



Teaching Games for Understanding versus differentiated instruction: Manipulative fundamental movement skill outcomes across motor educability levels in first-grade students

Perbandingan Teaching Games for Understanding dan pembelajaran berdiferensiasi terhadap keterampilan gerak dasar manipulatif berdasarkan edukabilitas motorik siswa kelas I sekolah dasar

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ARTICLE INFO

Received 31 July 2026

Revised 23 September 2026

Accepted 29 September 2026

Published 30 September 2026

Keywords:

Differentiated instruction
 Manipulative fundamental movement skills
 Motor educability
 Teaching Games for Understanding

Kata kunci:

Edukabilitas motorik
 Pembelajaran berdiferensiasi
 Tgfu
 Keterampilan gerak dasar manipulatif

APA style in citing this article:

Maghfirah, D. A. E., Lanos, M. E. C., & Rizhardi, R. (2026). Teaching Games for Understanding versus differentiated instruction: Manipulative fundamental movement skill outcomes across motor educability levels in first-grade students. *Physical Education Learning, Teaching, and Assessment (PELTA)*, 1(1), 52-60.

<https://doi.org/10.68536/pelta.v1i1.19>

ABSTRACT

Background: Differences in motor learning capacities among primary school students highlight the need for adaptive instructional strategies to support manipulative fundamental movement skills.

Objective: This study aimed to examine the effects of instructional strategies, motor educability, and their interaction on manipulative fundamental movement skill outcomes among first-grade primary school students.

Methods: A 2 × 2 factorial design was employed involving 36 students selected through purposive sampling and divided into four groups (n = 9 per group) according to instructional strategy (Teaching Games for Understanding [TGfU] and differentiated instruction) and motor educability level (high and low). Motor educability and manipulative skills were assessed using motor ability tasks and a manipulative skill assessment instrument. Data were analyzed using two-way analysis of variance (ANOVA) followed by Tukey's honestly significant difference test.

Results: Significant main effects were observed for instructional strategy ($F(1, 32) = 24.623, p < 0.001, \eta^2p = .435$) and motor educability ($F(1, 32) = 152.141, p < 0.001, \eta^2p = 0.826$), alongside a significant interaction ($F(1, 32) = 4.523, p = 0.041, \eta^2p = 0.124$). Among students with low motor educability, differentiated instruction yielded higher scores than TGfU (22.78 vs. 17.22, $p < 0.001$), whereas the difference was not statistically significant among those with high motor educability ($p = 0.207$).

Conclusion: These findings indicate that differences in manipulative skill outcomes between instructional strategies vary according to students' motor educability levels. Future studies should employ larger samples, pretest-posttest assessments, and follow-up measurements to evaluate skill retention.

ABSTRACT

Latar belakang: Perbedaan kemampuan belajar motorik siswa sekolah dasar memerlukan strategi pembelajaran yang adaptif untuk mengoptimalkan penguasaan keterampilan gerak dasar manipulatif.

Tujuan: Penelitian ini bertujuan menganalisis pengaruh strategi pembelajaran, tingkat edukabilitas motorik, dan interaksi keduanya terhadap hasil belajar gerak dasar manipulatif siswa kelas I sekolah dasar.

Metode: Penelitian menggunakan desain faktorial 2 × 2 dengan melibatkan 36 siswa yang dipilih melalui purposive sampling dan dibagi menjadi empat kelompok (n = 9 per kelompok) berdasarkan strategi pembelajaran (*Teaching Games for Understanding [TGfU]* dan pembelajaran berdiferensiasi) serta tingkat edukabilitas motorik (tinggi dan rendah). Edukabilitas motorik dan keterampilan manipulatif dinilai menggunakan tes kemampuan motorik dan instrumen penilaian keterampilan manipulatif. Data dianalisis menggunakan ANOVA dua jalur dan uji lanjut *Tukey HSD*.

Hasil: Hasil menunjukkan pengaruh signifikan strategi pembelajaran ($F(1, 32) = 24,623; p < 0,001; \eta^2p = 0,435$), edukabilitas motorik ($F(1, 32) = 152,141; p < 0,001; \eta^2p = 0,826$), serta interaksi keduanya ($F(1, 32) = 4,523; p = 0,041; \eta^2p = 0,124$). Pada siswa dengan edukabilitas motorik rendah, pembelajaran berdiferensiasi menghasilkan skor lebih tinggi

dibandingkan TGfU (22,78 vs. 17,22; $p < 0,001$), sedangkan pada edukabilitas tinggi perbedaannya tidak signifikan ($p = 0,207$).

Kesimpulan: Temuan ini menunjukkan bahwa perbedaan hasil antarstrategi bergantung pada tingkat edukabilitas motorik siswa. Penelitian selanjutnya disarankan menggunakan sampel lebih besar, pengukuran sebelum dan sesudah intervensi, serta evaluasi retensi keterampilan.

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Highlights

- ✓ Differentiated instruction yielded higher manipulative fundamental movement skill scores than TGfU ($p < .001$).
- ✓ Motor educability significantly influenced manipulative skill outcomes ($p < .001$, $\eta^2p = .826$).
- ✓ A significant interaction ($p = .041$) indicated a greater advantage of differentiated instruction among students with low motor educability.

