The Effect of Gamification in Computer Science Learning on Student Motivation and Learning Outcomes at SMP Negeri 27 Padang

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Abstract: This study aims to examine the effect of gamification in Informatics learning on students' motivation and academic achievement in Grade VII at SMP Negeri 27 Padang. A quasi-experimental method was employed with two groups: an experimental class using gamification and a control class using conventional teaching, involving 64 students. The results show that gamification significantly enhances both motivation and learning outcomes. The average pretest score in the experimental class increased from 66.37 to 85.00 in the posttest, while the control class rose from 66.43 to 75.23. Statistical analysis revealed a significance value of 0.000 < 0.05, indicating a significant difference between the two groups. The findings suggest that incorporating gamification elements such as points, badges, and challenges creates a more engaging and effective learning environment. In conclusion, gamification serves as an innovative pedagogical strategy to address low motivation and achievement in Informatics education, aligning with the characteristics of 21st-century digital-native learners.

Keywords: Computer science learning; Gamification; Learning outcomes; SMP Negeri 27 Padang; Student motivation

Introduction

Education plays a crucial role in shaping high-quality human resources, particularly in addressing the challenges of the digital era. According to Tampubolon & Sudrajat (2024), the rapid advancement of technology has significantly transformed how people interact, work, and learn, demanding a fundamental shift in educational practices. Information technology education, especially in computer science, is essential to prepare the younger generation for this digital landscape. However, many students still struggle to understand the abstract and complex foundational concepts of information technology (Zhan et al., 2022). In Indonesia, technological advancements have not only changed students' social interactions and learning patterns but also the overall dynamics of their lives (Wahyudin et al., 2025). While technology was once primarily used for entertainment, teachers now hold a strategic role in directing its use toward innovative and meaningful learning experiences (Wahyudin et al., 2025).

The uniqueness of this study lies in its integration of gamification elements—such as points, badges, and challenges—into computer science instruction, providing a pedagogical approach that aligns with students' digital habits and interests. This approach transforms the traditionally abstract and difficult-to-grasp concepts into engaging and interactive learning experiences. Given that over 90% of school-age teenagers in Indonesia are active internet users (Sundami & Azhar, 2019), leveraging gamification is not

only relevant but also necessary. It offers a practical solution to improve students' motivation and learning outcomes while adapting teaching strategies to the characteristics of digital-native learners, making education more effective and future-oriented (Zahran et al., 2025).

Students' frequent use of technology for gaming can be transformed into a valuable opportunity to design more engaging and effective learning strategies. Gamification, an innovative pedagogical approach that incorporates game elements such as points, levels, badges, and challenges into the learning process, aligns well with the characteristics of digital-native learners who are accustomed to interactive and game-based digital experiences (Haq et al., 2025). This approach does not merely exploit students' natural inclination for play but meaningfully channels it toward achieving educational goals, particularly in Computer Science learning, where abstract and complex concepts often hinder students' understanding.

At SMP Negeri 27 Padang, the school is committed to improving the quality of education and preparing students with the competencies needed to succeed at higher levels. However, field observations reveal that student motivation in Computer Science remains low, resulting in learning outcomes below expectations. The learning process is still dominated by teacher-centered instruction, limited questioning, and minimal student participation. Additionally, many students feel anxious and hesitant to express their ideas, which restricts their potential to actively engage in learning (Yurissa et al., 2022).

This condition illustrates a significant gap between expectations and reality in Computer Science education. It underscores the urgent need for pedagogical innovation that not only enhances motivation but also facilitates deeper conceptual understanding (Hasugian et al., 2024). The uniqueness of this study lies in its attempt to integrate gamification into Computer Science instruction, transforming students' gaming habits into a driver for active participation, motivation, and improved learning outcomes (Ryanto et al., 2025; Desky et al., 2025). This research is essential as it provides an adaptive solution to the challenges of digital-era learning while supporting students' cognitive and affective development in a subject that is increasingly vital for future academic and career success (Saputra et al., 2025).

