THE INTEGRATION OF ZEP QUIZ INTO GAME-BASED LEARNING: ITS EFFECTS ON STUDENT ENGAGEMENT AND UNDERSTANDING OF MATHEMATICAL CONCEPTS

Aima Rakhmawati [1*], Isnani [2], Moh. Shaefur Rokhman[3]

[123] *Universitas Pancasakti Tegal (INDONESIA)*

[*]*Corresponding author: aimarakhmawati2@gmail.com*

Abstract

Low levels of student engagement and understanding of mathematical concepts remain a challenge in mathematics education. One of the causes is the use of learning models that lack variety and the suboptimal use of digital technology. This study aims to analyze the effectiveness of integrating Zep Quiz into Game-Based Learning on student engagement and understanding of mathematical concepts. This study employed a quantitative approach using a quasi-experimental design. The research sample was selected through purposive sampling, involving an experimental class, a control class, and a pilot class. Data were collected via a learning engagement questionnaire and a mathematical concept comprehension test. Data analysis was conducted using Multivariate Analysis of Variance. The results showed that students in the experimental class exhibited higher levels of learning engagement and mathematical concept understanding compared to students in the control class. These findings provide empirical evidence that the integration of the Zep Quiz platform into Game-Based Learning is an effective instructional strategy for enhancing students' learning engagement and mathematical concept understanding in mathematics instruction.

Keywords: Game-Based Learning (GBL) Mode; Zep Quiz; Engagement; Conceptual Understanding;

1 INTRODUCTION

Active learning and understanding of mathematical concepts are two fundamental aspects of mathematics education because they contribute to logical thinking, problem-solving, and the meaningful construction of knowledge. Students' active participation in the learning process can help build knowledge and skills that contribute to improved learning outcomes (Agil et al., 2019). Furthermore, the abstract nature of mathematics makes conceptual understanding a crucial foundation for logical and systematic thinking (Isnani et al., 2022). Therefore, teachers need to implement varied instructional models tailored to students' characteristics and utilize diverse learning resources (Retno & Purwati, 2020). Mastery of instructional models is an essential competency that teachers must possess, as the appropriate selection of instructional models plays a key role in supporting the successful achievement of learning objectives (Prasetyo & Isnani, 2018).

Advances in digital technology have opened up new opportunities for creating more interactive and learner-centered learning experiences (Effendi & Wahidy, 2019). The integration of technology into mathematics education can expand access to learning resources, enhance the learning experience, and facilitate more active learner engagement (Aminullah & Irwansya, 2024). One approach that is relevant to the characteristics of students in the digital age is Game-Based Learning (GBL). GBL is a learning model that integrates game elements into learning activities to support the achievement of learning objectives (Lutfiyah & Linda Zakiyah, 2025). Various studies show that GBL can increase students' motivation, engagement, and learning outcomes through challenging, competitive, and enjoyable activities (Luh et al., 2025).

These findings are consistent with various international studies indicating that the implementation of GBL has the potential to increase student engagement and support better learning outcomes. However, the effectiveness of GBL is not always consistent across all learning contexts, as it is influenced by student characteristics, game design, and the learning environment used (Hamari & Sarsa, 2014). Furthermore, a systematic review conducted by (Hui & Mahmud, 2023) indicates that most GBL research in mathematics education still focuses on aspects of motivation and general learning outcomes, while studies that simultaneously measure affective and cognitive dimensions remain relatively limited. These findings highlight the need for further research to test the effectiveness of GBL in different mathematics learning contexts using more comprehensive outcome variables.

One digital tool that can support the implementation of GBL is Zep Quiz. Zep Quiz is an interactive quiz platform based on a virtual map that integrates various gamification elements such as a points system, avatars, time limits, and immediate feedback (Agnes et al., 2025). These features enable the creation of a more engaging learning experience, thereby increasing students' motivation, participation, and engagement in the learning process (Amajida et al., 2025). In addition to serving as an assessment tool, Zep Quiz also provides a learning environment that fosters interaction and collaboration among students.