Introduction

Fundamental movement skills (FMS) are essential components of children's motor development, supporting their participation in physical activities, games, and sports. These skills encompass locomotor, stability, and manipulative skills (object-control skills), such as throwing, catching, kicking, and dribbling a ball (Darussalam et al., 2025; Ludyana et al., 2022). The acquisition of manipulative skills during the early years of primary school is particularly important, as children increasingly engage in learning activities that require motor coordination, object control, and adaptation to various movement tasks. A systematic review by Koolwijk et al. (2024) indicated that fundamental movement skill interventions generally have positive effects on young children, with their effectiveness influenced by the variety of activities, opportunities for practice, and characteristics of program implementation. Furthermore, a meta-analysis by Zhang et al. (2024a), examining interventions among children aged 3–12 years, reported a significant improvement in object-control skills (SMD = 0.871; 95% CI: 0.660–1.081). However, the review was unable to identify the most effective type of intervention. These findings suggest that developing manipulative skills requires not only sufficient opportunities for practice but also instructional strategies that are appropriately aligned with children's developmental characteristics.

The selection of appropriate instructional strategies becomes particularly important in primary school physical education, where students differ considerably in their motor abilities and movement experiences. Empirical evidence suggests that both the characteristics and structure of learning experiences can influence motor development outcomes. In a cluster-randomized controlled trial involving 282 primary school students, Chan et al. (2019) found that an assessment-based fundamental movement skill intervention improved motor competence compared with a control condition. Similarly, Dapp et al. (2021) demonstrated that participation in structured physical activity was associated with more favorable gross motor skill development than participation in unstructured activities. More specifically, Zhang et al. (2024b) reported that a 12-week functional training program improved fundamental movement skills, including object-control skills, among children aged 6–7 years. Nevertheless, these studies primarily examined the effectiveness of different intervention types and organizational structures, providing limited insight into how distinct pedagogical approaches may produce different learning outcomes among students with varying capacities to acquire new motor skills.

Two instructional approaches relevant to primary school physical education are Teaching Games for Understanding (TGfU) and differentiated instruction. TGfU uses game-based learning experiences to develop tactical understanding, decision-making, and skill execution, whereas differentiated instruction emphasizes adapting learning activities, task difficulty, and instructional support to students' readiness and individual needs. Abad Robles et al. (2020) reported that tactical approaches provided significant advantages over technical approaches in decision-making, although no consistent significant advantage was observed for skill execution. Ortiz et al. (2023) also investigated TGfU in relation to game performance and psychosocial outcomes. Meanwhile, Suherman et al. (2026) identified persistent gaps in teachers' understanding, planning, implementation, and assessment of differentiated instruction in Indonesian primary school physical education. Together, these findings provide a pedagogical rationale for both approaches while highlighting the need for further evidence comparing their outcomes in manipulative skill development among students with different motor learning characteristics.

One individual characteristic that may influence students' responses to instructional strategies is motor educability, which refers to an individual's capacity to learn and perform unfamiliar motor tasks. This concept should be distinguished from existing motor skill proficiency, as the ability to acquire new movement patterns does not necessarily represent the same construct as performance in previously practiced motor skills. From a pedagogical perspective, students with different levels of motor educability may require different levels of task complexity, practice opportunities, instructional guidance, and learning support. The importance of tailoring instruction to individual characteristics is supported by Kok et al. (2021), who found that the relationship between instructional methods and motor learning outcomes was influenced by verbal working memory capacity among students with special educational needs. Although that study did not directly assess motor educability, its findings suggest that individual learner characteristics can moderate the relationship between instructional approaches and motor learning outcomes. Accordingly, examining the interaction between instructional strategies and motor educability is relevant to understanding variations in manipulative fundamental movement skill outcomes among primary school students.

Previous research has examined the effectiveness of motor learning interventions from several perspectives; however, differences in research focus and limitations in the applicability of existing findings remain. Zhang et al. (2024a) investigated the overall effectiveness of fundamental movement skill interventions without identifying a consistently superior pedagogical strategy. Abad Robles et al. (2020) compared tactical and technical instructional approaches, primarily focusing on decision-making and skill execution. Kok et al. (2021) examined the role of working memory capacity in responses to motor instruction among students with special educational needs, whereas Suherman et al. (2026) investigated the implementation of differentiated instruction from the perspective of physical education teachers. More directly related to the present study,

Rahman et al. (2024) compared TGfU and differentiated instruction across motor educability levels among fourth-grade primary school students, reporting superior outcomes for TGfU and a significant interaction between instructional strategy and motor educability. However, findings obtained from fourth-grade students may not necessarily generalize to first-grade students, whose developmental characteristics and instructional demands differ. Consequently, further empirical evidence is needed to determine whether the relationships among instructional strategy, motor educability, and manipulative skill outcomes follow similar patterns during the early stages of primary education.

To address this research gap, the present study compares TGfU and differentiated instruction among first-grade primary school students while considering high and low levels of motor educability within a 2×2 factorial design. This approach enables an examination of differences in manipulative fundamental movement skill scores across instructional strategies and motor educability levels, as well as the interaction between these factors. Unlike the study by Rahman et al. (2024), which focused on fourth-grade students, the present investigation extends this line of inquiry to first-grade students to examine the consistency of these relationships across different developmental stages. Thus, the novelty of this study lies in extending the available empirical evidence to a younger primary school population and examining the interaction between instructional strategies and individual motor learning characteristics, rather than claiming to be the first investigation of this combination of variables.

