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*Research Article*

# Effectiveness of integrative learning models in improving understanding of mathematical concepts

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**Abstract**

This research is whether the integrative learning model is effective in increasing understanding of mathematical concepts. The integrative learning model is intended to practice critical thinking skills and develop a deep understanding of building systematic knowledge simultaneously using a variety of thinking skills. The pretest-posttest control group design was used in the quasi-experimental design of this study. This research was conducted in Senior High School (SHS) 6 Kendari class XI.2 as an experimental class and XI.4 as a control class. The experimental class is taught the integrative learning model, while the control class is taught by the direct learning model. The results of this study are: (1) the integrative learning model can increase the average value of students 'understanding of mathematical concepts from $\bar{X}$= 60.56 to $\bar{X}$= 77.61 and the average understanding of students' mathematical concepts increases from $\bar{X}$= 60.11 to $\bar{X}$= 68.87 with direct learning models, (2) integrative and direct learning models are effective in increasing understanding of mathematical concepts, and (3) integrative learning models are more effective in improving understanding of mathematical concepts compared to direct learning models.

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## Introduction

One of the main objectives of Mathematics Subjects is that students can understand mathematical concepts. This goal is relevant to the Principles of School Mathematics Standards (NCTM, 2000), that students learning mathematics aim to develop and deepen understanding of mathematical concepts and relationships when they make, compare, and use various representations (Minarni, Napitupulu, & Husein, 2016). Understanding mathematical concepts are the ability to develop mathematical concepts, understand, transform information into meaningful forms based on the generalization of student involvement with the subject matter being taught (Sukardjo & Salam, 2020; Sumarni et al. 2018). Understanding mathematical concepts are the ability possessed by someone to be able to understand ideas correctly and be able to express the knowledge obtained about mathematics that is being learned both orally and in writing (Asria & Wahyudin, 2019). Understanding of mathematical concepts is the integrity of concepts that exist in mathematics with operations and relationships and can be measured by categories instrumentally and relationally (Gunawan, Kusnandi, & Darhim, 2019). Understanding concepts is one of the basic abilities in learning science (Nehru et. Al. 2020), and gives meaning to the subject matter being studied (Muhlisin, 2019), which can be obtained through reading and writing activities during learning (Lestari, Ristanto & Miarsyah, 2019), and is an advanced learning concept that aims to make students better (Thahir, Mawarni & Palupi, 2019). This shows that students who do not understand mathematical concepts will cause difficulties in working on various mathematical problems, while students who master these concepts can identify and work on more diverse new problems. Understanding concepts is very important because by mastering the concepts it will be easy to develop students' abilities in understanding mathematics.

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The ability to understand mathematical concepts as described in NCTM (2000) includes (1) defining concepts, (2) identify examples and not examples, (3) presents concepts in the form of diagrams, symbols, and models, (4) transform one form of representation to another, (5) get to know a variety of meanings and interpretations of concepts, (6) identify the properties of concepts, and compare and differentiate concepts (Ningsih & Paradesa, 2018). This explains the importance of students understanding mathematical concepts as goals of mathematics learning.

However, in reality, students' understanding of mathematical concepts is still low (Kudri, Rahmi & Haryono, 2018; Yeni, Syarifuddin & Ahmad, 2019; Widyastuti et al. 2019). This fact also happened in Senior High School (SHS) 6 Kendari, which was shown by the inability to do the questions given by the teacher and had difficulty in describing the material that had been learned (results of interviews with mathematics teachers). Students also still have problems in associating mathematical concepts with everyday life so students find it difficult to solve mathematical story problems related to daily life.

