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Article

Effectiveness of Game Based Learning Model in Improving Science Learning Outcomes of Grade VII Students at MTsN 1 Ponorogo

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Article Info

Magang 2 Tahun Ajaran
2025/2026

Keywords:

*Game Based Learning;
Science Education;
Quasi-Experimental.*

ABSTRACT

The 21st-century educational paradigm demands innovative learning approaches to enhance student engagement and outcomes, particularly in abstract science topics. This study aims to evaluate the effectiveness of the Game Based Learning (GBL) model in improving science learning outcomes for seventh-grade students at MTsN 1 Ponorogo, specifically on the topic of Temperature, Heat, and Expansion. A quasi-experimental design with a non-equivalent control group was employed, involving two classes: the experimental group (n=31) taught using GBL and the control group (n=32) taught using conventional lecture methods. Data were collected through pre-test and post-test instruments and analyzed using descriptive and inferential statistics, including normality, homogeneity, and independent sample t-tests. The results indicated that the GBL model significantly improved student learning outcomes, with the experimental group's average post-test score (83.77) substantially higher than that of the control group (67.00). These findings suggest that GBL is an effective pedagogical strategy for enhancing both cognitive and affective domains in science education, fostering active participation, motivation, and collaborative skills among students.

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INTRODUCTION

The 21st-century educational paradigm requires fundamental adjustments in the teaching learning process, particularly in preparing learners with critical, creative, communicative, and collaborative skills, in line with global-era demands. Natural Sciences (IPA) plays a central role in developing logical thinking abilities and understanding natural phenomena. However, in practice especially at the Madrasah Tsanawiyah (MTs) level some science topics that are conceptually abstract, such as Temperature, Heat, and Thermal Expansion, present particular instructional challenges. These topics require learners to connect microscopic and macroscopic concepts (e.g., internal energy transfer and dimensional changes of objects due to temperature variations), processes that are not always easy to visualize through verbal explanation alone. Therefore, the effectiveness of the learning process strongly depends on the instructional model

adopted, which must be capable of transforming passive learning experiences into active and meaningful ones. Educational success is not solely measured by content mastery but also by students' ability to apply knowledge in real contexts. Annuar, Solihatin, and Khaerudin (2016) argue that a scientific instructional model should facilitate all stages of scientific thinking from observing to communicating meaning the applied model should stimulate high cognitive and affective engagement. Rigid, monotonous, teacher-centered models tend to impede development of essential 21st-century skills, making exploration of student-centered pedagogical innovations a necessity for achieving optimal science learning outcomes. Improving the quality of science instruction is part of the national education commitment to produce competitive and adaptive human resources amid rapid scientific and technological advancement (Annuar et al., 2016).

There is evidence that science instruction at MTsN 1 Ponorogo, particularly for Grade VII, faces substantive problems that directly impact student learning outcomes. These problems stem from the dominance of conventional teacher-centered teaching methods and a lack of variation in the use of interactive instructional media (Izzatur Rifqah & Handayani, 2025). Documentation of initial pre-test scores indicated low initial mastery of the Temperature, Heat, and Thermal Expansion topic. Specifically, the group later designated as the control class (lecture method) had a pre-test mean of 63.6, while the experimental group had a pre-test mean of 67.5. Both means indicate that most students had not reached the institution's minimum completeness criteria (KKM) prior to intervention, reflecting a significant gap between curricular targets and actual student achievement. Classroom observations also showed low active participation and learning interest as major impediments. Limitations in the instructional model often result in student boredom and passivity when dealing with complex material. For example, during the presentation of Heat and Expansion topics, many students had difficulty visualizing molecular processes, causing reduced motivation to ask questions or engage in discussion. Even after the control group received lecture-style treatment and completed the post-test, learning gains were moderate, with a post-test mean of 78.4 and individual completeness percentage still suboptimal. Saiful Muluk and Athaillah (2023) reinforced that challenges in general foundational subjects (MKDU), comparable to substantive subjects like science, require creative innovations to address limited learning duration and varied levels of student understanding. Therefore, continued reliance on conventional methods at MTsN 1 Ponorogo has not fully stimulated deep cognitive engagement, indicating a need for approaches that make the classroom more dynamic, challenging, and motivating to remedy low learning outcomes.