The results of this study are expected to not only provide practical benefits in the development of learning models at SMP Negeri 27 Padang, but also contribute theoretically to the field of technology education. Thus, this study has the potential to become a strategic reference in revitalising Informatics teaching methods to be more innovative, interactive, and in line with technological developments and the needs of today's students (Fadilla & Nurfadhilah, 2022).

Poorly organised learning that is not tailored to students' needs can further reduce their motivation and learning outcomes. Therefore, it is necessary to change learning strategies, including the application of more effective instructional design models and the use of learning media more interesting. With this approach, physics learning can be more tailored to students' needs and achieve the desired goals (Rahmatiah et al., 2023). Learning outcomes are a reflection of the success of a learning process. In the context of physics learning, learning outcomes include mastery of concepts, scientific thinking skills, problem-solving skills, and scientific attitudes. Learning outcomes can be classified into cognitive, affective, and psychomotor domains. Efforts to improve physics learning outcomes cannot rely solely on mastery of the material but must also include learning strategies that can activate all these domains in an integrated manner (Hall et al., 2019).

One of the main causes of low physics learning outcomes is the lack of student motivation. This can be observed through several indicators, such as delays in completing assignments, lack of seriousness in following lessons, and a tendency to be passive in discussions. learners with a strong level of learning motivation generally show more optimal academic achievement. The greater the motivation they have, the higher the effort they make to understand the material optimally (Gimpel et al., 2013). Meanwhile, according to, motivation is awareness in a person that encourages him to act with certain goals, so that he can feel satisfaction from his actions (Asnur et al., 2025).

Method

This research adopts a quantitative approach with a quasi-experimental design to investigate the effect of gamification in Computer Science learning on students' motivation and learning outcomes at SMP Negeri 27 Padang. As stated by Arikunto (1993), quasi-experimental research is a type of experimental study that closely resembles a true experiment but has certain limitations in fully controlling or manipulating all variables. To address these limitations, careful adjustments are made to ensure a balance between internal and external validity. The main objective of this study is to analyze how the integration of gamification elements—such as points, badges, levels, and challenges—into the teaching and learning process can enhance student engagement, stimulate motivation, and improve academic achievement compared to conventional instructional approaches (Maimunah et al., 2025; Taali et al., 2024).

The research employs a Nonequivalent Control Group Posttest-Only Design, where two groups of participants (experimental and control) are compared without random assignment. The experimental group receives instruction through a gamification-based learning model designed to create a more interactive, enjoyable, and motivating learning experience aligned with the characteristics of digital-native learners. In contrast, the control group is taught using traditional teaching methods without gamified features (Ermawalis et al., 2025). At the end of the intervention, a posttest is administered to both groups to measure and compare their learning outcomes (Fiona et al., 2025). This design is appropriate for examining the actual impact of gamification in a real classroom setting, providing empirical evidence of its effectiveness in enhancing student motivation and improving learning performance in Computer Science education (Deviana et al., 2025).

Result and Discussion

Result

The figure illustrates the internet penetration rate in Indonesia by age group in 2022, showing a clear generational pattern in digital connectivity. The data reveal that the 13–18 age group records the highest penetration rate at 99.16%, which means that almost all adolescents at the secondary school level are connected to the internet. This demonstrates that teenagers are growing up in an environment where digital technology has become an inseparable part of their daily lives, influencing their communication patterns, learning habits, and access to information. The 19–34 age group follows closely with a rate of 98.64%, indicating that young adults are also highly active digital users. They use the internet for a variety of purposes, including formal and informal education, professional work, entrepreneurship, and social networking. Meanwhile, the 35–54 age group records a penetration rate of 87.3%, reflecting that internet use has become widespread among the productive workforce in Indonesia. In contrast, the 5–12 age group reaches a penetration rate of 62.43%, suggesting that more than half of children at the primary school level are already familiar with the digital world. The lowest penetration rate is observed among the over-55 age group at 51.73%, illustrating a noticeable digital divide between younger and older generations in terms of access, literacy, and usage. These patterns confirm that the younger population, particularly students, are highly accustomed to the digital environment, making the integration of technology-based learning strategies, such as gamification, highly relevant, engaging, and aligned

with their cognitive characteristics (Taali et al., 2024) (Liwayanti et al., 2025).

