THE EFFECT OF GAME-BASED LEARNING MODEL ON STUDENT LEARNING OUTCOMES IN THE SUBJECT OF SCIENCES IN GRADE IV OF STATE ELEMENTARY SCHOOL 040544 DOLAT RAYAT

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ABSTRACT

Science learning in elementary schools is often teacher-centered, leading students to be less active, quickly bored, and to experience suboptimal learning outcomes. This study aims to determine the effect of the Game-Based Learning model on the learning outcomes of fourth-grade students in Science at SD Negeri 040544 Dolat Rayat. The study used a quantitative, quasi-experimental design with a pretest-posttest control group. The research sample comprised 36 students: 20 in the experimental class and 16 in the control class. The main instrument was a 20-item learning outcome test that had undergone validity and reliability testing, with pretest reliability of 0.721 and posttest reliabilities of 0.681 and 0.723 for standardized items. Data analysis was carried out descriptively and inferentially using the Shapiro-Wilk normality test, the homogeneity test, the paired-samples t-test, and the independent-samples t-test. The results showed that the experimental class's average score increased from 52.75 to 86.05, while the control class's average score increased from 62.19 to 76.94. The hypothesis test shows a significance value of 0.000 and 0.001, as well as the independent-samples t-test post hoc test with a significance value of 0.000, indicating a significant effect of the Game-Based Learning model on students' science learning outcomes.

Keywords: game-based learning, learning outcomes, science, elementary school, quasi-experiment

ABSTRAK

Pembelajaran IPAS di sekolah dasar masih sering berpusat pada guru sehingga siswa kurang aktif, cepat bosan, dan hasil belajar belum optimal. Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran Game Based Learning terhadap hasil belajar siswa mata pelajaran IPAS kelas IV SD Negeri 040544 Dolat Rayat. Penelitian menggunakan pendekatan kuantitatif dengan desain quasi experimental berupa pretest-posttest control group design. Sampel penelitian berjumlah 36 siswa, terdiri atas 20 siswa kelas eksperimen dan 16 siswa kelas kontrol. Instrumen utama berupa tes hasil belajar 20 butir soal yang telah melalui uji validitas dan reliabilitas, dengan reliabilitas pretest 0,721 dan posttest 0,681 serta 0,723 pada standardized items. Analisis data dilakukan secara deskriptif dan inferensial melalui uji normalitas Shapiro-Wilk, uji homogenitas, paired sample t-test, dan independent sample t-test. Hasil penelitian menunjukkan bahwa rata-rata nilai kelas eksperimen meningkat dari 52,75 menjadi 86,05, sedangkan kelas kontrol meningkat dari 62,19 menjadi 76,94. Uji hipotesis menunjukkan nilai

signifikansi 0,000 dan 0,001, serta uji independent sample t-test posttest sebesar 0,000, sehingga terdapat pengaruh signifikan model Game Based Learning terhadap hasil belajar IPAS siswa.

Katakunci : game based learning, hasil belajar, ipas, sekolah dasar, quasi eksperimen

A. Introduction

Education is one of the most fundamental aspects of being human. Education is not only about school or formal education, but also about how an individual learns something.(Nurisma, 2021)Lifelong education does not consider age a benchmark for acquiring new knowledge. In lifelong education, everyone has the right to receive education until the end of their lives. As time passes, something new and developing occurs in society.(Khairani & Gusmaneli, 2024)(Nurisma, 2021) Lifelong education is an educational concept that describes the entire process of teaching and learning throughout a person's life. This education allows for alternative patterns and forms of education. It forms a comprehensive system that improves literacy and basic skills, enhances thinking skills, and helps children learn to think critically and develop a vision for the future.(Hudin et al., 2024)

According to Ahmad Tafsir, the foundations of education must be designed and firmly established. Therefore, the foundations of education are the perspectives that underlie all educational activities, including the development of theories, planning, implementation, and organization of education.(Aziz, 2021)Education, as a systematic, conscious endeavor, always stems from several specific principles. These foundations and principles are crucial because they are the main pillars of a nation's development of its people and society. Some of these educational foundations, including philosophical, sociological, and cultural, play a crucial role in determining educational goals.

