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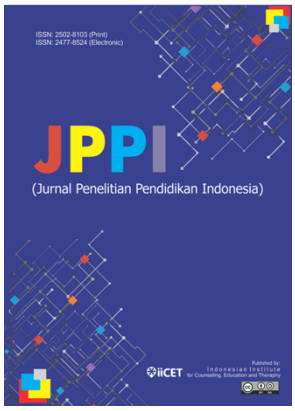

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The effect of game-based learning on backward rolling skills in children aged 11–12 years: an experimental study

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ABSTRACT

Backward roll ability remains a major obstacle in gymnastics learning for children aged 11-12 years. Difficulty performing this movement stems from limited coordination, physical strength, and fear. This situation highlights the need for learning innovations that can increase children's engagement and motivation. One potential solution is the use of a Game-Based Learning approach, a learning model that integrates game elements into the movement learning process. This study aims to analyze the effect of game-based learning on backward roll ability in children aged 11-12 years. This study used a quasi-experimental research design with a posttest-only control design. Participants consisted of elementary school children divided into an experimental group and a control group. Data were collected using a gymnastics ability assessment instrument and analyzed using descriptive statistics and an independent sample t-test. The results showed that children in the experimental group performed better than those in the control group. These findings suggest that game-based learning can increase children's engagement and provide a more effective and enjoyable movement learning experience. This approach has the potential to be an innovative strategy to improve the quality of gymnastics learning in elementary schools.

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Introduction

Gymnastics is a compulsory subject in schools (Zulbahri et al., 2022). Gymnastics is an important part of physical education in helping children improve motor skills, balance, coordination, and body control (Anderson et al., 2022; Radanović et al., 2025; Yu et al., 2025). Floor gymnastics in the physical education series provides opportunities for children to practice various basic skills, including back rolls (Arrosyadi et al., 2025). 50% of children learning gymnastics in elementary school face a number of challenges (Invernizzi et al., 2020), such as fear of doing back rolls, weak muscle strength, and poor

coordination, this makes it difficult for many children to develop motor skills (Alya Rahmawati et al., 2025). Furthermore, traditional teaching approaches and a lack of variety discourage children from actively engaging in the learning process (Bullard & Bahar, 2023), which results in children's gymnastics skills not developing optimally and the learning objectives of physical education not being fully achieved.

The development of fundamental motor skills is crucial in children to support sports and physical activity in later developmental stages (Komaini et al., 2023, 2025; Rasyid et al., 2024). Children's self-confidence and future engagement in physical activity can be enhanced through the development of strong fundamental motor skills (Gusril et al., 2022, 2024). Furthermore, the development of more complex sports skills is positively associated with mastery of fundamental motor skills in elementary school (Jiang et al., 2025; Zhang et al., 2024).

Floor gymnastics techniques, such as backward rolls, are crucial for improving body awareness, balance, and coordination (Alya Rahmawati et al., 2025; Yu et al., 2025). The ability to perform a backward roll forms the foundation for mastering various other motor skills in sports and physical activities, and supports gymnastics instruction (Gusti Handayani et al., 2026; Invernizzi et al., 2020). 81% of children and adolescents worldwide do not engage in the WHO-recommended daily physical activity, which can hinder motor skill development (Guthold et al., 2020). This situation highlights the importance of more creative and engaging teaching methods to help children master gymnastics skills, such as the backward roll.

More creative, engaging, and developmentally appropriate teaching strategies are needed to address the delay in developing gymnastics skills in children aged 11-12 years (Ikadarny et al., 2024). The use of Game-Based Learning strategies in physical education is one way to address this problem. This method integrates play elements into educational activities so that children can acquire motor skills through engaging, challenging, and interactive exercises (Alotaibi, 2024; Asadzadeh et al., 2024; Purwanto et al., 2024). Children can practice various physical skills, including muscle strength, coordination, balance, and courage, and develop skills in backward rolls. Children are instructed to begin this activity by lying on their backs on a mat and lifting their legs until their knees are bent toward their chest. To encourage movement, a ball is placed between the soles of their feet or on their toes. Children are then instructed to roll backward while maintaining the stability of the ball on their toes.

