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Mini-PlayLab model: A gamified approach to enhance motivation and fundamental movement skills

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ABSTRACT

Background: Physical education (PE) plays a critical role in supporting children's physical, cognitive, social, and emotional development. However, PE instruction in elementary schools often remains teacher-centred and provides limited opportunities for active participation. Although previous studies have demonstrated the positive effects of gamification on learning motivation and play-based movement activities on motor development, limited research has integrated these approaches within a structured pedagogical model that simultaneously addresses affective and psychomotor learning outcomes. **Objectives:** This study aimed to develop and evaluate the effectiveness of the mini-PlayLab Learning Model, a structured instructional model integrating gamification and play-based movement learning, to improve elementary school students' learning motivation and fundamental movement skills. **Methods:** A quasi-experimental pretest–posttest control group design was employed involving 60 fifth-grade students, with 30 students assigned to the experimental group and 30 students to the control group. Data were collected using a Learning Motivation Questionnaire and a Fundamental Movement Skills Assessment. The intervention was implemented over eight weeks. Data were analysed using descriptive statistics, analysis of covariance (ANCOVA), and effect size analysis. **Results:** After controlling for baseline differences using ANCOVA, the experimental group achieved significantly higher adjusted posttest scores than the control group for both learning motivation and fundamental movement skills (both $p < 0.001$). Large intervention effects were observed for learning motivation (partial $\eta^2 = 0.25$) and fundamental movement skills (partial $\eta^2 = 0.29$), indicating meaningful improvements in students' affective and psychomotor learning outcomes following implementation of the mini-PlayLab learning model. **Conclusion:** The mini-PlayLab Learning Model is an effective instructional model for enhancing elementary school students' learning motivation and fundamental movement skills. The findings contribute to Physical education pedagogy by providing empirical evidence for a structured instructional model that systematically integrates gamification and play-based movement learning to simultaneously support affective and psychomotor development.

Keywords: Mini-PlayLab; play-based movement learning; learning motivation; fundamental movement skills

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INTRODUCTION

Physical education (PE) plays an important role in promoting the holistic development of children by supporting physical, cognitive, social, and emotional growth (Condello et al., 2021; Syaukani et al., 2023). During childhood, students experience a critical developmental period for acquiring fundamental movement skills (FMS), such as running, jumping, throwing, catching, and balancing, which serve as the foundation for lifelong participation in physical activity and sport (Piotrowski et al., 2025). Beyond physical competence, the acquisition of these skills contributes to self-confidence, social interaction, cooperation, and positive attitudes toward physical activity (Almeida et al., 2025). Consequently, PE should provide meaningful, enjoyable, and developmentally appropriate learning experiences that actively engage students in movement and learning.

Despite its educational importance, PE instruction in many elementary schools continues to be influenced by teacher-centred pedagogies, repetitive skill-drill practices, and limited opportunities for student exploration and decision-making (Dockerty & Pritchard, 2025; Pill et al., 2024). Such instructional practices may reduce students' motivation, engagement, and enjoyment during learning activities, thereby restricting opportunities for meaningful learning and optimal motor development (Fletcher et al., 2025). As a result, students often participate as passive recipients of instruction rather than active learners who construct knowledge and movement competence through experience. These challenges highlight the need for innovative pedagogical approaches that align with children's developmental characteristics and promote active participation throughout the learning process.

One promising approach is game-based learning, which positions students as active participants through exploration, challenge, collaboration, and problem-solving activities. Previous studies have demonstrated that game-based learning can enhance students' intrinsic motivation, engagement, enjoyment, and movement learning outcomes in PE settings (Dese et al., 2025; Ezeddine et al., 2025; Mo et al., 2024). Furthermore, learning environments that incorporate playful experiences and collaborative interaction have been associated with improved participation, engagement, and learning achievement among elementary school students (Mo et al., 2024; Sulaimon et al., 2025). However, the implementation of games in PE often remains limited to isolated activities rather than being embedded within a structured instructional framework supported by clear pedagogical objectives, implementation procedures, and assessment strategies.

Recent developments in educational innovation have also highlighted the potential of gamification as a strategy for increasing students' motivation and engagement. Gamification is commonly defined as the application of game design elements in non-game contexts to promote motivation, participation, and goal-directed behaviour (Sailer & Homner, 2020). In educational settings, gamification typically incorporates elements such as points, badges, levels, rewards, challenges, and feedback systems to support learning processes and student participation. Previous studies have reported that gamification can positively influence students' motivation, engagement, participation, persistence, and learning outcomes (Dichev & Dicheva, 2017; Li et al., 2023; Sailer & Homner, 2020). Within PE, gamification has the potential to create motivating learning environments through immediate feedback, achievement recognition, and collaborative competition (Stolz & Pill, 2014). Nevertheless, most gamification research has been conducted in digital learning environments and has focused primarily on cognitive and affective outcomes, with relatively limited attention devoted to movement-orientated learning and motor skill development.

