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# The effect of play activities on motor ability of elementary school students

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### ABSTRACT

Motor development theory suggests that play-based activities promote motor competence by providing repeated, varied movement experiences that enhance coordination, balance, agility, and object-control skills through active exploration and practice. This study examines the effect of play-based activities on the motor ability of elementary school students. The study was motivated by the low level of motor skills among students at SDN 20/VI Muara Madras, reflected in their difficulty performing movement tasks during physical education classes and the reduced engagement in physical play due to increased gadget use and limited play facilities. A quantitative approach was employed using a quasi-experimental one-group pretest-posttest design. The sample consisted of 17 fifth-grade students selected through purposive sampling. Motor ability was assessed using the Scott Motor Ability Test, which comprises four components: Basketball Throw, 4-Second Dash, Wall Pass, and Standing Broad Jump. Data were analyzed using the Shapiro-Wilk normality test, the paired-sample t-test, and Cohen's d effect size. The mean motor ability score increased from 200.00 at pretest to 205.67 at posttest, representing a mean difference of 5.67 points. However, the paired-sample t-test indicated that this difference was not statistically significant ( $p = 0.096$ ). The calculated Cohen's d of 0.429 indicated a moderate effect size. These findings indicate that the play-based intervention did not produce a statistically significant improvement in students' motor ability under the conditions of this study. Further research employing larger samples, longer intervention periods, and stronger experimental controls is recommended to clarify the effectiveness of play-based approaches in enhancing motor development among elementary school students.



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## Introduction

Physical education provides an essential context for developing children's motor competence, a multidimensional construct that underpins lifelong physical activity, health, and sports participation. Contemporary motor development theories, particularly Dynamic Systems Theory and the Developmental Model of Motor Competence, conceptualize motor competence as emerging through continuous interactions among individual characteristics, task constraints, and environmental opportunities rather than through biological maturation alone (Robinson et al., 2020; Rudd et al., 2021). Consequently, learning environments

that provide varied, meaningful, and progressively challenging movement experiences are expected to facilitate children's motor development more effectively than repetitive skill-drill instruction.

Structured play has recently received considerable attention as one such pedagogical approach because it integrates goal-directed movement practice with children's intrinsic motivation, exploration, and problem solving. Unlike unstructured free play, structured play intentionally manipulates task difficulty, movement variability, and feedback to promote motor learning while maintaining enjoyment and engagement. Recent systematic reviews and meta-analyses published between 2019 and 2024 consistently report that structured play and game-based motor interventions significantly improve children's locomotor skills, object-control skills, balance, coordination, and overall motor competence compared with conventional teacher-directed instruction. These improvements are explained by increased movement repetitions, enriched environmental affordances, and opportunities for adaptive motor decision-making during play (Logan et al., 2021; Barnett et al., 2022; Palmer et al., 2024).

Despite this growing body of evidence, several important limitations remain. First, most intervention studies have evaluated isolated dimensions of motor competence using instruments such as the Test of Gross Motor Development (TGMD-3), Körperkoordinationstest für Kinder (KTK), or the Movement Assessment Battery for Children (MABC-2). Consequently, relatively little is known about whether structured play produces broader improvements in composite motor ability encompassing speed, agility, balance, coordination, explosive power, and reaction time simultaneously. Second, intervention protocols differ substantially in duration, instructional design, and movement content, making it difficult to determine whether standardized structured play programs consistently produce meaningful motor improvements. Recent reviews have therefore highlighted the need for intervention studies employing standardized protocols together with comprehensive motor assessments to strengthen the evidence base for school-based physical education.

These limitations reveal a conceptual and methodological gap rather than merely a local educational problem. Existing research has largely demonstrated that structured play enhances specific motor skills; however, considerably less evidence explains whether a progressive, theory-informed structured play intervention can improve children's overall motor ability as an integrated construct. Addressing this gap is important because comprehensive motor competence is increasingly recognized as the foundation for physical literacy and sustained participation in physical activity throughout life.

The present study extends existing motor development frameworks in two ways. First, it implements a standardized 16-session structured play intervention explicitly designed according to principles of progressive motor learning and environmental affordances, thereby reducing the variability commonly observed across previous intervention studies. Second, instead of focusing on isolated movement skills, this study evaluates children's composite motor ability using the Scott Motor Ability Test, which simultaneously measures multiple dimensions of motor performance. By integrating a theory-driven intervention with a comprehensive assessment approach, this study contributes new empirical evidence regarding how structured play influences overall motor development in elementary school children.

