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THE INFLUENCE OF GAMIFICATION ON COGNITIVE LEARNING OUTCOMES IN INFORMATICS FOR GRADE VIII STUDENTS

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Abstrak
Penelitian ini bertujuan untuk menganalisis pengaruh penerapan gamifikasi terhadap hasil belajar kognitif pebelajar pada mata pelajaran informatika materi jaringan komputer dan internet Kelas VIII SMP. Penelitian ini menggunakan pendekatan kuantitatif dengan desain kuasi-eksperimen tipe non-equivalent control group design yang melibatkan kelas eksperimen dan kelas kontrol. Subjek penelitian adalah pebelajar kelas VIII SMP dengan teknik purposive sampling. Instrumen penelitian berupa soal tes pilihan ganda yang diberikan melalui pretest dan posttest. Analisis data dilakukan menggunakan statistik deskriptif dan uji independent samples t-test setelah memenuhi uji prasyarat normalitas dan homogenitas. Hasil penelitian menunjukkan bahwa terdapat perbedaan signifikan antara kelas eksperimen dan kelas kontrol. Kelas eksperimen yang menggunakan gamifikasi memperoleh rata-rata hasil belajar lebih tinggi dibandingkan kelas kontrol. Temuan ini menunjukkan bahwa gamifikasi efektif dalam mencapai hasil belajar yang diharapkan pada rencana pembelajaran. Pada masa yang akan datang perlu ada penelitian lebih lanjut di tingkat pendidikan SMP terkait gamifikasi mampu mempengaruhi hasil belajar pada materi dengan karakteritik tertentu atau perluasan subyek penelitian lintas sekolah maupun dalam satu wilayah tertentu sehingga menguatkan temuan penelitian ini.

Kata Kunci: Gamifikasi; Kognitif; Hasil Belajar; Informatika; SMP

Abstract
This study aims to analyze the effect of implementing gamification on students' cognitive learning outcomes in the subject of Informatics—specifically regarding computer networks and the internet—at the eighth-grade level of junior high school (SMP). A quantitative approach was employed using a quasi-experimental, non-equivalent control group design, involving both an experimental group and a control group. The research subjects were eighth-grade junior high school students, selected via purposive sampling. Data were collected using multiple-choice tests administered as pretests and posttests. Analysis was conducted through descriptive statistics and an independent samples t-test, following the fulfillment of prerequisite tests for normality and homogeneity. The results indicate a significant difference between the experimental and control groups; the experimental group, which utilized gamification, achieved higher average learning outcomes than the control group. These findings suggest that gamification is effective in attaining the learning outcomes specified in the lesson plan. Future research at the junior high school level should further explore how gamification influences learning outcomes across different types of subject matter, or expand the scope of study to include multiple schools or a broader geographic region, thereby strengthening the findings of this research.

Keywords*: Gamification; Cognitive; Learning Outcomes; Informatic; Junior High School*

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INTRODUCTION

Learning does not merely involve transferring information from teachers to students or memorizing material. Students need to develop an in-depth understanding of concepts so that the knowledge they acquire can be explained in their own words and applied to real-life situations. This expectation has become increasingly important in contemporary learning, which places students at the center of instructional activities and encourages active engagement, particularly in developing cognitive competence. In practice, however, classroom learning is still frequently characterized by low student engagement, weak motivation, and difficulties in understanding learning materials, resulting in suboptimal cognitive learning outcomes.

Similar issues have been observed in Grade VIII Informatics, particularly in the chapter on computer networks and the internet. This material covers basic concepts and types of networks, topologies, configuration and routing, as well as internet security. Most of these concepts are abstract because data transmission processes between devices cannot be directly observed. Therefore, students need to do more than memorize terms such as LAN, router, or star topology; they must also understand the functions of each component and how they are interconnected within a system. Observations at SMP Negeri 1 Gudo indicated that some Grade VIII students were less engaged in learning activities, easily lost focus, and experienced difficulties answering review questions. Their answers also tended to rely on memorization, without demonstrating the ability to explain concepts in their own words. Similar issues were reported by Sarumaha & La'ia (2022) and Yesiliana & Roesdiana (2024), who identified low understanding of basic concepts and difficulties among students in explaining previously taught concepts. One contributing factor is the use of teaching strategies that are not sufficiently aligned with the characteristics and learning needs of students in the classroom.

