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Implementation of Gamification Technology to Improve Motivation and Understanding of IPAS Subject Material

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Abstract

Purpose: This study aims to evaluate the impact of gamification on increasing learning motivation and understanding of science subject material among fourth-grade elementary school students. Specifically, this study emphasizes the mechanisms by which gamification components can produce a more engaging, interactive, and efficient learning experience to increase student participation and conceptual comprehension.
Methodology: This study used a one-group pretest-posttest design and quantitative methodology. A total of 21 fourth-grade students participated in this study. A learning motivation questionnaire and material comprehension test with pre-tests and post-tests were used to collect data. In addition, student participation during the gamification-based learning process was observed. To assess the differences between the pretest and posttest, the data were analyzed using a paired sample t-test, validity and reliability tests, and normality tests.
Results: The results of the t-test for paired samples show a significant increase in students' understanding of IPAS material, as seen from the significance value (2-tailed) of 0.000, which is less than 0.05. The effectiveness of gamification in improving learning outcomes is proven by the higher average posttest scores compared to the pretest scores. In addition, students' motivation to learn increased from moderate to high, in line with existing motivational concepts. Furthermore, observations show that this approach creates a more competitive, energetic, and enthusiastic learning atmosphere in a constructive context.
Applications/Originality/Value: This research contributes significantly to the implementation of learning at the elementary school level by demonstrating the effectiveness of gamification in increasing intrinsic motivation and IPAS comprehension competencies. The novelty aspect of this research is evident in the adaptation of game components that are aligned with the developmental characteristics of fourth-grade students, which results in a more meaningful and engaging learning experience. The implications of this research can be used as a scientific reference for education practitioners, schools, and academics in designing learning innovations that are integrated with learning technology.

Keyword : gamification, subject comprehension, motivation, IPAS

Introduction

The world of education has been transformationally influenced by the advancements in digital technology today. With the implementation of e-learning, which enables geographically and virtually distributed learning supported by internet infrastructure, educators now have the opportunity to optimize various pedagogical innovations. Technology helps educators deliver basic material to students in elementary schools. The use of audio-visual media has been shown to improve students' academic achievement. This innovation is usually applied through animated content presentations to explain learning material in lower grades. In middle grades, on the other hand, the utilization of digital platforms such as Google Classroom encourages students to conduct experiments, research, and exploration in accordance with their cognitive abilities (Firdos et al., 2023). According to Taufiqurrahman (2022) Technology in the classroom, particularly in inclusive education, can support students' learning processes and ensure that every student has an equal opportunity to reach their full potential. However, integrating technology into the education system raises several issues that must be addressed through collaborative and measured efforts. Empirically, various educational technologies, such as digital communication media, educational software programs, and electronic learning platform systems, have been proven to aid instructional processes. By using these technologies, education becomes more unique, engaging, and enjoyable. This makes students more involved and actively participate in classroom activities (Malay et al., 2025).

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The subjects of Natural and Social Sciences (IPAS) have been developing students' scientific and social thinking skills since elementary school. However, field research shows that learning methods that still rely on traditional approaches are usually less engaging. This affects students' understanding of concepts and their self-motivation.

As a result, deliberate actions are needed to improve the quality of education in elementary schools. Research conducted at SDN Padangsidimpuan shows that natural science is not just an academic subject to be studied, but also has applications in everyday life and decision-making processes (Lubis et al., 2023). Utilizing visual and audio-visual teaching materials is one way to increase student engagement in lessons. Educators must be creative, innovative, and dynamic when using various teaching techniques to make the learning process more engaging and prevent students from becoming bored. One way to ensure that students achieve the established learning objectives is by using effective visual and audio-visual materials, especially in science education. In addition, teachers must be able to encourage and guide students who have not yet fully participated in the learning process (Suhaemi et al., 2020). According to Wedyawati et al (2024) Students often mistakenly think they are playing when educational games are incorporated into the learning process. Studies have shown that game-based learning materials can improve elementary students' understanding of how to handle disasters and their learning outcomes. It also makes them more active, creative, and enthusiastic while learning. Furthermore, this method has the potential to raise students' awareness of efforts made to reduce disaster risks and to build conceptual understanding of mitigation.