Findings from observations and interviews with 11th-grade mathematics teachers at SMAN 2 Slawi indicate that students' engagement in learning and their understanding of mathematical concepts remain relatively low. During the learning process, some students tend to be passive in discussions and problem-solving activities. In addition, assessment results show that students' mathematics learning outcomes have not met the expected targets. This situation is believed to be related to the predominant use of the lecture method and the suboptimal utilization of technology-based learning models capable of encouraging active student engagement.

Numerous previous studies on the application of GBL and Zep Quiz have been conducted. The results of Talib's (2025) study showed that 78.57% of students achieved the "high improvement" category after participating in GBL-based instruction. The findings of Putri Lala Sulistia et al. (2025) also indicated that the improvement in mathematical conceptual understanding was higher in the experimental group than in the control group. Other studies have also revealed that Zep Quiz is effective as an interactive learning tool for enhancing students' conceptual mastery (Agnes et al., 2025). However, most research on Zep Quiz has been conducted in science education—such as the studies by Amorita et al. (2026) and Muslimin (2025)—and has not extensively examined its implementation in mathematics education. Furthermore, research that integrates a Game-Based Learning model supported by Zep Quiz and simultaneously analyzes its effectiveness on student engagement and mathematical conceptual understanding remains very limited. Thus, there is a research gap regarding the learning context, the integration of digital media, and the outcome variables under study.

Based on the above description, this study offers a novel approach in the form of applying the GBL model aided by the Zep Quiz platform in mathematics instruction by examining its impact on student engagement and mathematical concept understanding, both individually and simultaneously. This study aims to analyze the effectiveness of GBL with Zep Quiz on students' learning engagement and understanding of mathematical concepts. The results of this study are expected to provide empirical contributions to the development of innovative, interactive mathematics learning strategies that are tailored to the characteristics of students in the digital age.

2 METHODOLOGY

This study employed a quantitative approach using a quasi-experimental research design. The research design used was a Posttest-Only Control Group Design, which involved one experimental class and one control class. The study was conducted from April 13 to May 13, 2026, at SMAN 2 Slawi, Tegal Regency, Central Java. The study population consisted of all 11th-grade students at SMAN 2 Slawi for the 2025/2026 academic year. The sample was selected using purposive sampling, taking into account the equivalence of academic characteristics between classes. The sample consisted of Class XI-4 as the experimental class, comprising 34 students, and Class XI-3 as the control class, comprising 33 students. Additionally, Class XI-5 was used as a pilot class for testing the research instruments.

The study was conducted over five sessions in each class. The experimental class received instruction using the GBL model with Zep Quiz, while the control class received instruction using the conventional learning model. After all treatments were administered, students in both classes took a posttest to measure their understanding of mathematical concepts and completed a questionnaire to measure their learning engagement. The research design is presented in ***Table 1*** below:

Table 1. *Research Design*

Group	Treatment	Quisioner	Post-test
Experimental	X1	Y1	Y2
Control	X2	Y1	Y2

Description:
X1: Implementation of GBL using Zep Quiz
X2: Implementation of the conventional model
Y1: Questionnaire to measure learning engagement
Y2: Post-test to measure conceptual understanding

The research instruments consist of test and non-test instruments. The test instrument consists of six questions assessing mathematical concept comprehension, which were developed based on the indicators of mathematical concept comprehension according to Pranata (2016). These indicators include the ability to restate concepts, classify objects, provide examples, represent concepts, identify the conditions of a concept, and apply procedures in problem-solving.

The non-test instrument, in the form of a learning engagement questionnaire consisting of 10 statements, was designed to measure students' level of engagement based on the indicators of learning engagement proposed by Rikmasari Rima & Hillya (2018). These indicators include the ability to communicate learning difficulties, the willingness to respond or provide answers, the ability to express opinions, respect for the opinions of other students, and the ability to take notes on key points of the learning material. Supporting data were obtained through observation sheets and documentation.