One of the factors causing the low understanding of mathematical concepts is the learning model applied by the teacher. The learning model used by teachers in mathematics so far is direct. Direct learning models are used to teach knowledge, skills, or both explicitly (Estes, Mintz & Gunter, 2016). In the direct learning model, the teacher determines what material should be learned. In the direct learning model, the teacher determines what material should be learned. Then, through clear, timely, and accurate feedback during guided and independent practice sessions, students gradually demonstrate success in targeted knowledge and skills. The teacher's role as a model is an important component of the direct learning model. According to (Joyce, Weil & Calhoun, 2015), the direct learning model consists of five phases, namely: a) Orientation. The teacher explains the subject matter, asks questions about previous learning, explains the purpose of the lesson, and explains the learning procedure, b) Explain the subject matter. The teacher shows or explains concepts and even new skills, through visual representations of the material being taught, then examines student understanding, c) Structured Practices. The teacher guides students both in groups and individually through examples of questions given for practice in front of the class, then students answer questions. The teacher gives corrections for wrong answers and provides reinforcement for students who answer correctly, d) Guided Practice. Students practice under the guidance of the teacher. The teacher monitors student activities and provides corrections, and e) Independent Practice. Students practice alone at home or in class without the teacher's help. Feedback is done later. Independent practice occurs repeatedly during learning.

Various attempts have been made to improve understanding of mathematical concepts, among others by applying learning models that are following mathematics subject matter (Kudri, Rahmi & Haryono, 2018; Yeni, Syarifuddin & Ahmad, 2019). One learning model that can be applied to instill mathematical concepts is integrative. The integrative model is a learning model that aims to help students develop an in-depth understanding of building systematic knowledge which simultaneously exercises their critical thinking skills by using various thinking skills, by developing the ability to create, recognize, and evaluate relationships between different concepts. and make a simple connection between ideas and experiences they get from inside and outside the classroom (Blessinger & Carfora, 2015; Kauchak & Eggen, 2012; Estes, Mintz & Gunter, 2016). The phases of the integrative learning model are explained in the following table.

**Table 1.**

*Phases in Implementing Lessons with the Integrative Model (*Kauchak & Eggen, 2012).

| Phase | Description |
|---|---|
| 1. The open-ended phase | Students explain, compare, and look for patterns |
| 2: The causal phase | Learners offer explanations for similarities and differences. |
| 3: The hypothetical phase | Students make hypotheses under different conditions. |
| 4: Closure and application | Students make conclusions and generalizations |

From table 1 the integrative learning model phase, it can be explained that the first phase can help students in defining concepts and identifying examples and not examples of concepts. The second phase can improve student understanding in terms of using models, diagrams, and symbols to present concepts, as well as identifying characteristics of concepts, and comparing and comparing concepts. The third phase can improve students 'understanding in transforming one form into a representation to another form, and the fourth phase can strengthen students' understanding in recognizing various meanings and interpretations of concepts. Thus, the integrative learning model is expected to be effective in increasing students' understanding of concepts in mathematics learning.

### Problem of Research

Based on the description above, the problems in this study are as follows:

- How is the description of students 'understanding of mathematical concepts before and after treatment ?
- Does the integrative and direct learning model can improve students' ability to understand mathematical concepts ?
- Is the integrative model more effective in increasing understanding of mathematical concepts than the direct learning model?

## Method

### Research Design

The design of the pretest-posttest control group (Ary, Jacobs & Sorensen, 2018; Cohen, Manion & Morrison, 2013) used in quasi-experimental research is as follows:

**Table 2.**

*Research Design*

| Group (Class) | | Pretest | Independent Variable | Posttest |
|---|---|---|---|---|
| R (Random) | E (Experiment) | $Y_1$ | X (treatment) | $Y_2$ |
| R (Random) | C (Control) | $Y_1$ | - | $Y_2$ |

The main strength of this design is the initial randomization, which ensures statistical equality between groups before the experiment; also the fact that the experiment has control over the pretest can provide additional checks on the equality of the two groups in the pretest, Y1 so that it can control most foreign variables that pose a threat to internal validity (Cohen, Manion & Morrison, 2013; Mertens, 2014; Ary, Jacobs & Sorensen, 2018).

### Participants

11th-grade students of SHS 6 Kendari consisted of five classes with a total of 181 students in this study. Sampling was done randomly and obtained class XI.2 as the experimental group and XI.4 as a control group, with 72 students. The number of students in the experimental and control groups was 36 students. The integrative learning model is applied to the experimental group, while the learning model is directly tested on the control group.

### Data Collection Tools

The instrument used to collect data that understands the mathematical concept is a test consisting of 6 items. The relationship between indicators that understand mathematical concepts and indicators is explained in table 3.

