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The Effect of Game-Based Learning in Physical Education to Improve Social Interaction and Physical Fitness of Students at State Junior High school 40 Bandung

Salsa Nabila Wardhani[1]✉, Reshandi Nugraha[2], Riansyah[3]

Indonesian University of Education, Bandung, Indonesia[123]

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Abstract

This study aims to examine the effect of Game-Based Learning (GBL) in Physical Education (PE) learning on social interaction and physical fitness of junior high school students. The method used is a quasi-experimental design with a Non-randomized Control Group Pretest-Posttest Design. The research subjects consisted of 62 eighth-grade students of State Junior Higschool 40 Bandung who were divided into an experimental group and a control group. Social interaction was measured using the Social Provisions Scale (SPS) questionnaire, while physical fitness was measured through the Nusantara Student Fitness Test (TKPN) which includes the Pacer Test, V-Sit and Reach, Sit Up, and Squat Thrust. The results of the analysis showed that social interaction data were normally distributed and were analyzed using a Paired Sample t-Test, while physical fitness data were not normally distributed and were analyzed using the Wilcoxon Signed-Rank Test. The Mann-Whitney U Test was used to compare improvements between groups. The results showed a significant increase in social interaction and physical fitness in the experimental group, while the control group showed no significant changes. Effect size analysis showed a large effect on social interaction (r=0.56) and a moderate effect on physical fitness (r=0.46). These findings indicate that Game-Based Learning is effective in improving the quality of physical education (PE) learning in junior high schools.

How to Cite

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✉ Correspondence Author:
E-mail: salsa.nabila1994@upi.edu

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INTRODUCTION

Education plays an important role in developing students› potential cognitively, affectively, and psychomotorically (Zainuddin & Perera, 2019). The Indonesian government has implemented 12 years of compulsory education through elementary, middle, and high school levels (Cep Kiki Kusumah, 2021). To ensure that every citizen receives equitable and quality basic education. However, in schools, the focus of learning is often limited to academic subjects such as mathematics, Indonesian, and science, leaving subjects such as physical education under-served despite their significant contribution to the development of students› character and social skills (Mahfud et al., 2020). Through physical activities and group games, Physical Education (PE) can be a means of learning values such as cooperation, sportsmanship, empathy, and communication (Opstoel et al., 2020). Furthermore, physical fitness is also an important component of PE, encompassing endurance, muscle strength, agility, and flexibility. Engaging and physically challenging PE learning has been shown to improve students› physical fitness and social interaction (Khairuddin et al., 2023), especially in the digital era which can cause social interaction between students to decrease.

Students often experience gadget addiction and prefer playing games or social media rather than interacting directly with their peers (Putri Widyaningrum et al., nd). Various efforts have been made to address these issues, one of which is through the implementation of participatory and collaborative learning models. Several studies have shown that learning approaches such as Project-Based Learning (PJBL) and Cooperative Learning can improve social skills and interactions between students. For example, PJBL has been shown to improve students› collaboration and communication skills (Izza et al., 2023; Syafruddin & Anwar, 2024), while the implementation of Cooperative Learning also has a positive influence on social interaction in sports learning (Darmawan et al., 2022; Paquita Bachtiar & Sunarso, 2025; Zulfikar & Budiana, 2019). In addition, the Experiential Learning approach was found to be effective in improving students› social interactions in secondary schools (Permatasari, 2013).

Previous studies have examined the influence of Game-Based Learning (GBL) on cognitive learning outcomes, both in mathematics, science and language (Acquah & Katz, 2020; Wang et al., 2022). GBL has been proven to increase student motivation, engagement, and collaboration in various learning contexts (Makri et al., 2021; Wang et al., 2022). GBL can also be a medium for students to interact as stated by Kalogiannakis et al., (2021), "GBL refers to the use of games as a tool to promote students› learning by engaging them in problem-solving activities embedded within a game environment." However, research that specifically evaluates the influence of GBL on affective aspects especially students› social interactions is still relatively limited, especially in the context of PE learning at the junior high school level.

In the context of PE which is based on physical activity and direct interaction, GBL is very relevant to implement because physical play provides space for healthy and constructive social exploration (Opstoel et al., 2020). Games in GBL can encourage communication, joint decision-making, and collaboration during the game, thus potentially increasing students› social interactions. (Chang et al., 2020). Through interaction, students can increase their understanding and perception of sports. As defined by Pelau et al. (2021), social interaction is «a form of reciprocal communication in which humans exchange information with a social agent.»