The next figure presents the results of a bibliometric analysis using VOSviewer, which maps the research trends and interconnections of keywords related to "gamification" during the period 2020–2023. The visualization shows that the keyword "gamification" occupies a central position and is frequently associated with other research themes such as concept, training, economy, and logistics. This finding indicates that gamification has been explored not only in the educational domain but also across a wide range of sectors, reflecting its growing versatility and global relevance. However, in recent years, there has been a clear shift in research focus toward education, as evidenced by the emergence of keywords such as education, learning, students, and gamifikasi, highlighted in yellow to represent more recent studies published between 2022 and 2023. This shift demonstrates that researchers increasingly recognize gamification as an innovative pedagogical strategy capable of transforming the learning process from a traditional, teacher-centered approach into a more interactive and student-centered experience. By integrating elements of play, competition, and reward systems, gamification fosters intrinsic motivation, active engagement, and sustained interest in learning activities, especially among digital-native learners who are already familiar with interactive technological platforms.

Younger generations, particularly students, are highly familiar with digital technology, making technology-based learning strategies such as gamification increasingly relevant, effective, and aligned with their characteristics.
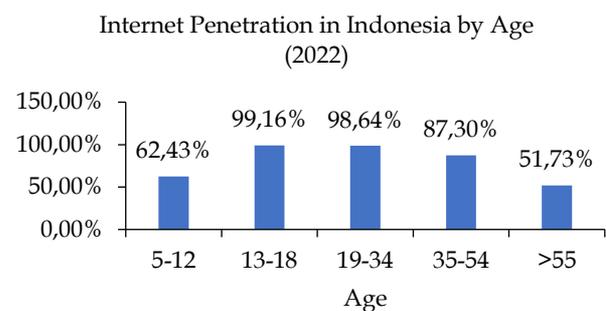

Figure 1. Internet penetration chart in Indonesia

The figure presents the results of a bibliometric analysis using VOSviewer, illustrating the research trends and relationships of keywords related to gamification from 2020 to 2023. The visualization shows that "gamification" is the central keyword frequently associated with various topics such as concept, training, economy, and logistics, indicating that gamification has

been widely explored in diverse fields beyond education. However, in recent years, there has been a noticeable shift in research focus towards the field of education, as reflected by the emergence of keywords like education, learning, students, and gamifikasi keywords highlighted in yellow, representing more recent studies (2022–2023). This trend suggests that gamification is increasingly recognized as a relevant and innovative approach in educational contexts, particularly in enhancing student motivation, engagement, and learning outcomes. The bibliometric mapping reinforces the importance of further research in developing gamification-based instructional models that are aligned with the needs and characteristics of digital-native learners in the modern educational landscape.
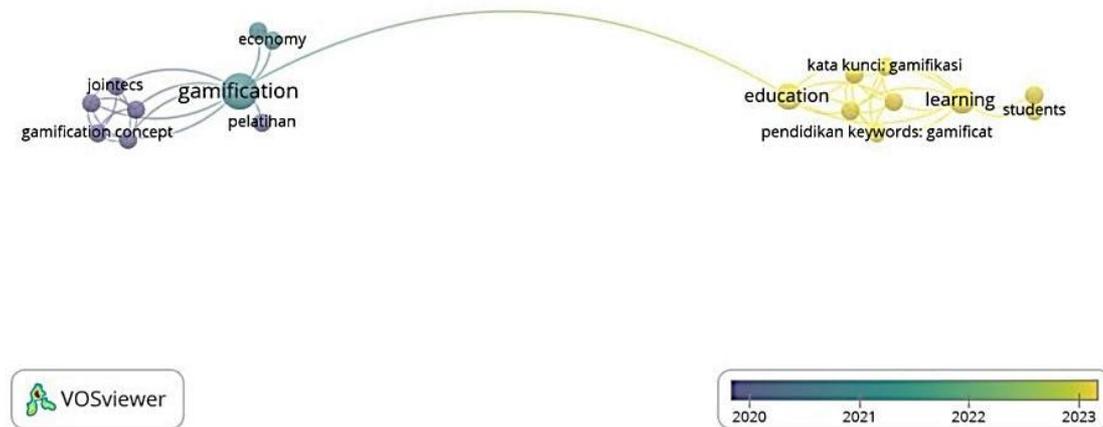