Another relevant pedagogical approach is play-based movement learning, which forms the conceptual foundation of the play-motion approach adopted in this study. Play-based movement learning emphasises structured movement experiences embedded within meaningful and enjoyable play activities that encourage active participation and experiential learning (Liu et al., 2025; Moghaddaszadeh & Belcastro, 2021). Through direct participation, active exploration, and movement-based problem solving, students can develop movement competence while engaging in enjoyable learning situations (Fletcher et al., 2025). Previous research has shown that movement-orientated play activities can improve students' physical activity participation, motor competence, enjoyment, and overall physical development (Liu et al., 2025; Moghaddaszadeh & Belcastro, 2021; Robinson et al., 2015). Despite these positive outcomes, play-based movement learning and gamification have generally been investigated as separate pedagogical approaches, limiting our understanding of their potential combined effects within PE settings.

The existing literature therefore reveals several important research gaps. First, previous studies have primarily examined the effects of gamification on motivation, engagement, participation, and learning outcomes, whereas its integration with movement-based learning remains underexplored (Dichev & Dicheva, 2017; Li et al., 2023; Sailer & Homner, 2020). Second, studies on play-based movement learning have predominantly focused on motor competence, physical activity participation, and movement development while rarely incorporating gamification mechanisms that may further strengthen students' motivation and engagement (Liu et al., 2025; Moghaddaszadeh & Belcastro, 2021; Robinson et al., 2015). Third, limited empirical evidence exists regarding how gamification and play-based movement learning can be integrated to simultaneously improve affective outcomes, such as learning motivation, and psychomotor outcomes, such as fundamental movement skills. More importantly, to the best of our knowledge, no previous study has developed and empirically evaluated a structured pedagogical model that systematically integrates gamification mechanics and play-based movement learning to simultaneously improve learning motivation and fundamental movement skills in elementary school physical education.

Addressing these gaps requires the development of a pedagogical model that combines gamification principles with movement-orientated play activities within a coherent instructional framework. Such a framework is important because the educational effectiveness of gamification depends not merely on the presence of game elements but on how those elements are meaningfully embedded within learning experiences and instructional processes (Dichev & Dicheva, 2017; Toda et al., 2019). Furthermore, effective PE instruction requires clearly articulated learning objectives, instructional procedures, teacher and student roles, and assessment strategies that support meaningful learning experiences (Metzler, 2017). Consistent with the principles of Models-Based Practice (MBP), effective pedagogical models provide coherent instructional frameworks to achieve specific learning outcomes (Casey & Kirk, 2020; Metzler, 2017). Therefore, integrating challenge-based movement activities, collaborative play, reward systems, and continuous feedback within a structured learning model may provide a comprehensive approach for enhancing both learning motivation and fundamental movement skills among elementary school students.

In response to these gaps, this study aimed to develop and evaluate the effectiveness of the mini-PlayLab Learning Model for elementary school PE. The model integrates challenge-based movement activities, gamification elements, collaborative play, and interactive feedback within a structured instructional framework designed to improve students' learning motivation and fundamental movement skills. Unlike established models-based practice approaches, such as Teaching Games for Understanding (TGfU), Sport Education, Cooperative Learning, and Game Sense, which primarily emphasise tactical learning, social interaction, or authentic sport participation (Casey & Kirk, 2020; Harvey & Jarrett, 2014), mini-PlayLab explicitly integrates gamification mechanics with play-based movement learning to simultaneously enhance affective and psychomotor outcomes. The novelty of this study therefore lies in the development of a structured pedagogical model that systematically combines these two approaches within a single instructional framework. Theoretically, the study contributes to the growing body of research on game-based learning and gamification by extending their application to movement-orientated learning contexts. Practically, it provides PE teachers with an innovative and evidence-based instructional alternative that is aligned with the developmental characteristics and learning needs of elementary school students.

METHODS

Research Design

This study employed a quantitative approach using a quasi-experimental design to examine the effectiveness of the mini-PlayLab learning model in improving elementary school students' learning motivation and fundamental movement skills. A quasi-experimental approach was considered appropriate because the study was conducted in naturally existing classroom settings, making random assignment of participants impractical. The research adopted a pretest–posttest control group design, enabling comparisons of changes in learning outcomes between an experimental group receiving the mini-PlayLab intervention and a control group receiving conventional physical education (PE) instruction (Creswell & Creswell, 2022).

Two intact fifth-grade classes that had been formed by the school before the study commenced were selected using purposive sampling. One class was assigned as the experimental group and the other as the control group. Group assignment was determined in consultation with the school administration to minimise disruption to the regular teaching schedule, and no individual randomisation of students was performed.