Research directly examining the application of GBL in PE to improve students› social interaction and physical fitness is still very limited, particularly at the lower secondary level. This presents a significant gap that requires further investigation to strengthen the development of PE learning models that focus not only on physical performance but also on developing students› social skills.

From the description above, the problem to be solved is «Can the application of GBL in PE learning have an impact on improving social interaction and physical fitness of students at State Junior Highschool 40 Bandung?»

According to Creswell (2014), hypothesis is a tentative statement about the relationship between two variables that can be empirically tested with data. In this context, the independent variable is the application of GBL in PE, while the dependent variable is students› social interaction skills and physical fitness.

Alternative Hypothesis (H_a): There is a significant difference in social interaction and physical fitness between students who participate in GBL-based PE learning and students who participate in conventional PE learning. → ($\mu_1 \neq \mu_2$)

Null Hypothesis (H_0): There is no significant difference in social interaction and

physical fitness between students who participate in GBL-based PE learning and students who participate in conventional PE learning. → ($\mu_1 = \mu_2$)

The GBL approach is a learning strategy that integrates game elements into the learning process to increase student involvement, motivation, and active interaction (Kalogiannakis et al., 2021). In the context of Physical Education (PE), GBL has appropriate characteristics because activities carried out in groups encourage communication, cooperation, and social interaction between students (Opstoel et al., 2020). Social interactions that are built through collaborative activities in PE play an important role in the social development of adolescents, especially junior high school students who are in a crucial phase of identity formation and social skills (Opstoel et al., 2020). In addition, GBL in PE not only contributes to social aspects, but also improves students› physical fitness through increasing the intensity and involvement of structured physical activities. (Opstoel et al., 2020; Sotos-Martinez et al., 2024). Physical activity carried out regularly and continuously has been proven to improve physical fitness components such as endurance, strength and fitness in adolescents (World Health Organization, 2020). Based on this, this study is important to analyze the effect of GBL in PE learning to improving social interaction and physical fitness of junior high school students. Although, a number of studies have proven that collaborative learning approaches such as Cooperative Learning, PJBL, and Experiential Learning can improve students› social interaction, studies that specifically integrate GBL in the context of PE and test its simultaneous impact on the aspects of social interaction and physical fitness of junior high school students are still relatively limited. Most previous studies have focused on cognitive learning outcomes or examined only one aspect, either social or physical, separately. Therefore, this study has a strategic position to fill the research gap by presenting empirical evidence regarding the effectiveness of GBL in PE that is oriented towards holistic student development.

METHOD

Research methods are systematic steps used to obtain scientific data in accordance with research objectives (Creswell, 2014). This research uses a quantitative approach with a quasi-experimental design. Experimental research is a method that aims to test the effect of a treatment on a particular variable by comparing the treated group with the untreated group (Fraenkel et al., 2023). The type of experiment used in this study is Quasi Experimental Design, namely an experimental design that is not completely random (non-randomized control group pretest-posttest design), but still has an experimental group and a control group (Cohen, 2007). A nonequivalent control group design involves administering a treatment to an experimental group and not a control group. Both are measured before and after the treatment is administered to determine its effects. This design was chosen because it allows for measuring the effectiveness of the treatment in a naturalistic educational context.

Data collection techniques are an important stage in the research process to obtain the information needed to answer the problem formulation. In this study, data collection used two methods: distributing the Social Provisions Scale (SPS) questionnaire (in paper form) to measure students' social interactions and administering the Nusantara Student Fitness Test (TKPN) to measure students' physical fitness. The social interaction instrument includes several aspects, namely the feeling of being needed by others, social guidance, emotional attachment, reliable support, social integration, and self-recognition (Motl et al., 2004). Meanwhile, the TKPN assesses physical fitness components through the V-Sit and Reach test, 60-second sit-up, 30-second squat thrust, and the Progressive Aerobic Cardiovascular Endurance Run (PACER) Test as physiological indicators of students (Ministry of Youth and Sports, 2022). GBL intervention is designed in the form of a series of structured physical games conducted over 8 (eight) sessions, with each game having clear objectives, rules that encourage collaboration, and reflection at the end of the activity. The games focus on group activities, teamwork simulations, and simple sports modifications that require active physical involvement as well as social interaction among students.

The subjects of this study were eighth-grade students at State Junior Highschool 40 Bandung who lacked access to GBL Learning for PE. Two classes with relatively homogeneous characteristics were selected from the population based on their previous average PE scores. The two classes were then divided into two groups: an experimental group receiving GBL for PE, and a control group receiving conventional PE instruction. The object of this study included the application of GBL as the independent variable, with social interaction and physical fitness as the dependent variables.