Based on research by Haryani & Nursanti (2022), The two main types of motivation for learning are intrinsic and extrinsic. The first comes from the student's internal sources, such as a strong desire to learn something like English. The second comes from external sources, such as rewards like grades, recognition, or social pressure. Their study shows that extrinsic motivation has a greater influence than intrinsic motivation on students. Research according to Yonanda et al (2024) exploring the challenges of modern education in the twenty-first century, with a particular emphasis on poorer academic outcomes in elementary schools and a lack of student motivation. In this study, multimedia-based interactive learning tools are used as a creative way to enhance student participation and overall educational effectiveness. Research shows that when learners' basic psychological needs are met, such as autonomy, competence, and relatedness, the highest levels of motivation arise. By giving students the choice to undertake assignments or learning challenges, a gamified learning environment can help them become more independent (Dunn & Zimmer, 2020).

According to Jaelani, (2024) Gamification is a key learning strategy that can boost student motivation. However, to achieve optimal educational goals, the implementation of gamification requires a process of continuous evaluation and adjustment. Although gamification offers various benefits, its effectiveness is highly dependent on thorough preparation, a deep understanding of student characteristics, and the development of relevant learning activities. An in-depth review of a number of studies reveals indications of the positive impact of gamification on motivation and overall learning outcomes. The quality of education has improved significantly through the implementation of the Merdeka Curriculum Policy and the integration of technology in teaching methods (Jailani, 2025). Although gamification offers various benefits in terms of increasing student motivation and learning competencies, its implementation faces various challenges. The main challenges faced by elementary school educators in implementing gamification include limited technological competencies, a lack of ongoing training programs, infrastructure limitations, complexity in designing gamification-based materials, and minimal institutional support (Nurhayati & , Langlang Handayani, 2020).

Rigorous empirical investigations are essential to assess the efficacy of gamification within the context of science education, particularly as an instructional approach with the capacity to enhance intrinsic motivation, promote active engagement, and deepen conceptual comprehension. This research endeavors to examine the influence of integrating gamification technology on the learning motivation and comprehension of scientific concepts among fourth-grade pupils at SD Negeri 2 Cepogo. Moreover, beyond delivering a comprehensive elucidation of the approach's efficacy, the findings are anticipated to function as a scholarly reference for advancing innovative pedagogical methods that align with the imperatives of digital-era education. Specifically, the study seeks to ascertain whether gamification-enhanced learning can markedly elevate students' grasp of IPAS content alongside their drive to engage in the learning process.

Method

This study used a single-group pretest-posttest design and a quantitative approach. The quantitative approach analyzes phenomena systematically using statistics, mathematics, or computation. A pre-experimental design is a type of experiment that has some unique features. These include using one class as a group rather than having a control group, and selecting research samples non-randomly. Before the intervention was applied, a gamification-based learning model was implemented on the experimental group. A post-implementation test was conducted after the gamified learning was carried out to determine whether there were differences in learning outcomes. The purpose of this study was to find out the extent to which the application of gamification affects fourth-grade students' conceptual understanding of the subject matter as well as their desire to learn Natural Science.

In this study, data collection was conducted using various tools, including learning achievement tests, student motivation questionnaires, observation sheets, and documentation. The learning achievement test was designed in the form of multiple-choice questions, which were evaluated for reliability using Cronbach's Alpha formula and for validity using Pearson Product Moment correlation. Of the total 15 questions, 11 were declared valid, with an alpha coefficient of 0.736,

indicating sufficient internal consistency (Putu Gede Subhaktiyasa, 2024). Using a Likert scale with four answer choices, the questionnaire on learning motivation has been tested for the validity of each of the fifteen questions. With a reliability coefficient of 0.876, this questionnaire is suitable for measuring students' learning motivation. Meanwhile, observation sheets are used to record students' participation and activities during the learning process, while documentation such as photos of learning activities and grade records helps strengthen the validity of the data through triangulation techniques. (Anisah & Puspasari, 2024).

The four main methods of data collection in this study are examination, questionnaires, observation, and documentation. These techniques were used before the implementation of the learning approach. Students' understanding of IPAS subject matter was assessed through pre- and post-intervention evaluations (Istiqomah & Ahmadi, 2025). A motivation survey was disseminated to measure the degree of participants' eagerness toward the integration of gaming components in the educational experience (Syamni et al., 2023). Observations facilitated direct oversight of student involvement during instructional sessions. Documentation acted as a supplementary mechanism, preserving visual records of classroom proceedings, academic information, and attendance registers. These procedures were implemented in a systematic and orderly fashion to guarantee the precision and pertinence of the resultant data