Gamification offers a potential solution to these conditions. According to Deterding et al. (2011), gamification refers to the application of game design elements in activities that are not inherently games. Kapp (2012) provides a further perspective by emphasizing the use of game mechanics, aesthetics, and thinking to encourage engagement, motivate action, facilitate learning, and support problem-solving. Kapp (2012) also cautions that gamification should not be narrowly defined as merely adding points, badges, and rewards. Other elements, such as narratives, challenges, feedback, and roles, need to be incorporated to create meaningful learning experiences. This concern is supported by Kwon & Özpolat (2021), who found that limited gamification approaches relying solely on points and rewards in assessments actually reduced students' perceptions and mastery of the learning material.

Based on these perspectives, the gamification approach examined in this study combines five elements: narrative, points, leaderboard, feedback, and role-playing. The narrative is presented through a mission-based storyline involving a fictional organization called "The Networkers," which is responsible for maintaining networks across the Indonesian archipelago. Each topic is therefore studied as part of an ongoing mission. Groups earn points through discussion challenges and short quizzes, which are then accumulated on a leaderboard displayed at the end of each meeting. Feedback is provided directly throughout the learning activities, while role-playing requires students to act as network components, such as nodes, transmission media, routers, and data packets, to simulate how different network topologies operate. This combination is designed to make game elements a means of making abstract network concepts easier to visualize rather than merely providing entertainment.

Similar mechanics have been examined across various educational levels. At the elementary school level, Jagušt et al. (2018) found that Grade II and III students achieved their highest

mathematics learning performance when competition was combined with narratives and adaptive challenges. Meanwhile, Fitri et al. (2026) reported an increase in Grade V students' science scores following gamified learning involving role-playing and missions on the Classcraft platform. At the junior high school level, Nurjannah et al. (2021) demonstrated that point-based quizzes and leaderboards through Kahoot and Quizizz improved Grade VIII students' mathematics learning outcomes, while Janibah et al. (2026) found higher Grade VIII Informatics learning outcomes among students who used gamified media to study data analysis. At the university level, Sailer & Sailer (2021) demonstrated that point-based quizzes combined with team leaderboards improved students' knowledge through greater engagement in classroom activities. Specifically in computer network learning, Zieliński & Konieczny (2023) implemented narratives, points, and role assignments in an introductory computer networking course and obtained a higher pass rate than in the non-gamified group. Furthermore, Suzuki (2018) found that having university students role-play as routers, switches, and computers resulted in greater improvements in TCP/IP understanding than those observed in the comparison class.

Overall, the meta-analyses by Sailer & Homner (2020) and Bai et al. (2020) estimated that gamification has a moderate effect on cognitive outcomes. Nevertheless, the findings have not been consistent. Alsadoon et al. (2022) reported that gamification in Grade VIII computer science learning increased motivation and satisfaction but did not produce a significant difference in academic achievement. Sailer & Homner (2020) also noted that the presence of a narrative does not automatically enhance cognitive effects. This suggests that the success of gamification depends more on the combination of elements and their relevance to learning activities than on any single element. In Educational Technology research, gamification has also been found to be appealing to students in project-based learning (Khuluq et al., 2023), to influence self-regulated learning in visual programming activities (Hadihabibi et al., 2023), and to improve Grade VII students' science understanding (Hidayatulloh et al., 2020).

This synthesis highlights a research gap that needs to be addressed. Syarifuddin et al. (2026) examined gamification as a supplementary instructional material for elementary school students, while Hakeu et al. (2023) and Missouri & Nurkasmir (2024) focused more on motivation and general learning outcomes. Studies on gamification in computer network topics that employed comparison groups have predominantly been conducted at the university level (Suzuki, 2018; Zieliński & Konieczny, 2023). Meanwhile, research involving junior high school students that examines the effects of gamification incorporating narrative and role-playing elements on cognitive learning outcomes in computer networks and the internet remains limited. The differing findings at the same educational level (Alsadoon et al., 2022; Janibah et al., 2026) suggest that the impact of gamification on junior high school students has yet to be conclusively established.

Based on this background, the research question is as follows: Is there a significant difference in cognitive learning outcomes in Grade VIII Informatics, specifically in the topic of computer networks and the internet, between junior high school students who learn through gamification and those who receive conventional instruction? In line with this question, this study aims to examine and analyze the effect of gamification on Grade VIII junior high school students' cognitive learning outcomes in Informatics, specifically in the topic of computer networks and the internet. The findings are expected to make a theoretical contribution to the field of Educational Technology by providing insights into gamification as an innovative instructional strategy with the potential to enhance student engagement and understanding in the digital era.

