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# Improving the ability to understand mathematical concepts and achievement of self-determination of elementary school students using realistic mathematics education approach

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**Abstract.** This study examines the differences in the increase in the ability to understand mathematical concepts and the achievement of students' self-determination using the RME approach. Quantitative research method by way of the experiment using "nonequivalent control-group design." The research sample amounted to 81 people. The instrument used is in the form of an essay test. Data obtained from the pretest and posttest were analyzed using descriptive and inferential statistics. The results obtained; The RME technique has a very high impact on the category's ability to comprehend mathematical ideas and attain self-determination. The RME method can help primary school children gain self-determination and increase their understanding of mathematical ideas. Students who learn to use the RME technique and students who learn to use conventional learning have different increases in their capacity to understand mathematical topics. There is no difference in self-determination between students who learn to use the RME approach and those who use conventional learning.

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## INTRODUCTION

Judging from the development of the era of learning mathematics, it is constantly changing, which is always associated with technological advances (Malik et al., 2020). In the era of digitalization, learning mathematics can be done anywhere and anytime. Learning mathematics using digitalization can change student learning patterns. Initially, teachers who taught mathematics only focused on textbooks in class. With digitalization, teachers can direct students to learn mathematics more broadly (Galimullina et al., 2020). For example, initially, math problems can be found in textbooks, but through digitization, in this case, the internet, students can find math problems there. The demands of the times encourage us to be more creative in developing or applying mathematics using learning models or approaches. This aims to make it easier for students to understand mathematical concepts (Weber et al., 2020).

The low ability of students to solve math problems because students do not master the concepts related to the questions given. Mastering concepts is crucial in solving a problem (Harsy et al., 2021). Once students are faced with various problems but do not master the concepts related to the problem, the student concerned cannot do anything. Students should prepare themselves in terms of mastering the concept so that once the problem is given, students no longer feel panic. Students who have understood the concept well in the learning process can have high learning achievement because it is easier to follow the lesson. Students who do not understand the concept tend to be more challenging to follow the lesson. Students' low ability to understand concepts is an important thing that must be followed up (Tuluk, 2020; Booysen & Westaway, 2022).

Concepts can be interpreted as an abstract or general intellectual representation of an object or event situation, a thought, idea, or mental image that can make it easier to communicate between humans and allow humans to think (Hammoudi, 2020). Concepts can also be said as markers of knowledge. If knowledge (in the sense of experience), then that knowledge needs to be tested—mathematics is the knowledge that places the "concept" as an object. Objects in abstract mathematics contain facts, concepts, operations/procedures, and principles. Take the concept of a triangle. The essential properties are flat shapes with many sides that limit 3. Unimportant properties such as the type of triangle, the size of the triangle, or the difference in the angles. This formation process can be observed intuitively, so the abstraction process is said to be classical abstraction (Niswah & Qohar, 2020).

Mathematical concepts are a series of cause and effect. Mathematical concepts can be arranged based on previous concepts and will be the basis for subsequent concepts, so a wrong understanding of a concept will result in the following concept (Angraini & Wahyuni, 2020). Therefore, mastery of mathematics is necessary, and mathematical concepts must be understood properly and correctly, especially the concepts given in learning mathematics in elementary schools (Ulusoy, 2021). Concepts in mathematics are arranged hierarchically, structured, logically, and systematically starting from simple to complex concepts. Mathematical concepts are interrelated; even simple concepts have a role as a prerequisite concept for understanding more complex concepts (Bakar & Ismail, 2020). It is crucial to understand that no phases or stages of a notion should be skipped when learning mathematics. Concepts in mathematics have a relationship, so students should be given many opportunities to see connections with other materials. It is intended that students can understand mathematical material in a structured and in-depth manner (Lohbeck, 2018).

Understanding the concept is essential to learning because students can develop their abilities in each subject matter by understanding the concept. Turmudi et al. (2021) understanding concepts is essential to learning mathematics since it is from these that theorems and formulas are derived. It is essential to be proficient in applying concepts and theorems in order for them to be applied to different circumstances. To apply concepts and theorems so that students can understand them quickly, an appropriate learning model or approach is needed (Chasanah et al., 2020). The learning model or approach serves as a liaison for teachers and students to learn so that students can quickly understand what the teacher is teaching. So many models or learning approaches will be applied in the classroom, so here we will emphasize the RME approach. This learning approach was implemented in the Netherlands in 1970 by the Freudenthal Institute and was proven successful (Johnson, 2018; Zubainur et al., 2020).