Based on these considerations, the present study aims to examine (1) differences in manipulative fundamental movement skill outcomes between students receiving TGfU and differentiated instruction, (2) differences in these outcomes between students with high and low motor educability, and (3) the interaction between instructional strategy and motor educability in relation to manipulative fundamental movement skill outcomes among first-grade primary school students. From a theoretical perspective, this study is expected to extend current evidence regarding the role of individual motor learning characteristics in the relationship between pedagogical approaches and fundamental movement skill outcomes. From a practical perspective, the findings may inform primary school physical education teachers in selecting and adapting instructional strategies according to students' readiness and motor learning capacities.

Materials and Methods

Study Design

This study employed a quantitative approach using a 2×2 factorial design to examine differences in manipulative fundamental movement skill outcomes according to instructional strategy and students' motor educability levels. The first factor was instructional strategy, comprising two conditions: Teaching Games for Understanding (TGfU) and differentiated instruction. The second factor was motor educability, classified as high or low based on students' assessed capacity to acquire new motor skills. The dependent variable was the manipulative fundamental movement skill score of first-grade primary school students.

The combination of these two factors resulted in four groups: TGfU with high motor educability ($n = 9$), TGfU with low motor educability ($n = 9$), differentiated instruction with high motor educability ($n = 9$), and differentiated instruction with low motor educability ($n = 9$). Students were classified according to their motor educability levels before the intervention based on an assessment of their motor learning capacity. Within each motor educability category, participants were randomly assigned to one

of the two instructional strategies. The study followed a 2×2 posttest-only factorial design. Upon completion of the instructional intervention, all participants underwent the same standardized assessment of manipulative fundamental movement skills. Post-intervention scores were analyzed to examine differences associated with instructional strategy, motor educability level, and the interaction between these factors.

Participants

The study was conducted during the second semester of the 2023/2024 academic year at SD Cikal Lebak Bulus, Jakarta, Indonesia. A total of 36 first-grade primary school students were recruited using purposive sampling. Participant selection considered physical health sufficient for participation in physical education activities and attendance throughout the instructional intervention. All participants included in the analysis were classified into four groups according to the combination of instructional strategy and motor educability level within the 2×2 factorial design. Each group comprised nine students, resulting in a balanced distribution of participants across the four experimental conditions ($n = 9$ per group; Figure 1).

Instrument

Motor Educability Assessment

Motor educability was assessed using the Iowa-Brace Test for Motor Educability, following procedures previously employed to evaluate the ability to learn and perform novel motor tasks in physical education research in Indonesia (Damai Yanti et al., 2023; Pradana & Noval, 2018). The assessment comprised 10 selected motor tasks designed to evaluate students' ability to imitate movements, maintain balance, coordinate body movements, and perform relatively unfamiliar movement patterns. Task selection and administration followed the version of the instrument adopted in this study.

For the 10-task assessment, each student was provided with a demonstration and allowed a maximum of two attempts to complete each task according to the specified performance criteria. A score of 2 was awarded when the task was successfully completed on the first attempt, 1 when it was completed on the second attempt, and 0 when the student failed to complete the task within two attempts. Scores across all tasks were summed to obtain a total score ranging from 0 to 20, with higher scores indicating a greater capacity to acquire and perform novel motor tasks.

Motor educability was assessed before the instructional intervention. Based on their assessment scores, students were classified into high- and low-motor-educability groups using the sample mean as the classification threshold. Students scoring above the sample mean were classified as having high motor educability, whereas those scoring below the mean were classified as having low motor educability. These classifications were subsequently used as an attribute factor in the 2×2 factorial design.

Assessment of Manipulative Fundamental Movement Skills

Manipulative fundamental movement skills were assessed using the object-control subtest of the Test of Gross Motor Development-Second Edition (TGMD-2), developed by Ulrich (2000). This instrument evaluates the quality of fundamental movement skill performance involving object manipulation and control (Aye et al., 2017). The subtest comprises six skills: striking a stationary ball, stationary dribbling, catching, kicking, overhand throwing, and underhand rolling.

Performance was evaluated using 24 movement criteria distributed across the six skills. Each skill was performed twice

following standardized assessment procedures. Each performance criterion was scored 1 when correctly demonstrated and 0 when the criterion was not met. Scores from both trials were summed to obtain a total raw score ranging from 0 to 48, with higher scores indicating better manipulative fundamental movement skill performance.

Intervention Procedures

The instructional intervention was conducted during the second semester of the 2023/2024 academic year over eight weeks, consisting of one 60-minute session per week. The instructional content focused on developing manipulative fundamental movement skills through object-control activities, including throwing, catching, dribbling, and kicking. Both instructional groups received equivalent learning objectives, core content, practice opportunities, and instructional duration. The primary difference between the groups was the pedagogical approach employed.

In the Teaching Games for Understanding (TGfU) group, instructional activities included paired throwing-and-catching games, target-oriented ball games, and simplified ball-possession games. Each activity incorporated modifications to game rules and playing situations to facilitate decision-making and manipulative skill execution.

In the differentiated instruction group, learning activities were designed to accommodate students' readiness and motor learning capacities by adjusting task complexity and the level of instructional support. Adaptations included modifications to equipment, task distance, difficulty, and instructional guidance. Students requiring additional support could be assigned less complex tasks accompanied by step-by-step instructions, whereas those demonstrating greater skill proficiency could engage in more challenging task variations. These adaptations were intended to support the achievement of the same manipulative skill learning objectives across participants.