Moreover, scientific and technical underpinnings will advance education into the future. Examining these diverse educational foundations can cultivate a comprehensive view of education. Initiatives to cultivate humanity via education are conducted

in alignment with the worldview and socio-cultural context of each specific community. Consequently, while education is universal, distinct variations emerge based on various worldviews and socio-cultural contexts. In essence, education is structured according to the philosophical principles of life and the socio-cultural underpinnings inherent in each community, including Indonesia.(Adib, 2024)(Bahri, 2024)(I. K. Sari & Siregar, 2021)

In the author's opinion, education is a conscious, planned process designed to help students realize their full potential. Through education, students not only acquire knowledge but also learn how to behave and interact with their surroundings. Education focuses not only on academic learning outcomes but also on character and personality development, enabling students to become independent, responsible, and beneficial members of society.

The Natural and Social Sciences (IPAS) subject in elementary school requires students to understand abstract concepts and relate them to everyday phenomena.(Y. P. Sari, 2023)(Amelia et al., 2025) However, in practice, science learning is often conventional and teacher-centered, leaving students less active and quickly bored. As a result, student learning outcomes in Science have not reached optimal levels.(Happyliya, 2025)(Farhan & Soleh, 2025).

One key skill that can be developed through game-based learning is critical thinking. Wouters et al. (2013) state that educational games allow students to explore, analyze, and solve problems in a safe learning environment.(Wouters et al., 2013)Research findings suggest that a lack of access to technology can limit the full potential of game-based learning. Furthermore, educator resistance to changes in teaching methods is also a barrier, particularly due to the lack of available training and technical support(Hébert et al., 2021); (Knight, 2025).

Monotonous and teacher-centered learning methods are among the causes of low student interest. These methods discourage students from actively participating in the learning process.(Niken et al., 2025)Fitriati, Ardiansyah, and Handayani (2021) stated that this method can make the learning environment more engaging and encourage students to participate in

the learning process actively. By incorporating game elements such as point challenges and rewards, this method has been shown to improve students' abilities and increase their engagement in learning.(Rifqah & Handayani, 2025) Through this approach, students are actively involved in problem-solving activities packaged as educational games that align with learning objectives.(Rifqah & Handayani, 2025)

Game-based learning has substantial benefits in elementary education, such as enhanced student motivation, engagement, and retention. A recent meta-analysis by Alotaibi (2024) indicates that game-based learning significantly influences the cognitive, social, and emotional development, motivation, and engagement of early childhood pupils. (Tavares, 2022) discovered that game-based learning surpassed traditional techniques in enhancing knowledge retention, motivation, and meaningful learning.

The interactivity, challenges, and immediate feedback systems in game-based learning create an active and enjoyable learning environment, enabling students to be more engaged and retain their learning in the long term. Furthermore, game-based learning also supports the strengthening of positive character traits such as cooperation, sportsmanship, honesty, and responsibility. In-game scenarios often challenge students to work together, make moral decisions, and reflect on their actions.

These elements use game-based learning to provide a foundation for contextually and naturally internalized character development rather than through direct instruction. However, the design and implementation of game-based learning also have limitations that require serious consideration. First, designing educational games requires a significant investment in time, effort, and funding; this is a particular obstacle for schools with limited resources.(Hu, 2024)(Tian et al., 2026). In addition, Alotaibi (2024) noted that issues such as age-appropriate design and time constraints for game use during class hours pose practical challenges in implementation.

Another risk that often arises is distraction, where students can focus too much on game elements (attractive visuals, scores,

leaderboards), losing focus on the core learning material, or the experience becomes shallow and unreflective.(Liu et al., 2025)This reflects the importance of pedagogical design that aligns fun elements with authentic, meaningful learning objectives. In summary, although game-based learning has great potential to support elementary school students' engagement, motivation, retention, and character development, its effectiveness depends heavily on the quality of its design, the availability of resources, and the ability to maintain a balance between fun learning experiences and fundamental educational objectives. Careful implementation with infrastructure support and teacher training is crucial to maximize benefits while minimizing risks.(Westera, 2019)(Ragni et al., 2023)(Alotaibi, 2024).