Participants

The participants were fifth-grade students recruited from an elementary school using purposive sampling based on similarities in age, curriculum, and educational background. A total of 60 students participated in the study and were assigned to either the experimental group (n = 30) or the control group (n = 30). The participants belonged to two existing fifth-grade classes that had been established before the study. One intact class was assigned as the experimental group and the other as the control group in consultation with the school administration to minimise disruption to regular instructional activities. Students remained in their original classes throughout the intervention to preserve the natural classroom setting and avoid disrupting regular teaching activities. Prior to the intervention, both groups completed pretests to assess their baseline levels of learning motivation and fundamental movement skills. An a priori sample size estimation was performed using G*Power 3.1 (Faul et al., 2009). Assuming a moderate effect size (f = 0.25), a significance level of 0.05, and statistical power of 0.80, the minimum required sample size was 52 participants. The final sample of 60 participants exceeded this minimum requirement and was therefore considered sufficient to detect statistically meaningful differences between groups while remaining appropriate for a quasi-experimental study in educational settings (Fraenkel et al., 2019).

The inclusion criteria were as follows: (i) students enrolled in the fifth grade, (ii) active participation in physical education classes during the study period, (iii) parental or guardian consent to participate in the research, and (iv) completion of both pretest and posttest assessments. The exclusion criteria included: (i) absence from more than two intervention sessions, (ii) incomplete questionnaire or assessment data, and (iii) medical conditions or injuries that prevented participation in Physical Education activities during the intervention period. Participant characteristics are presented in **Table 1.**

Table 1. Participant Characteristics

Variable	Experimental (n = 30)	Control (n = 30)	p-value
Age (years), Mean ± SD	10.87 ± 0.35	10.90 ± 0.31	0.721
Male, n (%)	16 (53.3%)	15 (50.0%)	0.796
Female, n (%)	14 (46.7%)	15 (50.0%)	0.796

Note. No significant differences were observed between groups at baseline ($p > 0.05$).

Intervention Procedure

The intervention was conducted over eight weeks and consisted of 16 instructional sessions, with two sessions delivered each week. Each session lasted approximately 60 minutes. During the intervention period, the experimental group participated in physical education lessons using the mini-PlayLab learning model, whereas the control group received conventional PE instruction. Conventional instruction consisted primarily of teacher-led explanations, skill demonstrations, individual practice activities, and repetitive movement drills without the integration of gamification elements, structured challenges, or collaborative play activities. Prior to the intervention, all participants completed pretest assessments measuring learning motivation and fundamental movement skills.

To ensure consistent implementation of the intervention, the PE teacher responsible for the experimental group participated in a training workshop conducted by the research team. The training focused on the instructional syntax, gamification components, classroom management procedures, and assessment strategies of the mini-PlayLab learning model. Intervention fidelity was monitored by two members of the research team through periodic classroom observations using a standardised implementation fidelity checklist that evaluated adherence to the instructional syntax, use of gamification elements, classroom management, and student participation. The observations were conducted throughout the intervention to verify that the learning activities were implemented according to the planned procedures.

Mini-PlayLab Learning Model

The mini-PlayLab learning model was developed through four stages: (1) needs analysis, (2) instructional syntax and learning material development, (3) expert validation, and (4) model revision prior to implementation. The model integrates gamification elements, including points, levels, challenges, badges, and rewards (Deterding et al., 2011; Sailer & Homner, 2020), with play-based movement activities that emphasise movement exploration through structured games. The primary objective of the model is to enhance students' learning motivation and fundamental movement skills through meaningful, enjoyable, and challenge-orientated learning experiences.

The learning process consists of four instructional phases: orientation, exploration, reflection, and evaluation. During these phases, students engage in movement-based activities supported by gamification mechanisms that encourage participation, collaboration, achievement, and continuous feedback. The instructional syntax of the mini-PlayLab learning model is presented in **Table 2**.

Table 2. Instructional Syntax of the Mini-PlayLab Learning Model

Phase	Learning Focus	Teacher Activities	Student Activities	Gamification Elements
Orientation	Goal setting and motivation	Introduce learning objectives, explain activity rules, and motivate students	Listen, prepare, and understand learning goals	Mission introduction
Exploration	Movement skill development	Facilitate challenge-based movement activities	Complete locomotor, non-locomotor, and manipulative tasks individually and collaboratively	Points, levels, challenges
Reflection	Feedback and self-evaluation	Provide feedback and facilitate discussion	Reflect on learning experiences and performance	Achievement badges
Evaluation	Performance assessment	Assess student performance and provide recognition	Demonstrate acquired skills and complete assessments	Rewards and recognition

Instruments

Two instruments were employed in this study to measure the effectiveness of the mini-PlayLab learning model: (i) a Learning Motivation Questionnaire and (ii) a Fundamental Movement Skills (FMS) Assessment.