Both instructional approaches were implemented according to structured lesson plans developed in accordance with the study objectives. All sessions were conducted by a physical education teacher, while adherence to the intervention protocol was monitored through observations using a structured assessment checklist. Upon completion of the intervention, manipulative fundamental movement skills were assessed using identical measurement procedures across all groups.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were reported as means and standard deviations. Residual normality and homogeneity of variance

were examined using the Shapiro-Wilk and Levene's tests, respectively. A two-way analysis of variance (ANOVA) with a 2 × 2 factorial design was performed to examine the main effects of instructional strategy and motor educability, as well as their interaction, on manipulative fundamental movement skill outcomes. Results were reported using F-statistics, degrees of freedom, p-values, and partial eta squared (η^2p) as a measure of effect size. Significant interactions were followed up using simple-effects analyses with appropriate adjustments for multiple comparisons. Tukey's honestly significant difference (HSD) test was also used for pairwise comparisons between groups, as performed in the initial analysis. Statistical significance was set at $\alpha = .05$.

Results

Data from 36 first-grade primary school students were analyzed. Participants were equally distributed across four groups based on the combination of instructional strategy and motor educability level, with nine students in each group. Descriptive statistics for manipulative fundamental movement skill outcomes are presented in Table 1.

Descriptively, students receiving differentiated instruction achieved higher manipulative skill scores than those receiving TGfU at both motor educability levels. However, the magnitude of the difference between instructional strategies varied across groups. Among students with high motor educability, the mean difference between strategies was 2.22 points, whereas a larger difference of 5.56 points was observed among students with low motor educability. This pattern suggests that differences in manipulative skill outcomes between instructional strategies may vary according to students' motor educability levels, warranting further examination using factorial analysis.

The two-way ANOVA revealed a significant main effect of instructional strategy on manipulative fundamental movement skill scores, $F(1, 32) = 24.623, p < .001, \eta^2p = .435$. A significant main effect of motor educability was also observed, $F(1, 32) = 152.141, p < .001, \eta^2p = .826$. Furthermore, a significant interaction was identified between instructional strategy and motor educability, $F(1, 32) = 4.523, p = .041, \eta^2p = .124$. The complete ANOVA results are presented in Table 2.

The significant interaction indicates that the difference in manipulative skill scores between differentiated instruction and TGfU varied according to students' motor educability levels. Accordingly, the interpretation of the findings should consider not only the main effects of instructional strategy and motor educability but also comparisons between instructional strategies within each motor educability category.

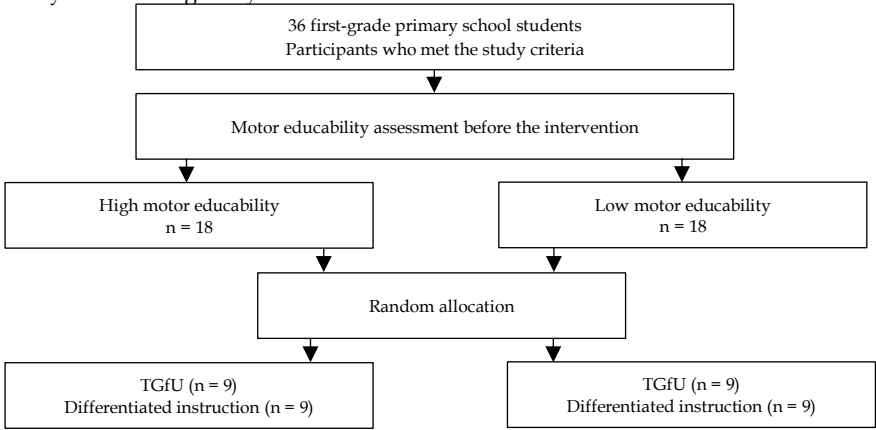


Figure 1. Flowchart of participant stratification by motor educability and random allocation to instructional strategies in a 2 × 2 factorial design

Table 1

Descriptive statistics of manipulative fundamental movement skill outcomes by instructional strategy and motor educability level

Motor educability	Differentiated instruction (Mean $\pm$ SD)	TGfU (Mean $\pm$ SD)
High (n = 9 per strategy)	30.78 $\pm$ 2.95	28.56 $\pm$ 2.35
Low (n = 9 per strategy)	22.78 $\pm$ 2.11	17.22 $\pm$ 1.86
Overall (n = 18 per strategy)	26.78 $\pm$ 4.81	22.89 $\pm$ 6.18

Note. Values are presented as means and standard deviations (SD). The total sample comprised 36 students.

Table 2

Two-way ANOVA results for manipulative fundamental movement skill scores

Source of variation	SS	df	MS	F	p	η^2p
Instructional strategy	136.111	1	136.111	24.623	<0.001	0.435
Motor educability	841.000	1	841.000	152.141	<0.001	0.826
Strategy $\times$ Motor educability	25.000	1	25.000	4.523	0.041	0.124
Error	176.889	32	5.528	-	-	-
Corrected total	1,179.000	35	-	-	-	-

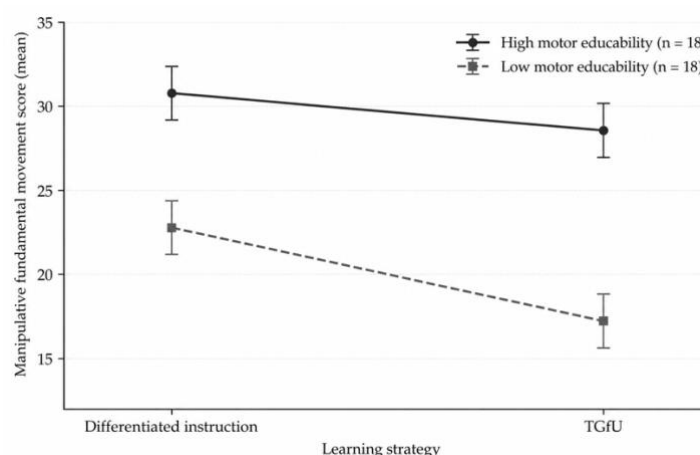
Note. SS = sum of squares; df = degrees of freedom; MS = mean square; η^2p = partial eta squared.