According to Nana Sudjana, learning outcomes result from a learning process using measurement tools, namely tests designed in a planned manner, including written, oral, and performance tests. Nasution argues that learning outcomes are changes in individuals who learn, not only knowledge, but also skills and appreciation. Learning outcomes are the results students achieve after studying a particular subject, expressed as quantitative and qualitative data. To assess learning outcomes, an assessment is conducted to determine whether students have mastered the material. Assessment is a systematic effort developed by an educational institution to ensure the quality of the educational process and students' abilities, in accordance with the established objectives.(Yusuf, 2021)(Harahap et al., 2023).

The aforementioned phrases indicate that learning outcomes refer to the competencies or skills acquired by students following participation in educational activities, as evidenced by research conducted by Miftahul Anisa and Amri Amsal Nurfadilah on fourth-grade students at UPT SDN Manuruki, Makassar City. The findings indicated a notable enhancement in student learning motivation following the adoption of the game-based learning approach, with an average post-test score of 85.65%. The hypothesis test yielded a significance value (Sig. 2-tailed) of 0.000, which is less than 0.05, resulting in the rejection of Ho and the acceptance of H1. Consequently, it can be inferred that

the game-based learning approach substantially impacts students' learning motivation. These findings suggest that game-based learning fosters a more engaging and dynamic educational experience, promoting active student participation in the learning process. This research advances the creation of unique educational methodologies for application in primary schools, specifically aimed at enhancing motivation in science topics (Anisa & Amri Amal, 2025).

Based on observations and interviews with the fourth-grade science teachers at SD Negeri 040544 Dolat Rayat, it was found that the current science learning process remains teacher-centered. The material that makes it difficult for students to understand also leads to boredom, making it difficult for teachers to choose appropriate learning models. Some students tend not to pay attention to learning and instead get busy with other activities, so they cannot learn well. Based on the researcher's interviews with students, they stated that they did not like science learning because the material was difficult. Some students also stated that they, and others, did not understand the previous lesson but had already moved on to the next material. This is what makes students increasingly bored with science learning. The teacher also only gave a few practice questions when explaining, but students had difficulty with a variety of questions during the test. Therefore, students had difficulty and confusion when working on the test questions. Therefore, this study will examine "The Effect of Game-Based Learning Models on Student Learning Outcomes in the Fourth-grade Science Subject of SD Negeri 040544 Dolat Rayat".

B. Research methods

Research design

This research employed a quantitative, quasi-experimental approach featuring a pretest-posttest control group. This design was employed due to the study's inclusion of two groups receiving pre- and post-tests, specifically the experimental and control classes, although the researcher did not implement individual-subject randomization. Initially, both groups had a pre-test to assess pupils' baseline competencies. The experimental group was subjected to Game-Based Learning,

whereas the control group had traditional instruction via lectures. Following therapy, both groups underwent a post-test to evaluate alterations in student learning outcomes. This strategy enables researchers to discern enhancements in learning outcomes within each group by contrasting pretest and posttest scores. The pretest-posttest control-group approach is suitable for investigating the impact of the Game-Based Learning paradigm on the science learning outcomes of fourth-grade students.

Participants and sampling techniques

Participants in this study were all fourth-grade students of SD Negeri 040544 Dolat Rayat in the odd semester of the 2025/2026 academic year. Based on the research document, the population consisted of two classes: class IVa with 20 students and class IVb with 16 students, for a total of 36 participants in this study. All fourth-grade students were used as research subjects because the population was relatively small and all available classes were relevant to the research objectives.