Therefore, this study aims to examine the effect of a 16-session structured play intervention on the composite motor ability of fifth-grade elementary school students using a one-group pretest-posttest quasi-experimental design. The findings are expected to strengthen current evidence regarding structured play as a pedagogical approach for motor development and provide theoretical and practical implications for designing evidence-based physical education programs in elementary schools.

## Method

This study employed a quantitative approach using a quasi-experimental method and a one-group pretest-posttest design. This design was chosen because it does not allow for a control group, so the research focuses only on measuring changes within a single experimental group before and after the intervention (Muhandis & Riyadi, 2023). The independent variable in this study is play activities, while the dependent variable is motor skills.

The study was conducted at SDN 20/VI Muara Madras. The study population consisted of all students at the school. Seventeen students were recruited as the research sample through purposive sampling, based on criteria encompassing class availability and regularity of attendance.

Motor skills were measured using the Scott Motor Ability Test, which consists of four components: (1) Basketball Throw, which measures upper-body strength; (2) 4-Second Dash, which measures speed and agility; (3) Wall Pass, which measures hand-eye coordination; (4) Standing Broad Jump, which measures lower-body

strength and motor coordination. The raw scores from each component were converted to T-scores to standardize the units before being summed to produce a composite motor ability score.

The intervention program consisted of 16 sessions of structured play activities, including pretest and posttest sessions. Each session lasted approximately 45 minutes and included progressive play activities, such as jump rope, ball relays, and movement combinations. The program was designed to be systematic and enjoyable in order to comprehensively develop various motor components.

Data were subjected to the Shapiro-Wilk normality test (selected due to  $n < 50$ ), a paired sample t-test for inferential hypothesis evaluation, Cohen's  $d$  for effect size quantification, and post-hoc power analysis in G\*Power 3.1.9.7. The significance threshold was fixed at  $\alpha = 0,05$ . Following Cohen (Brydges, 2019), effect magnitudes were categorized as small ( $d < 0,2$ ), moderate ( $0,2 \leq d \leq 0,8$ ), or large ( $d > 0,8$ ). Minimum acceptable statistical power was set at 0,80.

## Results and Discussions

### Descriptive Statistics

Descriptive statistics for the pretest and posttest motor skills scores are presented in Table 1. The mean motor skills score increased from 200.00 (pretest) to 205.67 (posttest), an increase of 5.67 points. The standard deviation also increased from 31.10 to 37.13, indicating a widening of individual scores following the intervention.

**Table 1.** Descriptive Statistics for Pretest and Posttest Motor Skills Scores

Variable	N	Mean	SD	Max	Min
Pretest	17	200,00	31,10	265,13	141,96
Posttest	17	205,67	37,13	285,99	139,83

In the pretest phase, the distribution of motor skills scores showed that 5.88% of students were in the "very good" category, 47.06% in "good," 29.42% in "average," 11.76% in "poor," and 5.88% in "very poor." After the intervention, the posttest distribution showed that 5.88% were "excellent," 35.30% were "good," 23.53% were "average," 23.53% were "poor," and 11.76% were "very poor."

### Normality Test

The Shapiro-Wilk normality test was applied to the pretest and posttest data given the small sample size ( $n = 17 < 50$ ). The test results are presented in Table 2.

**Table 2.** Results of the Shapiro-Wilk Normality Test

Variable	Sig. Shapiro-Wilk	$\alpha$	Notes
Pretest	0,961	0,05	Normal
Posttest	0,734	0,05	Normal

Significance values of 0,961 and 0,734 were obtained for the pretest and posttest respectively, both surpassing the  $\alpha = 0,05$  criterion. Normality was therefore confirmed for both datasets, satisfying the parametric assumption required for paired-sample t-test application.

### Hypothesis Testing: Paired Sample T-Test

A paired sample t-test was conducted to determine whether there was a significant difference in motor skills between the pretest and posttest measurements. The test results are presented in Table 3.

**Table 3.** Results of the Paired-Sample T-Test

Paired Data	t-calculated	t-tabel	Sig. (2-tailed)	Decision
Motor Skills Pretest-posttest	-1,768	1,746	0,096	H0 Accepted

The paired-sample t-test yielded a p-value of 0.096, which exceeds the significance threshold of  $\alpha = 0.05$  ( $p > 0.05$ ). Thus, H0 is accepted and Ha is rejected, meaning there is no statistically significant effect of play activities on motor skills. Nevertheless, there was an average increase of 5.67 points from the pretest to the posttest, indicating a positive trend in motor skills.

**Effect Size Test: Cohen's d**

Given the non-significant results of the statistical tests, Cohen's d was calculated to assess the practical significance of the intervention. The formula used was:  $d = (M_{\text{post}} - M_{\text{pre}}) / SD_{\text{diff}} = (205.67 - 200.00) / 13.217 = 0.429$ .

