indonesia's educational landscape is becoming more urgent. On the other hand, it has been demonstrated that incorporating cognitive reflective movement learning greatly enhances students' critical thinking abilities (Abduljabar et al., 2025), and creative media interventions like flashcards are essential for addressing the decline in physical fitness at the elementary school level (Hambali et al., 2025). The need to optimize learning models to raise students' capacity from merely dependent performers to adaptive movement learners is evident in East Kalimantan, where a specific investigation in Samarinda found that elementary school students' gross motor skill level is still primarily in the "Medium" category (Shakty et al., 2022).

The Multilateral Learning Method, which essentially rejects early specialization in favor of a holistic development philosophy based on the enrichment of basic movements (locomotor, non-locomotor, and manipulative), is repositioned as a crucial pedagogical alternative in contemporary physical education discourse as a strategic response to mitigate the movement competency gap. An experimental study by provides compelling evidence of the efficacy of this strategy, demonstrating that the incorporation of multilateral activities through small game interventions was able to significantly increase the accumulation of motor skills among elementary school students by 13.73% (Sidiq et al., 2024). The study demonstrated that a structured play approach successfully enhanced the quality of more stable movements, as evidenced by a decrease in standard deviation and variance in post-test measurement results, in addition to improving performance in agility (shuttle run), eye-hand coordination (throw and catch), and balance (stork stand). These results demonstrate that multilateral movement exercises presented as adaptive games are effective tools for establishing a strong foundation in movement, improving student performance consistency, and fostering a welcoming and joyful learning environment.

While multilateral approaches possess significant pedagogical potential, their operationalization within the Indonesian physical education system is hindered by fundamental barriers, particularly concerning deficits in teachers' Pedagogical Content Knowledge (PCK) and instructional creativity. Integrating these professional competencies with technological advancements is a crucial factor in regulating student engagement which typically diminishes under traditional learning models as digital monitoring tools have been proven to optimize both instructional efficiency and learning motivation (Carmen et al., 2024; Fantiro et al., 2025). The disparity between the ideal curriculum and the reality of movement competencies at the regional level is still a significant, unresolved issue, as demonstrated by the critical portrayal of this phenomenon in East Kalimantan, where physical education practices are still dominated by strict instructional routines that have implications for the stagnation of students' gross motor profiles. Epistemological fragmentation in the international literature adds to the complexity of this field; a recent bibliometric analysis found that the discussion of Fundamental Movement Skills is still sharply divided between the fields of education, sports science, and health, making it difficult to develop a cohesive pedagogical framework (Khudolii et al., 2025b).

Heterogeneity in definitions and evaluation tools is a significant obstacle to the empirical and standardized measurement of the efficacy of multilateral initiatives, thus this lack of theoretical agreement directly affects the validity of assessments (Khudolii et al., 2025a). By focusing on full educability skills learning rather than just measuring partial skill performance, this study introduces a fresh approach. This was done in response to the stark contrast between East Kalimantan's learning practices, which are still limited by strict instructional approaches, and the necessity for holistic movement development. As a determinant variable construct in this study, motor educabiliti lays special emphasis on students' cognitive-motor capacities, which include their independence in practice, learning transfer efficiency, and speed at which they pick up new skills. For movement pedagogy to balance cognitive components, this is essential. The basic issue of movement competence degradation, which has not yet been addressed by traditional evaluations that only consider final physical results, is being strategically addressed by this reorientation. This makes it possible to diagnose the caliber of pupils' movement learning with more accuracy.

The novelty of this research lies in its rigorous investigation of the ecological validity of applying multilateral techniques within an actual educational ecosystem, moving beyond the constraints of conventional laboratory-based efficacy tests. Unlike previous studies that often overlook practical constraints, this study introduces a novel perspective by dissecting the real-world dynamics of implementation, specifically focusing on how equipment modification facilitates neuromuscular adaptation in students. Furthermore, it addresses a significant gap in

the literature by examining crucial moderating factors often missed in experimental designs, such as structural impediments and instructor preparedness regarding Pedagogical Content Knowledge (PCK) in the Indonesian context. By providing contextual empirical evidence on the intersection of multilateral methods and motor educability, this research offers strategic recommendations that are essential for supporting pedagogical reform in Indonesia's physical education, ultimately aiming to foster a generation with robust physical literacy and precise movement skills.