**Table 3.**

*Indicators and Items*

| Indicator | Item question | Maximum score |
|---|---|---|
| Defining concepts | 1 | 4 |
| identify examples and not examples | 2 | 4 |
| Presents concepts in the form of diagrams, symbols, and models | 3 | 4 |
| Transform one form of representation to another | 4 | 4 |
| Get to know a variety of meanings and interpretations of concepts | 5 | 4 |
| Identify the properties of concepts, and compare and differentiate concepts | 6 | 4 |

The test used was validated by 2 experts and tested in SHS 6 Kendari, class XI.3 which was not a research sample. Validity testing uses product-moment correlation and reliability using Cronbach-alpha (Kaplan & Saccuzzo, 2017). The results of the testing instruments for understanding mathematical concepts are all valid and reliable (Table 4).

**Table 4**

*Test Results for Validity and Reliability*

| Item number | $r_{XY}$ | $r_{table}$ | Interpretation | Item variance | Total variance | Reliability value |
|---|---|---|---|---|---|---|
| 1 | 0.602 | 0.340 | Valid | 0.928 | 41.751 | 0.836213 |
| 2 | 0.801 | 0.340 | Valid | 3.081 | | |
| 3 | 0.835 | 0.340 | Valid | 2.146 | | |
| 4 | 0.789 | 0.340 | Valid | 2.328 | | |
| 5 | 0.717 | 0.340 | Valid | 2.146 | | |
| 6 | 0.700 | 0.340 | Valid | 2.029 | | |

**Data Analysis**

The data obtained were processed using descriptive and inferential statistics. Inferential statistics used to test hypotheses are t-tests (Maxwell, Delaney & Kelley, 2017). Before testing the hypothesis, data normality was tested using Kolmogorov-Smirnov (Albers, 2017). The results of testing data normality (table 5) are as follows.

**Table 5.**

*Normality Test Results.*

| Statistics | | Exp. Pre_test | Exp. Post_test | Cont. Pre_test | Cont. Post_test |
|---|---|---|---|---|---|
| N | | 36 | 36 | 36 | 36 |
| Normal Parameters[a,b] | Mean | 60.56 | 77.61 | 60.11 | 68.87 |
| | Std. Deviation | 5.91 | 8.65 | 5.93 | 5.28 |
| Most Extreme Differences | Absolute | .165 | .277 | .187 | .183 |
| | Positive | .141 | .160 | .092 | .123 |
| | Negative | -.165 | -.277 | -.187 | -.183 |
| Kolmogorov-Smirnov Z | | .987 | 1.161 | 1.122 | 1.098 |
| Asymp. Sig. (2-tailed) | | .284 | .158 | .161 | .179 |

Normality test results obtained Asymp.Sig (2-tailed)> 0.05. This shows that the pre-test and post-test data of the control and experimental classes are normally distributed.

**Research Procedure**

The activities in this study were carried out in 4 phases, namely: (a) the initial phase, including determining the research sample, preparing pre-test questions, developing learning tools, compiling post-test questions; (b) the planning stage, including setting a schedule for conducting research; (c) the implementation phase of the activity, including conducting the pretest, carrying out learning in the control and experimental groups; (d) the final stage of the activity, including conducting a post-test, processing data, and interpreting the results of data analysis.

## Results

Data processing of understanding mathematical concepts of students of SHS 6 Kendari in an experimental group descriptively is explained in table 6 below.

**Table 6.**

*Descriptive Analysis of the Experimental Group*

| Variable | N | Minimum | Maximum | Range | Mean | Std. Dev |
|---|---|---|---|---|---|---|
| Experiment pre-test | 36 | 48.00 | 72.00 | 24 | 60.56 | 5.91 |
| Experiment post-test | 36 | 52.94 | 88.24 | 35.3 | 77.61 | 8.65 |

The results in table 6 give meaning that in the experimental group before being given an integrative learning model, understanding of mathematical concepts spread from $\bar{X}$= 48.00 to $\bar{X}$= 72.00, with an average value of $\bar{X}$=60.56 and a standard deviation of 5.91. After being given an integrative learning model, understanding of mathematical concepts spread from $\bar{X}$=52.92 to $\bar{X}$= 88.24, with an average value of $\bar{X}$= 77.61 and a standard deviation of 8.65. These results indicate that students' understanding of mathematical concepts after being taught with integrative learning models increases both in terms of minimum, maximum, and average. Visually, an increase in understanding of students' mathematical concepts after being given an integrative learning model is explained in Figure 1 below.