Learning Motivation Questionnaire

Students' learning motivation was measured using a questionnaire adapted from the Intrinsic Motivation Inventory (IMI) developed by (McAuley et al., 1989). The instrument was designed to assess students' motivation toward participation in physical education learning activities. The questionnaire consisted of 20 items distributed across four dimensions: interest and enjoyment (5 items), effort (5 items), participation (5 items), and persistence (5 items). Responses were recorded using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher levels of learning motivation.

Fundamental Movement Skills Assessment

Fundamental movement skills were assessed using a performance-based assessment adapted from the Test of Gross Motor Development–Third Edition (TGMD-3) (Webster & Ulrich, 2017). Rather than administering the complete TGMD-3 battery, this study employed five representative movement tasks selected to reflect the major domains of fundamental movement skills while remaining feasible within the instructional context of elementary physical education. The selected tasks included running and jumping (locomotor skills), balancing (stability/non-locomotor skill), and throwing and catching (object-control/manipulative skills). These tasks were chosen because they represent essential movement competencies commonly emphasised in elementary PE curricula and are closely aligned with the movement activities incorporated in the mini-PlayLab learning model. Students' performances were evaluated using a standardised scoring rubric adapted from the TGMD-3, with higher scores reflecting greater movement competence. The assessment was conducted by two trained assessors to ensure consistency in scoring procedures.

Validity and Reliability

Prior to data collection, all instruments underwent content validity assessment through expert review involving three experts in physical education and educational measurement. Because the Fundamental Movement Skills Assessment employed a subset of TGMD-3 tasks rather than the complete instrument, content validity was established to ensure that the selected tasks adequately represented the targeted domains of fundamental movement skills. The content validity indices (Aiken's V) ranged from 0.88 to 0.92, indicating satisfactory content validity. Reliability analysis revealed a Cronbach's alpha coefficient of 0.87 for the Learning Motivation Questionnaire, exceeding the recommended threshold of 0.70 (Taber, 2018). For the Fundamental Movement Skills Assessment, inter-rater reliability analysis produced an intraclass correlation coefficient (ICC) of 0.84, indicating acceptable scoring consistency. A summary of the validity and reliability results is presented in **Table 3**.

Table 3. Validity and Reliability of the Research Instruments

Instrument	Number of Items/Tasks	Content Validity (Aiken's V)	Reliability
Learning Motivation Questionnaire	20 items	0.92	Cronbach's $\alpha = 0.87$
Fundamental Movement Skills Assessment	5 tasks	0.88	ICC = 0.84

Note. Aiken's V was used to assess content validity through expert judgment. Cronbach's alpha was calculated for the questionnaire instrument, whereas the Intraclass Correlation Coefficient (ICC) was used to assess inter-rater reliability for the performance-based movement assessment.

Data Analysis

Data were analysed using descriptive and inferential statistical techniques. Descriptive statistics, including means, standard deviations, minimum scores, and maximum scores, were calculated for all study variables. Prior to hypothesis testing, the assumptions of normality and homogeneity of variance were examined using the Shapiro–Wilk and Levene's tests, respectively.

To evaluate the effectiveness of the mini-PlayLab learning model, separate analyses of covariance (ANCOVA) were conducted for learning motivation and fundamental movement skills. Posttest scores served as the dependent variables, group membership (experimental vs. control) was treated as the independent variable, and pretest scores were entered as covariates to control for baseline differences between groups. The assumptions of homogeneity of regression slopes were examined prior to conducting the analyses.

Statistical significance was established at $\alpha = 0.05$. To assess the practical significance of the intervention, effect sizes were calculated using Cohen's d and interpreted according to Cohen's (1988) guidelines (small = 0.20, medium = 0.50, and large = 0.80). All statistical analyses were performed using IBM SPSS Statistics version 29.

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of Universitas PGRI Silampari, Indonesia (Approval No. 21/KEPK-UPGRIS/2025). Permission to conduct the study was also obtained from the participating elementary school. Written informed consent was obtained from parents or legal guardians, and verbal assent was obtained from all participating students prior to data collection. Participants were informed about the objectives and procedures of the study, and their participation was entirely voluntary. Students were free to withdraw from the study at any time without penalty. All collected data were treated confidentially, anonymised during analysis, and used solely for research purposes.

RESULTS AND DISCUSSION

Results

Descriptive Statistics

Descriptive statistics were calculated to examine changes in students' learning motivation and fundamental movement skills before and after the intervention. **Table 4** presents the pretest and posttest means and standard deviations for both the experimental and control groups.

