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The Effect of Gamification Method on Mathematics toward Students Achievement of Fifth-Grade in Elementary Students

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Abstract

The use of gamification in elementary mathematics instruction requires further examination to clarify its contribution to student achievement. This study examined the effect of gamification on the mathematics achievement of fifth-grade students at SD Negeri 7 Salotungo, Soppeng Regency. A quantitative approach was employed using a quasi-experimental nonequivalent control group design. Participants comprised 25 students from Class V.A as the experimental group and 23 students from Class V.B as the control group. Data were collected using an achievement test and analyzed through descriptive statistics and an independent-samples t-test. Descriptive results showed that the experimental group's mean achievement score increased from 48.2 before the intervention to 76.4 after its implementation. The independent-samples t-test indicated a statistically significant difference between the groups (two-tailed $p = .011$). These findings suggest that gamification has potential to support mathematics achievement among fifth-grade students in this setting. The study contributes contextual evidence to research on gamification in elementary mathematics education and informs the consideration of interactive instructional strategies. Its practical implications concern the use of game mechanics, including points, levels, and leaderboards, to structure mathematics learning activities. Further research should investigate the long-term effects of gamified instruction and its application across other mathematical topics.

Keywords: Gamification; Mathematics Achievement; Elementary Education; Mathematics Instruction; Quasi-Experimental Design

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INTRODUCTION

Mathematics plays a fundamental role in human life and serves as the foundation for the development of technology and science. However, in reality, the mathematical abilities of students in Indonesia are currently still concerning, as shown by the PISA 2022 data where Indonesia ranks 64th out of 81 countries with an average score of 366 (OECD, 2023). In line with Angriani et al., (2024) the low mathematics score of Indonesian students indicates that many students experience difficulties in understanding and practicing mathematical principles in daily activities. This proves the existence of a serious problem regarding basic mathematical skills and achievements among Indonesian students.

Low student learning achievement is caused by several factors. Yandi, et al., (2023) various factors can cause optimal student learning achievement not to be reached, such as a lack of practice, unsupportive learning environments, and teaching methods that are less attractive and do not foster active student participation in learning activities.

Based on these conditions, interventions are needed in the mathematics learning process to obtain better learning achievement. Learning dominated by the teacher's role and oral delivery tends to make students passive and cause them to experience difficulties when facing the challenge of understanding abstract concepts. Therefore, the selection of an appropriate learning method can be an alternative solution to improve the quality of learning. The learning method occupies a vital position in improving students' mathematical understanding. In the learning process, the application of traditional learning methods tends to make students bored and passive, whereas the application of an attractive learning method can easily ensure that the material provided by educators is optimally understood by students (Sabitafh & Bachtiar 2025).

The game elements utilized within it position the gamification method as one of the strategies that can be employed to enhance learning achievement (Tyaningsih et al., 2022). Nooviar, et al., (2024) By creating an active learning atmosphere, gamification is capable of delivering a significant impact on students' participation, motivation, and learning achievement. Consequently, this method can serve as an effective solution to overcome the learning difficulties that students encounter. In line with this, Farida et al., (2018) state that gamified learning assists students in understanding the material thoroughly. Furthermore Rahmadania et al., (2025) the presence of gamification elements successfully engages students and increases their interest in the learning process.

A number of previous studies indicate that the use of varied learning methods can significantly improve learning achievement. Research by Kusumadewi, et al., (2025) demonstrates that compared to conventional methods, gamification is proven to have a significant impact on student learning achievement in mathematics. In line with that, Zebua et al., (2024) states that one of the learning methods that can be used to improve student learning achievement is the gamification learning method. Furthermore, the research results of Sultan et al., (2025) indicate that the application of the gamification method in the learning process results in better learning achievement than before applying the gamification method.

However, the majority of existing studies still focus on the application of the gamification method to Natural and Social Sciences (IPAS) subjects. Research that specifically examines the application of the gamification method to mathematics learning materials, particularly the perimeter of flat shapes at the elementary school level, is still very limited. In fact, the perimeter of flat shapes material requires visualization and intensive practice, which often triggers learning confusion if taught conventionally. Based on this, further research is needed to determine the effect of the gamification learning method on improving the mathematics learning achievement of elementary school students.

The element of novelty in this study lies in the use of gamification elements in teaching the perimeter of flat shapes, where perimeter formulas that are usually memorized monotonically are transformed into game-based challenges. In addition, there is the inclusion of several gamification elements from the beginning to the end of learning, such as avatars, challenges, and surprises. The theoretical foundation of this study rests on Jean Piaget's theory of cognitive development, which states that elementary school students are at the concrete operational stage. This indicates that the learning process at the elementary school level should integrate real activities and direct learning experiences for students. Furthermore, students at the elementary school age have an active nature, like games, possess great curiosity, and have an interest in socializing with peers (Arifin et al., 2026). In line with the opinion of Legowo & Ageng (2022) elementary school students cannot be separated from play activities. Therefore, the application of gamification in learning becomes an innovation that empowers unique and beneficial play characteristics to the maximum extent for the student learning process.