In this study, the data were processed through several well-structured stages. To ensure high-quality instruments, we first tested their validity and reliability. Validity was tested using the Pearson correlation method. This was done to evaluate how well each instrument item measured the concept being studied. In contrast, the Cronbach's Alpha coefficient was used to assess the internal reliability of the instrument (Utami, 2023). Before proceeding to further analysis, we conducted prerequisite checks, including data normality tests using the Shapiro-Wilk technique, based on a sample of approximately 50 respondents. If the significance value exceeds 0.05, it indicates that the data does not follow a normal distribution pattern, as explained (González-Estrada et al., 2022). Next, further analysis was conducted using a paired t-test. This was done to find significant differences between scores before and after the intervention. This method was chosen because the data was collected from the same group of subjects at two different time points. If the probability value (Sig.) is less than 0.05, the gamification intervention is considered effective because there is a significant difference between the initial and final conditions. Finally, the paired t-test analysis was used to test the hypothesis about the impact of gamification on students' motivation and their understanding of integrated science material.

Result

The investigation was undertaken on October 18, 2025, aiming to explore the effects of integrating gamification technology on the intrinsic motivation and conceptual grasp of Integrated Science (IPAS) topics among fourth-grade elementary school pupils, utilizing a research cohort comprising 21 participants. Prior to the deployment of the gamification intervention, the subjects participated in a pretest to evaluate their initial comprehension levels, followed by a posttest to gauge advancements in their mastery of IPAS content. The ensuing data presents the mean pretest and posttest scores attained by the fourth-grade students.

Table 1. Comparison of Students' Average Understanding of the Material

Class	Test Type	Average	Improvement
	Pretest	61,05	-
	Posttest	73,97	12,92

The data analysis results from 21 students showed that the highest score was 90.90, the lowest score was 36.36, and the average pretest score was 61.05. These findings indicate that students who studied using conventional methods still have a limited understanding of basic IPS concepts. The average score increased to 73.97 after using gamification-based learning and conducting the post-test. Therefore, the average score increased by 12.92 points. These results indicate that students' competence in understanding IPS material improved significantly after gamification was applied in classroom learning activities.

By distributing questionnaires to 21 people participating in gamification-based learning, data on learning motivation was obtained. The questionnaire consisted of fifteen statements covering various aspects, such as satisfaction in learning, enthusiasm for learning, cooperation, and achievement orientation. The following image shows the distribution of students' learning motivation scores.

Table 2. Comparison of Students' Average Learning Motivation

Class	Type Test	Average	Improvement
	Pretest	27,23	-
	Posttest	33	5,77

The analysis of questionnaire data from 21 research respondents showed that the average questionnaire score at the pretest stage was 27.23. This finding indicates that students still have a relatively low level of knowledge and understanding of gamification-based learning. In addition, after the treatment, a re-measurement was conducted using the same questionnaire instrument, and students obtained an average score of 33 on this test. The results indicate that most students have higher learning motivation after the implementation of gamification-based learning in the classroom. This is reflected in an average score increase of 5.77 points.

Table 3 Question Validity Test

No. Soal	Pearson Correlation	Sig. (2-tailed)	conclusion
1	0,585	0,004	Valid
2	0,391	0,072	TidakValid
3	0,182	0,417	Tidak Valid
4	0,675	0,001	Valid
5	0,318	0,149	Tidak Valid
6	0,628	0,002	Valid
7	0,549	0,008	Valid
8	0,683	0,000	Valid
9	0,435	0,043	Valid
10	0,608	0,003	Valid
11	0,583	0,004	Valid
12	0,781	0,000	Valid
13	0,405	0,061	Tidak Valid
14	0,469	0,028	Valid
15	0,608	0,003	Valid

Out of a total of 15 questions tested, 4 were declared invalid, and the remaining 11 met the validity criteria, according to the analysis results shown in the table. Overall, this tool combines the three metrics mentioned earlier. After the test instrument was tested, the study proceeded with the questionnaire instrument. The validity test of the questionnaire was conducted to assess the instrument's ability to accurately and appropriately measure the specified constructs. In research, validity is very important because it relates to how well the obtained data can represent the constructs or variables being studied. The validity test is used by researchers to measure the indicators of research variables and ensure that each statement in the questionnaire is relevant. The following table shows the results of the validity test.