**Figure 1.**
*A comparison Between Understanding Mathematical Concepts Before and After the Integrative Learning Model is Given.*

Figure 1 above gives the meaning that students' understanding of mathematical concepts has improved after being given an integrative learning model.

**Test the first hypothesis:** The hypothesis to be tested is that there is a significant increase in students' understanding of mathematical concepts taught by the integrative learning model. Statistically, the hypothesis is formulated as follows:

$H_0: \mu_{Y_2-Y_1} \leq 0$ versus $H_1: \mu_{Y_2-Y_1} > 0$, by criteria, if the value of sig. smaller than α = 0.05 then $H_0$, is rejected.

The results of testing the hypothesis using the t-test can be seen in the following table 7.

**Table 7.**
*One sample of T-test Results From the Experimental Class*

| | T | Df | Sig. (2-tailed) | Mean $Post - Pre$ | CI of the $Post - Pre$ | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Experiment | 10.946 | 35 | .000 | 17.057 | 13.893 | 20.221 |

The results in table 7 obtained the value of t = 10,946 with Sig. = 0.0. When compared with α = 0.05, the value of sig. smaller than α = 0.05. This shows that $H_1$ is received, which means there is a significant increase in students' understanding of mathematical concepts after being given an integrative learning model.

The results of the descriptive analysis of the understanding of mathematical concepts of SHS 6 Kendari students in the control class are explained in table 8 below.

**Table 8.**
*Descriptive Analysis of the Control Group*

| Variable | N | Minimum | Maximum | Range | Mean | Std. Dev |
|---|---|---|---|---|---|---|
| Control pre-test | 36 | 48.00 | 68.00 | 20 | 60.11 | 5.93 |
| Control post-test | 36 | 52.94 | 76.47 | 23.53 | 68.87 | 5.28 |

Understanding of students' mathematical concepts in the control group before being taught with the direct learning model spreads from 48.00 to 68.00, with an average of 60.11 and a standard deviation of 5.93. After being given a direct learning model, understanding of mathematical concepts spread from 52.94 to 76.47, with an average of 68.87 and a standard deviation of 5.28. These results indicate that students' understanding of mathematical concepts after being given direct learning increases. Improved understanding of students' mathematical concepts visually are explained in Figure 2 below.

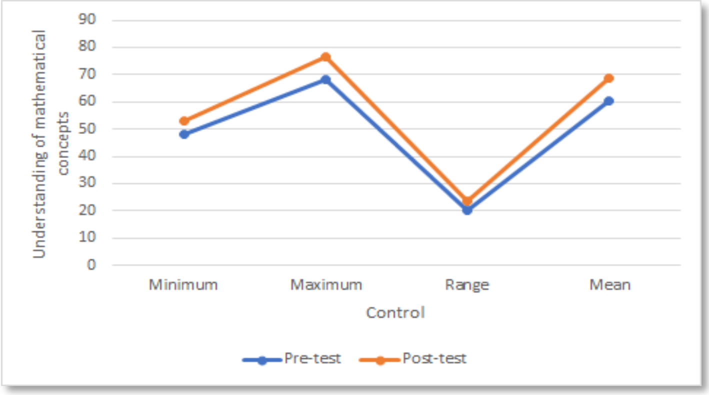


**Figure 2.**
*Comparison Between Understanding Mathematical Concepts Before and After Given a Direct Learning Model.*

**Second hypothesis testing:** The hypothesis to be tested is that there is a significant increase in students' understanding of mathematical concepts taught by the direct learning model. Statistically, the hypothesis is formulated as follows:

$H_0$: $\mu_{Y_2-Y_1} \leq 0$ versus $H_1$: $\mu_{Y_2-Y_1} > 0$, by criteria, if the value of sig. smaller than α = 0.05 then $H_0$, is rejected.

The results of testing the hypothesis using the one-sample test are explained in the following table 9.