Table 4. Descriptive Statistics of Pretest and Posttest Scores

Variable	Group (n)	Pretest (M ± SD)	Posttest (M ± SD)	Gain
Learning Motivation	Experimental (n = 30)	68.45 ± 6.12	82.73 ± 5.48	14.28
Learning Motivation	Control (n = 30)	67.90 ± 6.35	74.21 ± 6.02	6.31
Fundamental Movement Skills	Experimental (n = 30)	65.32 ± 7.01	80.15 ± 6.27	14.83
Fundamental Movement Skills	Control (n = 30)	64.87 ± 6.89	72.44 ± 6.55	7.57

As shown in **Table 4** and **Figure 1**, both groups demonstrated relatively similar scores during the pretest phase, indicating comparable baseline conditions prior to the intervention. Following the eight-week intervention, improvements were observed in both groups; however, the experimental group consistently achieved higher gain scores than the control group. For learning motivation, the experimental group achieved a gain score of 14.28 compared with 6.31 in the control group. Similarly, for fundamental movement skills, the experimental group demonstrated a gain score of 14.83, whereas the control group achieved a gain score of 7.57. **Figure 1** further illustrates the steeper improvement observed in the experimental group across both outcome variables compared with the control group. These descriptive findings indicate that students in the experimental group demonstrated greater improvements than those in the control group. The statistical significance of these differences was subsequently examined using ANCOVA.

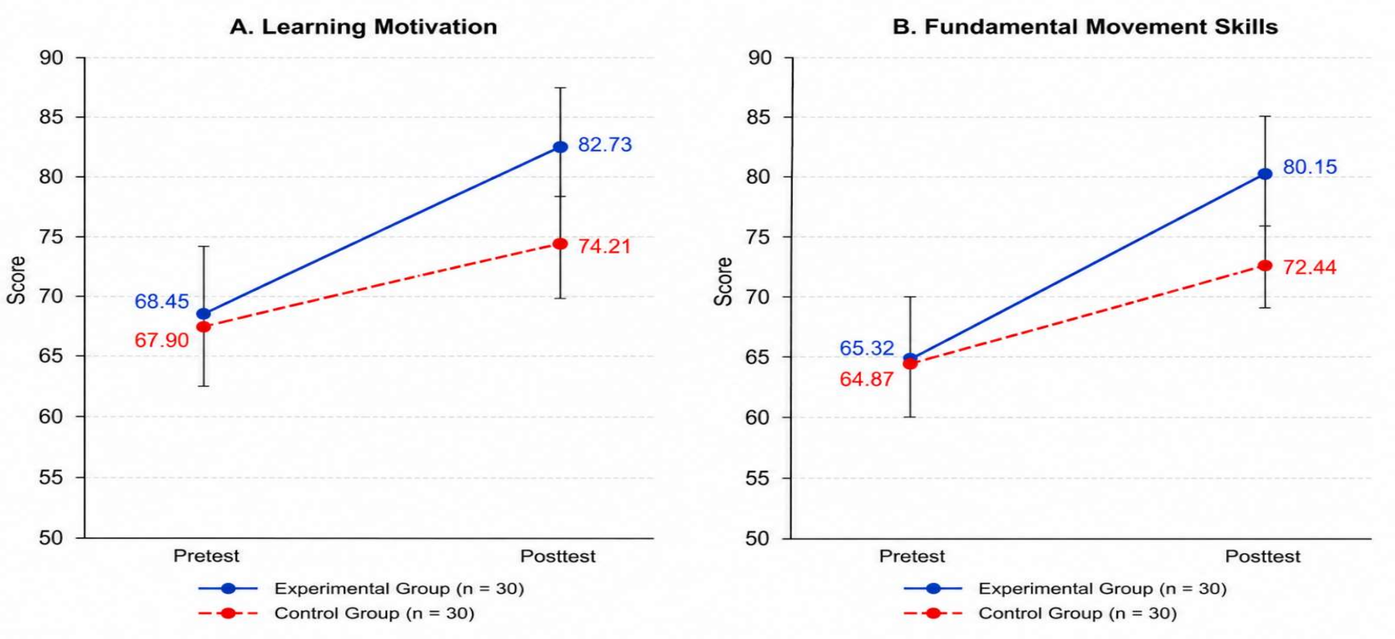

Figure 1. Pretest–Posttest Scores for Learning Motivation and Fundamental Movement Skills

Assumption Testing

Prior to conducting inferential statistical analyses, tests of normality and homogeneity of variance were performed to determine whether the data met the assumptions required for parametric analysis. The Shapiro–Wilk test was used to assess normality, whereas Levene's test was used to assess homogeneity of variance.

Table 5. Results of Normality and Homogeneity Tests

Test	Variable	Statistic	p-value	Result
Shapiro–Wilk (W)	Learning Motivation	0.964	0.126	Normal
Shapiro–Wilk (W)	Fundamental Movement Skills	0.972	0.118	Normal
Levene's Test (F)	Learning Motivation	1.58	0.214	Homogeneous
Levene's Test (F)	Fundamental Movement Skills	1.72	0.193	Homogeneous

Note. Data were considered normally distributed and homogeneous when $p > .05$.