Materials and methods
Study participants
This research was conducted at State Elementary School 001 Sungai Kunjang and State Elementary School 024 Samarinda Utara, situated in Samarinda City, East Kalimantan. These sites were purposively selected as they serve as representative educational hubs in the region, possessing the requisite outdoor facilities and equipment flexibility essential for the implementation of multilateral learning circuits. Furthermore, these institutions were identified as contextually relevant for investigating the stagnation of students' physical literacy, which is frequently exacerbated by a historical reliance on conventional, sport-centric pedagogical frameworks.

The study population comprised fifth-grade students (Phase C), with sampling executed through a purposive technique utilizing intact study groups to preserve the ecological validity of the learning environment while ensuring no disruption to school administration. To maintain rigorous internal validity, participants were selected based on specific inclusion criteria: (1) active enrollment in the current academic year; (2) an age range of 10–12 years; and (3) no history of orthopedic injuries or pathological disorders within the preceding three months that could impede participation in moderate-to-high-intensity physical activities. Consequently, a total sample of 50 students (N = 50) was established, all of whom participated as a single experimental group.

Study organization
This study employed a pre-experimental one-group pretest-posttest design to evaluate the motor educability and manipulative proficiency of 50 Phase C students (ages 10–12). Baseline data collection was conducted using the Throwing and Catching Test, a widely recognized method for assessing hand-eye coordination and motor agility within physical education settings. The instrument demonstrated robust psychometric standards, yielding a validity coefficient of 0.83 and a reliability coefficient of 0.94. To examine sensorimotor adaptability, the research utilized heterogeneous object stimuli, specifically tennis balls (57–58g) and size 5 basketballs (470–500g), to evaluate students' force modulation and neuromuscular calibration based on established equipment standardization protocols (Sathish et al., 2025).

The intervention was implemented over a six-week period, integrated into the regular curriculum through a multilateral method utilizing small-sided games and fundamental movement circuit approaches. This strategy was designed to comprehensively stimulate motor problem-solving abilities and develop the motor competence and physical literacy of students within this age group. The research sequence concluded with a post-test using equivalent instruments to measure the efficacy of the instructional method in enhancing fundamental manipulative skills (Piotrowski et al., 2025).

Statistical analysis
All quantitative data collected from the pre-test and post-test scores were statistically analyzed using IBM SPSS Statistics version 26. Descriptive analysis was conducted to present

the mean and standard deviation, providing an overview of the participants' motor educability profiles before and after the intervention.

Prior to hypothesis testing, assumption tests were performed to determine the appropriate statistical methods. The normality of the data distribution was examined using the Shapiro-Wilk Test, which is suitable for a sample size of 50 participants. In addition, the homogeneity of variances between the pre-test and post-test scores was assessed using Levene's Test.

To test the main hypothesis regarding the significance of improvement in motor educability particularly in manipulative skills a Paired Samples T-Test was employed at a significance level of 5% ($\alpha = 0.05$). This parametric test was used to compare the mean difference between the pre-test and post-test scores within the same group. However, if the assumptions of normality and homogeneity were violated, the non-parametric Wilcoxon Signed-Rank Test was prepared as an alternative to ensure the validity of the findings.

Furthermore, to evaluate the effectiveness of the intervention, the Normalized Gain Score (N-Gain) was calculated. This analysis aimed to classify the level of improvement into low, medium, or high categories, thereby providing a more comprehensive understanding of the multilateral method's impact on students' motor educability.

Results
Pre-Analysis Assumption Tests

Before hypothesis testing was conducted, the sample data were subjected to parametric prerequisite tests. Normality tests were conducted to ensure that the sample data came from a population with a normal distribution, allowing for proper parametric statistical analysis.

For the tennis ball throwing instrument, the pre-test significance value was 0.190 and the post-test significance value was 0.200, respectively. For the basketball throwing instrument, the pre-test and post-test significance values were 0.75, based on the results of the normality test using the Shapiro-Wilk Test. All probability values were greater than the established significance level ($\alpha = 0.05$). Therefore, it can be concluded that all data collected in this study were normally distributed.

Next, a homogeneity of variance test was conducted using the Levene's Test to determine whether the variances between the measurement groups were homogeneous. The test results showed that the tennis ball instrument had a significance value of 0.865 and the basketball instrument had a significance value of 0.993. There was no variation in the data, as both values were above the 0.05 significance level.

