Enhancing Physical Education Learning Outcomes Through Game Based Learning Approach in Primary Schools

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Abstract

This study aims to investigate the effectiveness of game-based learning strategies in improving physical education learning outcomes among fifth-grade students. A quasi-experimental research design with a pre-test and post-test control group model was employed. The sample consisted of 40 students from SDN Gondangan, divided equally into experimental and control groups. The experimental group received instruction through a structured game-based learning approach, while the control group followed conventional physical education methods. A purposive sampling technique was used to select participants based on equivalent academic and physical performance backgrounds. Data were collected using standardized physical education achievement tests administered before and after the intervention. Descriptive and inferential statistical analyses, including paired sample t-tests and independent sample t-tests, were conducted to evaluate learning outcomes. The results revealed statistically significant improvements in both groups; however, the experimental group exhibited a significantly greater increase in mean scores compared to the control group ($p < 0.001$). These findings suggest that game-based learning is more effective in enhancing student engagement and achievement in physical education. The study concludes that integrating game-based strategies into elementary physical education curricula can lead to improved learning outcomes and foster more active, participatory learning environments. These findings offer valuable implications for curriculum development, instructional practice, and future educational research in primary school settings.

Keywords
game based learning; physical education; primary school

INTRODUCTION

Physical education (PE) is universally recognized as an essential component of the primary education curriculum, contributing not only to students' physical development but

also to their emotional, cognitive, and social well-being (Kliziene, I., et al. 2021). At the elementary level, physical education serves as a foundational platform where children begin to acquire fundamental motor skills, develop physical literacy, learn the values of cooperation and fair play, and establish lifelong habits related to health and active living (Yan, J., et al. 2022). These early experiences are critical, as they shape attitudes toward physical activity and influence engagement in healthy behaviors across the lifespan (Camacho-Sánchez, R., et al. 2023).

However, despite its critical role, physical education in many primary schools continues to face significant challenges. Instructional delivery is often characterized by traditional, teacher-centered approaches, in which students passively follow instructions with limited opportunities for exploration, creativity, or collaborative interaction (Sgro, F., et al. 2019). Such approaches may undermine students' intrinsic motivation and fail to fully engage them in meaningful learning experiences. Moreover, the emphasis on repetitive skill drills and assessment of physical performance may unintentionally marginalize students with lower levels of physical ability, resulting in reduced participation and interest in PE classes (Cocca, A., et al. 2020).

In response to these challenges, recent advancements in educational theory have emphasized the importance of student-centered, engaging, and inclusive pedagogical models in physical education (Silva, R., et al. 2021). One such model that has gained increasing attention is game-based learning. This approach leverages the motivational and interactive nature of games to create dynamic learning environments that promote not only physical skill development but also critical thinking, social interaction, and emotional resilience (Nuraini, S., et al. 2023). By integrating learning objectives into structured games, educators can foster active participation, enhance enjoyment, and promote equitable learning outcomes for all students, regardless of their initial physical competence.

While the potential benefits of game-based learning in physical education have been acknowledged in numerous studies, much of the existing research has been concentrated at the secondary or high-performance level, with limited empirical investigations focused on elementary school contexts (Omarov, N., et al. 2024). Furthermore, there remains a lack of robust evidence on how such approaches influence students' physical, behavioral, and

cognitive outcomes in regular public-school settings particularly within developing countries where resources, infrastructure, and teacher training in innovative pedagogy may be limited.

This research seeks to address these gaps by exploring the implementation and effectiveness of a game-based learning model in physical education for fifth-grade students at a public elementary school. Specifically, the study aims to examine how this approach influences students' mastery of fundamental motor skills, levels of active engagement, and attitudes toward physical activity. The findings are expected to contribute to the broader discourse on pedagogical innovation in primary physical education, offering insights into scalable and sustainable strategies to improve learning outcomes and foster positive physical education experiences for young learners.