The assumptions of normality and homogeneity of variance were examined prior to conducting ANCOVA. As presented in **Table 5**, the Shapiro–Wilk test indicated that both learning motivation ($W = 0.964$, $p = 0.126$)

and fundamental movement skills (W = 0.972, p = 0.118) were normally distributed. Furthermore, Levene's test showed that the variances were homogeneous across groups for learning motivation (F = 1.58, p = 0.214) and fundamental movement skills (F = 1.72, p = 0.193). Therefore, all assumptions required for ANCOVA were satisfied.

Homogeneity of Regression Slopes

Prior to conducting ANCOVA, the assumption of homogeneity of regression slopes was examined by testing the interaction between group membership and pretest scores for each dependent variable. The results indicated that the interaction effects were not statistically significant for either learning motivation or fundamental movement skills (p > 0.05). These findings suggest that the relationships between the covariates (pretest scores) and the dependent variables (posttest scores) were similar across groups. Therefore, the assumption of homogeneity of regression slopes was satisfied, supporting the appropriateness of using ANCOVA to compare posttest outcomes between the experimental and control groups after controlling for baseline differences.

Table 6. Homogeneity of Regression Slopes Test

Dependent Variable	Source (Group × Pretest)	F	p-value	Result
Learning Motivation	Group × Pretest Motivation	1.04	0.312	Assumption Satisfied
Fundamental Movement Skills	Group × Pretest FMS	1.16	0.287	Assumption Satisfied

Note. The homogeneity of regression slopes assumption was considered satisfied when the interaction between group membership and the covariate was not statistically significant (p > .05).

Effectiveness of the Mini-PlayLab Learning Model

To determine the effectiveness of the mini-PlayLab learning model while controlling for baseline differences, an Analysis of Covariance (ANCOVA) was conducted using pretest scores as covariates and posttest scores as dependent variables.

Table 7. ANCOVA Results for Learning Motivation and Fundamental Movement Skills

Variable	F(1,57)	p	Partial η^2	Effect Size
Learning Motivation	19.10	< .001	0.25	Large
Fundamental Movement Skills	22.84	< .001	0.29	Large

Note. Partial η^2 values of .01, .06, and .14 indicate small, medium, and large effects, respectively.

As presented in **Table 7**, the ANCOVA results revealed significant differences between the experimental and control groups after controlling for pretest scores. For learning motivation, the mini-PlayLab learning model produced a significant intervention effect, $F(1,57) = 19.10$, $p < 0.001$, partial $\eta^2 = 0.25$. Similarly, a significant effect was observed for fundamental movement skills, $F(1,57) = 22.84$, $p < 0.001$, partial $\eta^2 = 0.29$. The observed effect sizes exceeded the criterion for large effects, indicating that a substantial proportion of the variance in posttest scores was attributable to the intervention after controlling for baseline differences. These findings indicate that the mini-PlayLab learning model was more effective than conventional physical education instruction in improving learning motivation and fundamental movement skills. To facilitate interpretation of the intervention effects, adjusted posttest means were estimated after controlling for baseline differences. The adjusted means are presented in **Table 8** and **Figure 2**.

Table 8. Adjusted Posttest Means (Estimated Marginal Means) Following ANCOVA

Variable	Experimental Group Mean (95% CI)	Control Group Mean (95% CI)
Learning Motivation	81.92 (79.85-83.99)	74.88 (72.74-77.02)
Fundamental Movement Skills	79.34 (77.12-81.56)	72.67 (70.41-74.93)

Note. Values represent estimated marginal means adjusted for pretest scores with 95% confidence intervals obtained from ANCOVA.

As shown in **Table 8** and **Figure 2**, the experimental group achieved higher adjusted mean scores than the control group for both outcome variables. Specifically, the adjusted mean score for learning motivation was 81.92 (95% CI: 79.85-83.99) in the experimental group compared with 74.88 (95% CI: 72.74-77.02) in the control group. Likewise, the adjusted mean score for fundamental movement skills was 79.34 (95% CI: 77.12-

81.56) in the experimental group and 72.67 (95% CI: 70.41-74.93) in the control group. **Figure 2** visually illustrates the higher adjusted posttest means achieved by the experimental group across both outcome variables after controlling for baseline differences. Collectively, these findings indicate that the mini-PlayLab learning model produced meaningful improvements in both learning motivation and fundamental movement skills compared with conventional physical education instruction.