This play activity is designed to develop motor coordination, abdominal and back muscle strength, and body control. Furthermore, in the context of physical education, the use of a ball as a play medium provides visual and motor stimulation that can increase children's focus and engagement during the learning process. This learning is carried out gradually through fun games and helps reduce children's fear of rolling. Thus, using the Game-Based Learning method, this game serves as an effective technique and educational strategy to improve motor skills and backward rolls.

The purpose of this study was to examine how the use of the Game-Based Learning method determines whether game-based learning with a ball as a medium can improve students' motor coordination, balance, and body control in backward rolls more effectively than traditional teaching techniques. It is hoped that the findings of this study will provide a scientific basis for the development of more creative and enjoyable gymnastics learning techniques for elementary school children.

Method

Study Design

This study used a quasi-experimental methodology with a post-test-only control group design to assess the impact of game-based learning on children's ability to perform backward rolls at ages 11-12. Two study groups were included: an experimental group and a control group. The experimental group used a planned game intervention to improve body control, balance, and coordination. Meanwhile, the control group underwent a learning process using traditional techniques often used in physical education classes at school. Using this method, the skill outcomes of children from the group receiving the game-based learning intervention were compared with those from the group not receiving the intervention. A total of 56 children aged 11-12 at Padang State Elementary School 32 participated in

the study voluntarily and received an explanation of the study's purpose and procedures before the experiment.

Research Procedure

Participants were divided into two groups in the first stage: an experimental group and a control group. To ensure that the characteristics of the two groups were relatively equal, group assignment was carried out in a controlled manner. While the control group learned using traditional techniques often used in school physical education programs, the experimental group received game-based instruction to improve body control, coordination, balance, and core muscle strength related to backward roll ability. Learning was divided into several sessions of equal duration for both groups, and the intervention was conducted over 8 weeks. After completing the full intervention series, a post-intervention test was administered to both groups to measure the children's ability to perform backward rolls. The effectiveness of the game-based learning used in this study was then evaluated by comparing the skill levels of the experimental and control groups using the measurement results.

Instrument

A backward roll gymnastics skill assessment sheet based on movement technique indications, such as starting position, roll execution, body movement coordination, and final position, was used as the research tool. Assessments were conducted by teachers or observers with a basic understanding of floor gymnastics methods.

Statistical analysis

The research data was analyzed using descriptive statistics to determine the mean and standard deviation. Furthermore, prerequisite tests for analysis, such as normality and homogeneity, were conducted. After the assumptions were met, hypothesis testing was carried out using an independent sample t-test to determine the difference in posttest results between the experimental group and the control group in Backward Roll skills in Physical Education learning.

Results and Discussions

The effectiveness of Game-Based Learning in enhancing backward roll ability among children aged 11–12 years warrants a closer examination of both the measurable improvements in gymnastics performance and the underlying factors that contribute to these outcomes. By comparing the experimental group, which experienced the game-integrated learning approach, with the control group receiving conventional instruction, this study provides insight into how interactive and engaging methods influence skill acquisition, coordination, and confidence in performing complex movements. The following sections present the detailed results of the intervention, including statistical comparisons, and discuss the implications of these findings in terms of learning strategies, student motivation, and potential applications for improving gymnastics education in elementary schools.

Table 1. Normality Test Calculation Results

Group	Variance	FCount	Ftable	Criteria
Eksperimen	0,138	0,167	Lo < Ltabel	Normal
Control	0,146	0,167		

Based on the results of the normality test in Table 1, the variance value of the experimental group is 0.138, and the variance value of the control group is 0.146. The condition of Lo < Ltable is met with a statistical value (Fcount = 0.167) smaller than the Ftable value. This indicates that the data of both groups have a normal distribution. The Backward Roll movement skills in the experimental and control groups have a proportional distribution and do not differ from the normal distribution, in accordance with the normal distribution of data. Research data in the context of physical education teaching can be considered valid if this normality assumption is met.