Once both classical assumptions of normality and homogeneity were met, researchers could proceed to test the hypothesis using a parametric statistical test known as the Paired Samples T-Test.

Hypothesis Testing (Effect of Intervention)

Hypothesis testing aims to compare the average manipulative abilities of students, which represent the level of motor educability, between before (pre-test) and after (post-test) the provision of multilateral method intervention. The analysis was conducted using the Paired Samples T-Test. The decision-making criteria are set as follows: the alternative hypothesis (H_1) is accepted if the calculated t_value > t_table (2.009) and the significance value (p-value) < 0.05. A summary of the comparative test results is presented in Table 1.

Table 1. Results of the Paired Samples T-Test for Manipulative Ability

Measurement Variable	N	Pre-test Mean (SD)	Post-test Mean (SD)	t-value	t-table	df	Sig. (2-tailed)

Tennis Ball Throwing and Catching	50	7.74 (2.84)	8.00 (2.92)	-2.768	2.009	49	0.008*
Basketball Throwing	50	3.07 (0.64)	3.37 (0.62)	-9.440	2.009	49	< 0.001*

Note: SD = Standard Deviation; df = degrees of freedom; $p < 0.05$

An overview of the increase in the average score of students' manipulative abilities from the pre-test to the post-test stage, both on the tennis ball throwing and catching instruments and the basketball throwing instruments, can be observed in the following bar chart Figure 1.
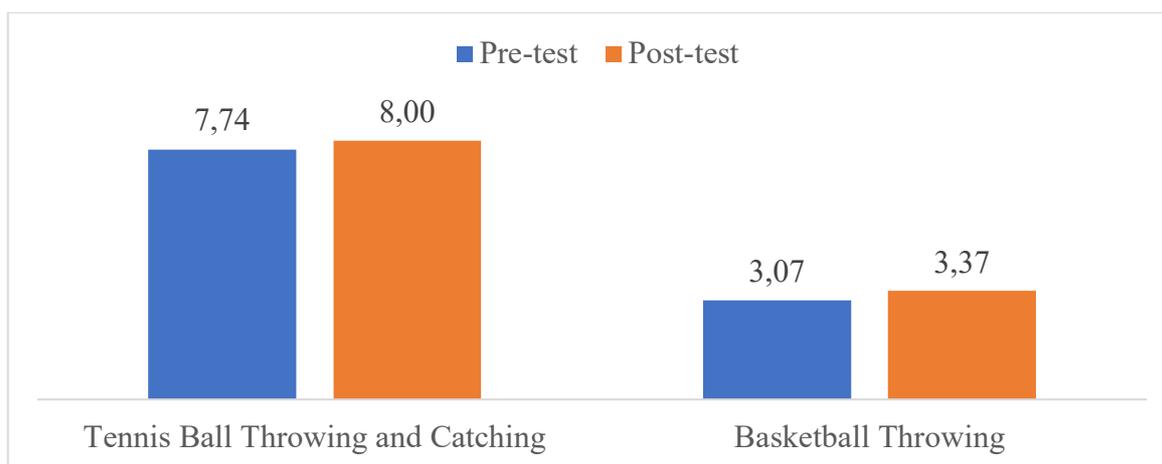
Figure 1. Mean Score Comparison of Students' Manipulative Skills: Pre-test vs Post-test

The research findings, as presented in Table 1, indicate that all measurement instruments experienced an increase in mean scores following the intervention. In the tennis ball throwing and catching instrument, the students' mean score increased from 7.74 at the pre-intervention stage (pre-test) to 8.00 at the post-intervention stage (post-test). Meanwhile, in the basketball throwing instrument, a more substantial descriptive increase was observed, rising from 3.07 to 3.37. The greater magnitude of improvement in the basketball instrument suggests that the multilateral method exerts a more pronounced effect on skills requiring adaptation to objects with more complex physical characteristics, particularly concerning ball mass and dimensions.

This pattern of improvement is visualized in Figure 1. The bar diagram presented illustrates comparatively the pattern of mean score increases from pre-test to post-test across both instruments. Visually, the diagram confirms that the most prominent improvement occurred in basketball throwing skills, which aligns with the descriptive findings presented in Table 1.