METHOD

This study employed a quasi-experimental research design utilizing a pre-test and post-test control group format to evaluate the effectiveness of a game-based learning approach in physical education. This research design was chosen due to its practical applicability in real-world educational settings where random assignment is not always feasible, yet a high degree of control over variables is still maintained (Hakiki, M., et al. 2024). Figure 1 presents the quasi-experimental research design.
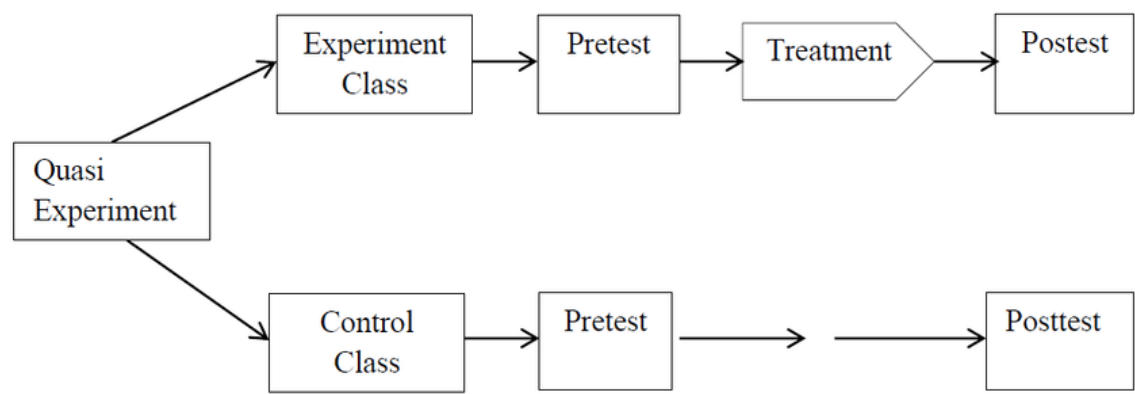

Figure 1. quasi-experimental research design

The design involved two groups of students: an experimental group, which received a structured intervention incorporating game-based learning strategies into physical education instruction, and a control group, which continued with conventional, teacher-

centered physical education practices. Both groups were assessed before (pre-test) and after (post-test) the intervention period, allowing for a direct comparison of learning outcomes attributable to the instructional approach (Hakiki, M., et al. 2024).

By implementing this design, the researchers were able to observe and analyze within-group changes over time as well as between-group differences in post-intervention outcomes. This structure provided a robust framework for evaluating the causal impact of the intervention on students' physical skills, participation, and engagement in physical education classes. Furthermore, the design ensured internal validity using comparable groups and consistent pre- and post-assessment procedures, thus enabling more accurate inferences regarding the effectiveness of the game-based instructional model in a primary school setting.

Participants And Sampling

The participants in this study were fifth-grade students from SDN Gondangan, a public elementary school located in East Java, Indonesia. A total of 40 students were selected and divided equally into an experimental group and a control group, with 20 students in each group.

The sampling technique employed was purposive sampling, based on specific inclusion criteria: (1) students were actively enrolled in the fifth grade during the 2024/2025 academic year, (2) students had regular attendance in physical education classes, and (3) parental consent was obtained for participation in the study. The selection of SDN Gondangan was also purposive, based on accessibility, administrative approval, and teacher collaboration.

Data Analysis Techniques

The data obtained in this study were analyzed using both descriptive and inferential statistical techniques to comprehensively assess the effectiveness of the game-based learning approach in physical education instruction.

Descriptive statistics, including mean, standard deviation, minimum, and maximum values, were used to summarize students' performance in both the pre-test and post-test for the experimental and control groups. This provided a general overview of central tendencies and variability in physical education outcomes.

To determine whether there were statistically significant differences in learning outcomes within and between groups, inferential statistical tests were employed. Specifically:

Paired Sample T-Test

This test was used to evaluate the differences between pre-test and post-test scores within each group (experimental and control). It aimed to identify whether the instructional approach either game-based or conventional produced significant learning gains over time. The formula for the paired sample t-test is as follows:

$$t = \frac{\bar{D}}{S_D/\sqrt{n}}$$

Independent Sample T-Test

To compare the post-test results between the experimental group and the control group, the independent sample t-test was applied. This test assessed whether the mean difference in outcomes between the two groups was statistically significant, thereby measuring the impact of the intervention. The formula for the independent sample t-test is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Prior to conducting the t-tests, normality and homogeneity of variance assumptions were tested using the Shapiro–Wilk test and Levene's test, respectively. These assumption checks ensured the appropriateness of the parametric tests applied.

All statistical analyses were conducted using IBM SPSS Statistics version 25, with the level of significance set at $p < 0.05$. This threshold was used to determine whether the observed differences in student outcomes were statistically meaningful.

By employing this multi-step analysis process, the study was able to systematically evaluate the impact of game-based physical education instruction on students' physical performance and engagement, while ensuring the rigor and validity of the findings.