The sampling technique used was probability sampling, as stated in the research document, involving all fourth-grade students as research samples. In its implementation, the research sample was drawn from two existing classes, namely IVa and IVb. Class IVa was designated as the experimental class that received learning using the Game-Based Learning model, while Class IVb was designated as the control class that received conventional learning. Selecting all members of the population as the sample indicates that this study uses a total sample within the population studied, so the results are expected to more fully describe the real conditions of the research subjects in the school context.

Research instruments

The main instrument used in this study was a learning outcome test. The test was administered in two stages: a pretest before the treatment and a posttest after the treatment. The pretest measured students' initial abilities before the Game-Based Learning model was implemented, while the posttest assessed student learning outcomes after the learning process. The use of these two types of

tests allowed researchers to assess changes in learning outcomes resulting from the treatment given to the experimental class and compare them with those of the control class.

The learning outcome test is structured around a grid based on fourth-grade science material, specifically on Force, its effects on objects, magnets, elastic objects, and gravitational Force. Research documents show that the instrument consists of 20 questions distributed into the cognitive domain of Bloom's Taxonomy at levels C3, C4, C5, and C6. This composition indicates that the instrument not only measures simple understanding skills, but also includes application, analysis, evaluation, and creation skills. Thus, the instrument has been designed to provide a more comprehensive picture of student learning outcomes in the cognitive domain.

In addition to tests, documentation is also used as a supporting research instrument. Documentation is used to supplement research data, including subject conditions, learning implementation, and student learning outcomes. To ensure the instrument is suitable for use, the research document explains that its validity and reliability must be tested first. The results of the validity test indicate that, of the 20 items tested, 10 were declared valid in the pretest and 10 in the posttest. Validity was determined by comparing the calculated value with a table of approximately 0.388; the item is considered valid if the calculated value exceeds the table value. Thus, items that meet the validity criteria are declared suitable for use as research instruments.

The reliability test results indicate that the instrument has adequate internal consistency. In the pretest, the Cronbach's Alpha value for item analysis was approximately 0.721, indicating quite good reliability. Meanwhile, in the posttest, Cronbach's Alpha was 0.681, and the standardized-item Alpha was 0.723. Alpha values within this range indicate that the instrument has sufficient reliability and can be used in research data collection.

Data analysis techniques

Descriptive and inferential analyses were implemented on the research data. Utilizing pretest and posttest scores, descriptive analysis was implemented to evaluate student

learning outcomes in both the experimental and control groups. The objective of this analysis is to provide a concise summary of the trends in student learning outcomes both before and after the intervention, thereby allowing researchers to identify patterns of change within each group. The data was analyzed using precondition tests before entering the hypothesis testing phase. The Shapiro-Wilk test was performed to determine the normality of the data, as the sample sizes in each group were less than 50 students. IBM SPSS Statistics 22 was employed to conduct the test at a significance level of 0.05. The objective of this test is to determine whether the learning result data in the experimental and control classes follows a normal distribution. A homogeneity test was carried out to determine whether the variances of the two data categories were homogeneous. The data are considered homogeneous and meet the criteria for subsequent analysis using parametric tests if the significance value exceeds 0.05. Hypothesis testing was conducted using independent and paired-sample t-tests after the normality and homogeneity criteria were met. The experimental and control groups were compared using the independent sample t-test to determine any discrepancies in their learning outcomes. To evaluate the differences in pretest and posttest scores within the same group, specifically in the experimental class following the implementation of the Game-Based Learning model, a paired-samples t-test was implemented. The null hypothesis would be rejected in favor of the alternative hypothesis if the p-value was less than 0.05, as stipulated by the decision-making criteria. The null hypothesis was adopted and the alternative hypothesis was rejected if the significance value exceeded 0.05. The impact of the Game-Based Learning model on students' science learning results was quantitatively assessed by researchers using this analytical method.

