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The Effect of the Artificial Intelligence-Based ZEP QUIZ App on Fifth-Year Primary School Pupils' Understanding of Mathematical Concepts

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Abstract

Conceptual understanding of mathematics among elementary school students remains relatively low, particularly regarding whole numbers. This study analyzes the effect of using the AI-based Zep Quiz app on the level of mastery of mathematical concepts among fifth-grade students at MI Raudhatul Jannah, specifically regarding whole numbers. This study was conducted using a quantitative approach designed as a one-group pretest-posttest pre-experimental study, involving 36 students selected using a saturation sampling technique. The research instruments met the validity criteria (Aiken's V = 0.88) and reliability criteria (Cronbach's Alpha = 0.676), and the teaching media were rated as highly appropriate (100%). The results showed an increase in the average student score from 53.75 on the pretest to 87.29 on the posttest. The Wilcoxon test was used in the analysis after the Shapiro-Wilk test revealed that the data distribution did not meet the normal distribution criteria, yielding a p-value of 0.029. The test results confirmed a significant difference between the pre- and post-intervention conditions, as indicated by a p- value of 0.000 (p < 0.05). Furthermore, the N-Gain value of 0.7162 was classified as high, demonstrating that students' mastery of mathematical concepts showed significant improvement following the implementation of AI-based Zep Quiz-assisted learning.

Keywords: Artificial Intelligence; Mathematics; Conceptual Understanding;

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Elementary School Students; Zep Quiz

INTRODUCTION

Mathematics is a fundamental science subject that makes a significant contribution to honing students' logical, methodical, and critical thinking skills. However, a number of research findings indicate that students' proficiency in understanding mathematical principles in elementary school remains relatively low. In fact, understanding concepts is a crucial component of learning mathematics because it serves as a foundation for students to learn material at subsequent educational levels (Susanto, 2016), as cited in (Wati et al., 2020). In line with this view, Suraji (2018) explains that conceptual understanding is not limited to mere knowledge but also involves students' ability to interpret and restate a concept using their own reasoning. Therefore, mathematical conceptual understanding can be defined as students' ability to master, explain, and apply concepts and relationships between concepts in a logical and meaningful manner.

Various studies indicate that the ability to understand mathematical concepts remains a significant challenge in mathematics education. Septihani et al. (2020) found that 41.17% of students' errors stemmed from an inability to understand the problems, while Jarmita (2020) noted that students' difficulties generally lie in understanding symbols, place value, and errors in basic arithmetic operations. One of the most important mathematical topics in building this conceptual understanding is whole numbers. According to Unaenah E. Khoirunnisa E. (2023), understanding whole numbers helps students grasp the concepts of quantity, order, and place value, which form the foundation for more complex arithmetic operations. Without a strong understanding of whole numbers, students tend to struggle with advanced mathematics.

According to the Ministry of National Education Curriculum (2013) as cited in Zuliana (2017); Harefa (2020); Giriansyah et al. (2022); and the Ministry of Education and Culture (2016) as cited in Nurfad (2025), there are indicators of mathematical concept understanding that can serve as a reference, including: (1) being able to restate a concept using one's own words, (2) grouping or classifying objects based on the characteristics or conditions of the concept, (3) providing examples and non-examples of a concept, (4) presenting the concept in various forms of mathematical representation, (5) applying the concept to solve real-world problems. The commonalities among these three sources indicate that conceptual understanding is multi-level and comprehensive, ranging from the ability to restate a concept to applying it in real-life situations. Thus, these indicators can serve as a foundation for developing research instruments

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to measure students' level of mathematical conceptual understanding, particularly regarding whole numbers in the implementation of the Merdeka Curriculum.

Empirically, many elementary school students still struggle to understand the concept of whole numbers, particularly numbers as large as 100,000. These difficulties include the ability to read, write, compare, and order numbers, which are caused by a weak understanding of place value and abstract learning (Irawan et al., 2024). (Siregar et al., 2024) explain that a contextual approach and the use of visual media in learning whole numbers can improve understanding because they help students connect numbers with concrete daily experiences. Thus, the teaching of whole numbers from 1 to 100,000 needs to be designed to be interactive, contextual, and supported by media appropriate to the students' characteristics.

The development of AI-based digital technology has brought about a major transformation in the world of education. The use of AI facilitates a more interactive, adaptive, and personalized learning process, enabling the system to adapt the material and provide feedback tailored to students' needs (Hermanto et al., 2024). Consequently, teachers need to leverage these technological advancements as innovative tools to enhance engagement, effectiveness, and the quality of the learning process, so that students can comprehensively understand the material and develop their ideas more independently (Husen F.A. & Wulandari F., 2025).

In the context of teaching mathematics, particularly the topic of natural numbers from 1 to 100,000, the integration of Zep Quiz has the potential to be an effective innovation in enhancing students' cognitive understanding. Through interactive elements such as adaptive auto-feedback, students can practice recognizing, reading, and ordering numbers while independently correcting conceptual errors. This app also allows teachers to share quizzes via links and barcodes so that students can access and learn flexibly at home. Engaging visual and audio designs, along with a leaderboard, make learning more competitive and enjoyable. Research by Rahmah U. M. (2025) also states that the use of the Zep Quiz app has been proven to increase student participation, motivation, and conceptual understanding through engaging visual features and gamification. Therefore, the use of Zep Quiz in teaching whole numbers is expected to result in a learning process that is adaptive, interactive, and focused on strengthening students' understanding of basic mathematical concepts.

Based on the above description, the research question of this study examines how the use of the Zep Quiz app affects fifth-grade students' understanding of mathematical concepts

related to the numbers 1–100,000 at MI Raudhatul Jannah. This research is motivated by the urgent need for learning media that is not only visually appealing but also capable of fostering

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a comprehensive and deep understanding of mathematical concepts among students. Given these conditions, this study was designed to examine the extent to which the application of the Zep Quiz app contributes to building fifth-grade students' understanding of mathematical concepts at MI Raudhatul Jannah regarding the topic of natural numbers from 1 to 100,000, while also measuring the degree of improvement in students' conceptual understanding from the pre- learning stage to the post-learning stage with the assistance of the Zep Quiz app.

RESEARCH METHODOLOGY

This study was conducted at MI Raudhatul Jannah during the odd semester of the 2025/2026 academic year using a quantitative approach. The research design chosen was pre-experimental, specifically a one-group pretest-posttest design based on Sugiyono's (2013) methodological framework. A pretest was administered to assess students' initial proficiency in the topic of natural numbers from 1 to 100,000 (O1). Afterward, students received the treatment (X), which involved using the educational game Zep Quiz as a learning medium. Once the treatment was completed, students took the posttest (O_2) to evaluate their level of conceptual mathematical understanding following the entire learning process. A complete overview of the research design is presented in Table 1.

Tabel 1. Desain One Group Pretest Posttest

Class	Pretest	Treatment	Posttest
V	O1	X	O2

The subjects involved in this study consisted of 36 students, all of whom were fifth-grade students at MI Raudhatul Jannah. The sample was determined using a saturated sampling approach, in which every member of the population was included in the sample. There were two main variables that were the focus of the study, namely the independent variable in the form of the use of the Zep Quiz educational game and the dependent variable in the form of students' conceptual mathematical understanding of the numbers 1–100,000.

Conceptual knowledge indicators were used in the development of this research instrument, referring to the Ministry of National Education Curriculum (2013) as cited by Zuliana

(2017), Harefa (2020) in Giriansyah et al. (2022), as well as the Ministry of Education and Culture in Nurfad (2025), and adapted to the learning outcomes of the Merdeka Curriculum. These

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indicators include: (1) being able to restate a concept using one's own words, (2) classifying objects based on specific characteristics, (3) providing examples and non-examples of a concept,

(4) presenting a concept in various mathematical representations, and (5) applying the concept to solve real-world problems.

Before the instrument was used in the study, its validity and reliability were evaluated in the initial stage. Aiken's V formula was used to evaluate content validity based on the assessments of three experts. The test results showed that the Aiken's V scores ranged from 0.67 to 1.00, with an average of 0.88. A total of 14 assessment items were deemed valid because they had a V value ≥ 0.75, while one assessment item—item number 12—was deemed invalid because it obtained a V value of 0.67 < 0.75 and was therefore not used in the research instrument. Furthermore, Cronbach's alpha was used to conduct a reliability test, yielding a result of 0.676. According to Tavakol & Dennick (2011), this value exceeds the minimum threshold of 0.60. Although this value falls within the moderate reliability range, it is still acceptable in the context of exploratory elementary education research, as noted by Tavakol & Dennick (2011), who state that an alpha value between 0.60 and 0.70 can be used if the instrument is still in the early stages of development. Therefore, the instrument is considered reliable and suitable for use in this study.

In addition to instrument validation, experts also validated the suitability of the Zep Quiz learning media used in this study regarding the appropriateness of the learning media. The assessment was conducted based on 14 indicators covering four aspects: media appearance, technical quality, appropriateness, and practicality, using a rating scale of 1–4. The assessment results showed a total score of 56 out of a maximum score of 56, resulting in a suitability rating of 100%, with all indicators classified as "highly suitable" (Riduwan, 2010). Therefore, it was concluded that the Zep Quiz is suitable for use as a teaching medium in this study.

Zep Quiz is an engaging teaching tool for this study—a web-based application that combines gamification elements with artificial intelligence (AI). This application enables teachers to design and share interactive quizzes with students via a share link or barcode. Zep Quiz's adaptive auto-feedback feature provides immediate feedback on students' answers, allowing them to correct their mistakes independently and boosting their engagement and motivation to learn.

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Figure 1. Zep Quiz App Interface

The data collection procedure was carried out in three stages: (1) administering a pretest to measure students' initial understanding of the concept of natural numbers from 1 to 100,000, (2) implementing an intervention involving learning with Zep Quiz over several sessions, and (3) administering a posttest to measure the extent of improvement in students' conceptual knowledge following the intervention. In addition to tests, observation and documentation techniques were also used as supporting evidence to reinforce the research findings.

The data obtained from the pretest and posttest phases were analyzed using descriptive statistical methods to provide an overview of the students' overall performance, including the maximum score, minimum score, and standard deviation. Since the number of research subjects was less than 50, the Shapiro-Wilk test was used to determine whether the data were normally distributed. If the test results indicated a normal distribution, inferential analysis would proceed using a Paired t-test. However, if the data did not meet the normality prerequisite, the testing would switch to a nonparametric approach, namely the Wilcoxon Signed Rank Test, to detect whether or not there were significant differences between the pre- and post-treatment conditions. In addition, the magnitude of the improvement in learning outcomes is calculated using the N-Gain formula as the basis for grouping into low, moderate, or high categories.

The statistical hypotheses used as a reference in this study are as follows:

H0: There is no significant difference in students' mathematical understanding between before

and after the implementation of the Zep Quiz educational medium.

H1: There is a significant difference in students' understanding of mathematical concepts between before and after the implementation of the Zep Quiz educational medium.

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RESULTS AND DISCUSSION

The findings of this study reveal that students' understanding of mathematical concepts improved following the implementation of AI-based Zep Quiz-assisted learning. As shown in Table 2, students' average scores increased from 53.75 on the pretest to 87.29 on the posttest.

Table 2. Descriptive Statistics

Assessment	N	MinimumScore	Maximum Score	Mean Score	Standard Deviation
Pretest	36	28	78	53.75	12.727
Posttest	36	75	98	87.29	6.850
Valid N (listwise)	36	–	–	–	–

This increase in scores indicates an improvement in students' understanding of various mathematical concepts, with a focus on natural numbers between 1 and 100,000. This is consistent with previous research, in which Ulfa et al., (2026) stated that the average score of students' mathematics achievement increased from 73.08 to 83.08 after the implementation of the Zep Quiz, with a significance level of 0.004 ($p < 0.05$). These findings indicate that the use of interactive quiz-based learning resources can more effectively promote increased learning motivation, active engagement, and students' understanding of mathematical concepts.



Figure 2. Sample Practice Questions for Comprehension Indicators in the Zep Quiz App

In addition to the analysis of overall average scores, students' improved understanding of mathematical concepts was also analyzed based on each indicator. This is shown in Figure 3, which illustrates a comparison of average scores between the pretest and posttest phases, as assessed

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by each indicator of mathematical concept comprehension.

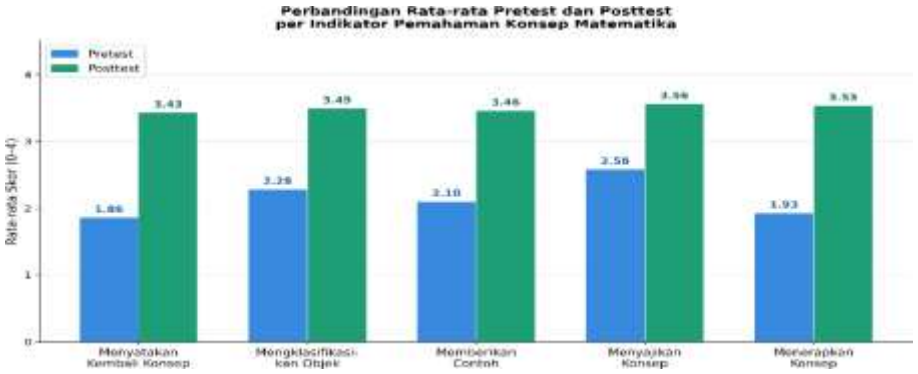


Figure 3. Comparison of the average pretest and posttest scores for each indicator

Figure 3 shows that after participating in learning that utilized the AI-based Zep Quiz, all indicators of conceptual understanding improved. For the indicator of the ability to restate concepts, the average score increased from 1.86 to 3.43. The indicator for the ability to classify objects increased from 2.28 to 3.49, while the indicator for providing examples and non- examples increased from 2.10 to 3.46. A similar increase was also seen in the aspect of presenting mathematical concepts, namely from 2.58 to 3.56, which was the highest achievement compared to other indicators. As for the indicator of applying concepts to real-world problem-solving, the score increased from 1.93 to 3.53.

The Shapiro-Wilk test was used to assess the normality of the data because the sample size was less than 50 students (n = 36) (Ahadi & Zain, 2023). The analysis results showed that the pretest data were normally distributed with a significance value of 0.557 ($p > 0.05$), while the posttest data did not meet the normal distribution assumption due to a significance value of

0.029 ($p < 0.05$), as presented in Table 3. Since one of the data groups did not meet the normality assumption, inferential hypothesis analysis could not proceed using the Paired Sample t-test; instead, the analysis switched to the nonparametric Wilcoxon Signed Rank Test.

Table 2. Normality Test Results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Nilai Akhir Pretest	,105	36	,200*	,974	36	,557
Nilai Akhir Posttest	,123	36	,184	,932	36	,029

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

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Based on the results of the hypothesis test using the Wilcoxon Signed-Rank Test, as shown in Table 4, the resulting significance level of 0.000 ($p < 0.05$) provides evidence that H1 is accepted, while H_0 is rejected. Thus, it can be concluded that there is a significant difference in students' understanding of mathematical concepts between before and after the intervention.

Tablel 3. Wilcoxon Test Results

Test Statistics[a]

	Nilai Akhir Posttest - Nilai Akhir Pretest
Z	-5,237[b]
Asymp. Sig. (2-tailed)	,000

The results of the rank analysis in Table 5 show that all students improved their scores, as evidenced by the presence of 36 positive ranks with no negative ranks or ties. These findings indicate that the implementation of the AI-based Zep Quiz had a positive impact on all students.

Table 4. Table Ranks

Ranks

		N	Mean Rank	Sum of Ranks
Nilai Akhir Posttest - Nilai Akhir Pretest	Negative Ranks	0[a]	,00	,00
	Positive Ranks	36[b]	18,50	666,00
	Ties	0[c]		
	Total	36		

The results obtained in this study are consistent with several previous empirical studies. Astuti et al. (2021) reported a significance level of 0.000 in the Wilcoxon test, accompanied by an increase in learning achievement from 66.29 to 94.16. Additionally, Nirmalasari & Susanti (2023) also demonstrated that interactive quiz media has a significant impact on student learning outcomes ($p < 0.05$). Another study by Nisa Sari et al. (2025) showed that Zep Quiz had a significant impact ($p < 0.001$), with the experimental group's performance proven to be superior to that of the control group. Meanwhile, Santiaji et al. (2025) confirmed that the integration of artificial intelligence (AI) through the Zep Quiz application was proven to effectively increase students' learning motivation. The consistency of these findings confirms that AI-based and gamified

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instructional materials, such as Zep Quiz, not only make the learning process more efficient but also provide equal benefits to every student.

In addition, by applying the N-Gain formula, students' improved understanding of mathematical concepts can be measured and analyzed. The average N-Gain score obtained from Table 6 is 0.7162 > 0.70, with a minimum score of 0.50 and a maximum score of 0.96. Based on Hake's (1999) categorization, this average falls into the high category (N-Gain > 0.70). This finding reinforces the evidence that the students' level of mathematical conceptual understanding has indeed improved, and this improvement is not only statistically significant, as indicated by the Wilcoxon test results showing a probability value of 0.000, but also has practical significance with a significant level of increase.

The high N-Gain scores indicate that using Zep Quiz can lead to a beneficial and meaningful learning experience. This is possible because features in Zep Quiz, such as real-time feedback, question visualization, and gamification elements, help students grasp concepts step by step while correcting their own mistakes. Additionally, the interactive and adaptive nature of the learning process encourages students to actively participate in the entire learning sequence, allowing their understanding of mathematical concepts to develop to its fullest potential.

Table 5. N-Gain Test Results

Descriptive Statistics

	N	Minimum	Maximum	Mean
N-Gain	36	,50	,96	,7162
Valid N (listwise)	36			

Furthermore, the findings of this study are supported by Anfa'ana et al. (2026), who reported an N-Gain score of 0.78—classifying it as high—in the development of a Zep Quiz-based Pancasila education medium at SD Negeri Jatirunggo 01 in Semarang. According to that study, the average score on the pretest increased from 43.75 to 86.12 on the posttest, with a learning achievement rate of 90%. Although the N-Gain score in this study (0.7162) is slightly lower, both remain in the same category, further strengthening the evidence that Zep Quiz is consistently effective in improving the academic achievement of elementary school students across various subject areas. Based on this, it can be concluded that students' level of understanding of mathematical concepts has shown significant improvement due to the implementation of the AI-based Zep Quiz application, resulting in significant and beneficial progress. These findings imply

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that the integration of AI-based technology and gamification, such as Zep Quiz, can serve as a beneficial alternative teaching method to optimize students' understanding of mathematical concepts at the elementary education level, particularly those related to whole numbers from 1 to 100,000.

However, it should be noted that the improvement in students' understanding of mathematical concepts is not solely influenced by the use of the Zep Quiz app. Another contributing factor is the introduction of practice problems that are routinely designed based on the five indicators of conceptual understanding used in this study. During the three treatment

sessions, students were repeatedly given problems covering the indicators of restating concepts, grouping objects, providing examples and non-examples, formulating concepts in mathematical form, and using concepts to solve real-world problems.



Figure 4. Implementation Phase

These findings align with the principles of behaviorist learning, which hold that structured and consistent repetition of stimuli fosters better learning responses and reinforces students' conceptual understanding. Amrain et al. (2023) demonstrated that the application of behaviorist theory through the consistent provision of practice problems in fifth-grade elementary school mathematics instruction was shown to significantly improve students' understanding, as students became accustomed to repeatedly responding to problem stimuli until a deeper and more robust pattern of understanding was established within them.

CONCLUSION AND RECOMMENDATIONS

This study demonstrates that fifth-grade students' understanding of mathematical

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concepts at MI Raudhatul Jannah is significantly influenced by the AI-based Zep Quiz app when studying the topic of natural numbers from 1 to 100,000. Furthermore, the N-Gain calculation results show an average score of 0.7162, which falls into the high category based on the classification established by Hake (1999). Thus, this proves that the increase is not only statistically significant but also has high practical significance.

The results of the study indicate that the integration of Zep Quiz—which combines adaptive auto-feedback features, interactive question visualizations, and gamification elements—when paired with concept-based practice exercises can serve as an effective

alternative learning tool in elementary schools. Two limitations of this study include a small sample size involving only one school and a pre-experimental design without a control group.

Based on these findings, teachers are advised to integrate Zep Quiz into mathematics instruction alongside consistent practice exercises based on concept understanding indicators. Additionally, schools need to provide adequate technological infrastructure to ensure the optimal implementation of digital-based media. As for future researchers, they are encouraged to adopt a quasi-experimental design involving a control group, expand the scope of the research sample, and assess the impact of using Zep Quiz on other variables, such as student learning motivation, critical thinking skills, and numeracy literacy.

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