To examine the statistical significance of the observed improvements, a Paired Samples T-Test analysis was conducted. The test results revealed that for the tennis ball throwing and catching instrument, the obtained t_value was 2.768, exceeding the critical t_table value (2.009) at 49 degrees of freedom, with a probability value (p) of 0.008 ($p < 0.05$). For the basketball throwing instrument, the t_value reached 9.440, substantially surpassing the critical t_table value (2.009) with $p < 0.001$. These findings confirm that the improvements in manipulative skills for both instruments were statistically significant, with a higher level of significance observed for the basketball instrument. Accordingly, the null hypothesis (H_0) is rejected, indicating that the multilateral method intervention had a meaningful effect on enhancing students' manipulative abilities.

Further analysis through paired samples correlation revealed a very strong relationship between pre-test and post-test scores on both instruments. The correlation coefficient for the tennis ball instrument reached r = 0.974 (p < 0.001), while the basketball instrument achieved r = 0.935 (p < 0.001). These findings reflect the consistency of students' responses to the intervention, wherein students with higher initial capacities tended to maintain their relative advantage after the intervention, and vice versa. This indicates that the multilateral method is not only effective in general terms but also capable of preserving the hierarchy of individual abilities within the group.

Collectively, the hypothesis testing results provide strong empirical evidence to reject the null hypothesis (H₀) and accept the alternative hypothesis (H₁). Based on the synthesis of findings presented both tabularly in Table 1 and visually in Figure 1 it can be concluded that the implementation of the multilateral learning method based on modified equipment significantly contributes to enhancing students' motor educability capacity, particularly in the domain of fundamental manipulative skills.

Discussion

The research findings indicate that a six-week intervention integrating Small-Sided Games and fundamental movement circuits significantly enhanced students' manipulative skills. These results provide empirical evidence that the multilateral approach, grounded in movement variability and adaptive learning, is capable of bridging the pedagogical gap between curricular demands and the reality of students' movement competencies in the field. This finding aligns with the perspective of (Syafei et al., 2025), who assert that the development of fundamental movement skills through a multilateral approach constitutes an essential foundation for children's holistic growth, encompassing physical, cognitive, and social dimensions. Furthermore, (Ceciliano, 2017) explains that the integration of extensive and intensive multilateral activities is a necessity in primary school physical education. This integrated approach not only expands students' movement repertoire but also specifically targets the development of kinesthetic differentiation and rhythmic control, which are key components of motor control. Consistency with the research of (Yang et al., 2025) is also confirmed, wherein non-linear pedagogy emphasizing task variability and adaptability proves superior in enhancing motor performance and long-term skill retention compared to rigid linear pedagogical approaches. Thus, the observed effectiveness of the multilateral method in this study does not stand in isolation; rather, it reinforces the convergence of empirical evidence in international literature that learning approaches rich in variation and adaptability are more responsive to children's motor development needs than conventional instructional methods.

The significant improvement observed in both instruments reinforces the theoretical foundation of multilateral development, wherein exposure to diverse movement experiences enhances children's adaptive capacity to varying motor demands. The greater improvement in the basketball throwing task an object with greater mass and dimensional complexity indicates that the multilateral method excels in developing force modulation and neuromuscular adaptability, aligning with the view that motor skill acquisition requires adaptive calibration to environmental and object constraints. Structured flexibility training significantly contributes to enhancing motor abilities in junior athletes, relevant to our finding that structured approaches facilitate neuromuscular adaptation to complex objects (Al-Sudani, 2025). Structured active play yields improvements in fundamental movement skills comparable to skill-oriented physical education, reinforcing the argument that structured physical activity is more effective than unstructured free play without guidance (Liu et al., 2025). Systematic drill-based training methods significantly improve elementary school students' soccer passing skills with a very high effect size (Cohen's d = 3.152), confirming that structured repetition with appropriate feedback establishes accurate movement automation (Dwi Efendi et al., 2025). (Septiano &

Amrulloh, 2025) emphasize that systematic program planning and effective organization constitute essential foundations for athlete development, principles that also apply to physical education in elementary school contexts. Thus, this study extends current understanding by demonstrating that structured play-based interventions integrated into formal curricula can systematically develop students' adaptive capacity.