**Table 4.** Results of the Cohen's d Effect Size Test

Statistics	Value	Category
Mean Difference	5,67	-
SD Difference	13,271	-
Cohen's d	0,429	Moderate

A Cohen's d value of 0.429 falls into the moderate category ( $0.2 \leq d \leq 0.8$ ) according to Cohen (Brydges, 2019). This finding implies that, although statistical significance was not achieved, the play-based activity program still had a practically meaningful effect. This moderate effect size indicates that the intervention has relevant pedagogical potential, particularly when implemented with a larger sample and over a longer duration.

**Post-hoc Power Analysis**

A post-hoc power analysis was conducted using G\*Power 3.1.9.7 to evaluate the adequacy of the study's statistical power. The results of the analysis are presented in Table 5.

**Table 5.** Results of the Post-hoc Power Analysis

Parameter	Value
Effect size (dz)	0,429
Alpha ( $\alpha$ )	0,05
Sampel size (n)	17
Test direction	Two-tailed
Non-centrality parameter ( $\delta$ )	1,769
Critical t	2,120
Degrees of freedom (df)	16
Achieved power ( $1-\beta$ )	0,38 (38,3%)
Minimum power standar	0,80 (80,0%)
Minimum sampel size (80% power)	$N \geq 45$

The power value obtained was 0.38 (38.3%), which is well below the minimum standard of 0.80 (80.0%) recommended by Cohen. The non-centrality parameter ( $\delta$ ) of 1.769 was obtained from the calculation  $d \times \sqrt{n} = 0.429 \times \sqrt{17} = 1.769$ . The low power value indicates a Type II error probability ( $\beta$ ) of 0.62, meaning there is a 62% risk of failing to detect a real effect that actually exists. Thus, the non-significance of the statistical test results is due more to the small sample size ( $n = 17$ ) than to the ineffectiveness of the play-based activity program. A minimum sample size of  $n \leq 45$  is required to achieve 80% power in similar future studies.

The present study found that the structured play intervention produced a positive mean improvement in children's fundamental motor skills; however, this improvement did not reach statistical significance ( $p = 0.096$ ). Rather than interpreting this finding as evidence of intervention effectiveness, the results should be understood as indicating that the present study was unable to demonstrate sufficient statistical evidence for a measurable intervention effect under the current experimental conditions. Although the observed effect size suggested a potentially meaningful practical impact, effect sizes should complement rather than replace statistical inference, particularly when statistical significance is not achieved. Consequently, the findings should be interpreted cautiously and viewed as preliminary evidence requiring confirmation through larger, adequately powered studies.

The relationship between structured play and motor development has been widely documented, although reported effect sizes vary considerably across intervention designs and participant characteristics. Meta-analyses and systematic reviews have consistently concluded that structured movement programs generally produce small-to-moderate improvements in fundamental motor skills, especially when interventions are implemented over longer durations, delivered by trained instructors, and integrated into regular physical education programs (Logan et al., 2012; Morgan et al., 2013; Robinson et al., 2015; Wick et al., 2017; Palmer et al., 2019; Barnett et al., 2022). Similarly, intervention studies conducted in school settings have demonstrated significant improvements in locomotor and object-control skills following structured play-based instruction (Brian et al., 2017; True et al., 2018; Webster et al., 2020; Bardid et al., 2021; Tompssett et al., 2022). However, other investigations have reported limited or non-significant effects when intervention duration was short, participant variability was high, or baseline motor competence differed substantially among children (Goodway et al., 2019;

Palmer et al., 2020; De Meester et al., 2021; Burns et al., 2022; Duncan et al., 2023). Therefore, the present findings are not inconsistent with the broader literature but instead fall within the range of heterogeneous outcomes commonly reported in motor development research.

Compared with previous studies, several methodological differences may explain why statistical significance was not observed. Many successful interventions reported in international studies lasted between 12 and 24 weeks, incorporated multiple weekly sessions, and involved larger sample sizes than the present study. Longer intervention periods provide greater opportunities for motor learning through repeated practice, feedback, and skill consolidation, which are fundamental principles of motor learning theory. In contrast, shorter interventions may generate observable performance improvements that remain insufficiently stable to produce statistically detectable group differences.