In this study, quantitative data was used, consisting of SPS questionnaire scores and TKPN scores. These were then entered into a table and calculated as the final score. Data analysis was conducted in stages according to a pretest-posttest experimental design with a control group. A normality test was performed first to determine the type of statistical test used (Field, 2013). To determine the change in scores in each group, a within-group analysis was conducted. If the pretest and posttest data were normally distributed, a Paired Sample t-Test was used. If the data were not normally distributed, the Wilcoxon Signed-Rank Test was used as a nonparametric alternative to the Paired Sample t-Test (Gravetter & Wallnau, 2015). Next, to determine the difference in improvement between the experimental and control groups, the difference (delta) between the posttest and pretest was calculated. The test for differences between groups was conducted using an independent sample t-test if the delta data were normally distributed, or a Mann-Whitney U Test if the data were not normally distributed (Field, 2013). In addition to the significance test, the magnitude of the treatment effect was analyzed using effect size to provide an overview of the strength of the influence of the application of GBL on students' social interactions and physical fitness (Creswell, 2019).

$$r = \frac{Z}{\sqrt{N}}$$

Figure 1. Mann-Whitney U Test Effect Size calculation formula

RESULTS AND DISCUSSION

This research was conducted in the odd semester of the 2025/2026 academic year and lasted for less than 2 months, starting on October 20, 2025, and ending on December 10, 2025. To complete this research, there are several steps that must be taken, starting from instrument preparation, instrument trials, data collection at school and experiments, to data processing and data analysis. As research subjects, the two classes of grade VIII at State Junior Highschool 40 Bandung were selected through a purposive sampling technique based on homogeneous characteristics. The collected data consists of social interaction scores measured by the SPS instrument, as well as scores from the results of the Physical Fitness Test which includes the PACER Test , Sit Up, Squat Thrust, and V-Sit and Reach. The results and discussion of the research will be discussed further in the analysis prerequisite test section.

Validity testing can be understood as the extent to which the statement items represent the concept to be measured and produce accurate data for drawing conclusions (Subhaktiyasa, nd). In this study, the validity test was conducted by analyzing the Corrected Item-Total Correlation for each statement item with the help of statistical software. The number of trial samples was 70 respondents, so the r value of the table at a two-sided significance level of $\alpha = 0.05$ was 0.235. An item is declared valid if the Corrected Item-Total Correlation ≥ 0.235 (Subhaktiyasa, nd).

Table 1. Results of the Validity Test of social interaction instruments.

Item	N	r table	r count	Information
24	70	0.235	≥ 0.235	Significant

Based on the data processing results, almost all statement items showed item-total correlation values above the critical r table, indicating that these items have a significant relationship with the total instrument score. This indicates that these items are able to consistently represent the construct being studied. This finding aligns with the principle that a valid instrument will produce representative data for further analysis (Subhaktiyasa, nd)

Instrument reliability testing is carried out to assess the internal consistency of the measuring instrument in producing stable and consistent scores under the same conditions (Tavakol & Dennick, 2011). In this study, the reliability of the instrument was tested using the Cronbach's Alpha coefficient, which is a statistic commonly used for instruments with a Likert scale or an ordinal scale with many items (Field, 2013). Based on the output from the statistical software, a Cronbach's Alpha value of 0.857 was obtained for all 24 items. According to reliability interpretation guidelines, a Cronbach's Alpha value above 0.80 indicates very high reliability, meaning the instrument has good internal consistency and its measurements are reliable (Hair et al., 2019).

Table 2. Result of the Reliability Test of social interaction instruments

Item	Alpha Range	Cronbach's Alpha	Information
24	0.80-1.00	0.857	Very High

Data normality testing is the initial step in quantitative statistical analysis to determine the type of statistical test to use. Normality measures whether data are normally distributed, allowing

the use of parametric tests with greater statistical power (Field, 2013). In this study, normality tests were conducted separately for the two main variables, namely social interaction and physical fitness. The results of the normality test used the Shapiro-Wilk Test, which is most recommended for small to medium samples (n<50-200) due to its sensitivity to distribution deviations (Gravetter & Wallnau, 2015).

Table 3. Results of the normality test for social interaction variables

Social Interaction	Sig.	Information
Pretest	0.145	Normal
Posttest	0.442	Normal

The significance values for the pretest and posttest were greater than 0.05, indicating a normal distribution of the data. Therefore, further analysis of this variable can use parametric tests such as Paired Sample t-Tests for each group.