Figure 2. Bibliometric results based on research novelty

This study uses a quantitative approach with a quasi-experimental research design. This approach was chosen because the study aims to test the influence and analyse the effectiveness of gamification in computer science learning on student motivation and learning outcomes. The research design used is a nonequivalent control group design, where two groups (experimental and control) are compared without full randomisation. This study involves two groups of seventh-grade students with similar characteristics. The research design is presented in Table 1.

Table 1. Desain penelitian nonequivalent control group design

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O3	-	O4

Description:
O1 and O3 = Pre-test scores given to students.
O2 and O4 = Posttest scores given to students.
X = Teaching with a gamification approach.

The first group acted as the control group, which received conventional learning methods, while the second group acted as the experimental group, which followed gamification-based learning approaches. This method was used to observe the differences in learning outcomes and motivation levels between the two groups after the treatment was given. Thus, this study is expected to provide a clearer picture of the positive impact of gamification in the context of education, particularly in computer science learning at the junior high school level.

Table 2. Frequency distribution of posttest learning outcomes of experimental class

Class Interval	Absolute Frequency	Relative Frequency (%)	Cumulative Absolute Frequency	Cumulative Relative Frequency (%)
50–57.9	5	13.89	5	13.89
58–65.9	7	19.44	12	33.33
66–73.9	7	19.44	19	52.78
74–81.9	7	19.44	26	72.22
82–88.9	4	11.11	30	83.33
90–97.9	6	16.67	36	100.00

Based on the frequency distribution data, there are 10 learners who score above the average. Visualization in the form of a histogram describing the frequency distribution can be seen in Figure 3.

The Archerys ID Model learning model is proven to have a significant effect on improving student learning outcomes in physics subjects. Through a structured approach, this model emphasizes student attention, relevance, confidence, and satisfaction. All these stages can create a more active, interesting and meaningful learning environment for students. Compared to the TPACK learning model which is more oriented towards technology integration, the Archerys ID Model provides a more thorough learning experience and encourages students to think reflectively, analytically and independently (Arnov et al., 2025).

Table 3. Normality test of pre-test and post-test data of experimental and control classes

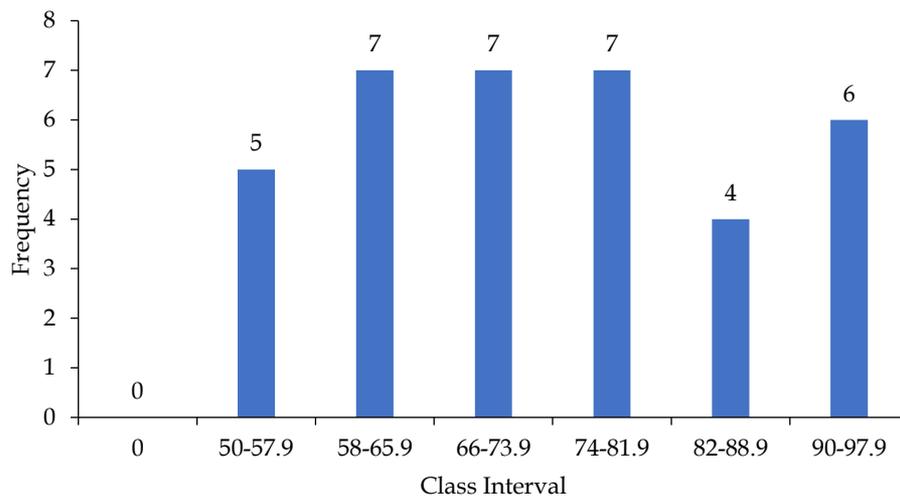| Class	Treatment	Post-test
Experiment	X	R_{E2}
Control	-	R_{K2}