RESULT AND DISCUSSION

RESULT

This section presents the findings of the study, which aimed to examine the effectiveness of a game-based learning approach in physical education on fifth-grade students' learning outcomes. The results are organized into two parts: (1) descriptive statistics and (2) inferential statistical analysis.

Descriptive Statistics

Descriptive statistical analysis was conducted to provide an overview of students' physical education performance before and after the intervention in both the experimental and control groups. This analysis includes the calculation of mean scores and standard deviations to summarize central tendencies and dispersion of the data.

Table 1 presents the descriptive statistics of the pre-test and post-test scores for both groups. Prior to the intervention, the mean scores of the experimental and control groups were relatively comparable, indicating that both groups started from a similar baseline in terms of physical education competence. The post-test results, however, revealed a noticeable difference between the two groups.

Table 1. Descriptive Statistics of Pre-Test and Post-Test Scores

Group	N	Pre-Test Mean ± SD	Post-Test Mean ± SD
Experimental Group	20	62.45 ± 5.32	81.70 ± 4.89
Control Group	20	61.85 ± 6.10	68.40 ± 5.75

In the experimental group, which received game-based physical education instruction, there was a substantial increase in the average score from the pre-test to the post-test. This suggests a significant improvement in students' physical performance, engagement, and learning outcomes because of the intervention. Meanwhile, the control group, which was taught using conventional methods, also demonstrated a modest increase in performance, but the magnitude of improvement was considerably smaller.

These descriptive findings suggest that while both instructional methods contributed to student development, the game-based approach was more effective in enhancing physical education outcomes. The standard deviations in both groups also remained relatively stable, indicating consistent performance improvements across participants. This initial descriptive analysis provided the foundation for subsequent inferential statistical

tests to determine the significance of the observed differences and assess the overall impact of the intervention.

Inferential Statistics

To assess the effectiveness of the game-based learning intervention in improving students' physical education outcomes, inferential statistical tests were conducted. These tests aimed to determine whether the differences observed between pre-test and post-test scores within each group, as well as between the experimental and control groups, were statistically significant.

1. Paired Sample t-Test Results

The paired sample t-test was used to examine the mean differences between the pre-test and post-test scores within each group. The results are presented in Table 2.

Table 2. Paired Sample t-Test Results for Pre-Test and Post-Test Scores

Group	Test	Mean Score	SD	Mean Difference	t-value	df	p-value	Interpretation
Experimental Group	Pre-Test	62.45	5.32					
	Post-Test	81.70	4.89	19.25	12.184	19	< 0.001	Significant improvement
Control Group	Pre-Test	61.85	6.10					
	Post-Test	68.40	5.75	6.55	4.215	19	< 0.001	Moderate improvement

As indicated in Table 5, the experimental group showed a substantial increase in performance, with a mean score improvement of 19.25 points, which was statistically significant ($t(19) = 12.184$, $p < 0.001$). This suggests a strong positive impact of the game-based learning intervention on students' physical education outcomes.

In contrast, the control group also exhibited a statistically significant improvement, with a mean difference of 6.55 points ($t(19) = 4.215$, $p < 0.001$). However, the magnitude of improvement was notably lower than that observed in the experimental group, indicating that while the conventional teaching method had a positive effect, it was less effective compared to the game-based approach.

These results reinforce the conclusion that game-based learning is a more effective pedagogical strategy for improving physical education achievement among fifth-grade students.

2. Independent Sample t-Test Results (Post-Test Scores)

An independent sample t-test was conducted to compare the post-test scores between the experimental and control groups. The aim was to evaluate whether the difference in performance between the two instructional methods was statistically significant.

Table 3. Independent Sample t-Test of Post-Test Scores Between Groups

Group	N	Mean Post-Test	SD	t-value	df	p-value	Interpretation
Experimental Group	20	81.70	4.89				
Control Group	20	68.40	5.75	8.372	38	< 0.001	Significant difference between groups

The test revealed a statistically significant difference in post-test scores between the experimental and control groups ($p < 0.001$), in favor of the experimental group. This finding confirms that students who received game-based physical education instruction achieved significantly higher learning outcomes than those who followed the conventional method. The mean post-test score of the experimental group (M = 81.70, SD = 4.89) was significantly higher than that of the control group (M = 68.40, SD = 5.75), with a t-value of 8.372 and degrees of freedom (df) = 38. The associated p-value (< 0.001) indicates a highly significant difference.