RME is a learning approach in mathematics education. The RME approach can stimulate students to carry out learning activities in mathematics. Freudenthal (2002) asserts that mathematics must be connected to reality and that it is a human endeavor. This implies that mathematics ought to be accessible to children and applicable to their everyday lives. According to Gravemeijer (1994) as mathematics is a human activity, it should be permitted for children to rediscover mathematical ideas and concepts under the supervision of adults. This attempt is conducted by looking into numerous "practical" circumstances and issues. In this context, the term "realistic" refers to anything that kids in the immediate area can imagine, rather than to actuality. While the rediscovery process makes use of the mathematization notion, the rediscovery principle might be motivated by informal problem-solving techniques. Uyen et al., (2021) defined horizontal and vertical mathematization as two different methods of mathematization. Identifying, defining, and picturing issues differently are examples of horizontal mathematics, as are turning practical issues into mathematical ones. Vertical mathematization includes things like using different models, fine-tuning and adjusting mathematical models, and generalizing formulas to depict relationships. Since these two mathematizations have the same Value, both types are given the same amount of consideration (Rejeki et al., 2023).

Mastery of concepts is beneficial for students in determining self-determination. Mastered mathematical concepts can develop self-confidence in students. The ability to master concepts can create learning that is relatedness, competence, and autonomy (Takaria & Palinussa, 2020). In simple terms, in self-determination theory, what is meant by relatedness is the level of satisfaction with social relationships that have been made, while competence describes the level when individuals feel able to perform different tasks, whether related to learning or not. The third part of self-determination is autonomy, which is the feeling of being able to choose an activity and experience that is appropriate for him. These three basic psychological needs can be developed in students; it is not impossible for the long-term goal of creating intrinsic motivation for students becomes something real. This intrinsic motivation will have an impact when a person will do something that comes from within himself because he feels happy, enjoy, and satisfied (Lohbeck, 2018).

According to research results Palinussa et al. (2021), RME greatly influences mathematics learning outcomes on communication and thinking abilities at each grade level. Likewise, Misu et al. (2019) research shows that students can use metacognitive knowledge and skills to understand the concept of indeterminate integrals. While in the integral concept, of course, some students (male) can use metacognitive knowledge and metacognitive skills. All students can use metacognitive knowledge and metacognitive skills for the summarizing category to understand the concept of indefinite integral. While the integral concept, of course, only some students (female) can use metacognitive knowledge and metacognitive skills. A similar study was conducted Febriana (2021) that applying the RME approach can improve the understanding of mathematical concepts of elementary school students in Munita Yogyakarta.

This research is different from research conducted by previous researchers. This study will examine the ability to understand mathematical concepts and the achievement of self-determination using the RME approach. Taking into account the descriptions stated above, the problems in this study can be formulated: Can the learning of the RME approach have an effect on increasing the ability to understand mathematical concepts and the achievement of self-determination in elementary school students?

Based on the explanation above, the researcher thinks a comprehensive study is needed regarding the ability to understand mathematical concepts and the achievement of students' self-determination using the RME approach. For this reason, the researchers conducted a study entitled "Improving the ability to understand mathematical concepts and achieving self-determination of elementary school students using the RME approach" to obtain a comprehensive study.

## METHOD

*Research design*

The study used a true experimental with a pretest-posttest control group design, using a quantitative approach by applying RME (Ishtiaq, 2019). In empirical research, the independent variables are always involved in specific groups, and the impact on the dependent variable is seen. In this case, the independent variable is learning applied to the experimental group, while the dependent variable is the ability to understand mathematical concepts and achieve self-determination under study (Thomas et al., 2020).