Table 3

Pairwise comparisons of manipulative fundamental movement skill scores between instructional strategies across motor educability levels

Motor educability	Mean difference	95% CI	p
High	2.22	[-0.78, 5.23]	0.207
Low	5.56	[2.55, 8.56]	<0.001

Note. Mean differences were calculated by subtracting the TGfU group mean from the differentiated instruction group mean. CI = confidence interval. Confidence intervals and p-values were adjusted using Tukey's HSD procedure.

**Figure 2.** Interaction between instructional strategies and motor educability

Interaction Analysis and Pairwise Comparisons

Post hoc comparisons using Tukey's honestly significant difference (HSD) test revealed that, among students with high motor educability, the difference in manipulative skill scores between differentiated instruction and TGfU was not statistically significant (mean difference = 2.22, 95% CI [-0.78, 5.23], $p = .207$). In contrast, among students with low motor educability, differentiated instruction yielded significantly higher scores than TGfU (mean difference = 5.56, 95% CI [2.55, 8.56], $p < .001$). The pairwise comparison results are summarized in Table 3.

The difference between the strategy-related mean differences across motor educability levels was 3.33 points (95% CI [0.14, 6.53]), consistent with the significant interaction identified in the two-way ANOVA. This finding indicates that the difference in manipulative skill outcomes favoring differentiated instruction over TGfU was more pronounced among students with low motor educability. Among students with high motor educability, the analysis did not provide sufficient statistical evidence to establish a difference between the two instructional strategies.

The interaction pattern is further illustrated in Figure 2. The graph shows a larger difference in manipulative skill scores

between differentiated instruction and TGfU among students with low motor educability than among those with high motor educability. This visual pattern is consistent with the statistically significant interaction observed in the two-way ANOVA.

As illustrated in Figure 2, the nonparallel trends indicate that differences in manipulative fundamental movement skill scores between differentiated instruction and TGfU vary according to students' motor educability levels. This pattern is consistent with the significant interaction between instructional strategy and motor educability identified by the two-way ANOVA, $F(1, 32) = 4.523$, $p = .041$, $\eta^2p = .124$.

Discussion

The present study demonstrated significant associations between instructional strategy, motor educability, and their interaction with manipulative fundamental movement skill outcomes among first-grade primary school students. Differentiated instruction yielded higher manipulative skill scores than Teaching Games for Understanding (TGfU), with a significant main effect of instructional strategy, $F(1, 32) = 24.623$, $p < 0.001$, $\eta^2p = 0.435$. A significant main effect of motor educability was also observed, $F(1, 32) = 152.141$, $p < 0.001$, $\eta^2p = 0.826$. Importantly, the significant interaction between instructional

strategy and motor educability, $F(1, 32) = 4.523$, $p = 0.041$, $\eta^2p = 0.124$, indicated that differences in learning outcomes between the two instructional approaches varied according to students' motor educability levels. Specifically, the difference in manipulative skill scores favoring differentiated instruction was greater among students with low motor educability than among those with high motor educability. These findings underscore the importance of considering individual motor learning characteristics when evaluating instructional outcomes in primary school physical education.

The higher manipulative skill scores observed in the differentiated instruction group may reflect a closer alignment between instructional demands and students' motor learning capacities. Differentiated instruction enables teachers to adapt task complexity, instructional support, and learning conditions according to students' readiness and individual needs. This approach is consistent with the inclusive education framework discussed by [van Munster et al. \(2019\)](#), which emphasizes the roles of universal design for learning and differentiated instruction in accommodating diverse learning needs in physical education. From a motor learning perspective, matching task difficulty to students' abilities may facilitate more focused practice opportunities and appropriate progression of motor challenges. However, this potential mechanism cannot be confirmed in the present study because practice intensity, task success rates, and the quality of instructional feedback were not independently assessed. Accordingly, the higher scores achieved through differentiated instruction should be interpreted within the specific context of this investigation rather than as evidence of its universal superiority over TGfU.

These findings can be considered alongside previous research examining the influence of structured learning experiences on children's motor development. [Dapp et al. \(2021\)](#) reported that participation in structured physical activities was positively associated with gross motor skill development compared with less structured activities. Similarly, a meta-analysis by [Zhang et al. \(2024a\)](#), comprising 36 studies, demonstrated significant improvements in object-control skills following fundamental movement skill interventions, with an effect size of 0.871 (95% CI [0.660, 1.081]). Nevertheless, the authors emphasized that the available evidence was insufficient to identify the most effective intervention approach. Although these studies highlight the importance of structured and appropriately designed motor learning experiences, they do not directly establish the superiority of differentiated instruction over TGfU. The present findings therefore contribute additional evidence concerning differences in manipulative skill outcomes under two distinct instructional conditions, while acknowledging the methodological limitations associated with the study design and outcome assessment.