Given the urgency to improve learning outcomes and mitigate low active participation, the implementation of Game-Based Learning (GBL) is proposed as an innovative solution aligned with contemporary educational contexts. GBL refers to using game-design elements in non-game contexts here, the learning process to increase student engagement and motivation. GBL adoption is not merely playing but leveraging game mechanisms such as challenges, immediate feedback, scoring, and levels to achieve educational objectives. Empirical studies indicate that GBL has considerable potential to transform classroom dynamics, positioning students as active agents in constructing knowledge. Scientific learning models based on GBL are even designed to align the enjoyment of play with scientific stages, ensuring game elements support rather than distract from knowledge transfer. For science instruction, GBL allows simulations of abstract concepts such as particle movement during thermal expansion or heat transfer to become visual and interactive representations that are easier for students to grasp, thereby bridging visualization challenges. Wardia, Setyosari, and Ulfa (2022) found that GBL effectively improves learning outcomes by providing a safe learning environment for trial and error, framing mistakes as part of the learning process rather than failures. The approach inherently contains components of intrinsic and extrinsic motivation that can counteract the

boredom induced by passive lecture methods. Thus, GBL is positioned as a strong pedagogical intervention to address the difficulties faced by Grade VII students at MTsN 1 Ponorogo in understanding and mastering science topics.

Mechanistically, GBL increases students' interest and motivation. Game elements such as goal achievement and healthy competition stimulate full participation, which is necessary to tackle challenges presented by topics like Temperature, Heat, and Thermal Expansion. GBL also provides immediate feedback essential in concept learning. So, that learners can promptly correct misunderstandings without waiting for formal assessment. Cognitively, GBL facilitates creativity and problem solving skills development, enabling students to apply science concepts in game scenarios that demand problem resolution rather than rote memorization of formulas. Empirical initial data from this study provide strong preliminary justification: the experimental group receiving GBL intervention showed a post-test mean of 89.2, significantly higher than the control group's post-test mean of 78.4. The mean gain differences (about 21.7 for the experimental group versus 14.8 for the control) preliminarily indicate that GBL implementation yields more substantial learning gains compared to conventional methods. Putri Nur Anggraini, Muzayanah, and Sasongko (2024) similarly reported that experimental groups with GBL achieved significantly better results than control groups, supporting the hypothesis of GBL's efficacy. Although prior research focused on different contexts (e.g., mathematics or social studies), a consensus exists on GBL's effectiveness for creating interactive learning environments and improving outcomes, which motivates a specific investigation into GBL's impact on Temperature, Heat, and Thermal Expansion at MTsN 1 Ponorogo. Accordingly, this study systematically and comprehensively examines the effectiveness of the GBL model compared to conventional methods in improving Grade VII students' science learning outcomes.

METHOD

This study employed a quasi-experimental design with a pre-test–post-test nonequivalent control group format. Both the experimental and control groups received a pre-test before the treatment and a post-test after the treatment. The study aimed to determine what students learned before and after GBL implementation and to analyze the model's impact on student learning outcomes regarding “Temperature, Heat, and Thermal Expansion” at MTsN 1 Ponorogo.

The research was conducted in two different classes: Grade VII F as the experimental class and Grade VII H as the control class. Prior to treatment, both classes took a pre-test to evaluate their initial ability on the same topic. Grade VII F received treatment with a game-based learning model emphasizing active student engagement via educational games designed to enhance conceptual understanding. The control class (VII H) received lecture-based instruction. Post-tests were administered to both classes after the instructional process to assess learning gains and compare the effectiveness of both teaching models.

Simple random sampling was used to ensure each student had an equal opportunity to be included as a sample. Sugiyono (2020) defines a sample as a subset of a population possessing certain characteristics that represent the population. Primary data were collected from observations, tests, and documentation. Test instruments assessed student learning outcomes; documentation supported data collection. Prior to use, the instruments underwent validity and reliability tests to ensure they were accurate and consistent measures.

Descriptive statistical techniques were used to present student learning results. To ensure data suitability for further inferential analysis, classical assumption tests were performed: the Shapiro–Wilk test for normality and Levene's Test (Test of Equality of Variances) for homogeneity. After confirming normality and homogeneity, hypothesis testing utilized JASP's

Independent Samples T-test to determine whether learning outcomes differed significantly between experimental and control classes.