C. Results and Discussion

Research result

The study found an increase in science learning outcomes in both groups, with the experimental group showing a higher increase than the control group. This can be seen in Table 1:

Table 1. Pretest and posttest results and descriptive statistics

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Experimental pretest	20	30	70	52.75	10,818
Experimental posttest		80	92	86.05	3,649
Pretest control	16	40	80	62.19	12,106
Posttest control		67	89	76.94	5,904

The experimental class consisted of 20 students, as indicated by the descriptive analysis. The experimental class's pretest score was an average of 52.75 with a standard deviation of 10.818, ranging from 30 to 70. The experimental class's posttest score, which ranged from 80 to 92 after treatment, had an average of 86.05 and a standard deviation of 3.649. The standard deviation illustrates the extent to which the data deviates from the average, whereas the average delineates the overall trend of student scores.

The sample size in the control class was 16 students. The pretest scores in the control class were 40–80, with an average of 62.19 and a standard deviation of 12.106. At the same time, the control class's posttest scores varied from 67 to 89, with an average of 76.94 and a standard deviation of 5.904. The posttest's lower standard deviation suggests that the distribution of student scores is more homogeneous, or more concentrated around the average, than it was in the pretest.

Descriptively, the average learning outcomes of both the experimental and control classes increased from the pretest to the posttest. Nevertheless, the experimental class exhibited a greater average increase, rising from 52.75 to 86.05, compared to the control class, which saw an increase from 62.19 to 76.94. Additionally, the experimental class's posttest scores were higher than those of the control class, suggesting that the treatment resulted in enhanced student learning outcomes.

Additionally, the homogeneity test demonstrated that the data variances among the groups were homogeneous. The mean-based Levene's significance value in the pretest was 0.574, while in the posttest it was 0.332. Both values were greater than 0.05, thereby

satisfying the homogeneity assumption and qualifying for additional parametric analysis.

Table 2. Results of the Shapiro-Wilk normality test

Data	N	Sig.	Decision
Pretest control	16	0.204	Normal
Experimental pretest	20	0.313	Normal
Posttest control	16	0.271	Normal
Experimental posttest	20	0.224	Normal

The Shapiro-Wilk normality test showed that all data were normally distributed, as the p-values in each group were greater than 0.05.

Table 3. Results of the homogeneity test

Data	Levene Statistics	Sig.	Decision
Pretest control and experiment	0.322	0.574	Homogeneous
Posttest control and experiment	0.969	0.332	Homogeneous

Furthermore, the results of the homogeneity test indicate that the variances are homogeneous across the pretest and posttest scores, so the requirements for parametric hypothesis testing have been met.

Hypothesis testing

Table 4. Results of the independent sample t-test

Data pair	Initial mean	Final mean	Standard Deviation	Sig. (2-tailed)	95% CI Upper	95% CI Lower	Sig. (2-tailed)
Pretest Posttest (experiment)	52.75	86.05	5,904	0.000	-5,856	-12,369	0.001
Pretest Posttest (control)	62.19	76.94	3,649	0.001			

Independent sample t-tests and paired sample t-tests were implemented to evaluate hypotheses. The experimental and control classes showed a significant difference between pretest and posttest scores in the paired-samples t-test results, with p-values of 0.000 and 0.001, respectively. This suggests that the learning outcomes of students in both categories were significantly enhanced.

Additionally, the posttest value's significance value (2-tailed) was 0.000 in the independent sample t-test, indicating that it is less than 0.05. In

the experimental class, the 95% confidence interval is in the range of -12.369 to -5.856 and does not include the number zero, which further confirms the statistical significance of the improvement in learning outcomes following the treatment. A negative sign in the interval indicates that the pretest score is lower than the posttest. These findings suggest that there is a substantial disparity in the learning outcomes of students who utilize the Game-Based Learning model and those who receive conventional instruction. The Game-Based Learning model's substantial impact on fourth-grade students' science learning outcomes at SD Negeri 040544 Dolat Rayat is attested to by the experimental class's higher average posttest score in comparison to the control class.