Figure 3. Histogram of experimental class learning outcomes

The application of the Archerys ID Model instructional design in physics learning has proven to have a significant impact on improving student learning outcomes. The model is designed by integrating the motivational principles of ARCS (Attention, Relevance, Confidence, Satisfaction) developed by Keller, as well as promoting a reflective approach that is able to encourage students to think critically and build meaning from every learning process they go through. Learning is no longer simply oriented towards achieving grades, but transforms into a more contextual and meaningful experience. This is reflected in the increase in the average score of student learning outcomes in the experimental class compared to the control class using the TPACK model. Thus, the Archerys ID Model not only creates a more interesting and interactive learning atmosphere, but is also able to shape students' mindsets that are more logical, structured, and academically responsible.

In addition to the learning model used, student learning motivation also plays an important role in the achievement of learning outcomes. In this study, students with high levels of learning motivation showed a tendency to be more enthusiastic in participating in learning, completing assignments in a timely manner, and showing better academic results compared to students with low motivation. Although there was no significant interaction between learning model and motivation level, both were found to have a positive effect separately on learning outcomes. This reinforces the notion that successful learning is the result of a combination of appropriate teaching strategies and students' internal readiness to learn.

In addition, learning motivation is also a factor that plays a major role in supporting the success of learning. High motivation encourages students to be more active, diligent and enthusiastic in following every stage of learning. Motivated students will be more eager to do assignments, participate in discussions, and be better prepared for learning evaluations. In this study, it was found that learning motivation has a significant influence on learning outcomes, both for students who follow the Archerys ID model and the TPACK model. Although there was no significant interaction between instructional design and learning motivation, these two factors independently contributed to improving student learning outcomes.

Visualization of this distribution can be seen through the histogram presented in Figure 4. From the research results, the lowest score of learning outcomes in the experimental class (50) was higher than the lowest

score in the control class (45). While the highest score of learning outcomes in the experimental class (97.5) is higher than the control class score (82.5), and the standard deviation of the experimental class is higher than the control class. So, it can be concluded that the experimental class has the most spread and diverse values. For more details, the data above can be seen in the attachment.

Table 4. Frequency distribution of control class posttest

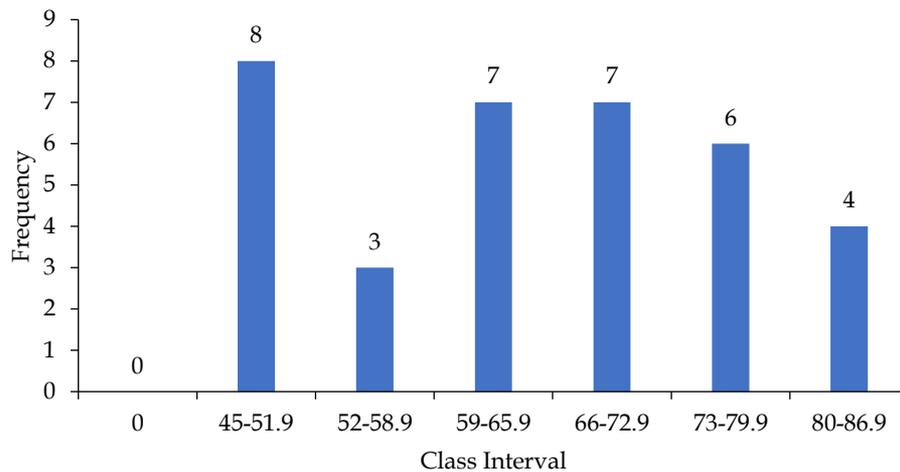| Class Interval	Absolute Frequency	Relative Frequency (%)	Cumulative Absolute Frequency	Cumulative Relative Frequency (%)
45–51.9	8	22.86	8	22.86
52–58.9	3	8.57	11	31.43
59–65.9	7	20.00	18	51.43
66–72.9	7	20.00	25	71.43
73–79.9	6	17.14	31	88.57
80–86.9	4	11.43	35	100.00