Table 4 Questionnaire Validity Test

No. Soal	Pearson Correlation	Sig. (2-tailed)	conclusion
1	0,712	0,000	Valid
2	0,693	0,001	Valid

3	0,658	0,002	Valid
4	0,601	0,004	Valid
5	0,720	0,000	Valid
6	0,688	0,001	Valid
7	0,392	0,083	Tidak Valid
8	0,417	0,069	Tidak Valid
9	0,715	0,000	Valid
10	0,290	0,191	Tidak Valid
11	0,662	0,002	Valid
12	0,648	0,003	Valid
13	0,721	0,000	Valid
14	0,324	0,155	Tidak Valid
15	0,702	0,001	Valid
16	0,687	0,001	Valid
17	0,733	0,000	Valid
18	0,694	0,001	Valid
19	0,709	0,000	Valid
20	0,398	0,087	Valid

Of the 20 items tested, 15 met the criteria for the desired indicators, and 5 were declared invalid. The correlation coefficient (calculated r) for all valid items ranged from 0.552 to 0.733 with a significance level of $p < 0.05$. On the other hand, the five items that did not meet the validity standard had correlation coefficients below 0.433 with a significance level of p greater than 0.05, so they were removed from the instrument. This distribution pattern indicates a strong correlation between most of the instrument's components and the construct being measured.

The next step is to test the reliability of the instrument. The goal is to determine how consistently an instrument internally measures the same object over different time intervals. In other words, reliability defines how often a research instrument can produce consistent and stable measurements under comparable conditions. After testing validity, reliability testing is conducted using the Cronbach's Alpha formula. The results of the reliability calculations are shown below.

Table 6 Reliability Test Results

Cronbach's Alpha	N of Items
0,736	15

The instrument configuration consists of 15 statements, with a Cronbach's alpha coefficient of 0.736, according to the data presented in the Reliability Test Results Table. For the reliability interpretation criteria, values between 0.61 and 0.80 are considered "high," indicating that the research instrument has a reliable level of internal consistency. The reliability test results of the questionnaire instrument are shown below.

Table 7 Questionnaire Reliability Test Results

Cronbach's Alpha	N of Items
0,876	20

Analysis using SPSS software shows that Cronbach's Alpha coefficient reached 0.876 for each of the 20 statements. This figure indicates that this research tool is quite reliable, as the value exceeds the minimum standard of 0.70. In other words, when measuring student motivation in learning through gamification, all items in the questionnaire had strong internal consistency.

Normality test, on the other hand, is used to determine whether the data distribution pattern conforms to the normality assumption. If the data is normally distributed, it means that parametric analysis techniques such as the t-test can be used

because the data is evenly spread around the midpoint (average). We processed the data using the Shapiro-Wilk method in SPSS because the sample size was less than 50 people. Below is a summary of the normality test results.

Table 8 Results of Normality Test Questions

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Understanding of IPAS material before gamification	.178	21	.081	.924	21	.106
Understanding of IPAS material after gamification	.197	21	.032	.941	21	.230

Data regarding the understanding of IPAS material before and after the implementation of gamification showed a normal distribution, according to the Shapiro-Wilk test results, which is more accurate for samples less than 50. The significance values for both were above 0.05. Therefore, the requirement for data normality has been met. The results of the questionnaire normality test are presented here.

Table 9 Questionnaire Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Motivation to learn IPAS before gamification	.178	21	.083	.948	21	.306
Motivation to learn IPAS after gamification	.131	21	.200*	.931	21	.142

The data processing results show a normal distribution pattern in students' learning motivation both before and after the implementation of gamification. This is confirmed by a significance test with a value above 0.05, indicating that the data normality requirement has been met. Gamified learning was applied to 21 students and produced post-test scores. After the intervention, exam questions were designed to assess how well students understand and interpret science subjects. From this data, an average score of 77.92 and a total of 1,636.35 were obtained. While the highest score was 90.90, the lowest score was 45.45. These findings indicate that students who participated in gamification-based learning have achieved an adequate level of competence in understanding IPAS material. After the implementation of gamification-based learning, a questionnaire was administered to determine whether the intervention could increase students' desire to learn.

The results of the paired sample t-test show a significant difference between students' understanding of IPAS material and their motivation to learn before and after the implementation of gamification-based learning.

Table 10 Paired Sample t-test Test Data Questions

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pretest - Posttest	-12.987	10.192	2.224	-17.626	-8.348	-5.839	20	.000

As shown in the table, the analysis conducted using the paired sample test indicated an average difference of -12.987, with a t-statistic of -5.839 and 20 degrees of freedom. The significance probability (2-tailed Sig.) was only 0.000, far below the 0.05 threshold, indicating that there is a statistically significant difference between the pre-test and post-test scores. The results suggest that gamification in learning successfully improved students' conceptual understanding of Natural and Social Sciences (IPAS). The results of the paired questionnaire test used are presented here.