An alternative explanation for the relatively high correlation observed between pretest and posttest scores is that it may primarily reflect measurement stability rather than genuine intervention effects. High correlations between repeated measurements are common in motor development assessments because children who perform relatively well at baseline frequently maintain their relative ranking over time. Consequently, the observed association may indicate good test-retest reliability or stability of individual differences instead of substantial changes attributable to the structured play program. Furthermore, natural maturation, previous movement experience, classroom environmental factors, and differences in daily physical activity outside the intervention may also have contributed to children's motor performance independently of the treatment. These alternative explanations should be considered before attributing observed improvements exclusively to the intervention.

From a theoretical perspective, the present findings suggest that structured play alone may not be sufficient to produce statistically detectable improvements in fundamental motor skills under all conditions. Contemporary models of motor development emphasize that skill acquisition emerges from dynamic interactions among individual characteristics, environmental opportunities, task constraints, instructional quality, and accumulated practice experiences rather than from a single intervention component. Therefore, future interventions should consider combining structured play with progressive task difficulty, individualized feedback, greater practice frequency, and longer intervention duration to maximize learning outcomes.

The present findings also contribute to the scientific literature by demonstrating the importance of reporting well-conducted studies even when statistical significance is not achieved. Publishing rigorously designed studies with null findings helps reduce publication bias and provides more balanced evidence for future systematic reviews and meta-analyses. Nevertheless, the current results should not be interpreted as definitive evidence of intervention effectiveness. Instead, they indicate that replication with larger samples, improved statistical power, and longer intervention periods is necessary before strong practical recommendations regarding structured play can be made.

The findings of this study are also consistent with (Sukoco, 2020), who reported that meaningful improvements in motor skills among elementary school students generally require an 8- to 12-week program with consistent frequency and an adequate sample size. The 16-session program implemented in this study, although structured and progressive, was conducted over a relatively short period with a limited number of participants, thereby limiting the ability to detect statistically significant changes.

These findings are further supported by (Chaeroni et al., 2021), who demonstrated through an 8-week physical activity program involving 44 adolescent students that moderate- to high-intensity physical activity significantly improved physical fitness and mental health, and concluded that structured physical activity should be a regular part of students' lives to maintain overall well-being. This underscores the importance of sustained and systematic physical engagement—a principle that can be directly applied to the game-based interventions implemented in this study, where a longer program duration would likely yield stronger and more statistically detectable effects. Furthermore reported that a physical activity-based physical education model delivered in the form of games resulted in a significant improvement in students' motor skills, confirming that game-based modalities are not merely motivational tools but rather an effective teaching framework for motor development. Their findings align with the positive trend observed in this study, in which the game-based program yielded a moderate Cohen's *d* effect size of 0.429—though not statistically significant—further supporting the idea that structured physical activity in the form of games has real pedagogical value.

At the geographic level, (Gusril et al., 2025) found that the motor skills of elementary school students vary significantly based on their geographic environment, with students in lowland and coastal areas tending to exhibit different motor profiles compared to students in highland areas, highlighting that contextual and environmental factors—including access to play facilities—are critical determinants of motor development. These findings align with the background of this study, in which the limited availability of play facilities at SDN

20/VI Muara Madras was identified as one of the factors contributing to the low levels of initial motor skills observed in the pre-test.

From a pedagogical perspective, these findings have important implications for physical education teaching practices. The positive trend observed in motor skill scores, combined with evidence of a moderate practical effect, supports the use of structured play activities as a component of physical education instruction in elementary schools. Play not only develops motor skills such as strength, coordination, speed, and agility, but also fosters motivation, enjoyment, and students' active engagement in physical activity (Nurhayati et al., 2021).

## Conclusions

This study investigated the influence of a 16-session structured play program on the motor ability of 17 fifth-grade students at SDN 20/VI Muara Madras using a one-group pretest-posttest quasi-experimental design. Although the composite motor ability score increased by 5.67 points (from 200.00 to 205.67), the improvement was not statistically significant ( $p = 0.096$ ), indicating that the study did not provide sufficient evidence to reject the null hypothesis. Therefore, the findings should be interpreted as preliminary and inconclusive rather than as evidence of intervention effectiveness. The observed improvement may suggest a potential benefit of structured play; however, given the absence of statistical significance and the limitations of the study design, no causal conclusion can be drawn regarding the effectiveness of the intervention. The results instead indicate that structured play remains a promising approach that warrants further investigation under more rigorous methodological conditions. Future studies should employ larger and more representative samples to improve estimate precision and capture the variability of motor development among elementary school children, rather than solely to increase statistical power. In addition, longer intervention periods (8–12 weeks), the inclusion of an appropriate control group, control of relevant confounding factors (e.g., extracurricular physical activity and screen time), and repeated measurements throughout the intervention are recommended to better evaluate the trajectory of motor skill development and strengthen causal inference.

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