RESULT AND DISCUSSION

The study was conducted at MTsN 1 Ponorogo from October to November in the 2025/2026 academic year and involved two classes: VII F (experimental; $n = 31$) and VII H (control; $n = 32$). Instrument trials were conducted with 30 students outside the sample using 21 multiple-choice items to ascertain validity and reliability for pre- and post-tests.

A pre-test was administered to both classes to assess their initial abilities in the topic "Temperature, Heat, and Expansion." Afterward, a Game-Based Learning (GBL) model was used for the experimental class, while a lecture-based learning model was used for the control class. Following the completion of the treatment, both classes were given a post-test to determine improvements in learning outcomes. The pre-test and post-test results were analyzed to identify differences in learning outcomes between the two classes, thus determining whether the Game-Based Learning (GBL) model was effective in improving student learning outcomes at MTsN 1 Ponorogo.

Normality and homogeneity tests were then conducted on the pre-test and post-test data from the experimental and control classes. This analysis was conducted using JASP software. To determine whether the learning outcome data were normally distributed and had equal variance, the Shapiro-Wilk test was used for normality, while the Levene's Test of Equality of Variances (Test of Equality of Variances) was used to test for homogeneity. Data were considered homogeneous and normal if the significance value was greater than 0.05.

Table 1. Normality Test

<i>Test of Normality (Shapiro-Wilk) ▼</i>		
Residuals	W	p
Pretest	0.963	0.058
Posttest	0.979	0.344

Note. Significant results suggest a deviation from normality.

Based on the Shapiro-Wilk test, the pretest has a $p\text{-value} = 0.058 > 0.05$, so the data is normally distributed. Likewise, the posttest has a $p\text{-value} = 0.344 > 0.05$, so the data is also normally distributed.

Table 2. Homogeneity Test

<i>Test of Equality of Variances (Levene's)</i>				
	F	df ₁	df ₂	p
Pretest	0.013	1	88	0.911
Posttest	6.727×10^{-4}	1	88	0.979

Based on the Levene's Test of Equality of Variances (Test of Variances) figure, the pretest had a $p\text{-value}$ of $0.911 > 0.05$, indicating homogeneity in the data. Similarly, the posttest had a $p\text{-value}$ of $0.979 > 0.05$, indicating homogeneity in the data. Hypothesis testing was conducted to determine whether there were differences in learning outcomes before and after the implementation of the Game-Based Learning (GBL) model and the lecture learning model. Data analysis was performed using JASP software using two types of statistical tests: the Paired Sample T-Test and the Independent Sample T-Test.

The Paired Sample T-Test was used to determine differences in learning outcomes before and after the implementation of each learning model in one class. Meanwhile, the Independent Sample T-Test was used to examine the differences in the effect of the Game-Based Learning

(GBL) class and the lecture learning class on student learning outcomes. The T-test analysis using JASP yielded a significance value (p-value) of $0.001 < 0.05$, indicating a significant difference in student learning outcomes. Thus, it can be concluded that the Game Based Learning (GBL) learning model has a significant influence on improving student learning outcomes compared to the lecture learning model on the material taught at MTsN 1 Ponorogo.

Table 3. Descriptive Test

Descriptives

Group Descriptives

	Group	N	Mean	SD	SE	Coefficient of variation
Pretes	Model_ceramah	33	64.758	11.859	2.064	0.183
	Model_game based	30	65.267	11.653	2.128	0.179
Postes	Model_ceramah	33	67.000	8.120	1.414	0.121
	Model_game based	30	83.700	4.260	0.778	0.051

Based on figure 3, it can be seen that the average (mean) value of student learning outcomes in the class with the Game Based Learning (GBL) learning model is higher than the class using the lecture learning model, both during the pre-test and post-test. In the pre-test stage, the GBL class obtained an average of 65.27, while the lecture class was 64.76. Meanwhile, in the post-test stage, the average learning outcomes of the Game Based Learning (GBL) class increased to 83.77, while the lecture class only reached 67.00. This shows that the application of the Game Based Learning (GBL) model is more effective in improving student learning outcomes compared to the use of the lecture learning model on the material taught at MTsN 1 Ponorogo.