The findings of this study reinforce the efficacy of structured multilateral approaches in fostering the development of children's fundamental movement skills (FMS). Central to this development is the establishment of high-quality instructional environments that prioritize the systematic adaptation of frequency, intensity, time, and type (FITT) principles (O'Brien et al., 2023). Specifically, the significant performance gains observed in the basketball throwing task—a skill requiring the manipulation of an object with substantial mass and dimensional complexity—underscore the effectiveness of multilateral methods in facilitating adaptive calibration to environmental constraints. This observation is congruent with the premise that participation in structured physical activity within school settings significantly enhances both student learning indicators and motor engagement (Duta Putra Utama et al., 2023). Furthermore, evidence suggests that movement proficiency is positively correlated with moderate-to-vigorous physical activity (MVPA) and overall daily physical activity levels in children (K. Prasetyo, 2016; Xu et al., 2024). Nevertheless, the attainment of FMS is mediated by various biological and behavioral determinants; for instance, boys and older children frequently achieve superior FMS scores, whereas children characterized by obesity and sedentary lifestyles often exhibit diminished motor performance (Praxedes et al., 2024). Within the context of special populations, research indicates that lower limb spasticity correlates negatively with motor execution, thereby highlighting the critical necessity for individualized programming and rigorous classification systems (Afif. B. E. X. Prasetyo & Kusumawardhani, 2025). Consequently, these integrated findings confirm that structured, play-based interventions when synthesized with FITT principles, individual characteristics, and task complexity can systematically enhance the adaptive capacity of students within elementary education frameworks

Although the accumulation of empirical evidence increasingly confirms the effectiveness of structured multilateral interventions in enhancing children's fundamental movement skills (FMS), a substantial research gap remains regarding the optimal proportion between structured and unstructured approaches that aligns with the characteristics of each child's developmental stage. On one hand, meta-analytic findings indicate that structured interventions produce significantly greater effects on preschool children's locomotor skills compared to unstructured approaches, with long-term interventions proving to be highly effective (Chen et al., 2024). On the other hand, theoretical arguments suggest that the exclusive use of extensive multilateral activities is insufficient to support comprehensive motor development, necessitating integration with intensive multilateral activities that specifically target motor control areas such as kinesthetic differentiation and rhythmic control (Ceciliano, 2017). This theoretical tension is further complicated by findings that school-based sport-oriented physical education programs prioritizing early specialization over diversification result in 72% of boys and 77% of girls demonstrating "inadequate" FMS proficiency, indicating that training which prematurely directs children toward specific sports without a solid foundation of basic skills may potentially impair the development of motor competence (Makaruk et al., 2025). The contradiction among these perspectives underscores a critical research gap: the absence of consensus regarding the most adaptive dosage, intensity, and integration patterns of multilateral activities across diverse spectrums of child development contexts. This complexity is exacerbated by the fact that many FMS intervention studies possess weak methodological quality, reflected in their low risk of bias assessment scores, thereby emphasizing the urgency of research with more rigorous designs to formulate evidence-based guidelines capable of

bridging the advantages of structured practice with the ecological validity of varied, play-based learning environments (Morgan et al., 2013).

The scientific novelty of this study lies in the systematic integration of modified equipment as a strategic pedagogical instrument within the framework of multilateral learning, a dimension that remains underexplored in the fundamental movement skills intervention literature. In contrast to previous studies that focused on structural components such as frequency, intensity, and duration, this study demonstrates that task complexity manipulation through equipment modification (tennis ball versus basketball) serves as a crucial mechanism in developing neuromuscular adaptability and force modulation in elementary school children. These findings substantiate the postulate that adaptive calibration to environmental constraints constitutes an essential foundation of motor learning, wherein equipment modification induces greater movement variability and optimizes skill acquisition, aligning with the constraints-led approach that emphasizes task constraint variation in facilitating adaptive learning (Brocken, 2022; Brocken et al., 2020). The discrepancy in improvement patterns between instruments—with the basketball task demonstrating significantly superior effect sizes—provides empirical evidence that physical attributes of objects (mass, dimensions, coefficient of restitution) interact with intervention effectiveness, indicating that the multilateral approach achieves optimal effectiveness when task constraints are systematically varied to stimulate children's adaptive capacity (Abatedaga et al., 2020). However, the effectiveness of equipment modification is neither linear nor universal; increased execution redundancy does not always correlate with improved performance in beginners, and its effectiveness depends on alignment with children's developmental stage and the typology of skills targeted for intervention (Buszard et al., 2016; Ranganathan & Newell, 2013). This critical perspective enriches the understanding that implementation of equipment modification-based multilateral approaches must consider moderating factors such as initial skill level, chronological maturity, and individual developmental readiness of learners.