Figure 4. Histogram of posttest frequency distribution control class

The normality test is used to determine whether the data obtained from the experimental and control classes are normally distributed or not. A normality test is an absolute requirement before conducting parametric analysis. The Liliefors test is used to test normality. The following are the results of the normality test for student learning outcomes.

Table 5. Results of normality tests on learning outcomes in the experimental class and control class

Sample	L_{count}	L_{table}	Description
Experiment	0.098	0.147	Normal
Control	0.114	0.14976	Normal

Based on the test results above, it is known that $L_{count} < L_{table}$ at a significant level of 5%, it can be concluded that the data is normally distributed. Conversely, if $L_{count} > L_{table}$ at a significant level of 5%, it can be concluded that the data is not normally distributed. A summary of the overall normality test can be seen in the attachment.

The homogeneity test was carried out to determine the homogeneity of the data of the experimental and control classes. Data from the two classes that will be tested hypothesis first carried out a homogeneity test to ensure that the data obtained is homogeneous. This homogeneity test is an absolute requirement before hypothesis testing. This test is carried out with the test criteria, namely if the test results show a significance value > α = 0.05 then the data is homogeneous. The following are the results of the homogeneity test of student learning results.

F-Test Two-Sample for Variances

	Experimental class	control class
Mean	73,47222222	64,42857143
Variance	196,8849206	144,5168067
Observations	36	35
df	35	34
F	1,362366946	
P(F<=f) one-tail	0,184753593	
F Critical one-tail	1,766998931	

Figure 5. Homogeneity test results of experimental and control class learning outcomes

Based on the test results above, it is known that the significance value of the experimental and control class learning outcomes is 0.184. This value is greater than $> \alpha = 0.05$, so it can be concluded that the learning outcomes data obtained from the control class and experimental class are homogeneous. Furthermore, the homogeneity test of the learning outcomes of high motivation students was carried out. The following are the results of the homogeneity test of the learning outcomes of high motivation students.

Discussion

The Archerys ID learning model is developed through three main stages, namely introduction, core, and closing. At the introduction stage, the process begins with three systematic steps: giving attention, relevance reinforcement, and increased confidence. Since the beginning, this approach has included moral and spiritual elements, such as familiarizing learners to pray and be grateful before learning begins. explained that prayer activities are not just religious rituals, but a means of internalizing the value of honesty and spirituality (Hayuningtyas & Jenuri, 2024). Darmansyah & Darman (2024) also asserts that the level of religiosity contributes to the formation of moral decisions and ethical behavior, while views gratitude as an important element in strengthening and motivating the moral values of learners.

In addition to spiritual habituation, giving attention also emphasizes the formation of discipline through the active presence of students at the beginning of learning. Attendance is not just a formality, but a reflection of commitment and responsibility. Khaerani et al. (2023) highlighted that discipline is the result of consistent practice, and Farisa et al. (2023) added that attendance discipline contributes to academic achievement and character building such as responsibility and honesty.