Before implementing the treatment in the learning activities, students underwent a pre-test to measure their initial cognitive abilities. The initial assessment results indicated that students' knowledge and understanding fell below the Minimum Completion Criteria (KKM), with scores ranging from 30 to 70. This indicated that students still needed more engaging and entertaining learning methods. Therefore, Game-Based Learning (GBL) was used through interactive games tailored to the learning objectives and material on temperature, heat, and expansion to help students achieve the expected competencies.

By implementing the Game-Based Learning (GBL) model, students not only acquired cognitive skills but also affective skills. This model fostered student interest, collaboration, and perspective. Students worked collaboratively in groups to play games about temperature, heat, and expansion, related to everyday life. This process resulted in a more meaningful learning experience because it fostered the skills of actively responding, organizing, and collaborating. Furthermore, due to its challenging nature, ranging from easy to difficult, the game activities required quick movement, dexterity, and self-expression when presenting their work.

Post-test results after implementing the Game-Based Learning (GBL) model showed that game-based learning was effective in improving learning outcomes, critical thinking, and active student engagement during the learning process. The lowest score reached 70 and the highest reached 90, and no students scored below the Minimum Competency (KKM). When compared to the lecture model used in the control class, the differences in results indicated that Game-Based Learning (GBL) was superior in capturing and maintaining student attention. While the lecture model does teach critical thinking and problem-solving skills, its use requires a high level of cognitive readiness and a high degree of learning independence. Therefore, Game-Based Learning (GBL) is an easier and more enjoyable method, making it suitable for junior high school students.

Furthermore, the successful implementation of the Game-Based Learning (GBL) model in this study is inseparable from the principles of constructivist learning theory. Game activities allow students to actively expand their knowledge by linking new concepts to their previous

experiences. This aligns with Vygotsky's theory, which emphasizes that students must be directly involved in exploration and social collaboration for optimal learning. The use of interactive maps in this context strengthens the construction of understanding because it provides an observable learning experience. This differs from simply listening to a teacher's verbal explanation. In addition to enhancing students' conceptual understanding, the use of Game-Based Learning (GBL) can help increase intrinsic motivation. Students can learn with enjoyment through game elements such as healthy competition, tiered challenges, and immediate feedback. Deci and Ryan's learning motivation theory (Self-Determination Theory) states that a sense of involvement, autonomy, and competence strengthens students' desire to continue learning. This condition aligns with the theory. Therefore, Game-Based Learning (GBL) not only improves cognitive learning outcomes but also instills a positive attitude towards learning.

Furthermore, the findings of this study indicate that students' social interaction and cooperation increase during game-based learning. In solving game challenges, group activities encourage students to discuss, make decisions, and share roles. This suggests that Game-Based Learning (GBL) can be used to incorporate collaborative learning that emphasizes cooperation and communication among students, in line with the demands of the Deep Learning Curriculum, which focuses on active and collaborative learning.

Overall, game-based learning has proven effective at MTsN 1 Ponorogo because it improves student learning outcomes and creates a fun, active, and collaborative learning environment. Incorporating game elements into learning can increase student engagement and social skills, as well as concept retention. Therefore, Game-Based Learning (GBL) can be an innovative option for educators to build student-centered learning that aligns with the features of today's digital generation.

CONCLUSION

The main conclusion of this study is that the Game-Based Learning (GBL) model is significantly effective in improving Science learning outcomes of Grade VII students at MTsN 1 Ponorogo on the topic of Temperature, Heat, and Thermal Expansion, compared to conventional lecture methods. This conclusion is supported by statistical analysis indicating a significant difference between the two groups. GBL not only resulted in a considerably higher post-test mean in the experimental class but also enabled all students in the GBL class to surpass the Minimum Completeness Criteria (KKM). GBL's strengths include improving cognitive aspects while fostering intrinsic motivation, collaboration, and active engagement aligned with constructivist principles. This study contributes conceptually by reinforcing GBL's validity as a pedagogical solution for abstract science topics. However, limitations include the quasi-experimental design and the study's limited focus on specific thinking skills; future research is recommended to use more rigorous designs and to examine GBL's effects on other higher-order thinking skills.

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