Differences between instructional approaches should also be interpreted in relation to their pedagogical characteristics and the specific learning outcomes being assessed. TGfU is a game-based instructional approach that integrates technical skill execution, tactical understanding, and decision-making within meaningful game situations. In their systematic review and meta-analysis, [Abad Robles et al. \(2020\)](#) found that tactical approaches produced significant advantages in decision-making compared with technical approaches (effect size = 0.89; 95% CI [0.12, 1.65]), whereas no significant differences were identified in skill execution. Similarly, [Ortiz et al. \(2023\)](#) reported advantages of TGfU in decision-making but found no consistent evidence of superior skill execution compared with technical instructional approaches. In contrast, [Manninen et al. \(2025\)](#), in a meta-analysis involving 28 studies and 1,600 participants, found that game-based approaches produced favorable effects on motor skills assessed through skill-based tests (Hedges' $g = 0.36$; 95% CI [0.14,

0.57]), although the magnitude of these effects varied across study characteristics. Taken together, these findings suggest that the effectiveness of game-based instruction may depend on the targeted learning domain, assessment instruments, and intervention conditions.

Within the context of the present study, the potential alignment between instructional strategy and outcome assessment warrants critical consideration. If the manipulative skill assessment primarily captures movement technique and execution quality, instructional approaches that provide targeted practice opportunities and progressively structured support may yield higher scores. Conversely, TGfU also seeks to develop students' ability to apply motor skills within game situations, including tactical decision-making and problem-solving. Therefore, lower manipulative skill scores should not necessarily be interpreted as evidence that TGfU is less effective across all domains of physical education learning. This explanation remains hypothetical because game performance, tactical understanding, and decision-making were not independently assessed in the present study. Future investigations should incorporate multiple outcome domains to provide a more comprehensive comparison of the pedagogical effectiveness of these instructional approaches.

The significant interaction between instructional strategy and motor educability indicates that the difference in manipulative skill scores between differentiated instruction and TGfU was more pronounced among students with low motor educability. One possible explanation is that students with a lower capacity to acquire unfamiliar motor tasks may benefit from simplified activities, more explicit guidance, and practice opportunities adapted to their individual learning needs. Evidence supporting the importance of individual characteristics in motor learning was provided by [Kok et al. \(2021\)](#), who demonstrated that the relationship between instructional methods and motor learning outcomes was influenced by verbal working memory capacity among students with special educational needs. Students with lower verbal working memory capacity benefited from certain forms of implicit instruction, whereas those with higher capacity responded more favorably to explicit instruction. Although verbal working memory and motor educability represent conceptually distinct constructs, these findings support the broader proposition that motor learning responses to instructional approaches are not uniform across learners. Accordingly, the interaction observed in the present study highlights the importance of examining the correspondence between individual learning characteristics and pedagogical approaches.

Among students with high motor educability, the difference in manipulative skill scores between differentiated instruction and TGfU was not statistically significant ($p = .207$). This finding should not be interpreted as evidence that the two strategies are equally effective. Rather, it indicates that the present study did not provide sufficient statistical evidence to establish a difference between them within this subgroup. One possible explanation is that students with higher motor educability may be better equipped to adapt to different instructional demands, enabling them to perform relatively well under either approach. A potential ceiling effect should also be considered if participants' scores approached the maximum attainable score of the assessment instrument. However, these explanations require further investigation through examination of score distributions, instrument characteristics, and students' baseline motor proficiency. The relatively small sample size within each factorial group may also have reduced the precision of the estimated differences. Consequently, the findings for students with high motor educability should be interpreted cautiously and should not be taken as evidence of equivalence between the two instructional strategies.

The present findings contrast with those reported by Rahman et al. (2024), who directly compared TGfU and differentiated instruction across motor educability levels among fourth-grade primary school students. Their study reported higher manipulative skill learning outcomes in the TGfU group, both overall and across the motor educability categories examined. In contrast, the present study found higher scores among students receiving differentiated instruction, particularly those with low motor educability. These opposing patterns are noteworthy because they indicate that the relative outcomes associated with the two instructional approaches may vary across research contexts. One identifiable difference concerns the participants' grade levels: Rahman et al. investigated fourth-grade students, whereas the present study focused on first-grade students. Developmental differences between these populations may be associated with variations in previous movement experiences, understanding of game rules, and ability to respond to instructional demands. Nevertheless, without a direct comparison of assessment instruments, intervention dosage, implementation fidelity, and baseline motor characteristics, the contrasting results cannot be conclusively attributed to students' grade levels or developmental stages. The present study should therefore be viewed as an extension of the existing empirical evidence, highlighting contextual variation in instructional outcomes rather than invalidating previous findings.

Beyond instructional strategy, motor educability demonstrated a particularly strong association with manipulative skill scores within the factorial model ($\eta^2p = .826$). This finding indicates that motor educability accounted for a substantial proportion of the variance relative to the residual variance in the ANOVA model. However, partial eta squared should not be interpreted as the percentage improvement in motor skills or as an independent measure of causal influence. The magnitude of this association also warrants consideration of the conceptual distinction between the constructs being assessed. Motor educability represents an individual's capacity to acquire unfamiliar movement tasks, whereas manipulative skill outcomes reflect performance in object-control activities. If the instruments used to assess these constructs share substantial motor performance components, the observed association may partly reflect overlap between the underlying constructs. Future research should therefore establish the discriminant validity of these measures and consider analyzing motor educability as a continuous variable to avoid the potential loss of information associated with categorizing participants into high- and low-educability groups.