A homogeneity test was conducted on the learning outcomes of both classes using the Fisher exact test formula. The calculated Ftable value was 2.52 and Fcal value was 1.84, with a numerator of 2, a denominator of 26, and a significance level of 0.05. Because Fcal < Ftable and 1.84 < 2.52, the data in Table 2 are homogeneous.

Table 2. Homogenity Test Criteria

Group	Variance	FCout	Ftable	Criteria	Description
Eksperimen	143,92				
Control	276,61	1,84	2,52	Fo < Ftabel	Homogen

From the research data, it was obtained that the average score of the gymnastics learning outcomes rolling backward of students in the experimental class was 81.20 with a standard deviation of 13.21. Meanwhile, the average score of gymnastics learning outcomes rolling backward of students in the control class was 70.43 with a standard deviation of 16.45. To determine whether the difference in averages is due to differences in treatment or simply coincidence, further analysis is needed. From the results of the analysis requirements test, which includes the normality test and the homogeneity test, it can be seen that the two learning outcomes of backward rolling gymnastics are in a normal distribution and homogeneous so that they can test the research hypothesis with the t-test.

The results of the t-test calculation in this study were obtained thcount = 3.51 at a significant level of $\alpha = 0.05$ with a degree of freedom (dk) = 26 for a value of 1.70. Because the tcount is greater than the table (3.51 > 1.70) it can be concluded that Ho is rejected and H1 is accepted which shows that the research hypothesis is accepted meaning that there is an Effect of the Application of the Game Based Learning Model on the Learning Outcomes of Gymnastics Rolling Backwards in Grade V Students of SDN 32 Padang. The test results proved that the difference in backward gymnastics learning outcomes that occurred was not a coincidence, but due to the difference in treatment applied to each class. Namely experimental classes that are given treatment with a game-based learning model and control classes that are not given. So that it can be concluded that the classes that are given treatment applied with the game-based learning model have a positive impact on the learning outcomes of gymnastics rolling backwards students to be more active. This can be seen in table 3.

Table 3. T-test criteria

Group	Mean	Sgab	Dk	thit	ttab	Description
Eksperimen	81,20	13,04	28	3,51	1,70	tcount > ttable
Control	70,43					

Table 4. Frequency Distribution of Gymnastics Learning Outcomes Rolling Backwards for control Class Students

Interval	Mean	Real Limits	Frequency Absolute	Frequency Cumulative	Frequency Relative
53 – 59	56	52,5 – 59,5	2	2	7,14 %
60 – 66	63	59,5 – 66,5	3	5	10,71 %
67 – 73	70	66,5 – 73,5	4	9	14,28 %
74 – 80	77	73,5 – 80,5	5	14	17,85 %
81 – 87	84	80,5 – 87,5	7	21	25,00 %
88 – 94	91	87,5 – 94,5	5	26	17,85 %
95 – 101	98	94,5 – 101,5	2	28	7,14 %
Total			28		100 %

The frequency distribution table shows the distribution of rolling backward learning outcomes in the control class with 28 respondents. The highest score was in the 81–87 interval with a frequency of 7 children (25%), indicating that most children were in the middle to upper score category. The 74–80 and 88–94 intervals each had a frequency of 5 children (17.85%), so the score distribution was relatively centered in the 74–94 range. Meanwhile, the lowest score interval of 53–59 and the highest score of 95–101 only had a small frequency (7.14%). In general, this distribution indicates that the children's ability to perform rolling backward movements in the control class was at a sufficient level, with a relatively even distribution of scores but dominant in the middle category.

The frequency distribution of gymnastics learning outcomes in the experimental class, as shown in Table 6, shows a relatively even range of abilities. With a relative frequency of 21.42%, the highest score

intervals were in the 59–67 and 77–86 ranges, respectively. This indicates that most children performed the Backward Roll with moderate to good ability. Only 14.28% of children fell into the lowest score range (41–49).