Before being used in the study, the instruments were first pilot-tested in Class XI-5. The instrument testing included validity, reliability, difficulty level, and discriminant power tests for the test instruments, as well as validity and reliability tests for the questionnaire instruments. Validity testing used the product-moment correlation, which showed that both the test and questionnaire instruments met the validity criteria. Additionally, reliability testing used Cronbach's Alpha, with a calculated r value of 0.976 for the test instrument and 0.773 for the questionnaire. Since these values exceed 0.601, both instruments are reliable and suitable for use as research data collection tools. The difficulty level test showed that there were 4 test items in the moderate category namely, items 1, 2, 4, and 5 and 2 items in the difficult category namely, items 3 and 6. The discriminant validity test showed that there were 4 test items in the good category namely, items 1, 2, 4, and 5 and 2 items in the very good category namely, items 3 and 6.

Data analysis was conducted using IBM SPSS Statistics software. The analysis began with multivariate prerequisite tests, including a multivariate normality test and a multivariate homogeneity test. Next, to determine the simultaneous effects of the GBL model and the Zep Quiz on learning engagement and mathematical concept understanding, a Multivariate Analysis of Variance (MANOVA) was conducted at a 5% significance level.

3 RESULTS

Data on learning engagement and mathematical concept comprehension were collected through a learning engagement questionnaire administered to students after the learning process was completed. The descriptive statistics for the learning engagement data of students in the experimental and control classes are presented in ***Table 2*** below:

Table 2. *Descriptive Statistics on Student Learning Engagement*

Class	Number of Students	Total Score	Average Score	Standard Deviation
Experimental	34	1331	39,14	4,768
Control	33	1189	36,03	4,179

Based on ***Table 2***, the analysis results show that the average level of student engagement in the experimental class was 39.14, while in the control class it was 36.03. These averages indicate that the experimental class achieved a higher average score than the control class.
Meanwhile, the results of the data analysis on the mathematical conceptual understanding of students in the experimental and control classes are presented in ***Table 3*** below:

Table 3. *Descriptive Statistics on Students' Conceptual Understanding*

Class	Number of Students	Total Score	Average Score	Standard Deviation
Experimental	34	2785	81,91	13,160
Control	33	2463	74,63	16,288

Based on ***Table 3***, the analysis results show that the average mathematical concept comprehension score for the experimental class was 81.91, while that for the control class was 74.63. These results indicate that the experimental class achieved a higher average score than the control class.

Before testing the hypotheses, the data were first tested using multivariate normality and multivariate homogeneity tests. The test results showed that the data were normally distributed and had homogeneous variances across the groups, thus meeting the prerequisites for parametric analysis.

To determine the simultaneous effect of the learning model on learning engagement and mathematical concept comprehension, a MANOVA test was conducted. The results of the MANOVA analysis are presented in ***Table 4*** below:

Table 4*. Multivariate Analysis of Variance (MANOVA)*

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	,987	2417,789[b]	2,000	64,000	,000
	Wilks' Lambda	,013	2417,789[b]	2,000	64,000	,000
	Hotelling's Trace	75,556	2417,789[b]	2,000	64,000	,000
	Roy's Largest Root	75,556	2417,789[b]	2,000	64,000	,000
Kelas	Pillai's Trace	,119	4,329[b]	2,000	64,000	,017
	Wilks' Lambda	,881	4,329[b]	2,000	64,000	,017
	Hotelling's Trace	,135	4,329[b]	2,000	64,000	,017
	Roy's Largest Root	,135	4,329[b]	2,000	64,000	,017

a. Design: Intercept + Kelompok

b. Exact statistic

Based on ***Table 4*** of the multivariate analysis, the significance value of Wilks' Lambda (0.017) is less than 0.05. These results indicate that there is a significant difference between the experimental and control groups regarding learning engagement and mathematical concept understanding simultaneously. Thus, the Game-Based Learning model supported by the Zep Quiz medium has an effect on both dependent variables under study.