From a practical perspective, the effectiveness of a six-week intervention integrated into the regular physical education curriculum provides a tangible solution to the implementation gap that has long been a persistent challenge within the Indonesian educational ecosystem. These findings reinforce the accumulating empirical evidence that structured play-based learning approaches, as represented by the circuit games model, can significantly enhance the motor capacity of elementary school students (Ardanari et al., 2023). This indicates that theoretically grounded multilateral interventions can be feasibly implemented within existing curricular structures without requiring specialized equipment or extensive teacher training a critical consideration for educational environments with limited resources. The consistency of these findings is strengthened by a study demonstrating that the "Motion Circuit" play model not only successfully improves students' locomotor skills but also substantially accelerates learning outcomes across the affective, cognitive, and psychomotor domains, with success attributable to the interactive and recreational characteristics of the approach, which has been shown to enhance students' intrinsic motivation while simultaneously creating a more dynamic learning ecology compared to conventional teaching methods laden with repetitive and monotonous routines (Waluyo et al., 2024). Another fundamental aspect reinforced in this study is the validity of the manipulative skill-based approach, which receives empirical justification through the development and validation of a basic manipulative movement skills test instrument for children aged 6-8 years encompassing throwing, catching, hitting, and kicking indicators with all indicators satisfying construct validity requirements and demonstrating high reliability, thereby providing a robust methodological foundation for the use of similar instruments within the context of this research (Ashidiqie et al., 2024). Integratively, the synthesis of findings from these various studies confirms that structured play-based multilateral learning models such as circuit games and motion circuit—offer scalable, evidence based pedagogical models ready for

adoption by classroom teachers to address the stagnation of students' motor profiles in regions such as East Kalimantan, while simultaneously responding to the urgent need for effective and contextual pedagogical strategies in educational environments with limited resources.

By confirming that multilateral interventions enhance children's adaptive capacity namely, their ability to calibrate force, modulate movement responses, and transfer learning across tasks this study provides an empirical foundation for broadening the conceptualization of motor development, wherein the primary objective of physical education extends beyond mere technical skill mastery to encompass the cultivation of adaptable, confident, and motorically competent individuals capable of active participation across diverse physical activity contexts throughout the lifespan. This paradigmatic shift positions motor educability as an essential competency in building long-term physical literacy, while simultaneously underscoring the urgency of pedagogical practices oriented toward developing adaptive capacity rather than merely accumulating isolated skills. Within the Indonesian context, where conventional instructional approaches tend to perpetuate the stagnation of students' gross motor profiles, the success of structured play-based multilateral interventions integrated through circuit games and motion circuit models and supported by validated manipulative skill instruments offers a strategic pathway toward more contextual and sustainable physical education reform. Thus, this study not only substantiates the effectiveness of the multilateral approach but also redirects scholarly discourse toward the holistic development of motorically adaptive learners, thereby bridging the enduring gap between theoretical formulations and the realities of classroom practice.

Conclusions

This study confirms that a six-week multilateral intervention integrating Small-Sided Games and fundamental movement circuits into the regular physical education curriculum significantly enhances the motor educability of elementary school students. The systematic integration of modified equipment namely tennis balls and basketballs proves to be a strategic pedagogical instrument, demonstrating that task complexity manipulation plays a fundamental role in developing neuromuscular adaptability and force modulation capacity. The superior effect size observed in the basketball task confirms that systematically varied task constraints optimally stimulate children's adaptive capacity. This intervention also successfully preserves the heterogeneity of individual abilities while accelerating collective performance, and can be implemented without requiring significant additional resources thereby offering an evidence-based pedagogical model that is both applicable and scalable. Consequently, the paradigm of physical education can no longer remain complacent with mere technical skill mastery, but must transform to cultivate individuals who are adaptively and motorically competent throughout their lifespan, while simultaneously bridging the discrepancy between theoretical constructs and the realities of classroom practice.

Acknowledgment

Conflict of interest

The authors declare that there are no conflicts of interest.

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