Table 4. Results of the normality test of physical fitness variables

Physical Fitness	Sig.	Information
Pretest	0.001	Abnormal
Posttest	0.006	Abnormal

The pretest and posttest values for the physical fitness variable were less than 0.05, which means the data was not normally distributed.

The Paired Sample t-Test was used to determine whether there was a significant difference between pretest and posttest scores within a group. Before testing the mean difference, the data were first tested for normality using the Shapiro-Wilk test, which is recommended for small to medium-sized samples (Field, 2018). The results of the normality test indicate that the pretest and posttest scores for the analyzed variables have a significance value of p>0.05, so it can be concluded that each data is normally distributed. Based on the fulfillment of this normality assumption, the Paired Sample t-Test was continued for each group (Field, 2018).

Table 5. Results from the Paired Sample t-Test of experiment and control group

Group	Correlation Pretest Posttest	Sig. Pretest Posttest	Information
Experiment	0.597	0.000	Significant
Control	0.827	0.000	Significant

The results of the Paired Sample t-Test showed a significant change in scores on the variable. Statistically, the t-value indicates a significant difference between the pretest and posttest scores, with a significance value of p<0.05. This indicates that after the application of the treatment (application of GBL in PE learning), there was a significant increase in the variable scores in the tested group. This finding supports the statement that the treatment has an effect on improving students' abilities/social interactions/physical fitness, in accordance with the theory of effective learning in educational research (Creswell, 2019).

Statistical tests were conducted to determine whether there were significant changes between pretest and posttest scores on the variables tested in each group. Since the data normality test showed that the physical fitness variable was not normally distributed (p-value <0.05), a comparative analysis of pretest and posttest scores within the groups was conducted using the Wilcoxon Signed-Rank Test, a nonparametric test appropriate for paired data that does not meet the assumption of normality (Field, 2018).

Table 6. Result from the Wilcoxon Signed-Rank Test of experiment and control group

Group	Posttest-Pretest		Information
Experiment	Z.	-2,546	Significant
	Asymp. Sig.	0.011	
Control	Z.	-0.787	No Significant
	Asymp. Sig.	0.431	

In this study, the Wilcoxon Signed-Rank Test results for the experimental group showed a z-value of -2546 and a significance value of 0.011 (<0.05), indicating a significant change in physical fitness scores after being given GBL treatment. Conversely, the control group obtained a z-value of -0.787 with a significance value of 0.431 (>0.05), indicating no significant change in physical fitness scores before and after treatment in the control group. Thus, the Wilcoxon Signed-Rank Test results support that the treatment given to the experimental group had a significant effect on improving students' physical fitness, while the control group, which was not given special treatment, did not show any significant changes. This finding is consistent with the principle that nonparametric analysis such as the Wilcoxon Signed-Rank Test is effective for detecting paired changes in non-normal data without relying on certain distribution assumptions (Field, 2018; Gravetter & Wallnau, 2015).

After the normality analysis showed that the data on changes in physical fitness scores

(delta) and social interactions were not normally distributed, a comparison test between the experimental group and the control group was conducted using the Mann-Whitney U test. The Mann-Whitney U test is a nonparametric test used to compare two independent groups when the normality assumption is not met (Field, 2018). Statistical theory states that nonparametric tests such as the Mann-Whitney U Test are suitable for use with ordinal or interval or ratio data that are not normal, and when the sample size is relatively small and the distribution is not standardized (Gravetter & Wallnau, 2015). This is in accordance with the experimental research design involving two independent groups (experimental and control) which are tested based on changes in scores between the pretest and posttest.

Table 7. Result from the Mann-Whitney U test of social interaction and physical fitness variabel

Variables		Delta	Information
Social Interaction	Mann Whitney	171,500	Significant
	Wilcoxon	667,500	
	Z.	-4,382	
	Asymp. Sig.	0.000	
Control	Mann Whitney	168,500	Significant
	Wilcoxon	664,500	
	Z.	-4,440	
	Asymp. Sig.	0.000	

In this study, the Mann-Whitney U Test was conducted on the delta values (posttest – pretest) of physical fitness and social interaction. The results of the Mann-Whitney U Test showed an asymp.sig. value of <0.05, which means there was a significant difference between the experimental and control groups in both variables. Thus, the GBL treatment given to the experimental group was proven to produce changes (improvements) that were statistically different compared to the control group. This finding supports the hypothesis that the application of a GBL approach in the PE subject has a significant effect on improving students' physical fitness and social interaction.