METHOD

This quantitative study employed a quasi-experimental non-equivalent control group design (Creswell & Creswell, 2018). Individual randomization was not possible because students had already been assigned to their respective classes at the beginning of the academic year. Therefore, one class was designated as the experimental group, which received gamified instruction, while another class served as the control group and received non-gamified instruction. Both groups completed pretests and posttests.

The study population comprised all Grade VIII students at SMP Negeri 1 Gudo, Jombang Regency, during the 2025/2026 academic year. The sample was selected through purposive sampling, with Class VIII-F (31 students) assigned as the experimental group and Class VIII-I (30 students) as the control group. Both classes were at Phase D of the Merdeka Curriculum, used the Informatika SMP/MTs Kelas VIII textbook published by Grafindo Media Pratama, and received instruction in classrooms and computer laboratories equipped with projectors. Neither class had previously experienced systematically gamified Informatics instruction. The mean pretest scores were 37.61 for the experimental group and 44.70 for the control group, with no statistically significant difference between them (Sig. = 0.057), indicating that their initial abilities were considered comparable.

Both classes received the same learning materials, objectives, instructional models (discovery learning and problem-based learning), and time allocation, consisting of four instructional sessions and one posttest session, each lasting 2 × 40 minutes. The topics covered, in sequence, were network concepts and types, network topologies, network configuration and routing, and internet crimes and internet security. In the experimental group, all students were positioned as members of a fictional organization called “The Networkers,” which received a new mission at each meeting. Students were randomly assigned to eight groups. Correct answers to discussion challenges and end-of-session quizzes earned group points, which were accumulated on a leaderboard, with the highest-scoring group receiving recognition. Feedback was provided throughout the learning activities rather than only at the end of each session. During the network topology lesson, two groups were combined, and their members assumed the roles of nodes, transmission media, hubs/switches/routers, or data packets to simulate message transmission across bus, star, ring, and mesh topologies. The control group followed the subject teacher's lesson plan, which included an introductory activity, material explanations using presentations and illustrations, class discussions, and verbal praise, without mission narratives, points, leaderboards, intergroup competition, or role-playing.

Cognitive learning outcome data were collected using an 18-item multiple-choice test, with four answer options per item, covering the remembering (C1), understanding (C2), and applying (C3) levels of the revised Bloom's Taxonomy (Krathwohl, 2002). The same test was administered as a pretest before the intervention and a posttest afterward through Google Forms, with students completing it individually in the classroom under direct supervision. Content validity was reviewed by an Informatics teacher, while empirical validity was examined using Pearson's product-moment correlation with respondents outside the study sample. Of the 20 initial items, 18 were declared valid. The Cronbach's Alpha coefficient of 0.683 exceeded the 0.65 threshold for teacher-made tests (Frisbie, 1988), indicating that the test was suitable for use.

The study was conducted from September to November 2025. The pretest was administered before the intervention to assess students' mastery of the material and examine the comparability of the two classes. Both groups then underwent four instructional sessions according to their respective treatments, followed by the posttest during the fifth session within a similar time frame. Scores were

analyzed descriptively using the mean, minimum and maximum scores, and standard deviation. After the assumptions of normality (Shapiro–Wilk) and homogeneity (Levene's test) were met, differences in mean scores were examined using an independent-samples t-test at a significance level of 0.05 with IBM SPSS Statistics.

RESULTS

Table 1 summarizes the initial ability test scores. The mean score of the control group (44.70) was slightly higher than that of the experimental group (37.61), and the highest score in the control group (86) also exceeded that in the experimental group (63). Both mean scores remained substantially below the maximum possible score, with relatively wide score distributions, indicating that students' initial mastery of the material was inadequate in both groups. The Shapiro–Wilk values (0.357 and 0.067) and Levene's test value (0.204) all exceeded 0.05, indicating that the data were normally distributed and the variances were homogeneous.

Table 1. Descriptive Statistic of Initial Competencies Assessment

Class	N	Mean	Min.	Max.	Std. Dev.	Shapiro Wilk	Levene
Control	30	44,70	18	86	15,76	.357	.204
Experiment	31	37,61	18	63	12,69	.067	.204

Since the assumptions were met, the initial equivalence of the two classes was tested using an independent t-test. This step is important to ensure that any differences in final achievement do not stem from an imbalance in the students' starting levels.