Table 5. Frequency Distribution of Gymnastics Learning Outcomes Rolling Backwards for Experimental Class Students

Interval Class	Middle Value	Real Limits	Absolutely	Frequency Cumulative	Frequensi Relative
41 – 49	45	40,5 - 49,5	4	4	14,28%
50 – 58	54	49,5 - 58,5	3	7	10,71%
59 – 67	63	58,5 - 67,5	6	13	21,42%
68 – 76	72	67,5 - 76,5	5	18	17,85%
77 – 86	81	76,5 - 85,5	6	24	21,42%
87 – 94	90	85,5 - 94,5	4	28	14,28%
Quantity			28		100%

This distribution indicates that after participating in physical education lessons, most children in the experimental class had achieved a high level of skill mastery. Overall, the distribution pattern tends to increase in the moderate to high score range, indicating that the use of game-based learning can help children become skilled at gymnastics.

The results of the study showed that the use of game-based learning strategies can improve children's ability to perform backward rolls. Most children in the experimental group obtained scores in the mid- to high-range, indicating improved motor skills after participating in game-based learning. This suggests that game-based learning can increase children's engagement and encourage active participation in the learning process (Alotaibi, 2024; Ruiz et al., 2024). In the context of physical education learning, game activities also provide opportunities for children to practice motor coordination, balance, and muscle strength in a more natural and enjoyable way (Chaeroni et al., 2023; Rasyid et al., 2024).

Physical education learning requires strategic innovation to make the learning process more effective and improve children's learning outcomes. This aligns with previous research findings showing that improved learning outcomes in physical education are significantly influenced by the use of innovative and engaging learning models (Awaluddin & Imran, 2025). One effective approach is integrating games into the learning process, which has been shown to increase student engagement, strengthen learning motivation, and positively impact learning outcomes (Septianing et al., 2024). Furthermore, a game-based learning model utilizes game elements as part of a learning strategy, making the learning process more enjoyable and meaningful (Alotaibi, 2024; Li & Zhang, 2025). According to Wiseza et al., (2023), a game-based learning model is designed by integrating fun activity components throughout the learning process, creating an effective learning environment while simultaneously helping to deliver material more accurately and more easily understood by students.

The main finding of this study was that the experimental class implementing a game-based learning model received higher scores because it trained students to be good recipients of material, increased students' interest and motivation in learning, increased students' active participation in the learning process, facilitated teacher-child interactions, and fostered sportsmanship in students. Furthermore, this study found that children can gradually understand the mechanics of movement by using toys such as balls placed on the tips of their toes during backward rolls (Aktifa et al., 2021). During the backward roll, these materials serve as tools to improve coordination between the head, body, and legs. This reduces the anxiety often experienced when attempting backward rolls and allows children to learn gymnastics movements more systematically.

This research was well-conducted, but there are several caveats that the researchers need to address. These include the study's conclusions not being widely applicable due to the small number of participants, the study only testing one gymnastics skill, the backward roll, and the inability to explain how game-based learning impacts other gymnastics skills. Furthermore, children's skill improvement may have been affected by the very short duration of the intervention. To gain a more complete picture of the effectiveness of game-based learning in physical education, it is recommended that future

studies use larger sample sizes, extend the intervention period, and analyze a variety of different gymnastics skills.

Conclusions

The conclusion of this study indicates that the implementation of a game-based learning model significantly improved the learning outcomes of 11-12-year-old children at SDN 32 Padang, particularly in the backward roll exercise topic in Physical Education. The results showed an increase in children's learning outcomes after the model's implementation, as indicated by an increase in children's scores from below the Minimum Completion Criteria (KKM) to reaching or exceeding the established standard. These findings demonstrate that the use of innovative and enjoyable learning approaches can create a more effective learning experience for children.

The game-based learning model not only improves cognitive and psychomotor learning outcomes but also encourages children's active involvement in the learning process. Through play activities, children become more motivated to participate, practice movements repeatedly, and develop collaboration with peers. This demonstrates that an interactive and enjoyable learning environment can support the mastery of movement skills in gymnastics. This study emphasizes the importance of teachers' role in designing and managing creative learning to create a conducive and participatory learning environment.

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