These results validate the effectiveness of the intervention and indicate that game-based learning can serve as a powerful pedagogical strategy in primary school physical education. The findings were further supported by assumption checks, including the Shapiro Wilk test for normality and Levene's test for homogeneity of variance, which confirmed that the data met the necessary assumptions for parametric testing. These results validate the effectiveness of the intervention and indicate that game-based learning can serve as an impactful pedagogical strategy in primary school physical education. The results are further supported by assumption checks that confirmed normal distribution and homogeneity of variance across groups.

DISCUSSION

The results of this study provide compelling evidence for the effectiveness of game-based learning strategies in the context of physical education for primary school students. The significant improvement in post-test scores among students in the experimental group,

as compared to those in the control group, highlights the pedagogical value of incorporating game elements into learning activities. These findings align with previous research, which suggests that game-based instruction can foster higher engagement, motivation, and retention of content among learners in various subject areas, including physical education (Kumar, S., et al. 2025), (Guan, X., et al. 2024).

The experimental group, which received physical education instruction through structured game-based methods, demonstrated a substantial increase in learning outcomes. The observed improvement (mean difference of 19.25 points) was statistically significant ($p < 0.001$), indicating not only that the intervention was effective, but that it also had a large effect size. This suggests that game-based instruction is not merely a supplementary strategy, but a transformative approach that actively enhances the learning experience in physical education settings. The results support the assertion that active, participatory learning environments such as those provided through games can significantly improve physical literacy, motor skills, and understanding of physical concepts (Mo, W., et al. 2024), (Mikrouli, P., et al. 2024).

In contrast, while the control group also showed a statistically significant improvement ($p < 0.001$), the gain was comparatively moderate (mean difference of 6.55 points). This indicates that traditional teaching methods, although still beneficial, may not be as impactful in engaging students or in developing deeper conceptual and practical understanding. The disparity between the two groups underscores the added instructional value of game-based learning, especially in developing competencies that require active participation, collaboration, and physical interaction (Pellas, N., et al. 2019), (Culajara, C. J. 2023).

Additionally, the results are consistent with contemporary educational theories such as constructivism and experiential learning, which emphasize the importance of learner-centered environments where students construct knowledge through meaningful and authentic experiences. Games in physical education provide such experiences, allowing students to learn by doing, experimenting, and reflecting core tenets of effective pedagogy (Fizi, R. M., et al. 2023), (Purwanto, D., et al. 2024).

Furthermore, the success of the intervention has important implications for curriculum design and instructional practices in elementary schools. Teachers and curriculum developers should consider integrating game-based learning as a central

component of physical education programs to enhance student outcomes holistically including cognitive, psychomotor, and affective domains. With increasing emphasis on 21st-century learning skills, such as collaboration, communication, and critical thinking, game-based learning also serves as a platform to cultivate these competencies in a natural and engaging way.

Despite the positive findings, it is important to acknowledge several limitations. The study was conducted in a single geographic region with a relatively small sample size (n = 40), which may affect the generalizability of the results. Future studies involving larger and more diverse populations are recommended to validate and expand upon these findings. In addition, longitudinal research could assess the long-term impact of game-based physical education on student outcomes beyond immediate academic achievement, such as physical fitness, social skills, and lifelong engagement in physical activity.

In conclusion, this study provides robust empirical support for the integration of game-based learning in primary school physical education. The findings underscore its potential to enhance both learning outcomes and student engagement, positioning it as a valuable and effective instructional strategy in contemporary educational settings.

CONCLUSION

This study has demonstrated that game-based learning is an effective pedagogical approach for enhancing physical education outcomes among fifth-grade students. The significant improvement observed in the experimental group's post-test scores, as compared to the control group, highlights the positive impact of integrating structured game elements into instructional design. These findings suggest that game-based learning not only improves students' understanding of physical education content but also fosters higher engagement and motivation, which are critical for long-term educational success. By promoting active participation, collaboration, and experiential learning, the game-based approach offers a dynamic alternative to traditional methods, making physical education more enjoyable and meaningful for young learners. The results support the incorporation of game-based strategies into elementary physical education curricula to achieve more effective, inclusive, and student-centered learning experiences. While the study provides strong evidence of effectiveness, it also highlights the need for further research involving larger, more diverse populations and longer-term evaluations. Future

studies should explore the broader implications of game-based learning on physical fitness, social development, and students' lifelong engagement with physical activity. In conclusion, game-based learning holds significant promise as a transformative instructional model in primary school education, particularly in promoting deeper learning, active engagement, and improved academic performance in physical education.

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