Table 11 Paired Sample t-test Questionnaire Data

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1 Motivasi belajar IPAS sebelum gamifikasi - Motivasi belajar IPAS sesudah gamifikasi	-5.762	7.252	1.583	-9.063	-2.461	-3.641	20	.002

For the paired sample, the t-test analysis showed a mean score difference of -5.762, with a t value of -3.461 and 20 degrees of freedom. The two-tailed significance probability (Sig. 2-tailed) was only 0.000, well below the 0.05 threshold, indicating that the scores from the pre- and post-test questionnaires showed a statistically significant difference. This suggests that students are more interested in learning science subjects with a teaching method that incorporates gamification.

Discussion

According to research conducted at SD Negeri 2 Cepogo, gamification technology can help fourth-grade students understand Natural and Social Science (IPAS) material. The significance value (Sig. 2-tailed) of 0.000 was obtained from a paired t-test statistical analysis, which is less than 0.05. This finding indicates that there is a significant difference between pretest and posttest results. Descriptively, the average pretest score was 61.86 and increased to 77.92 after the treatment. This increase of 16.06 points indicates that gamification is an effective learning method.

The results of this study are in line with the findings of Ovi Rahmadania, Muhammad Asrul Sultan (2025), who stated that game-based learning methods can produce better learning outcomes for first-grade students compared to conventional learning methods. It has been proven that incorporating gamification elements into learning activities improves students' abilities in the field of science. In a study conducted by Dasar et al. (2024) , the researchers found that using various gamification methods enhanced students' understanding of science learning. The percentage of learning mastery increased from 57% in the first cycle to 86% in the second cycle, indicating this improvement.

The research results show that students find it easier to understand abstract concepts in science learning when the material is presented through game simulations and interactive visualizations, Sri Legowo (2022) stated that learning experiences that involve direct sensory stimulation can encourage students to continue learning throughout a better learning process. In addition, it is believed that an enjoyable learning environment can increase students' interest in learning activities and encourage them to actively participate in experiences presented through games. The research results indicate that students are not only able to remember facts but also able to articulate ideas in their own way and apply them to different situations. These findings are. The results of the learning motivation questionnaire show that students have greater motivation to learn after implementing gamification-based learning. As a result of the descriptive analysis, most students are in the high motivation category, with an average learning motivation score of 27.24 out of the maximum score. This increase indicates that gamification is effective in enhancing students' interest and enthusiasm for learning Natural and Social Sciences (IPAS).

Lutviana et al (2025) It shows that the use of gamification-based teaching materials can increase students' interest in science lessons. The students' average score increased from 42.29 before the use of this method to 60.29 after the use of this method. Students also showed positive responses to the use of gamification-based teaching materials in the classroom. These findings reinforce empirical evidence that gamification plays a role in reducing learning fatigue and creating a more enjoyable learning atmosphere. The increase in learning motivation in this study can be examined through the Self-Determination Theory (SDT) framework, Dunn & Zimmer (2020), explain that learning motivation will develop optimally if the three basic psychological needs of learners are met, namely autonomy, competence, and social connectedness. In gamification-based learning, the need for autonomy is realized through providing choices in learning activities, the need for competence is facilitated through gradual challenges and clear feedback, while the need for social connectedness is fulfilled through social features such as group work and the use of leaderboards.

Conclusion

Overall, the research results indicate that gamification improves students' understanding of Natural and Social Sciences (IPAS) material. The paired sample t-test results show its effectiveness, with a significance value of 0.000 (< 0.05) and an increase in the average score from 61.05 in the pretest to 73.97 after the treatment. Additionally, gamification has a positive impact on learning motivation, which increased from a moderate to a high category, as indicated by an average motivation score of 27.24. This improvement is reflected in students enthusiastically participating in the learning process, actively asking questions, and being encouraged to study independently. The increase in student engagement and the development of a positive learning environment are evidence that gamification has succeeded in changing the dynamics of the learning process to be more interactive, participatory, and meaningful. The role of teachers as creative facilitators and designers of innovative learning experiences is crucial to the success of gamification implementation. This success depends heavily on teachers' creativity in creating game-based activities, integrating technology with STEM (science, technology, engineering, and mathematics) content, and providing constructive criticism. Overall, gamification technology can be applied as a strategic innovation in teaching IPAS in elementary schools in line with the Merdeka CurriculumThis application not only enhances cognitive learning outcomes but also fosters affective elements such as curiosity, motivation to learn, and a positive attitude towards learning. As a result, this application provides a complete and satisfying learning experience for students.

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