Based on the overall data analysis, the research results show that the GBL model using Zep Quiz is effective in increasing students' learning engagement. This effectiveness is evident from the analysis results, which show a significant difference between the experimental and control classes. These findings indicate that integrating game elements into learning can encourage students to engage more actively during the learning process.

The increase in learning engagement can be explained by the characteristics of the GBL model, which places students at the center of learning activities. Through challenges, a point system, competition, and immediate feedback available on Zep Quiz, students are encouraged to actively participate in completing learning tasks. This aligns with the view of Hamari et al. (2014), who state that gamification can increase user engagement and participation by incorporating engaging game elements. The findings of this study also support the results of Amajida et al. (2025), which show that the use of Zep Quiz can increase students' enthusiasm and engagement during the learning process.

In addition to influencing learning engagement, the GBL model supported by the Zep Quiz media has also been shown to improve students' understanding of mathematical concepts. These results indicate that learning presented in the form of game-based activities not only enhances affective aspects but also supports cognitive development. During the learning process, students not only focus on competition but also engage in exploring concepts and solving problems related to the material being studied.

These findings align with Piaget's constructivist theory, which states that knowledge is actively constructed through learning experiences. Through play, discussion, and problem-solving activities, students are actively engaged in building their own understanding of mathematical concepts. Additionally, the research findings are supported by Vygotsky's sociocultural theory, which emphasizes the importance of social interaction in the learning process. During the learning process, students interact with their peers and

teachers to discuss concepts and solve the challenges presented to them, thereby allowing their conceptual understanding to develop more effectively.

Improving the understanding of mathematical concepts is also consistent with Skemp's relational understanding theory, which emphasizes the importance of understanding the relationships between concepts, rather than simply memorizing formulas. Through game-based learning activities, students not only arrive at the correct answers but also understand the processes and reasons behind the use of mathematical concepts. In addition, the visual and interactive features of Zep Quiz support Bruner's theory of representation, which states that concepts are easier to understand when presented in various forms of representation. Presenting material through images, symbols, and interactive activities helps students understand abstract mathematical concepts more effectively.

Apart from the theoretical aspect, these findings are also consistent with the research by Talib (2025), which states that the implementation of GBL can improve students' mathematical thinking skills. Furthermore, research by Putri Lala Sulistia and Maulana (2025) also shows that game-based learning yields better learning outcomes than conventional learning. This advantage arises because enjoyable learning activities can increase students' attention and focus on the learning material, thereby allowing the concept-construction process to proceed more optimally.

The results of the MANOVA analysis show that the GBL model supported by the Zep Quiz media has a simultaneous effect on learning engagement and mathematical concept understanding. These findings indicate that success in mathematics learning is not determined solely by cognitive aspects but is also influenced by students' active engagement during the learning process. The higher students' engagement in the learning process, the greater their chances of developing a better conceptual understanding. Therefore, the use of the GBL model supported by the Zep Quiz media can serve as a relevant alternative learning strategy to improve the quality of mathematics education in the digital age.

4 CONCLUSIONS

Based on the research findings, the GBL model supported by the Zep Quiz media is effective in enhancing students' learning engagement and understanding of mathematical concepts. Students who received instruction using the GBL model supported by the Zep Quiz media demonstrated greater learning engagement and a better understanding of mathematical concepts compared to students who received conventional instruction. Therefore, this model can serve as an interactive alternative for mathematics instruction that aligns with student characteristics in the digital age.

Future research is recommended to apply the GBL model supported by the Zep Quiz platform to different subject matter, educational levels, and learning variables to gain a broader understanding of its effectiveness. Additionally, studies with a larger sample size and a longer duration are needed to strengthen the research findings.

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