Table 2. Independent T-Test of Initial Competencies Assessment

Assessment	t	df	Mean Difference	Sig.(2-tailed)
Initial Competencies	1,937	59	7.087	.057

Table 2 shows t = 1.937, df = 59, and Sig. (2-tailed) = 0.057. Since the significance value exceeded 0.05, the mean difference of 7.087 points was not statistically significant, and the two groups could be considered to have equivalent initial abilities.

Table 3. Descriptive Statistics of Final Learning Outcomes

Class	N	Mean	Min.	Max.	Std. Dev.	Shapiro Wilk	Levene
Control	30	54,57	11	94	20,14	.485	.880
Experiment	31	69,65	22	100	19,18	.464	.880

The final test results are presented in Table 3. The mean score of the experimental group increased to 69.65, while that of the control group was 54.57. Two students in the experimental group achieved perfect scores (100), whereas the highest score in the control group was 94. The score distributions in both groups were wider than those in the initial test (standard deviations of 19.18 and 20.14, respectively). The Shapiro–Wilk values (0.464 and 0.485) and Levene's test value (0.880) were again not statistically significant, indicating that the independent-samples t-test could be used to test the hypothesis.

Table 4. Independent-Samples t-Test of Final Learning Outcomes

Assessment	t	df	Mean Difference	Sig.(2-tailed)
Cognitive Learning Results	-2.994	59	-15,078	.004

The test results presented in Table 4 yielded t = −2.994 (df = 59), with a Sig. (2-tailed) value of 0.004. Since this value was below 0.05, the null hypothesis was rejected: the mean cognitive learning outcome score of the experimental group was 15.08 points higher than that of the control group. In terms of effect size, this difference corresponded to a Cohen's d of approximately 0.77, indicating a medium-to-large effect.

The changes from pretest to posttest further reinforce this finding. The experimental group, which initially had lower scores, improved by 32.04 points (N-gain of approximately 0.51, categorized as moderate), whereas the control group improved by only 9.87 points (N-gain of approximately 0.18, categorized as low). In other words, the group that received gamified instruction not only caught up with but also outperformed the comparison group.

DISCUSSION

Based on the analysis of the initial abilities of both groups, the findings indicated that there was no significant difference between the experimental and control groups before the intervention. The independent-samples t-test yielded a significance value greater than 0.05, indicating that the two groups had equivalent initial abilities. Although a descriptive difference in mean scores was observed, with the control group achieving a slightly higher score than the experimental group, this difference was not statistically significant. This equivalence in initial abilities is a crucial aspect of quasi-experimental research because it enables researchers to control for external variables that may influence the research outcomes. Thus, differences in cognitive learning outcomes observed after the intervention can be more confidently attributed to the effect of the intervention, namely the implementation of gamification in learning. This condition also strengthens the internal validity of the study, as both groups had relatively homogeneous initial characteristics and could therefore be compared fairly (Creswell & Creswell, 2018).

The descriptive analysis of the final ability test revealed a clear difference between the two groups. The experimental group, which received gamification-based instruction, achieved a higher mean score than the control group, which received conventional instruction. Furthermore, the maximum score achieved by students in the experimental group was also higher, indicating that gamification not only increased mean learning outcomes but also encouraged some students to achieve optimal performance. This suggests that gamification can provide a more meaningful learning experience and promote more active student engagement throughout the learning process.

These findings were further supported by the independent-samples t-test, which yielded a significance value of 0.004 ($p < 0.05$), indicating a significant difference in students' cognitive learning outcomes between the two groups. This result suggests that the implementation of gamification had a positive effect on students' cognitive learning outcomes. Theoretically, this finding is consistent with Kapp's (2012) view that gamification is an instructional approach capable of enhancing individual engagement and motivation through the application of game elements in non-game contexts. Increased engagement and motivation encourage students to better understand the material, complete tasks, and participate more effectively in learning activities.