The interpretation of these findings should also account for other variables that may not have been adequately controlled. Manipulative skill performance may be influenced by previous play experiences, opportunities for physical activity outside school, individual differences in motor development, motivation, and broader learning characteristics. In addition, teacher competence, feedback frequency, equipment characteristics, practice opportunities, and intervention fidelity may contribute to differences in learning outcomes between groups. This consideration is consistent with Manninen et al. (2025), who identified intervention provider experience, study quality, and comparison-group characteristics as potential moderators of outcomes associated with game-based approaches. Within the Indonesian context, Suherman et al. (2026) also reported variation in the implementation of differentiated instruction in primary school physical education, identifying challenges related to instructional planning, available resources, and assessment practices. These findings suggest that differences in learning outcomes may reflect not only the instructional approach itself but also the quality and consistency with which it is implemented.

Clinical implications

The findings highlight the importance of considering individual motor educability when designing instructional strategies to support manipulative fundamental movement skill development in young children. Differentiated instruction may be particularly beneficial for students with low motor educability, suggesting that adapting task complexity, equipment, and instructional support to individual learning capacities could facilitate skill acquisition. For physical education teachers and practitioners involved in children's motor development, preliminary motor assessments may help identify students who require additional instructional support. However, TGfU should not be disregarded, as incorporating differentiation principles into game-based activities may provide a more inclusive learning environment. These implications remain specific to educational practice and should not be interpreted as evidence of clinical treatment effectiveness.

Study limitations

This study has several limitations. First, the relatively small sample size ($n = 36$), with nine students per group, may limit the precision and generalizability of the findings. Second, participants were recruited from a single primary school, restricting the applicability of the results to broader educational contexts. Third, although participants were randomly assigned to instructional strategies, the absence of baseline manipulative skill assessments prevented direct verification of pre-intervention equivalence between groups. Finally, the lack of follow-up assessments limited the evaluation of long-term skill retention.

Future studies should employ larger, multisite samples and randomized pretest-posttest designs to strengthen the robustness and generalizability of the findings. Further research should also incorporate follow-up assessments and additional outcomes, including game performance, decision-making, and student engagement. Investigating hybrid approaches that integrate TGfU with differentiated instruction may provide further insight into instructional strategies suited to students with different motor educability levels.

Conslusions

This study demonstrated significant associations between instructional strategy, motor educability, and manipulative fundamental movement skill outcomes among first-grade primary school students. Differentiated instruction yielded higher manipulative skill scores than Teaching Games for Understanding (TGfU), with a significant interaction between instructional strategy and motor educability ($p = .041$). The difference between the two instructional approaches was more pronounced among students with low motor educability, whereas no statistically significant difference was observed among those with high motor educability. These findings highlight the importance of considering individual motor learning characteristics when selecting and adapting instructional strategies in primary school physical education. From a practical perspective, teachers are encouraged to assess students' motor learning capacities and provide developmentally appropriate, adaptive learning activities. However, given the relatively small sample size and single-school setting, further research involving larger and more diverse samples, randomized pretest-posttest designs, and follow-up assessments is needed to confirm these findings and evaluate the comparative effectiveness of both instructional approaches.

Author contributions

Conceptualization: D.A.E.M., M.E.C.L., and R.R.; Methodology: D.A.E.M., M.E.C.L., and R.R.; Investigation: D.A.E.M. and M.E.C.L.; Data curation: D.A.E.M. and R.R.; Formal

analysis: D.A.E.M. and R.R.; Validation: M.E.C.L. and R.R.; Project administration: D.A.E.M.; Visualization: D.A.E.M. and R.R.; Writing – original draft: D.A.E.M. and M.E.C.L.; Writing – review & editing: D.A.E.M., M.E.C.L., and R.R. All authors have read and approved the final version of the manuscript and agree to be accountable for the integrity and accuracy of the work.

Ethical statement

This study was conducted with reference to the ethical principles outlined in the Declaration of Helsinki, particularly those concerning participant welfare, respect for individuals, privacy, and confidentiality. Formal ethical approval from an institutional research ethics committee was not obtained. Permission to conduct the study was obtained from SD Cikal Lebak Bulus, Jakarta, Indonesia, prior to data collection. Research activities were coordinated with the school and the physical education teacher to ensure that the procedures were appropriate for the participants' age and educational setting. Participant confidentiality and welfare were maintained throughout the study.

Informed consent

Formal written informed consent from parents or legal guardians was not obtained. The study was conducted with permission from the school, and participants were informed about the research activities and the voluntary nature of their participation in an age-appropriate manner. Participants' personal information was kept confidential, and research data were used exclusively for scientific purposes.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) solely to improve language, grammar, and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the accuracy, integrity, and content of the publication.

Funding

This research received no external funding.

Conflicts of interest

The authors declare no conflicts of interest.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to appropriate ethical and privacy considerations.