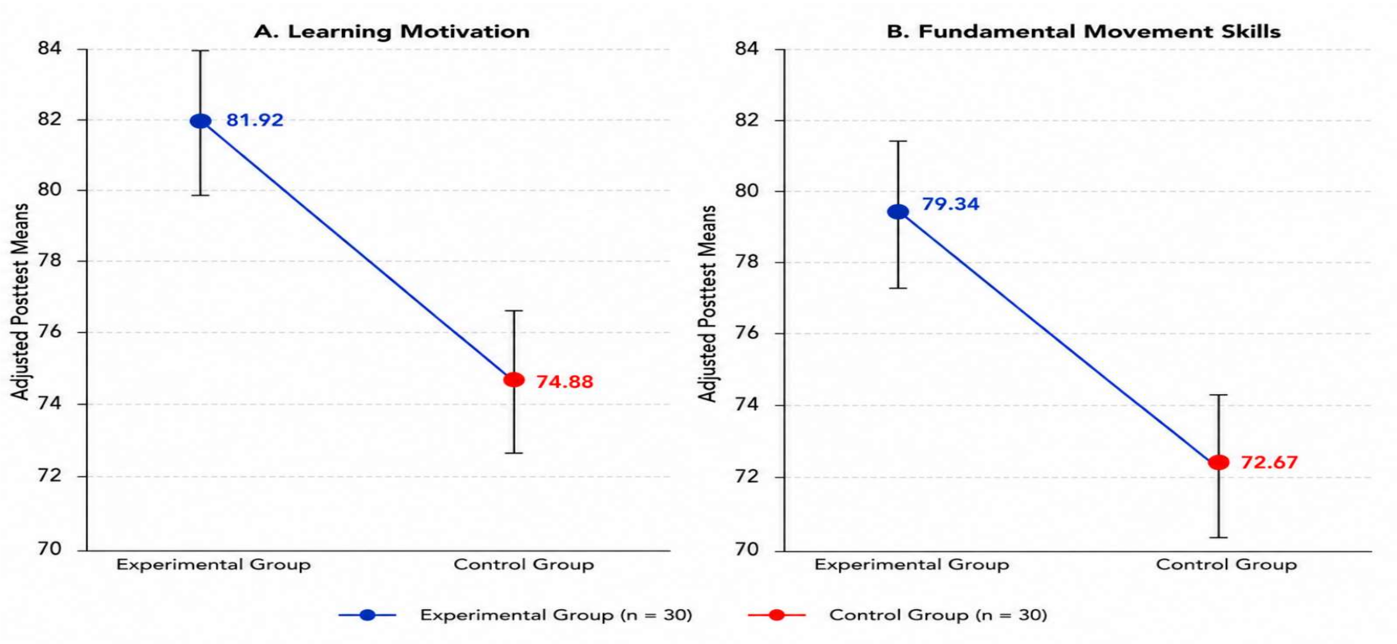

Figure 2. Adjusted Posttest Means (Estimated Marginal Means) Following ANCOVA

Discussion

The present study investigated the effectiveness of the mini-PlayLab learning model in enhancing elementary school students' learning motivation and fundamental movement skills in physical education. The findings demonstrated that students who participated in the mini-PlayLab intervention achieved significantly greater improvements in both learning motivation and fundamental movement skills than those who received conventional instruction. These results provide empirical evidence supporting the effectiveness of integrating gamification and play-based movement learning within a structured pedagogical framework. More importantly, the findings address a notable gap in the literature concerning the limited availability of instructional models that systematically combine motivational game mechanics with movement-orientated learning experiences in elementary school physical education.

The significant improvement in learning motivation may be attributed to the integration of gamification elements, including points, levels, challenges, badges, rewards, and continuous feedback embedded throughout the learning process. Previous studies have shown that gamification can enhance motivation by providing clear goals, achievement experiences, immediate feedback, and opportunities for progression (Jaramillo-Mediavilla et al., 2024; Li et al., 2023; Oliveira et al., 2026). Within the mini-PlayLab model, these elements enabled students to monitor their progress, experience success, and remain actively engaged in learning activities. From the perspective of self-determination theory, learning motivation is strengthened when educational environments support learners' needs for competence, autonomy, and relatedness (Ryan & Deci, 2020). The challenge-based activities, collaborative tasks, and achievement systems incorporated into the mini-PlayLab model may have contributed to satisfying these psychological needs, thereby encouraging greater participation, persistence, and enthusiasm during learning. The present findings are therefore consistent with previous research demonstrating that gamification positively influences students' motivation, engagement, and participation across educational settings (Sailer & Homner, 2020; Zeng et al., 2024).

The findings also revealed significant improvements in students' fundamental movement skills following participation in the mini-PlayLab intervention. This result suggests that movement learning becomes more effective when students engage in meaningful, enjoyable, and developmentally appropriate physical activities rather than merely repeating isolated movement drills. The model encouraged students to perform locomotor, non-locomotor, and manipulative movements through structured games requiring active exploration, decision-making, problem-solving, and movement adaptation. Such experiences align with experiential learning perspectives, which emphasise the importance of direct engagement and active participation in knowledge and skill acquisition (Kolb et al., 2017; Kong, 2021). Previous studies have reported that movement-orientated learning environments positively influence motor competence, movement confidence, and physical activity participation among children (Martinez-Merino & Rico-González, 2024; Moon et al., 2024). The present findings extend this evidence by demonstrating that movement skill development can be further enhanced when movement experiences are integrated with motivational mechanisms derived from gamification.