The improvement in cognitive learning outcomes observed in the experimental group was closely related to the key characteristics of gamification, which can create an interactive, challenging, and enjoyable learning environment. Gamification elements such as narratives, points, leaderboards, feedback, and role-playing contributed to creating a more dynamic learning experience. Narratives provide an engaging context and storyline, allowing students to feel emotionally involved in the learning process. Points and leaderboards serve as forms of external reinforcement that encourage healthy competition among students, while feedback helps students identify their mistakes and continuously improve their understanding. Role-playing also enables students to take an active part in learning situations that resemble real-life conditions, thereby helping to reinforce their conceptual understanding.

Furthermore, gamification is closely related to motivation theory and flow theory. According to flow theory, individuals experience optimal engagement when participating in activities that are challenging yet appropriate to their abilities (Csikszentmihalyi, 1990). Gamification creates such

conditions through progressively structured challenges, level systems, and rewards for achievements. Consequently, students feel challenged to continue learning and improving their abilities. This condition ultimately contributes to improved cognitive learning outcomes because students are not merely passive participants but actively construct knowledge through meaningful learning experiences.

The findings of this study are also supported by previous research demonstrating the positive impact of gamification on student learning outcomes. Studies conducted by Azizah et al. (2025), Missouri and Nurkasmir (2024), Nurjannah et al. (2021), and Rostiani et al. (2023) showed that the implementation of gamification in learning can significantly improve students' motivation, engagement, and learning outcomes. Similar results were reported by Hidayatulloh et al. (2020), who found that the class receiving game-based instruction achieved a mean posttest score of 75.35, higher than that of the control group (63.21), with a significance value of 0.000. Rukmi et al. (2020) also found that the Team Game Tournament game-based model produced a higher mean learning outcome score than the comparison group (69.09 versus 61.74; $p = 0.044$). The consistency between the findings of this study and those of previous research strengthens the argument that gamification is an effective instructional strategy relevant to various learning contexts, including Informatics at the junior high school level.

In the context of cognitive learning outcomes, the improvement observed in the experimental group indicates that gamification affects not only students' motivational aspects but also their cognitive abilities. In this study, cognitive learning outcomes refer to students' abilities to understand, remember, and apply the concepts they have learned. This is consistent with the revised Bloom's Taxonomy proposed by Krathwohl (2002), which classifies cognitive processes into several levels: remembering, understanding, applying, analyzing, evaluating, and creating. Through gamification-based instruction, students have opportunities to develop these various levels of cognitive abilities through structured and challenging activities.

Gamification provides opportunities for students to learn actively through various activities, such as answering questions, completing challenges, and receiving immediate feedback. This process helps students move beyond memorizing information toward developing a deeper understanding of concepts and applying them in different contexts. Thus, gamification serves as an instructional strategy that not only increases engagement but also strengthens students' conceptual understanding.

The implications of this study suggest that gamification can serve as an effective alternative instructional strategy for improving students' cognitive learning outcomes. Its implementation can help create a more active, interactive, and meaningful learning environment, thereby addressing learning problems such as low student motivation and engagement. In Informatics instruction, gamification can be used to present abstract material in a more concrete and accessible manner through engaging approaches.

Nevertheless, implementing gamification requires careful planning to achieve optimal results. Gamification should not be applied arbitrarily but must be adapted to the characteristics of the learning material, student conditions, and teachers' readiness to manage the learning process. Furthermore, the use of gamification elements must be balanced to ensure that the focus does not shift solely toward gameplay but remains directed toward achieving learning objectives. With systematic and appropriate planning, gamification can serve as an effective and relevant instructional strategy for improving the quality of learning.

Overall, the findings of this study confirm that gamification has a significant effect on improving students' cognitive learning outcomes. The implementation of gamification in Informatics instruction at the junior high school level was shown to improve student engagement, motivation, and understanding of the learning material. Therefore, gamification can be recommended as an instructional innovation to improve the quality of learning in the digital era.

CONCLUSION

Gamification integrating mission narratives, points, leaderboards, feedback, and role-playing had an effect on the cognitive learning outcomes of Grade VIII junior high school students in the topic of computer networks and the internet. The group receiving this instructional approach started with initial abilities equivalent to those of the comparison group but completed the learning sequence with clearly higher achievement. This advantage appears to have stemmed from the integration of game elements into core learning activities, particularly role-playing simulations that allowed students to experience how computer networks operate firsthand. Informatics teachers can adopt this approach using simple classroom resources, provided that the game elements remain aligned with learning objectives. Future research is recommended to involve more schools and examine the contribution of each element to identify the most effective gamification design for Informatics topics.

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