References

- Abad Robles, M. T., Collado-Mateo, D., Fernández-Espínola, C., Castillo Viera, E., & Giménez Fuentes-Guerra, F. J. (2020). Effects of teaching games on decision making and skill execution: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 17(2), 505. <https://doi.org/10.3390/ijerph17020505>
- Aye, T., Oo, K. S., Khin, M. T., Kuramoto-Ahuja, T., & Maruyama, H. (2017). Reliability of the test of gross motor development second edition (TGMD-2) for Kindergarten children in Myanmar. *Journal of physical therapy science*, 29(10), 1726-1731. <https://doi.org/10.1589/jpts.29.1726>
- Chan, C. H. S., Ha, A. S. C., Ng, J. Y. Y., & Lubans, D. R. (2019). The A+FMS cluster randomized controlled trial: An assessment-based intervention on fundamental movement skills and psychosocial outcomes in primary schoolchildren. *Journal of Science and Medicine in Sport*,

22(8), 935-940. <https://doi.org/10.1016/j.jsams.2019.05.002>

- Damai Yanti, R., Supriatna, E., Putra Perdana, R., Juni Samodra, Y. T., & Rubiyatno, R. (2023). Identifikasi kemampuan motor educability siswa sekolah dasar. *Jurnal Pendidikan Jasmani Kesehatan dan Rekreasi (Penjaskesrek)*, 10(2), 107-119. <https://doi.org/10.46368/jpkr.v10i2.1300>
- Dapp, L. C., Gashaj, V., & Roebbers, C. M. (2021). Physical activity and motor skills in children: A differentiated approach. *Psychology of Sport and Exercise*, 54, 101916. <https://doi.org/10.1016/j.psychsport.2021.101916>
- Darussalam, A. M., Sugiharto, S., & Adi, S. (2025). Fun game-based learning improves gross motor skills in early primary school children. *Physical Education and Sports: Studies and Research*, 4(3), 236-249. <https://doi.org/10.56003/pessr.v4i3.613>
- Ismaryati, I., Wijanarko, B., Nuryadin, I., Doewes, R. I., & Muhyi, M. (2023). Validity and reliability of TGMD-2 Surakarta children aged 7-10 years. *Indonesian Journal of Research in Physical Education, Sport, and Health*, 1(1), 73-77. <https://doi.org/10.17977/um086v1i12023p73-77>
- Kok, M., Kal, E., van Doodewaard, C., Savelsbergh, G. J. P., & van der Kamp, J. (2021). Tailoring explicit and implicit instruction methods to the verbal working memory capacity of students with special needs can benefit motor learning outcomes in physical education. *Learning and Individual Differences*, 89, 102019. <https://doi.org/10.1016/j.lindif.2021.102019>
- Koolwijk, P., Hoeboer, J., Mombarg, R., Savelsbergh, G. J. P., & de Vries, S. (2024). Fundamental movement skill interventions in young children: A systematic review. *International Journal of Sport and Exercise Psychology*, 22(7), 1661-1683. <https://doi.org/10.1080/1612197X.2023.2210597>
- Ludyana, E., Hariadi, I., & Fadhl, N. R. (2022). Preschool Age Fundamental Movement Skills Level. *Physical Education and Sports: Studies and Research*, 1(2), 63-78. <https://doi.org/10.56003/pessr.v1i2.117>
- Manninen, M., Magrum, E., Campbell, S., & Belton, S. (2025). The effect of game-based approaches on decision-making, knowledge, and motor skill: A systematic review and a multilevel meta-analysis. *European Physical Education Review*, 31(1), 18-32. <https://doi.org/10.1177/1356336X241245305>
- Ortiz, M., Meroño, L., Morales-Belando, M. T., Vaquero-Cristóbal, R., & González-Gálvez, N. (2023). Teaching games for understanding in game performance and psychosocial variables: Systematic review and meta-analysis of randomized control trial. *Children*, 10(3), 573. <https://doi.org/10.3390/children10030573>
- Pradana, V. O., & Noval, A. (2018). Hubungan motor educability dan percaya diri dengan hasil belajar renang gaya bebas pada siswa putra kelas X SMA Budi Mulia Jakarta. *Journal Sport Area*, 3(1). [https://doi.org/10.25299/sportarea.2018.vol3\(1\).1316](https://doi.org/10.25299/sportarea.2018.vol3(1).1316)
- Rahman, L. A., Subandi, O. U., & Hernawan. (2024). The effect of learning strategies and motor educability on the outcomes of learning basic manipulative movement of elementary school students. *Gladi: Jurnal Ilmu Keolahragaan*, 15(3), 350-362. <https://doi.org/10.21009/GJIK.153.09>
- Suherman, W. S., Prasetyo, Y., Guntur, G., Rismayanthi, C.,

- Podung, B. J., Firdaus, K., Pramono, H., Priyono, B., Suherman, A., Siahaan, J., Fakhrurozi, Z. A., Ningsih, A. G., & Amran. (2026). Differentiated instruction in Indonesian primary school physical education: A mixed-methods study. *Frontiers in Sports and Active Living*, 8, 1638892. <https://doi.org/10.3389/fspor.2026.1638892>
- Ulrich, D. A. (2000). *Test of Gross Motor Development--Third Edition (TGMD-2)*. APA PsycTests. <https://doi.org/10.1037/t87935-000>
- van Munster, M. A., Lieberman, L. J., & Grenier, M. A. (2019). Universal design for learning and differentiated instruction in physical education. *Adapted Physical Activity Quarterly*, 36(3), 359-377. <https://doi.org/10.1123/apaq.2018-0145>
- Zhang, D., Soh, K. G., Chan, Y. M., & Zaremohzzabieh, Z. (2024a). Effect of intervention programs to promote fundamental motor skills among typically developing children: A systematic review and meta-analysis. *Children and Youth Services Review*, 156, 107320. <https://doi.org/10.1016/j.childyouth.2023.107320>
- Zhang, D., Soh, K. G., Chan, Y. M., Zaremohzzabieh, Z., Soh, K. L., & He, S. (2024b). Exploring the effects of a 12-week functional training program on fundamental motor skills for primary school children aged 6-7. *Children and Youth Services Review*, 167, 108008. <https://doi.org/10.1016/j.childyouth.2024.108008>