Prior to beginning studying, each class is given a pretest to gauge their level of understanding of mathematical ideas (O). Each class receives a posttest that is identical to the pretest after the learning process is complete. To measure the improvement in conceptual understanding and the development of self-determination, pretest and posttest were administered. The experimental group (X) is the class that applies the RME approach to learning, whereas the control group is the class that applies traditional learning. The research design can be shown in Figure 1 below;

| | | | |
|---|---|---|---|
| *R* | *O* | *X* | *O* |
| *R* | *O* | | *O* |

**Figure 1.** Pretest-postest control group design

This study thoroughly investigates and evaluates the effects of learning elements on enhancing conceptual understanding and the development of self-determination.

### *Sample*

Grade 8 students at one of the state junior high schools in Ternate City, Indonesia, were used as samples in this research. The school used as the research location has implemented the 2013 National Curriculum (K–13). The research was conducted in the 2021–2022 academic year. Two classes were randomly selected to be used as research samples, one as the experimental class and the other as the control class. The experimental class was treated with the RME approach, while the control class received conventional learning.

### *Research Instruments*

Test questions in the form of essays served as the study's primary data collection tool. The ability to understand mathematical concepts and the attainment of self-determination are measured by a series of questions that are set in the form of those two notions. The ability to comprehend mathematical ideas and the development of self-determination, including translation, interpretation, and extrapolation, are always taken into consideration when creating these problems (Deci & Ryan, 2004). The quadratic equation material on the aptitude test for understanding mathematical concepts in this course consists of five essay-style problems with a processing duration of two and a half hours. Tests for reliability and validity are carried out before the test instrument is used. The results of the validity and reliability tests are predicated on the views that Cohen et al. (2020) expressed. To assess the validity of the test instrument used in this study and determine the relevance of the context in algebraic material—particularly the idea of quadratic equations both theoretically and practically—content validation was selected and deemed acceptable. The researcher was interested in the readability of students' understanding of quadratic equations, even though the reliability test was done to evaluate how the context of the information provided influences students' performance in answering questions.

### *Research procedure*

The preparation stage (introduction) and the implementation stage are the two phases of this study. The researcher develops the research problem during the planning phase of the study. Place learning tools and equipment next. They are approving research equipments and tools. The researcher asked two mathematics teachers with teaching experience as validators to validate the research instrument. After the instrument was validated, then a limited trial was carried out with several students. The objectives of this brief trial are to evaluate the readability of the language and the viability of using this research instrument for data collection. In order to develop effective instruments and tools, the findings of the validation and small-scale trials can be taken into account for analysis and improvement. The Implementation Phase is the following step, during which the researcher selects a school to serve as the research site. Manage correspondence to relevant parties about research. They are keeping an eye on the research site and participating in discussions and Q&A sessions with math teachers on the selection of the experimental group and control class for this project. Both research classes received pretests once the experimental and control classes had been established. The following task involves using the RME approach on the experimental group; learning is often used on the control group. Both groups took a posttest on conceptual understanding and self-determination after the meeting (Samura et al., 2021; Samura & Darhim, 2023).

*Data analysis*

With the use of Microsoft Office Excel products and SPSS 24 software, descriptive and inferential statistics were used to evaluate the data in this study. The aim of the descriptive statistical analysis was to describe conceptual understanding and to improve conceptual understanding in both research groups before and after treatment. To come to a conclusion, inferential statistical analysis is performed in the interim. The use of inferential statistics in this study makes it easier for future researchers to draw conclusions about the distinctions between attaining self-determination and being able to understand mathematical ideas.

The information for this study was gathered from the outcomes of the pretest and posttest, and it was then subjected to quantitative analysis. After it is established that the data has similar normality and variance, tests for normality and homogeneity of variance are conducted first. The Mann-Whitney test is used for data that are not normally distributed, and the independent sample t-test is used for data that are normally distributed, for descriptive and inferential statistical testing. The steps involved in data processing are listed below in detail; First, using the normalized gain to determine the extent of the improvement in conceptual understanding and the development of students' self-determination (Ulfah et al., 2020; Noviani et al., 2017). The normalized gain can be determined using the following formula.

$$\textit{Normalized gain (g)} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal max score} - \text{pretest score}}$$

The gain index criteria can be seen in Table 1 below:

**Table 1.** Normalized gain score criteria

| Normalized Gain Score (g) | Interpretation |
|---|---|
| g ≥ 0,70 | Heigh |
| 0, 30 ≤ g < 0,70 | Medium |
| g < 0, 30 | Low |

Calculating Effect Size using Cohen's difference (d) with the following formula

$$Cohen's\ (d) = \frac{\overline{X_B} - \overline{X_A}}{Pooled\ SD}$$

Were,

$$Pooled\ SD = \sqrt{\frac{(S_A)^2 + (S_B)^2}{2}}$$

To translate the Value of d, Cohen's effect size classification is used (Juandi & Tamur, 2021), as shown in Table 2 below.

**Table 2.** Classification of Cohen's effect size

| Effect Size | Criteria |
|---|---|
| 0,00 ≤ ES < 0,20 | Very low |
| 0,20 ≤ ES < 0,50 | Low |
| 0,50 ≤ ES < 0,80 | Medium |
| 0,80 ≤ ES < 1,30 | High |
| 1,30 ≤ ES | Very high |

Calculating descriptive statistics for the pretest, posttest, and gain scores—which include the average Value—comes next.

## RESULTS AND DISCUSSION

The results of this study obtained quantitative data derived from the results of the ability to understand mathematical concepts. The data are grouped into categories: data on the ability to understand mathematical concepts. To clarify, the following data description is presented in Table 3 as follows:

**Table 3.** Description of the test data for concept understanding ability improvement mathematics using the RME approach

| Statistics | RME Learning | | | Conventional Learning | | |
|---|---|---|---|---|---|---|
| | Pretest | Posttest | N-Gain | Pretest | Posttest | N-Gain |
| Maks | 9 | 28 | 0,21 | 7 | 23 | 0,21 |
| Min | 0 | 3 | -0,02 | 0 | 6 | 0,05 |
| Mean | 4,33 | 14,65 | 0,1081 | 1,88 | 11,78 | 0,1011 |
| s | 2,422 | 5,489 | 0,05091 | 1,52 | 4,453 | 0,03869 |
| n | 40 | 40 | 40 | 41 | 41 | 41 |
| Ideal Maximum Score: 30 | | | | | | |

Table 3 explains that, from the results of descriptive statistical tests, students who learn to use RME learning and students who learn to use conventional learning have differences in the ability to understand concepts. The difference in these abilities is shown in the results of each posttest test between students who learn to use RME learning and students who learn to use conventional learning. Here, it can be seen that the average posttest score among students who learn to use RME learning is higher than students who learn to use conventional learning. Referring to Table 1 above, it can be concluded that; there are differences in the ability to understand mathematical concepts between students who learn to use RME learning and students who learn to use conventional learning.

Here we will examine how much influence RME learning has on the ability to understand mathematical concepts. To test the effect of the RME approach using Cohen's difference formula (d) with an unpaired t-test. The test results found that the effect of the Realistic Mathematics Education approach on the ability to understand the concept of the category was very high. Calculations can be seen in Table 4 below;

**Table 4.** Cohen's(d) test results and effect sizes

| Learning | Cohen's Value (d) | Effect Sizes |
|---|---|---|
| RME approach | 10,32 | Very high |
| Conventional | 2,975 | Very high |

Considering Table 4, it can be explained that learning using the RME and conventional approaches can significantly influence the ability to understand concepts. It is said to have a powerful influence because, from the results of calculations using Cohen's formula (d) and compared with the criteria of effect sizes, the calculation results are more than the specified criteria. So, it can be concluded that the effect of learning using the RME approach on the ability to understand mathematical concepts is a very high category.

Tests to increase the ability to understand mathematical concepts can be done using the Normalized Gain Value test. Because in the N-Gain test, the pretest and posttest data can be referred to as data on increasing the ability to understand mathematical concepts. To obtain a more detailed picture of the data on improving the ability to understand mathematical concepts, a description of the N-Gain data for the RME approach and the N-Gain for conventional learning on the ability to understand mathematical concepts is presented can be seen in Table 5.

Students who learn to use the RME approach experience an increase in their ability to understand mathematical concepts with an average increase (N-Gain) of 0.1081. Likewise, for students who learn to use conventional learning with an average increase (N-Gain) of 0.1011. The data distribution on increasing the ability to understand mathematical concepts in each learning group has different data distribution. Thus, it can be said that learning with the RME approach and conventional learning has increased the ability to understand mathematical concepts, with the distribution of data in the learning class using the RME approach being more diverse or uniform compared to conventional learning classes seen in Table 5.

**Table 5.** Description of N-Gain data on concept understanding ability

| Statistics | N-Gain Approach RME | Conventional N-Gain |
|---|---|---|
| Maximum | 0,21 | 0,21 |
| Minimum | -0,02 | 0,05 |
| Mean | 0,1081 | 0,1011 |
| Std. Deviation | 0,05091 | 0,03869 |

Paying attention to Table 5, the comparison of the improvement of the two learnings that is more improved is learning using the RME approach, where the average Value of learning using the RME approach is higher than the average Value of conventional learning. It can be shown in Figure 2 below.

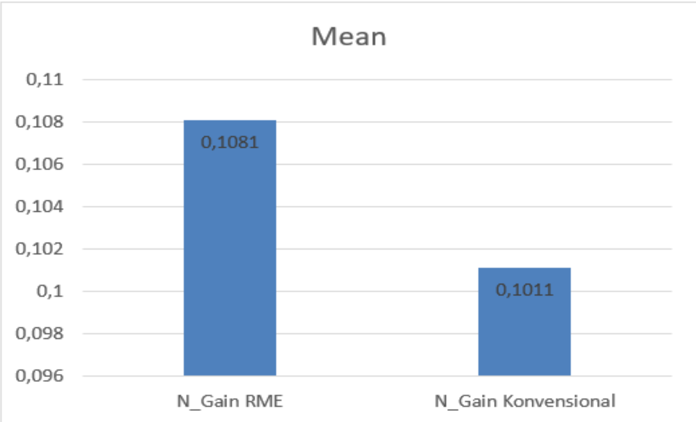


**Figure 2.** Comparison of average ability improvement

The normality test is used to determine whether or not population samples may be distributed normally. The range of data taken in this study was between $20 \leq n \leq 50$, the Shapiro-Wilk test was used. Using SPSS output, the Shapiro-Wilk test determined the significance value of the two learnings, with learning using the RME approach having a significance value more significant than and learning using the traditional N-Gain having a significance value less than, as shown in Table 6. Using SPSS output, the Shapiro-Wilk test determined the significance value of the two learnings, with learning using the RME approach having a significance value more significant than and learning using the traditional N-Gain having a significance value less than, as shown in Table 6.

**Table 6.** Shapiro-Wilk normality tests

| Learning | | Statistics | df | Sig. |
|---|---|---|---|---|
| NGain_Score | RME approach | 0,056 | 40 | .200* |
| | Conventional | 0,165 | 41 | 0,007 |

Referring to the decision-making rules for the normality test, and based on Table 6, it can be concluded that the data on Learning using the RME approach are normally distributed, and data on conventional learning are not normally distributed. So, it can be said that the data on both studies are not normally distributed. The rules in statistical testing to test the difference between the two averages of increasing the ability to understand mathematical concepts if the data are generally not distributed can be made by non-parametric statistical testing. Because the data in

Table 6 above is not normally distributed, the variance similarity test (homogeneity) can be ignored, followed by testing using non-parametric statistics.

The research hypothesis is; the increase in the ability to understand mathematical concepts of students who take part in learning using the RME approach is higher than that of conventional learning students. Then the statistical hypothesis proposed to see the difference in the increase in students' understanding of mathematical concepts in the two lessons is:

$H_0$: $\mu_1 = \mu_2$

$H_1$: $\mu_1 \neq \mu_2$

Information:

$\mu_1$: Understanding of Mathematical Concepts - Using the RME approach

$\mu_2$: Understanding Mathematical Concepts - Using conventional Learning

The results of the calculation of the Mann-Whitney test using SPSS can be seen in Table 7.

**Table 7.** Summary of the Mann-Whitney test of differences in mean ability understanding mathematical concepts based on learning

| | Pretest | Posttest | