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Realistic Mathematics Education (RME) Approach Assisted by Kahoot to Enhance Understanding of Mathematical Concepts

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ABSTRACT

This study was motivated by the low level of students' understanding of mathematical concepts, particularly in algebra learning, where students tend to memorize procedures without fully understanding the underlying concepts. Although the Realistic Mathematics Education (RME) approach has been widely implemented to support contextual learning, its application often lacks interactive media that can enhance students' engagement and participation. The objectives of this study were: (1) to examine whether students who learned through the Kahoot-assisted RME approach achieved better improvement in mathematical conceptual understanding than those who learned through RME without Kahoot, and (2) to determine the magnitude of the effect of Kahoot integration within the RME approach. This study employed a quasi-experimental method with a nonequivalent control group design. The participants were seventh-grade students of SMP Negeri 14 Tasikmalaya, consisting of 26 students in the experimental class and 24 students in the control class. The learning topic focused on algebra. Data were collected through pretest and posttest conceptual understanding tests and analyzed using N-Gain analysis, Independent Sample t-test, and Cohen's d effect size analysis. The results showed that students who learned through the Kahoot-assisted RME approach demonstrated greater improvement in mathematical conceptual understanding compared to students who learned through RME without Kahoot. The hypothesis test indicated a significance value of 0.009 (< 0.05). In addition, the experimental class achieved a higher average N-Gain score, while the effect size result of 0.696 indicated a medium effect category. The novelty of this study lies in the structured integration of Kahoot as an interactive formative assessment and gamification tool within each stage of the RME learning process on algebra material.

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Introduction

Mathematics education plays an important role in developing students' logical, analytical, critical, and creative thinking skills needed to face global challenges in the modern era. Education is not merely a process of knowledge transfer but also a transformative instrument that shapes individuals' competencies to contribute meaningfully to society (Cahyani et al., 2024). In this context, one of the essential goals of mathematics learning is students' conceptual understanding, which enables them to connect ideas, explain concepts in their own words, classify objects, represent concepts in various mathematical forms, and apply appropriate procedures in problem solving.

However, many junior high school students still experience difficulties in understanding mathematical concepts deeply. Students tend to memorize formulas without comprehending the meaning and relationships between concepts, resulting in procedural rather than meaningful learning (Listyaningrum et al., 2025). This issue is particularly evident in algebra learning, where students struggle to distinguish variables, constants, and coefficients and to apply algebraic operations correctly in various representations (Riri & Roesdiana, 2025). These findings indicate that students' conceptual understanding in algebra remains at a moderate level and requires more contextual and meaningful instructional strategies. This is supported by Tularam & Hassan (2025), who found that many students demonstrate limitations in understanding basic mathematical principles, particularly when solving algebraic problems presented in different forms. This is also reflected in their lack of accuracy in performing algebraic operations, including addition, subtraction, multiplication, and division. The low level of understanding of algebraic concepts indicates the need for innovative learning strategies.

Preliminary observations at SMP Negeri 14 Tasikmalaya revealed that students' average mathematics score was still below the minimum mastery criterion. Learning was dominated by procedural approaches, lacked contextual problems, and rarely used interactive media. Although the Realistic Mathematics Education (RME) approach had been introduced, its implementation was not optimal due to limited contextual relevance and insufficient student involvement in constructing mathematical concepts. This condition highlights the need for a more systematic and engaging implementation of contextual learning supported by appropriate media.

RME emphasizes horizontal and vertical mathematization processes that allow students to construct mathematical concepts from real-life situations (Fredriksen, 2021). This approach aligns with constructivist principles and encourages students to rediscover concepts meaningfully through exploration and discussion. The effectiveness of RME can be strengthened through interactive digital media such as Kahoot, which provides real-time feedback, varied question types, visual representations, and competitive yet collaborative learning experiences that support students' engagement and conceptual reflection (Jarrah et al., 2025). Previous studies have shown the effectiveness of RME and Kahoot separately in improving learning outcomes; however, research integrating Kahoot systematically within the RME framework to enhance students' mathematical conceptual understanding, particularly in algebra topics at the junior high school level, is still limited. This gap highlights the need for systematic integration of contextual learning principles and gamification-based digital media in mathematics instruction. Therefore, this study offers novelty through the implementation of the Kahoot-assisted RME approach to improve students' conceptual understanding of algebra in junior high school mathematics learning. Based on this rationale, this study aims to examine the effect and the magnitude of the effect of the Kahoot-assisted RME approach on students' understanding of mathematical concepts.

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5056 Volume 6, No 2, April - June 2026, pp. 719 – 734

Method

Research Design

This study employed a quasi-experimental research design to investigate the contribution of Kahoot! integration within the Realistic Mathematics Education (RME) approach toward students' mathematical conceptual understanding. A quasi-experimental method was considered appropriate because the study aimed to examine the effectiveness of a particular instructional intervention implemented in naturally existing classroom settings, where full control over external variables and random assignment of participants were not feasible. The research was conducted at SMP Negeri 14 Tasikmalaya, in which students had been administratively assigned to intact classes prior to the study. Therefore, the researcher was unable to randomly assign participants into experimental and control groups. Under these circumstances, a nonequivalent pretest–posttest control group design was employed. This design enabled the researcher to compare the improvement in students' conceptual understanding before and after the intervention between two groups receiving different instructional treatments within the same pedagogical framework. Prior to the implementation of the instructional treatment, both groups were administered a pretest to assess students' initial understanding of mathematical concepts in algebra. The research was conducted over five instructional meetings consisting of one meeting for the pretest, three meetings for the learning intervention, and one meeting for the posttest. During the intervention phase, the experimental group received instruction through the RME approach integrated with Kahoot! as an interactive and gamification-based learning medium, whereas the control group received instruction using the RME approach without Kahoot! integration. Following the completion of the instructional sessions, both groups were administered a posttest to evaluate the extent of students' improvement in mathematical conceptual understanding. Through this design, the study specifically examined whether the integration of Kahoot! within the RME approach provided additional contributions to students' conceptual understanding compared to the implementation of RME alone.

Population and Sample

The study population comprised all seventh-grade students at SMP Negeri 14 Tasikmalaya who had been assigned to permanent classes. The sample was selected using the cluster random sampling technique, as the selection of subjects was based on existing classes. The randomization results showed that seventh-grade class VII-G was selected as the experimental class receiving Realistic Mathematics Education (RME) instruction with the aid of Kahoot!, while seventh-grade class VII-I served as the control class receiving RME instruction without Kahoot!. The relatively balanced number of students in both classes supported a more objective comparison of mathematical concept understanding.

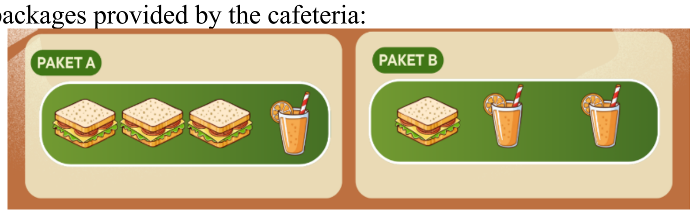
Instrument

The research instrument used in this study was a mathematical concept comprehension test. The test was designed to measure students' level of conceptual understanding after participating in lessons using the Realistic Mathematics Education (RME) approach, supported by Kahoot!, on seventh-grade algebra material. The test items were developed based on the indicators of mathematical concept understanding according to Darmin & Kasmawati (2022), which include: (1) restating a concept, (2) classifying objects based on specific properties according to the concept, (3) providing examples and non-examples, (4) presenting concepts in various forms of mathematical representation, and (5) using and selecting appropriate procedures or operations to solve problems. The questions were designed as open-ended items linked to realistic problem contexts to align with the characteristics of the RME approach. The scope of the test and the complete set of mathematical concept comprehension questions are presented in the following Table 1.

Table 1. Mathematics Concept Comprehension Test Question Outline

Learning Outcomes	Learning Objectives	Indicators
By the end of Phase D, students can identify, predict, and generalize patterns in arrangements of objects and numbers. They can express a situation in algebraic form. They can use the properties of operations (commutative, associative, and distributive) to derive algebraic expressions	Students will be able to understand patterns and their relationship to the use of variables to represent changing quantities. In this section, algebraic expressions and their components including constants, coefficients, variables, and terms will be introduced, and each will be connected to its context. This chapter will also cover the use of more than one variable to model a problem, as well as substituting values for a variable and interpreting the meaning of the resulting values.	Restating a concept Classifying objects based on specific properties according to the concept Providing examples and non-examples Presenting concepts in various forms of mathematical representation Using and selecting appropriate procedures or operations to solve problems

Table 2. Pre-test and post-test on mathematical concept understanding

No.	Question
1.	During every break, the school cafeteria is always crowded with students. To streamline service and make food choices more convenient, the school cafeteria management decided to offer two types of meal packages: Package A and Package B. With these meal packages, students don't have to choose items one by one, which helps reduce lines in the cafeteria. Each package includes a sandwich and fruit juice. Package A contains several sandwiches and fruit juices, as does Package B, but the quantities differ. Therefore, students do not have to buy items individually and can simply choose the package they want. Here are the meal packages provided by the cafeteria:  All food items used are taken from the school cafeteria's inventory. According to data held by the cafeteria manager, there are 260 sandwiches and 190 fruit juices available. The cafeteria manager plans to assemble Package A and Package B with precise calculations so that the entire supply of sandwiches and fruit juices can be used up without any leftovers. With this plan, sales are expected to run more efficiently and no food items will be wasted. (a) Group Package A and Package B based on the number of sandwiches and fruit juices, then create a table showing the number of sandwiches and fruit juices in Package A and Package B! (b) Express each of the four process stages above in the form of mathematical functions with respect to the initial weight. Write an algebraic expression representing the number of food items in Package A and Package B using appropriate variables. Then, write an algebraic expression that does not match the story, and explain your reasoning! (c) Determine how many Packages A and Package B can be made so that all the sandwiches and fruit juices are used up with no leftovers. Use the method you think is most most appropriate, then explain the steps of your solution!

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5056 Volume 6, No 2, April - June 2026, pp. 719 – 734

Before being used in the study, the test instrument was first reviewed by experts specifically, mathematics education faculty members to ensure content appropriateness, clarity of wording, and alignment of the test items with the concept comprehension indicators used. Subsequently, the instrument was pilot-tested with students outside the study sample group to assess the quality of each test item before it was administered to the sample class.

Instrumen Validity Testing

Validity is a measure that indicates the reliability or validity of a measurement tool. An instrument is considered valid if it is able to measure what it is intended to measure (Hartanto, 2023). The formula for Pearson's moment correlation using raw scores is as follows:

$$r_{xy} = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)\,((N\sum Y^2 - (\sum Y)^2)}}$$

Description:

r_{XY}	:	Correlation coefficient
n	:	Number of respondents
X	:	Independent variable
Y	:	Number of respondents

To assess the validity of an evaluation instrument, item validity criteria are used as a reference. The resulting rxy correlation coefficient serves as the basis for determining validity categories according to the classification in Table 3

Table 3. Instrument Validity Criteria

Interval	Category
$0.80 \leq \mathbf{r}_{XY} \leq 1.00$	Very High
$0.60 \leq \mathbf{r}_{XY} \leq 0.80$	High
$0.40 \leq \mathbf{r}_{XY} \leq 0.60$	Moderate
$0.20 \leq \mathbf{r}_{XY} \leq 0.40$	Low
$0.00 \leq \mathbf{r}_{XY} \leq 0.20$	Very Low

Next, the value of r_{count} is compared with the value of r_{table} based on the distribution for α = 0.05 and degrees of freedom $db = n - 2$. The testing criteria used are as follows: If $r_{count} > r_{table}$, then the test item is deemed valid and if $r_{count} < r_{table}$, the item is therefore deemed invalid. The results of the validity test for the mathematics concept understanding test are presented in the following Table 4

Table 4. Validity Test Results

Item Number	r_{count}	Interpretation	r_{count}	r_{table}	Validity	Conclusion
1a	0,856	Verry High	0,856	0,361	Valid	Used
1b	0,820	Very High	0,820	0,361	Valid	Used
1c	0,889	Very High	0,889	0,361	Valid	Used

Based on Table 4, the correlation coefficients for item 1a are 0.856, for item 1b are 0.820, and for item 1c are 0.889. An item is considered valid if $r_{count} > r_{table}$,. The value of $thitung$ is obtained from consulting the critical value table for the t-product-moment test with α = 5% and n = 30. Based on the statistical table for n = 30, $thitung$ = 0.361. Based on the validity test of items 1a, 1b, and 1c, it can be concluded that they are all valid.

Instrumen Reliability Testing

According to Wahyuning (2021), reliability can be defined as the degree of stability in the measurement results produced by an instrument. An instrument is considered reliable if its repeated use yields consistent results over time. Reliability is tested using Cronbach's alpha formula as follows:

$$r_{11} = \frac{n}{(n-1)}\left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right)$$

Description:

r_{11}	:	Reliability coefficient
n	:	Number of items tested
$\sum \sigma_b^2$	:	Variance of scores for each item
σ_t^2	:	Variance of the total score

The criteria for interpreting the reliability categories of evaluation instruments are based on the following classification in Table 5.

Table 5. Item Reliability Categories

Interval	Criteria
$0{,}800 \leq r_{11} \leq 1{,}000$	Very high reliability
$0{,}600 \leq r_{11} \leq 0{,}800$	High reliability
$0{,}400 \leq r_{11} \leq 0{,}600$	Moderate reliability
$0{,}200 \leq r_{11} \leq 0{,}400$	Low reliability
$0{,}000 \leq r_{11} \leq 0{,}200$	Very low reliability

After obtaining the reliability calculation results, the next step is to compare the Pearson product-moment correlation coefficient (r) with the Tabell coefficient ($rtabel$) ($dk = n - 2$) at a 5% significance level. If $r_{11} \geq 0{,}60$ than the question is declared reliable, and if $r_{11} < r_{table}$ than the question is declared unreliable. The results of the reliability test for mathematical concept comprehension are presented in Table 6

Table 6. Results of the reliability test using

Cronbach's Alpha	Criteria	Standard	Decision
0,718	High reliability	0,60	Reliable

Based on the table 6, the Cronbach's Alpha value is 0.718, which is greater than 0.60 and meets the criteria for high reliability. This indicates that the instrument is reliable for use in research.

Data Collection Techniques and Data Analysis

Data in this study were obtained through mathematical concept comprehension tests administered to students individually, both before and after the implementation of the Realistic Mathematics Education (RME) approach using Kahoot!. To assess students' level of mathematical concept understanding, a scoring rubric was used, developed based on concept understanding indicators according to Suciati (2018), which had been modified in the previous section. The scoring rubric is presented in Table 7

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5056 Volume 6, No 2, April - June 2026, pp. 719 – 734

Table 7. Guidelines for Grading the Mathematics Concept Comprehension Test

indicators of mathematical concept understanding	Description	Score
Redefining a concept	No answer.	0
	Unable to restate the concept.	1
	Able to restate the concept but still makes many mistakes.	2
	Able to restate the concept but not accurately.	3
	Able to restate the concept accurately.	4
Classifying objects according to their characteristics	No answer.	0
	Unable to classify objects based on their characteristics	1
	Able to list characteristics consistent with the concept but makes many mistakes.	2
	Able to list characteristics consistent with the concept but not accurately.	3
	Able to list characteristics consistent with the concept accurately.	4
Provide examples and non-examples	No answer.	0
	Unable to provide examples and non-examples.	1
	Able to provide examples and non-examples, but there are still many errors.	2
	Able to provide examples and non-examples, but they are not yet accurate.	3
	Able to provide examples and non-examples accurately.	4
Presenting the concept	No answer.	0
	Unable to demonstrate the concept.	1
	Able to demonstrate the concept but with many errors.	2
	Able to demonstrate the concept in mathematical form but not accurately.	3
	Able to demonstrate the concept accurately in mathematical form.	4
Using the benefits and choosing a procedure	No answer.	0
	Unable to use, apply, and select procedures.	1
	Able to use, apply, and select procedures but still makes many mistakes.	2
	Able to use, apply, and select procedures but not yet accurately.	3
	Able to use, apply, and select procedures accurately.	4

Source: (With Modification, Suciati, 2018)

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics were used to describe the pretest and posttest results through the mean, maximum, minimum, standard deviation, and variance in the experimental and control classes. The analysis phase began with the calculation of N-Gain to determine the improvement in students' understanding of mathematical concepts according to Navarrete et al. (2024).

$$N_{Gain} = \frac{Posttest\ Score - Pretest\ Score}{Ideal\ Score - Pretest\ Score}$$

To determine the categories of N-Gain score improvement, the researchers referred to the Normalized Gain criteria in Table 8

Table 8. Category of N-Gain

Score Interval	Interpretation
$0{,}70 \leq g \leq 1{,}00$	High
$0{,}30 \leq g < 0{,}70$	Moderate
$0{,}00 \leq g < 0{,}30$	Low

Next, normality (Shapiro-Wilk) and homogeneity tests were conducted as prerequisite tests by Sugiyono (2023). Once the prerequisites were met, hypothesis testing was performed using an independent samples t-test (one-tailed) by Ruscio (2020) to determine differences in mathematical concept understanding between students learning with the Realistic Mathematics

Education (RME) approach assisted by Kahoot! and students learning with RME without Kahoot. Finally, the effect size (Cohen's d) was calculated to determine the practical magnitude of the treatment's effect according to Nadid et al. (2025):

$$d = \frac{\bar{X}_1 - \bar{X}_2}{s}$$

Description:

$\bar{x}_1$: N-gain Values for the Experimental Class
$\bar{x}_2$: N-gain Values for the Control Class
s : $\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$
n_1 : Total N-gain Data for Students in the Experimental Class
n_2 : Total N-gain Data for Students in the Control Class
s_1^2 : Variance of N-gain Data for the Experimental Class
s_2^2 : Variance of N-gain Data for the Control Class

The effect size criteria in Table 9

Table 9. Category of Effect Size

Score Interval	Category
$d > 0,8$	High
$0,5 < d \leq 0,8$	Moderate
$0,2 < d \leq 0,05$	Low

The research hypothesis is "Students' understanding of mathematical concepts who learn using the RME approach supported by Kahoot is better compared to students who learn using the RME approach without Kahoot.". The researchers then grouped the students' posttest scores on mathematical concept understanding as shown in the following Table 10

Table 10. Category of mathematical concept understanding

Score Interval	Interpretation
Score $\geq \bar{X} + Sbi$	High
$\bar{X} - Sbi \leq$ Score $< \bar{X} + Sbi$	Moderate
Score $< \bar{X} - Sbi$	Low

Research Findings

Data on mathematical concept understanding were collected through a posttest administered after students had participated in three sessions of instruction, both in the experimental and control classes. The test instrument consisted of a single open-ended question designed to assess a total of five indicators of mathematical concept understanding, as defined by Darmin & Kasmawati (2022). The maximum total score for the test was 100.

Normalized Gain Test (N-Gain)

The n-gain results from the mathematical concept understanding test are shown in Table 11

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5056 Volume 6, No 2, April - June 2026, pp. 719 – 734

Table 11. N-Gain Result

Class	Pre-Test Average	Post-Test Average	N-Gain	Category
Experimental	22,36	74,26	0,70	Moderate
Control	22,22	68,36	0,60	Moderate

Based on the results of the N-Gain calculation, it can be concluded that the improvement in students' understanding of mathematical concepts in the experimental class was greater than that in the control class.

Descriptive Statistics

The results of descriptive statistics on mathematical concept understanding are shown in Table 12

Table 12. Descriptive Statistics

Type	Class	*n*	*db*	*dk*	$\bar{x}$	*r*	σ
Pretest	Experimental	30	54	8,33	22,36	45,83	9,18
Posttest	Experimental	28	100	25	74,26	75	15,42
Pretest	Control	27	50	8,33	22,22	41,67	8,88
Posttest	Control	27	83,33	37,50	68,36	45,83	11,62

Based on the results of the descriptive statisticsin Table 12, it appears that the average posttest score for mathematical concept understanding in the experimental class was higher than that of the control class. This indicates that, in general, students' understanding of mathematical concepts in the class that received instruction using the Realistic Mathematics Education (RME) approach supplemented by Kahoot! was better than that of students in the class that learned using the RME approach without Kahoot.

Prerequisite Test for Analysis

Normality Test

The normality of the data was assessed using the Shapiro–Wilk test at a significance level of α = 0.05, as the sample size was fewer than 50 participants. The results of this test are shown in Table 13.

Table 13. Results of the Normality Test

Class	Sig.	α	Decision
Experimental	0,099	0,05	H_0 accepted
Control	0,066		H_0 accepted

According to Table 13, the significance value for the experimental group is 0.099, and for the control group, it is 0.066. It can be concluded that both groups have significance values > 0.05, so H_0 is accepted. Therefore, it can be concluded that both groups are normally distributed. The prerequisite for testing the first hypothesis has been satisfied.

Homogeneity Test

A homogeneity test can only be applied if the data are normally distributed. In this study, Levene's Test for Equality of Variances was used with a significance level of 5% ($\alpha = 0.05$). The results are shown in Table 14.

Table 14. Results of the Homogeneity Test

Sig.	α	Decision
0,965	0,05	H_0 accepted

Based on Table 14, the significance value is 0.965. It can be concluded that both groups have a p-value > 0.05, so H_0 is accepted. Therefore, it can be concluded that the two groups the experimental class and the control class are homogeneous or have the same variance. Thus, the prerequisite is met.

Hypothesis Testing

Independent Sample T-test

To test the hypothesis in this research to determine whether the RME approach using Kahoot! is more effective than RME without Kahoot!, an independent two-sample t-test (independent sample t-test) with a one-tailed test was used. The result are in Table 15.

Table 15. Results of the Independent Sample T-Test

Sig. (2-tailed)	$\frac{1}{2} sig\ (2 - tailed)$	α	Decision
0,018	0,009	0,05	H_0 rejected

Based on Table 15, the $\frac{1}{2}$sig $(2 - \text{tailed})$is 0.009, since $0.009 < 0.05$, H_0 is rejected. It is concluded that the Kahoot!-assisted Realistic Mathematics Education (RME) approach is more effective than the approach that uses only Realistic Mathematics Education (RME).

Effect Size

The next step is to calculate the effect size using Cohen's d formula. This calculation aims to determine the extent of the impact of Realistic Mathematics Education (RME) supported by Kahoot! on students' understanding of mathematical concepts by comparing the average learning outcomes of the experimental and control classes in terms of the combined standard deviation of both classes. The following are the results of the effect size calculation using Cohen's d formula.

Table 16. Results of the Effect Size

Description	Experimental Class	Control Class	S	Cohen's	Category
Total of students	26	24			
Mean N-Gain	0,7014	0,6009	0,1444	0,696	Moderate
Standard Deviation	0,15123	0,13662			

Based on the results of the calculations, an effect size of 0.696 was obtained, which falls into the moderate category. This value indicates that there is a significant difference in the

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5056 Volume 6, No 2, April - June 2026, pp. 719 – 734

improvement of mathematical concept understanding between the experimental class and the control class.

Discussion

Results of Understanding Mathematical Concepts

The results of the statistical analysis indicate that students who participated in Realistic Mathematics Education (RME) lessons supported by Kahoot! tended to demonstrate a better understanding of mathematical concepts compared to students who learned using the RME approach without Kahoot. The mean difference obtained, accompanied by an effect size (Cohen’s d) of 0.692 and an average of 0.70 in the moderate category, indicates that the use of Kahoot in RME instruction has a significant impact on improving students’ understanding of mathematical concepts.

These findings not only illustrate a general difference in outcomes but also demonstrate that the implementation of Kahoot at every stage of RME by Gravemeijer (1944) learning further strengthens the concept comprehension process. Kahoot’s features which provide immediate feedback, varied question formats, and interaction through competition and discussion support students in reflecting on their learning, representing concepts, and selecting appropriate problem-solving procedures, aligning with the indicators of mathematical concept understanding used in this study.

In the beginning of the learning process, students still faced challenges adapting to the Realistic Mathematics Education (RME) approach, which requires active engagement in understanding contextual problems, as well as technical difficulties accessing Kahoot! via QR codes and links. Additionally, students were not yet accustomed to solving contextual problems because they had previously practiced mostly routine formula-based problems, and some were still weak in prerequisite algebra concepts. The use of teaching materials and worksheets based on real-world contexts helped students understand the problem flow step by step. However, by the second and third sessions, these obstacles began to diminish. Students became increasingly accustomed to discussing, modeling problems using the provided teaching materials, and using Kahoot independently, allowing the learning and evaluation processes to proceed more smoothly. Some documentation during the lesson:

Figure 1. A Photo Taken During The Lesson

Some questions displayed on Kahoot that meet the indicators for conceptual understanding and are RME based Figure 2

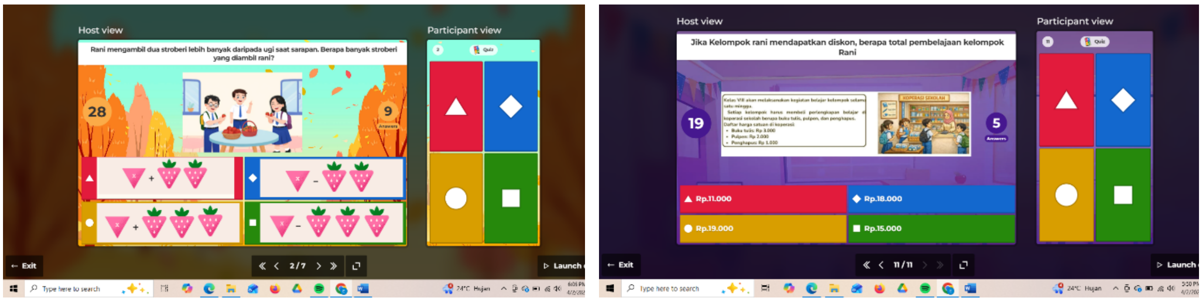


Figure 2. Kahoot Question Display

The improvement in conceptual understanding in this study was assessed using N-gain scores, with the experimental class showing a higher average N-gain than the control class. This indicates that learning using RME supported by Kahoot, supplemented with contextual teaching materials, leads to a greater improvement in conceptual understanding. This finding aligns with research by Gupta et al. (2023), which showed that the use of Kahoot in mathematics learning influences student understanding, as evidenced by differences between students who used Kahoot and those who did not, as well as increased active student participation during the learning process. This finding also aligns with Jean Piaget's constructivist theory, which emphasizes that knowledge is formed through active learning experiences. According to research Arifin (2025), the use of Kahoot! in the classroom has a positive impact on the process and outcomes of mathematics learning. A review of various studies found that Kahoot! is capable of improving learning outcomes, motivation, and student effectiveness in mathematics learning because this tool significantly fosters student motivation and engagement. Other research also indicates that Kahoot! increases student engagement in the learning process and strengthens their understanding of the material being studied.

The Role of the RME Approach and Kahoot in Understanding Mathematical Concepts

In addition to the teaching approach, the application of Realistic Mathematics Education (RME) characteristics in the experimental class also contributed to improving students' understanding of mathematical concepts. RME characteristics such as phenomenological exploration, the use of models, students' own production and construction, interactivity, and intertwinement provide students with opportunities to construct their own understanding through contextual problems, modeling, discussion, and the interconnection of concepts. This process enables students not only to receive information but also to actively construct concepts through meaningful learning experiences. The results of this study are thus consistent with the findings of a study Sunyoto et al. (2024), which showed that the use of the RME approach can improve students' understanding of mathematical concepts compared to conventional teaching. This is because RME provides students with the opportunity to understand concepts through real-world contexts, making learning more meaningful rather than merely rote memorization.

The findings of this study align with Fredriksen (2021) view, which emphasizes that mathematics becomes more meaningful when it begins with real-world contexts that are relevant to students' lives. Furthermore, the role of models as a bridge from real-world problems to formal concepts is supported by Gravemeijer (1944) theory, which explains that modeling in RME helps students organize information before applying formal procedures. The support provided by the interactive platform Kahoot! in this process also enhances student engagement through immediate feedback and engaging assessment activities.

This finding is consistent with Piaget (1965) constructivist theory, which states that knowledge is formed when students actively engage with their learning experiences. In line

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with this, the studies cited in your manuscript, such as Utami & Qomariyah (2025), indicate that the implementation of RME and the use of Kahoot in mathematics instruction have a positive impact on students' conceptual understanding because they enhance engagement, interactivity, and the quality of students' thinking processes during instruction.

Research Implications

Based on the research findings, the implementation of the Realistic Mathematics Education (RME) approach supported by Kahoot! has a positive impact on students' understanding of mathematical concepts. The use of contextual problems through teaching materials and worksheets, group discussions, modeling, and interactive assessment via Kahoot creates more meaningful learning and enhances students' cognitive engagement during the learning process. Conceptually, this study demonstrates that integrating RME characteristics with interactive media can serve as an effective alternative learning strategy to help students develop a deeper understanding of mathematical concepts. The researcher also faced several challenges in the early stages of implementing the instruction, particularly in acclimating students to the RME learning approach which requires active engagement in understanding contextual problems as well as technical difficulties in accessing Kahoot. However, these challenges gradually diminished in subsequent sessions as students became more adapted to the instructional materials, worksheets, group discussions, and the use of Kahoot as a learning assessment tool.

Conclusion

Based on the research findings, the integration of Kahoot! within the Realistic Mathematics Education (RME) approach has been shown to contribute positively to students' understanding of mathematical concepts through contextual, interactive, and meaningful learning activities. Since both the experimental and control groups implemented the RME approach, the findings specifically indicate that the addition of Kahoot! provided added value in supporting students' conceptual understanding compared to the implementation of RME without Kahoot!. The use of contextual problem-based teaching materials and worksheets combined with interactive assessment through Kahoot! enhanced students' engagement, participation, and quality of thinking processes in understanding algebraic concepts.

The statistical findings further supported these results. The experimental group achieved a higher average N-Gain score than the control group, indicating greater improvement in conceptual understanding. In addition, the Independent Sample t-test showed a significance value of 0.009 (< 0.05), confirming a statistically significant difference between the two groups. The effect size analysis using Cohen's d produced a value of 0.696, which falls within the medium category, indicating that the integration of Kahoot! within the RME approach had a moderate effect on improving students' mathematical conceptual understanding. The improvement was particularly evident in students' ability to restate mathematical concepts, classify algebraic objects based on their properties, represent concepts in various mathematical forms, and select appropriate procedures in solving algebraic problems.

These findings confirm that integrating the characteristics of RME with interactive gamification-based media can serve as a relevant and effective strategy for improving students' understanding of mathematical concepts. However, this study still has several limitations, including the limited scope of the material, which focused only on algebra topics, the relatively short duration of the instructional sessions consisting of three learning meetings, and students' initial adaptation to the use of Kahoot! and the RME learning approach. Therefore, future studies are recommended to expand the range of mathematical topics, extend the duration of the instructional intervention, and further optimize the integration of interactive digital media in order to obtain more comprehensive findings regarding students' conceptual understanding in mathematics learning.

Conflict of Interest

The researcher states that there is no conflict of interest in this research.

Auhor Contributions

E.N. was actively involved in the entire research process, including conducting the study, collecting data, designing and developing instruments, drafting the initial manuscript, discussing the results, and finalizing the manuscript. V.A. and E.N. contributed to strengthening the main research ideas, deepening the theoretical foundation, designing the methodology, processing and analyzing data, interpreting results, and approving the final manuscript. All authors have reviewed and approved the final version of the article. The proportion of contributions to the conceptualization, writing, and revision of the manuscript is as follows: E.N.: 40%, V.A.: 30%, and E.N.: 30%.

Data Availability Statement

The authors declare that data sharing cannot be conducted, as no new data were generated or analysed in this study.

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