An important contribution of this study lies in demonstrating that gamification and play-based movement learning can function synergistically when integrated within a structured instructional model. Previous studies have generally examined gamification and movement-based learning as separate pedagogical approaches. Research on gamification has predominantly focused on motivational and engagement outcomes, whereas studies on play-based movement learning have primarily investigated motor development and physical activity participation. Consequently, limited evidence has been available regarding how these approaches may interact to influence both affective and psychomotor outcomes simultaneously. The mini-PlayLab learning model addresses this limitation by integrating challenge-based movement activities, collaborative play, continuous feedback, level progression, and achievement systems within a coherent instructional framework. The significant improvements observed in both learning motivation and fundamental movement skills suggest that combining motivational and movement-orientated strategies may produce broader educational benefits than implementing either approach independently (Aliriad et al., 2024; Johnson et al., 2019).

The findings further contribute to the growing body of research on innovative pedagogical approaches in physical education. While previous studies have established the value of gamification in promoting participation and engagement (Looyestyn et al., 2017), the present study demonstrates that gamification can also support movement learning when embedded within carefully designed physical activities. Likewise, the study extends research on play-based learning by showing that the integration of achievement systems, structured challenges, and continuous feedback can strengthen students' commitment to movement practice. Therefore, the mini-PlayLab model expands the application of gamification beyond motivational enhancement toward the simultaneous development of affective and psychomotor learning outcomes in physical education.

The findings contribute theoretically to the integration of self-determination theory and experiential learning perspectives within physical education. Self-determination theory suggests that learning environments supporting competence, autonomy, and relatedness foster higher levels of intrinsic motivation and sustained engagement (Ryan & Deci, 2020). Simultaneously, experiential learning theory emphasises that meaningful knowledge and skill acquisition emerge through active participation and reflective experiences (Chae, 2024; Silviya et al., 2019). The mini-PlayLab model combines these principles by providing structured movement challenges, collaborative interactions, and gamified achievement systems that encourage students to actively engage in learning. Consequently, the present study provides evidence that motivational and movement-orientated learning processes can be effectively integrated within a single pedagogical framework to enhance both affective and psychomotor outcomes.

From a practical perspective, the findings suggest that physical education teachers should consider adopting instructional approaches that integrate motivational and movement-orientated learning strategies. Traditional instruction often emphasises technical skill repetition and teacher-directed activities, which may not fully address students' motivational needs. In contrast, the mini-PlayLab model provides a structured yet flexible framework that combines movement exploration, collaborative learning, continuous feedback, and gamification mechanisms. Such an approach may help teachers create learning environments that are more engaging, student-centred, and aligned with the developmental characteristics of elementary school learners (Dichev & Dicheva, 2017; Mohammed et al., 2024). Consequently, the model may serve as an effective pedagogical alternative for promoting both active participation and movement competence in school-based physical education programmes.

Despite these promising findings, several limitations should be acknowledged. First, the study was conducted in a single elementary school with a relatively limited sample size, which may restrict the generalisability of the findings. Second, the intervention was implemented over an eight-week period, preventing the examination of longer-term effects on students' motivation and movement development. Third, the study focused exclusively on learning motivation and fundamental movement skills, whereas other potentially relevant outcomes, such as physical activity levels, social skills, self-efficacy, enjoyment, and attitudes toward physical education, were not investigated. Future research is therefore encouraged to involve larger and more diverse samples, longer intervention periods, and additional outcome variables. Furthermore, experimental studies comparing the mini-PlayLab model with other contemporary pedagogical models in physical education would provide deeper insights into its relative effectiveness and broader applicability across different educational contexts.

CONCLUSION

This study demonstrated that the mini-PlayLab learning model effectively enhanced elementary school students' learning motivation and fundamental movement skills. The integration of gamification elements and play-based movement learning within a structured instructional framework contributed to significant improvements in both affective and psychomotor outcomes. These findings address a gap in physical education research by providing empirical evidence for a pedagogical model that systematically combines motivational game mechanics with movement-orientated learning experiences. Practically, the mini-PlayLab model offers a student-centred instructional alternative that can support more engaging and meaningful physical education learning. The model can also be integrated into the elementary school physical education curriculum as an alternative activity-based instructional approach to promote active participation, learning motivation, and fundamental movement skill development. Future studies should involve larger and more diverse samples, longer intervention periods, and additional outcome variables to further examine the model's effectiveness and applicability across different educational contexts.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the research reported in this study.

AI DISCLOSURE STATEMENT

The authors used QuillBot solely for language editing, grammar correction, and readability enhancement. The tool was not used to generate research ideas, formulate research questions, conduct data analysis, interpret findings, or produce scientific content. All intellectual contributions, including the study design, data interpretation, and manuscript preparation, were performed exclusively by the authors, who take full responsibility for the content of this manuscript.

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