Based on the explanation above, this study focuses on analyzing the effect of the gamification learning method on mathematics flat shape material. The purpose of this study is to describe the profile of students' mathematics learning achievement regarding the perimeter of flat shapes material in grade V before and after treatment, and to test the effect of applying the gamification method to the mathematics learning achievement of grade V elementary school students.

METHODS

A quantitative approach was chosen for this study with a quasi-experimental research design. Santoso & Madiistriyatno (2021) explain that a quantitative approach involves the collection and analysis of numerical data for description and explanation, which can be used as information in drawing conclusions and making decisions. Furthermore Priyono (2016) states that experimental research can be conducted in various settings, ranging from the field to the laboratory. Researchers have full control over the variables in the study to test specific hypotheses.

This study applied a quasi-experimental design in the form of a nonequivalent control group design. This research design uses two groups, namely the group that receives special treatment (experimental) and the comparison group (control). These two groups were not selected randomly. Both groups were given an initial test (pretest) before treatment (Arib et al., 2024).

The location of this study was SD Negeri 7 Salotungo, Soppeng Regency. The samples consisted of students in classes V.A and V.B at SD Negeri 7 Salotungo. Class V.A, acting as the experimental class, had 25 students, and class V.B, acting as the control class, had 23 students. Sampling was conducted using the purposive sampling technique. Khoiroh & Anam (2026) state that purposive sampling is a sample selection technique that takes into account special requirements or considerations.

Data collection through the test technique was carried out by administering test instruments to students, which contained a set of questions or problems Anwar, et al., (2021). The test used was a multiple-choice test consisting of 40 items (20 pretest items to measure initial ability and 20 posttest items to measure final achievement). Instrument validation was performed logically through content validity by material experts before the test was administered. The gamification treatment procedure in the experimental class was

implemented through group division (avatars), gradual worksheet completion (levels), a 7-minute time limit for tasks (challenges), score accumulation (points), teacher surprises, as well as rank rendering (leaderboards) and badge distribution (rewards/badges).

The data analysis techniques used included descriptive statistics and inferential statistics. Descriptive statistics were used to find the mean, mode, median, range, standard deviation, and N-Gain score, while inferential statistics were used for hypothesis testing. (Alfianti & Kartikasari, 2023) explains that inferential statistics are statistical procedures aimed at analyzing population data based on empirical evidence from representative samples collected through the research process. Amalia et al., (2025) states that descriptive statistics are statistical methods aimed at summarizing, presenting, and describing the basic characteristics of a sample based on the data obtained in the study, such as the mean, mode, and median. The data prerequisite tests included the Shapiro-Wilk normality test and Levene's homogeneity of variance test. Furthermore, hypothesis testing was carried out through the Independent Sample T-test with the help of SPSS version 27 software.

RESULTS

The results showed a difference in the learning achievement of students involved in the application of the gamification learning method and students involved in conventional learning. The mathematics learning achievement of the experimental class students before being given treatment (pretest) had an average score of 48.2. However, after the implementation of the gamification learning method (posttest), the average score of student learning achievement jumped drastically to 76.4, dominated by the "Very Good" category with 11 students. On the other hand, the control class taught with conventional methods only showed an increase in the average score from 50.8 (pretest) to 64.78 (posttest).

In addition, the test results showed that the t_{value} was greater than the t_{table} (2.655 > 1.679), which led to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1). Thus, it was concluded that the application of the gamification learning method had a significant effect on the mathematics learning achievement of grade V students.

Table 1. Descriptive Statistics of Students' Mathematics Learning Achievement in Grade V

Statistics	Statistical Value			
	Pretest Experimental	Pretest Control	Posttest Experimental	Posttest Control
Samples	25	23	25	23
Mean	48.2	50.8	76.4	64.78
Median	45	55	75	65
Mode	20 and 40	60	75	45
Range	65	55	35	65
Standard Deviation	19.84	18.50	10.85	20.08
Maximum	85	80	95	95
Minimum	20	25	60	30

As shown by Table 1, there is a clear difference in learning achievement, with the experimental class achieving higher scores compared to the control class.

Table 2. Results of the Independent Sample T-tes

		Df	Sig (2-tailed)
Learning Achievement	*Equal Variances Assumed*	46	0.011

As shown by Table 2, the significance value is less than 0.05, thereby indicating a significant difference between the experimental class and the control class.

Although the learning achievement of students in the experimental group was superior, some individuals still achieved scores below the established average value. This occurrence is hypothesized to be influenced by variations in students' basic competencies and their level of engagement in the learning process.