This was confirmed by Deviana et al. (2025) who found that habituation practices such as morning greetings and prayers together play an important role in fostering strong moral character among learners. The next step in the introduction is increasing confidence, where teachers provide psychological encouragement so that learners believe that they are able to achieve learning goals. This confidence has been shown to have a significant impact on students' moral development and positive attitudes. Darmansyah & Darman (2024) found that confident students tend to be more engaged and show high learning motivation. Entering the core stage, Archerys ID learning is designed to be relevant to real life, such as linking renewable energy material to everyday practices in households. Emphasizes the importance of connecting learning materials with real-life contexts to make it more meaningful, while Liwayanti et al. (2025) added that the contextual

approach helps students understand the social and moral impact of the science they learn. The cultivation of moral values is also strengthened through the practice of giving fair praise and rewards. According to, praise is not just academic motivation, but also a means of strengthening relationships between individuals and strengthening respect for diversity. mentioned that Proportional and equitable praise can reduce behavioral inequality, while emphasize that verbal motivation can foster learners' moral responsibility and awareness of good and bad behavior.

The superiority of Archerys ID is not only on the moral side, but also has been shown to have a significant impact on academic learning outcomes. in their research concluded that the implementation of this model in informatics learning is able to improve academic achievement while strengthening student character, making it an effective and holistic instructional model. One of the learning strategies used in this model is the repetition of material through reminders of previous learning. This strategy aims to reinforce basic understanding and build connections between old and new knowledge. Support this approach by stating that repetition through evaluation helps improve long-term retention. Furthermore, the dialogic nature of teacher-student interaction also encourages critical reflection and the development of learners' ethical awareness.

These results reinforce the view that effective learning does not solely rely on students' internal motivation, but rather on how the learning design is structured to encourage participation, stimulate interest in learning, and provide space for critical and reflective thinking. Archery's ID structured with the ARCS Motivational approach indirectly influenced learning motivation, even in students who initially had low motivation levels. In the long run, this shows that successful learning does not only come from dispositional factors, but is also strongly influenced by appropriate instructional interventions. Therefore, teachers and instructional designers need to pay great attention to systematically designed and goal-oriented learning models, such as Archery's ID, as this model is able to bridge the gap of students' motivation and ensure all participants learners have the same opportunity to achieve academic success.

Conclusion

The findings of this study clearly demonstrate that the integration of gamification into computer science learning significantly enhances both student motivation and learning outcomes at SMP Negeri 27 Padang. By incorporating game-based elements such as point systems, badges, leaderboards, and interactive challenges, the learning process becomes more

engaging, enjoyable, and relevant to students' daily experiences. This dynamic approach successfully transforms traditional, monotonous learning environments into interactive spaces that stimulate curiosity, perseverance, and active participation. The results show that students taught using gamification strategies achieve higher levels of conceptual understanding and improved academic performance compared to those in conventional classrooms. Moreover, the data indicate that gamified learning encourages students to develop critical thinking skills, problem-solving abilities, and collaborative learning behaviors, which are essential for mastering computer science concepts in the digital era. Additionally, the study highlights that motivation serves as a key mediating factor in achieving successful learning outcomes. Students with high levels of intrinsic motivation who engage with gamified content demonstrate significantly better performance, indicating that the synergy between motivation and game-based learning plays a crucial role in knowledge retention and application. Importantly, the research also reveals that gamification can effectively support students across different motivation levels, making it a flexible and inclusive instructional approach. These findings underline the transformative potential of gamification as a pedagogical innovation capable of fostering deeper learning experiences, promoting active student engagement, and preparing learners to adapt to the evolving demands of technology-based education. Thus, gamification should be considered not merely as a supplementary tool, but as a strategic instructional design capable of revolutionizing how computer science is taught and learned in secondary education.

Authors Contribution
Conceptualization and methodology, writing—original draft preparation, software, formal analysis, investigation, data curation, Y., D.I., and T.S.W.; validation, writing—review and editing, R., A.H., and A.H.A.D.

Conflicts of Interest
There is no conflict of interest.

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