**Table 9.**
*Control Group T-test Results*

| | T | Df | Sig. (2-tailed) | Mean $Post - Pre$ | CI of the $Post - Pre$ | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Control | 9.050 | 35 | .000 | 8.763 | 6.797 | 10.728 |

The results in table 9 obtained the value of t = 9.05 with Sig. = 0.0. When compared with α = 0.05, the value of sig. smaller than α. This shows that $H_1$ is accepted, which means there is a significant improvement in understanding students' mathematical concepts after being given a direct learning model.

Descriptive analysis results improve the understanding of mathematical concepts between the control group and the experimental group described in table 10 below.

**Table 10.**
*Increased Understanding of Students' Mathematical Concepts*

| Variable | N | Minimum | Maximum | Range | Mean | Std. Dev |
|---|---|---|---|---|---|---|
| Experiment | 36 | 0.71 | 34.35 | 33.64 | 17.06 | 9.35 |
| Control | 36 | 0.71 | 22.59 | 21.88 | 8.76 | 5.81 |

The results in table 10 give meaning that improves students' understanding of mathematical concepts taught with the integrative learning model has a range of 33.64, with a minimum value of 0.71, a maximum of $X$= 34.35, an average of 17.06 and a standard deviation of 9.35. Meanwhile, students' understanding of mathematical concepts taught by the direct learning model has a range of 21.88, with a minimum value of 0.71, a maximum of $\bar{X}$= 22.59, a standard deviation of 5.81, and an average of 8.76. A comparison of increasing understanding of mathematical concepts between students being taught with integrative learning models and direct learning models is explained in Figure 3 below.

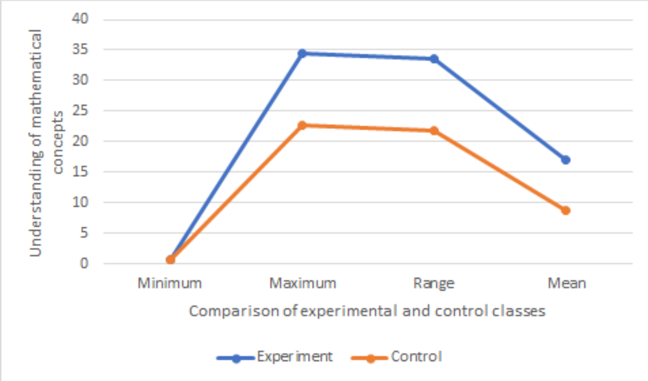


**Figure 3.**
*Comparison of Increased Understanding Between the Control Class and the Experimental Class*

Descriptive analysis (table 10) and Figure 3 mean that increasing students' understanding of mathematical concepts taught with the integrative model is higher than the direct learning model.

**Test the third hypothesis:** The hypothesis to be tested is an increase in students' understanding of mathematical concepts taught with integrative learning models that are higher than direct learning models. Statistically, the hypothesis is formulated as follows:
$H_0: \mu_1 \leq \mu_2$ versus $H_1: \mu_1 > \mu_2$, with the reject criteria $H_0$, if the value of sig. smaller than $\alpha = 0.05$. The results of testing the hypothesis using the t-test are explained in the following table 11.

**Table 11.**
*T-test Results of Control-Experimental Group Scores*

| | F | Sig. | T | Df | Sig. (2-tailed) | Mean Diff. | S.E Diff. | CI of the Diff. Lower | Upper |
|---|---|---|---|---|---|---|---|---|---|
| Equal variances assumed | 9.62 | .003 | 4.52 | 70 | .000 | 8.294 | 1.835 | 4.635 | 11.953 |
| Equal variances not assumed | | | 4.52 | 58.52 | .000 | 8.294 | 1.835 | 4.622 | 11.966 |

The results in table 11 obtained the value of t = 4.52 with Sig. = 0.0. When compared with α = 0.05, the value of α = 0.05 is greater than the value of sig. = 0.00. This shows that $H_0$ is rejected, which means an increase in understanding of students' mathematical concepts taught by the integrative learning model is higher than the direct learning model.