Figure 1. Gamification Learning Flow

Based on Figure 1, the implementation of the gamification learning method in the experimental class was carried out systematically through four main stages:

1. Focused on classroom conditioning and the formation of heterogeneous groups. At this stage, each group was directed to establish a team identity and select a group avatar.
2. Students faced a series of problem-solving missions regarding the perimeter of flat shapes. The group worksheets were designed progressively (leveling) with increasing levels of difficulty, accompanied by a challenge element in the form of a 7-minute time limit for each level.
3. Direct evaluation of students' work. Groups that successfully completed the missions quickly and accurately received accumulated points and badges. The teacher also introduced a surprise element in the form of sudden bonus points to sustain the students' extrinsic motivation.
4. Marked by updating and displaying the leaderboard at the front of the classroom to appreciate group performance, followed by the distribution of rewards.

DISCUSSION

The findings of the study reveal that the application of the gamification learning method has an impact on students' mathematics learning achievement in grade V. The application of game elements in mathematics learning makes the learning process interesting and challenging. Through the integration of avatar elements and gradual challenges (levels), students no longer view the perimeter of flat shapes formulas as a monotonous memorization task, but rather as a game mission that must be solved. Manipulative activities within these challenge levels serve as a concrete bridge that matches the cognitive development stage of elementary school-aged students. In addition, the system of points, badges, and surprises from the teacher successfully triggered students' intrinsic motivation. This statement is supported by the difference in the average learning achievement of students between the experimental class and the control class, as well as the independent sample t-test which shows that the that the t_{value} was greater than the t_{table} (2.655 > 1.679), which led to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1).

These findings are in line with the research of Kusumadewi, et al., (2025) demonstrates that compared to conventional methods, gamification is proven to have a significant impact on student learning achievement in mathematics. In line with that, Zebua et al., (2024) states that one of the learning methods that can be used to improve student learning achievement is the gamification learning method. Furthermore, the research results

of Sultan et al., (2025) indicate that the application of the gamification method in the learning process results in better learning achievement than before applying the gamification method.

In addition to being consistent with those previous studies, the results of this study also provide empirical confirmation of the theoretical foundation used. Based on Jean Piaget's theory of cognitive development, grade V elementary school students are at the concrete operational stage, where they need physical representations and direct experiences to understand abstract concepts like flat shape perimeter formulas. The integration of gamification elements in the form of gradual challenges (levels) and game-based manipulative activities successfully concretized the material, making it easier for students to internalize compared to the conventional expository approach used in the control class.

This study enriches the literature on playful learning models, specifically for mathematics topics that are often considered abstract and intimidating by elementary school students. These results prove that game mechanics do not merely function as entertainment, but can be integrated as cognitive tools that facilitate mathematical understanding.

For educators in elementary schools, this study provides an applicable alternative strategy to overcome low student engagement. The application of gamification components such as avatars, leaderboards, and points is proven effective in increasing learning motivation. For educational institutions, these results can serve as a basis for designing competency development training for teachers to design innovative, gamification based learning instruments.

Despite showing a significant effect, this study has several limitations that need to be considered. The research was only conducted over a short term on one specific topic, namely the perimeter of flat shapes, and thus has not been able to measure students' long-term memory retention regarding the mathematical concepts taught through gamification. Additionally, there was limited control over students' external factors such as baseline internal motivation, learning facilities at home, or social interactions outside of school hours which have the potential to influence variations in individual learning achievement.

Therefore, future research is expected to expand the scope of the experiment by implementing a longitudinal design to observe the consistency of the cognitive impact of gamification over a longer period. In addition, it is also recommended for future

researchers to integrate a mixed-methods approach to explore more deeply the qualitative perceptions and psychological barriers faced by students during the gamification learning process.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that the application of the gamification learning method has a positive and significant effect on the mathematics learning achievement regarding the perimeter of flat shapes material among fifth-grade students at SD Negeri 7 Salotungo, Soppeng Regency. This is proven by the drastic increase in the average score of the experimental class from 48.2 (pretest) to 76.4 (posttest), as well as the results of hypothesis testing showing that $t_{value} > t_{table}$ (2.655 > 1.679) with a significance value of 0.011, which is smaller than 0.05.

This study makes a tangible contribution to the development of elementary school pedagogy by proving that the natural characteristics of elementary school-aged children who love to play can be positively channeled to support academic achievement. Game mechanics such as points, levels, and leaderboards that are structurally designed are able to bridge abstract geometric concepts into fun and meaningful mathematical reasoning activities for students.

As a step toward academic sustainability, it is recommended for future researchers to develop more varied gamification learning media involving digital platforms to test the effectiveness of this method on a wider and more heterogeneous population scope. Additionally, educational practitioners are expected to adapt this gamification structure flexibly to other mathematics topics that have a high level of complexity.

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