



# Implementing the Game Based Learning Model with ZepQuiz Media to Improve Junior High School Students' Mathematical Concept

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## Abstract

This study was motivated by students' limited understanding of mathematical concepts, which is largely influenced by teacher-centered learning practices. The purpose of this research was to compare the effectiveness of traditional instruction with that of the Game Based Learning (GBL) paradigm, with the use of Zep Quiz media, in improving students' grasp of mathematical concepts. A Nonequivalent Control Group Design was used in this quantitative quasi-experimental investigation. Class VIII.2 students from SMP Negeri 4 Tanjungpinang ( $n = 30$ ) served as the experimental group, while Class VIII.3 students ( $n = 26$ ) served as the control group. The tool used was a pre- and post-test essay measuring conceptual knowledge of mathematical concepts. As a whole, the experimental group achieved a high N-Gain score of 0.71, while the control group managed a medium level of 0.38. The significance value of  $0.001 < 0.05$  in the Independent Samples T-Test demonstrated that students who were taught utilising the GBL model with the use of Zep Quiz media exhibited considerably greater progress. This finding implies that GBL assisted by Zep Quiz can serve as an innovative and interactive learning alternative in mathematics learning.

**Keywords:** Game Based Learning; Zep Quiz; Understanding of Mathematical Concept

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## INTRODUCTION

According to (Zuhaida et al., 2025) mathematics is an important subject for developing analytical, logical, and critical thinking skills that support human resource development. Through education, students not only acquire knowledge but also develop the competencies needed to face various life challenges. In line with Law No. 20 of 2003 concerning the National Education System, the learning process should be designed effectively to enable students to



develop their potential optimally. One of the essential subjects in achieving this goal is mathematics, as it equips students with logical, systematic, and analytical thinking skills that are useful in both academic and everyday contexts.

One of the primary goals of mathematics education is developing students' conceptual understanding. The National Council of Teachers of Mathematics (NCTM) emphasizes that students should understand mathematical concepts and the relationships among them so that they can apply mathematical knowledge in solving problems. Kilpatrick et al. (2001) define mathematical conceptual understanding as the ability to comprehend mathematical concepts, operations, and relationships and apply them in various situations. Similarly, Duffin & Simpson (2000) state that conceptual understanding enables students to explain mathematical ideas and use them appropriately in different contexts.

Mathematical conceptual understanding involves more than the ability to recall formulas or procedures. According to the National Council of Teachers of Mathematics (NCTM, 2000), students with conceptual understanding are able to recognize and represent mathematical concepts, explain relationships among concepts, apply concepts in various situations, and justify mathematical reasoning. Similarly, conceptual understanding can be reflected in students' ability to restate concepts in their own words, classify objects according to their properties, provide examples and non-examples, represent concepts in different forms, and apply concepts to solve problems (Saepuloh et al., 2024). These indicators demonstrate that conceptual understanding requires students to develop meaningful connections among mathematical ideas rather than memorizing isolated facts and procedures.

The development of conceptual understanding is closely related to constructivist learning theory. Constructivism views learning as an active process in which students construct knowledge based on their prior experiences and interactions with their environment. According to Piaget, knowledge is built through the processes of assimilation and accommodation, while Vygotsky emphasizes the importance of social interaction in cognitive development. Therefore, learning activities that encourage exploration, discussion, collaboration, and problem-solving are considered more effective in supporting conceptual understanding because they allow students to actively construct meaning from the concepts being learned (Afriansyah et al., 2023; Purnamasari, 2024).

However, students' mathematical conceptual understanding remains relatively low. The results of the Programme for International Student Assessment (PISA) indicate that Indonesian students' mathematical performance is still below the international average (Masfufah & Afriansyah, 2021). Many students tend to memorize formulas without understanding the underlying concepts and experience difficulties when solving problems that differ from examples provided by the teacher (Purnomo & Sari, 2021). Students also struggle to connect mathematical concepts to problem situations, indicating a lack of deep conceptual understanding.

Observations conducted at SMP Negeri 4 Tanjungpinang revealed similar conditions, particularly in learning triangle material. Based on the results of the daily assessment on triangle topics in the 2025/2026 academic year, only 39% of students achieved the minimum mastery criterion (KKM), while 61% did not meet the expected standard. Furthermore, interviews with mathematics teachers indicated that students frequently struggled to identify relationships among triangle concepts, apply formulas appropriately, and solve contextual problems. These findings suggest that students' mathematical conceptual understanding of triangle material remains relatively low.

One factor contributing to this issue is the predominance of teacher-centered learning. Teachers generally explain the material and provide examples, while students act as passive recipients of information. Such learning conditions limit students' opportunities to actively construct their own understanding. In addition, the limited use of innovative learning media often reduces students' interest and participation during mathematics lessons.

To address these challenges, a learning approach that promotes active student involvement is needed. One promising approach is Game Based Learning (GBL). According to Szilágyi et al. (2025), GBL has evolved from simple games and simulations into technology-supported learning environments and remains one of the active learning strategies used today. Game-based learning is an instructional approach that integrates game mechanics into learning activities to facilitate meaningful learning experiences (Seddighi- Khadivak et al., 2026). Consistent with constructivist principles, GBL encourages students to actively explore concepts, solve problems, test strategies, and receive immediate feedback. These activities help students connect new information with prior knowledge and construct a deeper understanding of mathematical concepts. Previous studies have also shown that GBL can improve students' conceptual understanding and problem-solving skills (Marzuki et al., 2025).

In this study, the implementation of GBL is supported by Zep Quiz, a digital learning platform that presents quizzes in a game-map format. Zep Quiz provides various interactive features, such as avatars, leaderboards, and collaborative game modes, which allow students to participate actively in learning activities. Through these features, students can explore mathematical concepts in a more meaningful and interactive manner. Learning through game-based activities and simulations has also been found to support deeper conceptual understanding (Sugianto, 2023).

Several previous studies have demonstrated the potential of both Game Based Learning (GBL) and Zep Quiz in supporting learning outcomes. However, important limitations remain. Rusmana et al. (2025) examined the use of Zep Quiz within a Project-Based Learning framework and focused on students' critical and creative thinking skills rather than mathematical conceptual understanding. Medila et al. (2023) investigated the effect of GBL on conceptual understanding but did not integrate digital game-based platforms such as Zep Quiz. Likewise, Mukaromah (2021) combined GBL with game media but focused on numeracy skills and employed a different type of game. Consequently, previous studies have not specifically

examined the effectiveness of integrating the Game Based Learning model with Zep Quiz media in improving junior high school students' mathematical conceptual understanding, particularly on geometry topics such as triangles. Therefore, empirical evidence regarding the combined effect of GBL and Zep Quiz on students' mathematical conceptual understanding remains limited.

This gap is important because mathematical conceptual understanding remains one of the major challenges in mathematics education, particularly in geometry topics such as triangles, where students often rely on memorizing formulas without understanding underlying concepts. Integrating GBL with Zep Quiz may provide a more interactive and constructivist learning environment that supports deeper conceptual understanding.

Based on the research gap identified above, the research question of this study is: "Is the improvement in students' mathematical conceptual understanding achieved through the Game Based Learning (GBL) model assisted by Zep Quiz media higher than that achieved through conventional learning?"

Accordingly, the purpose of this study is to examine the effectiveness of the Game Based Learning (GBL) model assisted by Zep Quiz media in improving students' mathematical conceptual understanding compared to conventional learning.

## **METHODS**

A quantitative technique using a quasi-experimental method was used in this investigation. A Nonequivalent Control Group Design was used for the study. This design included two classes, one for the experimental group and one for the control group. Class VIII.2 and class VIII.3 were chosen as the study samples because they were cluster sampling nine classes with comparable academic ability. This design was used for this purpose. During the second semester of the 2025/2026 academic year, this research was carried out at SMP Negeri 4 Tanjungpinang.

Eighth graders from all nine classes at SMP Negeri 4 Tanjungpinang made up the study's population. Cluster sampling, which involves picking samples based on groupings of students that develop spontaneously in the classroom, was the method utilised for this study. Using this method, 30 students from Class VIII.2 served as the experimental group and 26 students from Class VIII.3 served as the control group for the study.

Both independent and dependent variables were used in this investigation. The GBL model, with the help of Zep Quiz media, served as the independent variable, while students' capacity to grasp mathematical concepts served as the dependent variable. While the control group continued to employ the tried-and-true method of classroom instruction, the experimental group used a Game Based Learning (GBL) model with the help of Zep Quiz media to improve their academic performance. Both groups took a pretest to gauge the students'

starting points before the intervention began. After the lesson was over, students in both groups took a posttest to gauge their overall progress and growth as learners.

The study was conducted in six meetings consisting of one pretest session, four treatment sessions, and one posttest session. The treatment was implemented over four meetings, with each meeting lasting  $2 \times 40$  minutes. The learning materials covered triangle concepts, including types and properties of triangles, perimeter and area of triangles, and triangle problem-solving tasks. During the intervention, students in the experimental class learned through the Game Based Learning (GBL) model assisted by Zep Quiz media, while students in the control class received conventional instruction.

The implementation of GBL in the experimental class involved several stages. At the beginning of each lesson, the teacher introduced the learning objectives and explained the rules of the learning activities. Students were then organized into small groups and engaged in discussions to explore the concepts being studied. Zep Quiz was used as the main learning medium, where students completed interactive quizzes and challenges related to triangle concepts through a game-based environment. Students received immediate feedback on their answers and could monitor their progress through the platform's scoring and leaderboard features. At the end of each meeting, students discussed the solutions with the teacher, reflected on the learning activities, and summarized the mathematical concepts learned.

A mathematics conceptual understanding test consisting of essay questions was used as the research instrument. The test was designed based on indicators of mathematical conceptual understanding, namely the ability to restate concepts, classify objects based on their properties, represent concepts in various forms, and apply concepts to solve problems. The instrument consisted of several essay items that were developed in accordance with the learning objectives of triangle material for junior high school students. The test was administered twice, namely as a pretest and a posttest using the same instrument to measure students' improvement in conceptual understanding.

Before being used in the research, the instrument was validated through expert judgment and tested for item validity, reliability, level of difficulty, and discrimination index to ensure its appropriateness as a data collection tool. In this study, data were collected through test-based assessment.

The collected data were analyzed using SPSS 27. The analysis procedures included calculating N-Gain scores for both experimental and control classes, conducting a normality test using the Shapiro-Wilk test, a homogeneity test using Levene's Statistic, and hypothesis testing using the Independent Samples t-test to determine differences in students' improvement in mathematical conceptual understanding between the two groups.

## RESULTS AND DISCUSSION

Findings and Analysis Students' pre-test scores on measures of arithmetic conceptual knowledge placed the experimental and control groups in about the same ballpark. The average pretest score of the experimental class was 44.12, while the control class obtained an average score of 40.00. This indicated that both classes had relatively equivalent initial abilities before the treatment was administered

**Table 1.** Recapitulation of Pretest and Posttes Scores in the Experimental and Control Groups

Informations	Eksperimental Class (30)		Control Class (26)	
	Pretest	Posttest	Pretest	Posttest
<b>Lowest Score</b>	13,8	69,4	16,6	22,2
<b>Highest Score</b>	66,4	94,4	52,7	80,5
<b>Mean</b>	44,12	84,19	40,0	62,35
<b>Standard deviation</b>	12,60	7,12	9,84	13,53
<b>Confidence intervals (95% CI Lower)</b>	66,60		27,95	
<b>Confidence intervals (95% CI Upper)</b>	76,14		45,18	

Table 1 presents the descriptive statistics of the pretest and posttest scores for both groups. In the experimental class (n = 30), the pretest scores ranged from 13.8 to 66.4, with a mean score of 44.12 and a standard deviation of 12.60. After the intervention, the posttest scores increased, ranging from 69.4 to 94.4, with a mean score of 84.19 and a standard deviation of 7.12. The 95% confidence interval for the posttest mean ranged from 66.60 to 76.14.

In the control class (n = 26), the pretest scores ranged from 16.6 to 52.7, with a mean score of 40.00 and a standard deviation of 9.84. The posttest scores ranged from 22.2 to 80.5, with a mean score of 62.35 and a standard deviation of 13.53. The 95% confidence interval for the posttest mean ranged from 27.95 to 45.18. The descriptive statistics indicate that both groups obtained higher mean scores on the posttest than on the pretest. The experimental class recorded a higher posttest mean score than the control class.

### Descriptive Analysis of N-Gain Data

Explanation of N-Gain ResultsThe purpose of the N-Gain calculation was to find out how much each group of eighth graders at SMP Negeri 4 Tanjungpinang improved their mathematics conceptual comprehension skills. The N-Gain data were examined with the help of SPSS 27. A look at Table 2 reveals the N-Gain findings.

**Table 2.** N-Gain Results of the Experimental and Control Classes

Information	Minimum	Maxsimum	Average	Criteria	Standard Deviation
<b>Eksperimental Class</b>	0,42	0,91	0,71	High	0,12
<b>Control Class</b>	0,50	0,68	0,38	Moderate	0,21

In Table 2, we can see that the control group achieved an average N-Gain score of 0.38, which is considered medium, compared to the experimental group's high score of 0.71. The N-Gain scores ranged from 0.42 at the bottom to 0.91 at the top in the experimental group. The control group, however, had N-Gain scores ranging from 0.50 to 0.68. There was higher homogeneity in the experimental group's data since their standard deviation was 0.12, compared to 0.21 in the control group. These results demonstrated that compared to students who learnt using the traditional model, those whose learning was aided by the Game Based Learning (GBL) approach and the Zep Quiz media exhibited a greater gain in their mathematics conceptual comprehension skills.

### Normality Test

Test for Normality The normalcy test was carried out with the help of SPSS 27 and the Shapiro-Wilk test. When testing for data normality with a small sample size, the Shapiro-Wilk test is often used (Habibzadeh, 2024).

The analysis of normalized N-Gain data was continued using the Independent T-Test to determine whether the average improvement in students' mathematical conceptual understanding abilities using the Game Based Learning model assisted by Zep Quiz media was higher than that of students using the conventional learning model. To ensure that the data followed a normal distribution, a normality test was run before to the hypothesis test. The normalcy test was based on the following hypotheses:

$H_0$  = The data were normally distributed.

$H_a$  = The data were not normally distributed.

If the significance value was higher than  $\alpha = 0.05$ ,  $H_0$  was accepted; otherwise, it was rejected.

Table 3 displays the results of the normalcy test.

**Table 3.** Normality Test Results of N-Gain Scores in the Experimental and Control Classes

		<i>Test of Normality</i>	
		<i>Shapiro-Wilk</i>	
<i>N-Gain Value</i>	<b>Eksperimental Class</b>	<b>df</b>	<b><i>Sig</i></b>
		<b>Control Class</b>	<b>26</b>

The experimental class's significance value was  $0.221 > 0.05$  ( $H_0$  was accepted) according to Table 3, whereas the control class's significance value was  $0.051 > 0.05$  ( $H_0$  was approved). The results of the tests indicated that the control and experimental groups' N-Gain data followed a normal distribution. We then used the Levene Statistics to check for homogeneity, as both datasets followed normal distributions.

### Homogeneity Test

Next, we ran a homogeneity test to see whether the two samples' variances were similar after the normality test showed that the N-Gain data for both classes followed a normal distribution. We used the Levene test to check whether the variances were equal across groups and if the data was homogeneous.

Data were deemed to be homogenous if the significance value was higher than 0.05, as per the testing requirements. On the other hand, data were deemed non-homogeneous if the significance value was below 0.05. These were the working hypotheses:

$H_0$  = The data were homogeneous.

$H_a$  = The data were not homogeneous.

**Table 4.** Homogeneity Test Results of N-Gain Scores in the Experimental and Control Classes

<i>N-Gain</i>	<i>Test of Homogeneity of Variance</i>			
	<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>Sig</i>
	<b>15.839</b>	<b>1</b>	<b>54</b>	<b>0,001</b>

According to Table 4, the achieved significance value was 0.001, which is less than 0.05. The non-homogeneity of the N-Gain data in the two groups was therefore shown by the rejection of  $H_0$ .

### Hypothesis Testing

Next, we used the Independent Samples T-assess to assess our hypotheses, following the normality and homogeneity tests. Data were found to be regularly distributed according to the normality test; however, they were found to be non-homogeneous according to the homogeneity test. According to (Chicco et al., 2025) when comparing the means of two independent samples, the independent samples t-test is used. According to Raharjo in Isdayanti et al. (2022) cites Raharjo as saying that the Independent Samples T-Test does not absolutely need homogeneity, hence it could be used even if the data were not homogenous. Hence, the Equal Variances Not Assumed output was used to understand the test findings.

Here were the hypotheses that were tested in this study:

$H_0$  : Using Zep Quiz media in conjunction with the Game Based Learning (GBL) paradigm improved students' mathematics conceptual thinking skills on par with the traditional learning methodology.

$H_a$  : Compared to students who learnt using the traditional model, those who used the Game Based Learning (GBL) approach with the use of Zep Quiz media showed a greater average gain in their arithmetic conceptual comprehension skills.

According to the decision criterion,  $H_a$  was accepted if the p-value was less than  $\alpha$  at a significance level of 0.05. We rejected  $H_a$  and accepted  $H_0$  if that wasn't the case. Table 5 shows the outcomes of the Independent Samples Test.

**Table 5.** Independent Samples T-Test Results

<i>Independent Samples Test</i>		
<i>Hasil N-Gain</i>	<i>t-test for Equality of Means</i>	
	<i>df</i>	<i>Sig. (2-tailed)</i>
<i>Equal variances not assumed</i>	40	.001

Table 5 shows that the significance value (Sig. 2-tailed) was 0.001. In this study, the hypothesis was formulated as a directional hypothesis (one-tailed test), because the research

specifically predicted that the Game Based Learning (GBL) model assisted by Zep Quiz media would produce a greater improvement in students' mathematical conceptual understanding compared to conventional learning. Therefore, the p-value for the one-tailed test was obtained by dividing the two-tailed value by two, resulting in 0.0005.

Since the p-value was lower than 0.05,  $H_0$  was rejected and  $H_a$  was accepted. This indicates that there was a significant difference in the improvement of mathematical conceptual understanding between students taught using the Game Based Learning (GBL) model assisted by Zep Quiz media and those taught using conventional learning. Furthermore, the experimental class obtained a higher mean N-Gain score (0.71) than the control class (0.38), indicating greater improvement in mathematical conceptual understanding among students in the experimental group.

Through the usage of game features including challenges, scoring, leaderboards, and group contests, students were also more motivated and engaged in learning while using Zep Quiz media. There was a marked improvement in the level of engagement and participation from the students. Students engaged in meaningful discussion and worked together to solve mathematical problems as they learned. The learning process was not centred on the instructor alone because of these discussion activities, which allowed students to share ideas and build conceptual knowledge collectively. The results were consistent with those of Sari et al. (2022), who found that students were more engaged and engaged in class when they learned via conversation.

Further, rather than just reciting formulae, students demonstrated increased proficiency in applying mathematical principles to a range of issue types. This proved that when students were actively involved in their own learning, they were able to get a more profound conceptual grasp. The results of this study are corroborated by those of Ammy et al. (2025) who found that using Quizizz to facilitate Problem-Based Learning improved students' conceptual grasp of mathematics by having them actively participate in solving problems and reflecting on their own learning. According to Hermaya et al. (2025) "gamification has a positive impact on conceptual understanding and problem-solving skills, as students achieve higher learning outcomes compared to conventional learning methods."

The use of Zep Quiz also helped reduce students' boredom and anxiety in learning mathematics because the learning activities were packaged in the form of educational games. Students became more confident in answering questions and participating in learning activities. In addition, teachers could obtain immediate feedback through the real-time evaluation features available in Zep Quiz. This aligns with the findings of Zhang & Crawford (2024) who stated that incorporating game features into learning tools significantly increases learners' motivation and engagement, making learning more interactive and enjoyable. Furthermore, Maryana et al. (2024) emphasized that gamification can effectively enhance educational experiences by making learning more interactive and motivating, thus increasing student engagement Yie et al. (2024) also added that most students consider gamified learning environments more

appealing and motivating, which encourages greater enthusiasm and participation in learning activities. Furthermore, teachers can more easily obtain direct feedback through the real-time evaluation feature available on Zep Quiz, which accelerates the learning reflection process.

According to the findings of this investigation, using games to teach mathematics is a successful method (Himmawan & Juandi, 2023). Having games in the learning process will induce motivation to learn (Garcia-vita et al., 2021). These findings were consistent with the studies conducted by (Ratnawati & Wahyuni, 2026) and (Muslimin, 2025), which stated that Zep Quiz improved students' self-confidence and assisted teachers in the learning evaluation process.

Overall, the findings suggest that the Game Based Learning (GBL) model assisted by Zep Quiz media created a learning environment that encouraged active participation and engagement, which may have contributed to the improvement of students' mathematical conceptual understanding. However, this result is specifically limited to this study, which was conducted in one junior high school, focusing on grade VIII students and triangle material. Therefore, the effectiveness of GBL with Zep Quiz in other contexts, subjects, or educational levels may require further investigation.

## CONCLUSION

The findings of this study indicate that the Game-Based Learning (GBL) model assisted by Zep Quiz significantly improves students' mathematical conceptual understanding compared to conventional learning. This is supported by the results of the Independent Samples t-test, which showed a significant difference between the two groups ( $p = 0.001$ ), as well as the N-Gain results, where the experimental class obtained a higher mean score (0.71, high category) than the control class (0.38, medium category). These results demonstrate that students who learned through the GBL model assisted by Zep Quiz experienced greater improvement in understanding triangle concepts.

These findings imply that the integration of GBL with Zep Quiz can be used by mathematics teachers as an alternative instructional approach to enhance student engagement and support deeper conceptual understanding, particularly in geometry learning. The use of game elements such as interaction, challenges, and immediate feedback can help create a more active and student-centered learning environment. In addition, for educational technology developers, these results highlight the importance of designing digital learning platforms that not only focus on engagement features but also support structured conceptual understanding through meaningful tasks and feedback.

However, this study is limited to one school, one grade level (VIII), one topic (triangles), and a relatively short implementation period. Therefore, future research is recommended to apply the GBL model assisted by Zep Quiz in different mathematical topics, educational levels, and longer durations to obtain more generalizable results. Further studies may also compare

this approach with other digital learning platforms to strengthen evidence regarding its effectiveness.

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### Declarations

- Author Contribution : Author 1 was responsible for the research conceptualization, writing the original draft, and processing the research results. Author 2 and Author 3 contributed by providing suggestions, feedback, and guidance for improving the methodology, data analysis, and manuscript writing.
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