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D. Discussion

The results of this study are to analyze how the results of students' social studies learning before and after using the Game-Based Learning learning model and the influence of the Game-Based Learning learning model on the Independent Curriculum to improve the results of students' social studies learning in grade IV of SD Negeri 040544 Dolat Rayat. To determine whether there is a difference in student learning outcomes after the application of the Game-Based Learning model and before it was implemented, the study compared the percentage of graduates meeting the Minimum Completion Criteria (KKM) for the experimental and control classes. In the Independent curriculum, the completion of learning outcomes is no longer measured by the Minimum Completion Criteria (KKM) in terms of quantitative values. The criteria for students' eligibility to advance to the next level or class are set by teachers and educational units. Based on the decisions of teachers and educational units at SD Negeri 040544 Dolat Rayat, the KKM for social studies is 75.

The findings of this study indicate that the percentage of students in the experimental class who surpassed the KKTP (Criteria for Achieving Learning Objectives) in their Pre-test scores is 0%. Following the implementation of the Game-Based Learning approach, the students achieved a 100% score on the Post-test questions. In the control group, students achieved a score of 12.5%

on the Pre-test; following standard instruction, their scores rose to 75% on the Post-test. The findings of the experimental class are superior than those of the control class.

The average Pre-test score for the experimental class is 52.75%, while the average Post-test score for 20 pupils is 86%. The average pre-test score of the control class is 62.18%. The learning outcomes of grade IV students who employ the Game-Based Learning paradigm are significantly different from those who do not, as evidenced by the average post-test score of 76.93% for 16 students. This discrepancy serves as an illustration of the influence of the Game-Based Learning paradigm on the scientific learning outcomes of students.

The results of the hypothesis test using the Paired Sample t-test and Independent Sample t-test, conducted with IBM SPSS statistical software version 22, indicate that if the significance value is 0.00 < 0.05, then Ho is rejected and Ha is accepted. The test results show a significant difference in the learning outcomes of students in Science who use the Game-Based Learning model and those who do not.

Changes in student learning outcomes are influenced by the implementation of the Game-Based Learning model, which encourages students to think more critically and become more active in class. Furthermore, students become more skilled and creative in answering various types of questions. Learning outcomes are the goal of this learning process. It is important to note that, in addition to cognitive factors, other factors can influence learning, including internal and external factors originating within and outside the student.

Research by Fani Anggita Lubis, Khoirun Nisa Lubis, and Nirwana Anas at SDN 060811 Medan indicates that critical thinking is a cognitive result of the students' learning process. The use of learning models to enhance students' critical thinking must be both successful and interesting. This study aimed to investigate the impact of game-based learning on students' critical thinking in the Science topic, specifically regarding Force, at SDN 060811. The study employed a quantitative

methodology, incorporating both experimental and quasi-experimental designs. The tool employed in this research was a descriptive assessment. This study implemented several treatments to the experimental and control groups. The subjects were courses IVA and IVB of SDN 060811. Both the control and experimental classes comprised 35 individuals, and both successfully completed the pretest and posttest assessments. This study employed t-test data analysis, revealing a beneficial impact of the game-based learning model on the treatment. (Lubis et al., 2022).

From the explanation above, it can be concluded that the factors influencing student learning outcomes in this study originate from outside the individual (the student) and are external. External factors here refer to the student's learning environment, specifically the school environment. Teachers must encourage students to think critically and actively during learning to improve student learning outcomes. One way to encourage critical and active thinking in learning is by selecting a learning model that is appropriate to their needs.

E. Conclusion

The results of students' science learning utilizing the Conventional Learning Model and the Game-Based Learning Model have improved. The Pre-test scores of experimental class pupils that exceeded the KKTP (Learning Objective Achievement Criteria) were 52.75%. The post-test scores of 20 students increased to 86% after learning using the Game-Based Learning model. Students in the control cohort achieved a score of 62.18% on the Pre-test. The post-test scores of 16 students increased to 76.93% after conventional learning. This demonstrates that the experimental class achieves superior learning outcomes in comparison to the control class. The experimental group's pretest-posttest difference was statistically significant (0.000 < 0.05), indicating that the Game-Based Learning model's material in class IV at SD Negeri 040544 Dolat Rayat has an impact on students' learning outcomes. Therefore, H0 is rejected, and Ha is accepted.

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