In addition to statistical significance testing, this study also analyzed effect size to determine the extent of the impact of GBL implementation in PE on students' social interactions and physical fitness. Effect size analysis is important because statistical significance testing only indicates the presence or absence of a difference, but does not explain the practical impact of the treatment. Sullivan & Feinn, (2013) emphasized that "the p value is limited because it does not convey the magnitude of an effect; therefore, reporting effect size is essential for understanding the practical significance of research findings."

$$r = \frac{Z}{\sqrt{N}}$$

$$r = \frac{4,440}{\sqrt{62}} = \frac{4,440}{7,87} \approx 0,56$$

Figure 3. Results of calculating social interaction variables

Based on the results of the effect size calculation, the social interaction variable has a large effect size value. This result indicates that the implementation of GBL has a strong and practically meaningful impact on improving social interaction. A large effect size value indicates that the differences observed are not only statistically significant but also significantly relevant in the learning context. This aligns with the view Cumming, (2014) which states that "reporting effect size allows researchers to move beyond dichotomous thinking based on statistical significance."

$$r = \frac{2,546}{\sqrt{31}} = \frac{2,546}{5,57} \approx 0,46$$

Figure 4. Results of calculating physical fitness variables

Meanwhile, the effect size for the physical fitness variable was in the medium to large range, indicating that GBL in PE learning significantly improved students' physical fitness. Although the effect was not as strong as for social interaction, this effect size still demonstrates that GBL contributes significantly to improving students' physical abilities. Lakens, (2013) emphasizes that "effect size provides a quantitative measure of the strength of a phenomenon and should be reported alongside significance tests," particularly in nonparametric analyses such as Wilcoxon Signed-Rank Test and Mann-Whitney U Test.

The results showed a significant increase in social interaction in the experimental group compared to the control group. This finding indicates that the GBL intervention not only produced statistical differences but also had a strong practical impact on students' ability to communicate, cooperate, and collaborate during PE learning. Theoretically, GBL increases motivation, engagement, and collaborative mechanisms that facilitate social interaction practices, such as through teamwork, game rules, and immediate feedback, all of which encourage higher participation (Ca-

macho-Sánchez et al., 2023). Systematic reviews in PE contexts have found consistent evidence that GBL and gamification increase student motivation and engagement, and support the development of social and emotional skills (Arufe-Giráldez et al., 2022). Therefore, the large effect size results on social interactions in this study are consistent with recent empirical evidence emphasizing the role of GBL in shaping structured social opportunities within learning.

Another analysis showed that the experimental group experienced significant improvements in physical fitness compared to the control group. This indicates that GBL is also physically effective: games designed with appropriate intensity, repetition, and movement variety can improve fitness components (aerobic, strength/endurance, flexibility) in the intervention. Recent empirical support suggests that game-based physical learning programs can increase active participation and movement time, contributing to improved fitness in children/adolescents (Mo et al., 2024). In addition, applied research that developed traditional game models or game circuits found similar results, namely that GBL improves fitness indicators when designed in a structured manner (Khairuddin et al., 2023). Systematic reviews of gamification/GBL also report increased commitment to physical activity, although results on specific fitness measures sometimes vary due to differences in protocols and duration of intervention (Arufe-Giráldez et al., 2022). The data above strengthens the evidence that GBL can be an effective strategy for improving physical fitness if the program is sufficiently intense and targeted.

CONCLUSION

Based on the research results and data analysis, it can be concluded that the implementation of GBL in PE learning has a substantial and meaningful impact on the social interactions and physical fitness of junior high school students. The analysis results within the groups showed that the experimental group experienced a statistically meaningful improvement after receiving the treatment, while the control group showed no significant changes. These findings indicate that the improvement that occurred in the experimental group was the result of the implementation of GBL.

The intergroup comparison analysis also showed a clear difference in improvement between the experimental and control groups in both social interaction and physical fitness variables. Furthermore, the effect size calculation results showed that the implementation of GBL had a strong effect on students' social interactions (r=0.56) and a moderate effect on students' physical fitness (r=0.46). These findings confirm that GBL is not only statistically reliable but also practically effective in improving the quality of PE learning.

Thus, GBL can be recommended as an effective learning approach to improve students' social engagement and physical fitness in PE lessons at the junior high school level. The results of this study are expected to serve as a reference for PE teachers and educational policymakers in developing more active, enjoyable, and holistic student-oriented learning strategies.

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