## Discussion and Conclusion

The results in table 6, figure 1, and testing the first hypothesis can be concluded that the integrative learning model significantly increases students' understanding of mathematical concepts. This shows that the integrative learning model is effective in increasing understanding of mathematical concepts. This result is supported by research conducted by (Salam, Ibrahim, & Sukardjo, 2019a) that learning models can improve mathematics learning outcomes. This is because integrative learning can help students see the relationship between mathematics subject matter that is interrelated to one another, even interdisciplinary relationships (D'Souza et al. 2016). Likewise, research conducted by (Becker & Park, 2011), that integrative learning models are effective for improving understanding of mathematical concepts both in elementary schools and at universities. The integrative learning model is designed to help students see the relationship between components of complex topics in mathematics learning. When students try to understand complex mathematical problems, they construct or revise schemes that they previously built to understand the same information to help students organize information so that it is easily assimilated and then retrieved. The integrative model presents content to students in an organized manner that allows connections to be built smoothly and effectively (Estes, Mintz & Gunter, 2016). Studies (Stronge, 2018) show that using manipulatives together integrative approach to problem-solving in mathematics improves students' performance on standardized assessments.

Based on the results in table 8, figure 2, and testing the second hypothesis that students' understanding of mathematical concepts, was significantly improved through direct learning. This shows that direct learning is effective in increasing understanding of mathematical concepts. The direct learning model has been used extensively and is proven effective in teaching basic skills to students to get procedural knowledge (Arends, 2014). In the direct learning model, facts, rules, and sequences of actions are presented to students directly, although initially the presentation format, explanation of examples and opportunities for students to practice and provide feedback requires considerable time. The teacher's presentation here is not a long or open monologue but a collection of very neat, controlled, and focused material on achieving a certain set of conceptual understandings, whether in the form of facts, rules, or prescribed action sequences. Thus, the direct learning model is not just boring and dry learning from activities that involve students in learning, more than that, direct learning is a learning model that is planned, organized, controlled and focused on achieving learning objectives (Borich, 2017). Direct learning model can increase awareness of knowledge gaps (cognitive) and increase curiosity about the material being studied (Glogger-Frey et al. 2015).

Based on table 10, figure 3, and testing the third hypothesis, the integrative learning model is more effective than the direct learning model in improving students' mathematical understanding. These results are in line with (Salam, Ibrahim & Sukardjo, 2019b), that the integrative learning model influences mathematics learning outcomes. This is in line with the theory developed by (Kauchak & Eggen, 2012; Kilbane & Milman, 2014) that the integrative learning model aims to support students to develop independent learning abilities and an in-depth understanding of building systematic knowledge which simultaneously exercises their critical thinking skills by using various thinking abilities. This shows that students who are taught with integrative learning models, students' understanding of mathematical material will be deeper so that they will master the concepts in mathematics learning by looking for differences and similarities, making hypotheses and finding generalizations in mathematics learning. In addition, integrative learning models can increase academic excellence (Woodside, 2018), student involvement and understanding to achieve predetermined goals (Lowenstein, 2015), and can help students make connections throughout the learning experience so as to achieve learning at cognitive levels (Durrant & Hartman, 2015) and to meet the rapidly changing demands of new competencies needed by schools that function as transfers between theory and practice (Isacsson, 2017). As a result, students in learning mathematics are not only able to work on problems similar to those learned in school, but they can develop themselves or build themselves through building on the knowledge they already have so that their understanding of mathematical concepts increases.

Based on the results and discussion presented earlier, it was found that the integrative learning model significantly increased students' understanding of mathematical concepts by 17.06, with an average of 60.56 in the pre-test increasing to $\bar{X}$=77.61 at the time of the post-test. Likewise, the direct learning model increased by 8.76, with the average value at the time of the pre-test from $\bar{X}$= 60.11 increasing to $\bar{X}$= 68.87 at the time of the post-test. The integrative learning model is more effective in increasing understanding of mathematical concepts than the direct learning model, which is indicated by the increased value of understanding mathematical concepts taught with the integrative learning model by 17.06 higher than the direct learning model by 8.76.

## Recommendations

Mathematics teachers are advised to use integrative learning models in improving students' understanding of mathematical concepts. The integrative learning model can also be applied to improve critical thinking skills as the aim of this model. For other researchers who are interested in the integrative learning model, it is recommended to apply the integrative learning model to other subjects related to conceptual understanding and can be applied at different school levels. The integrative learning model can also be combined with other learning models to improve the understanding of mathematical concepts and mathematics learning outcomes.

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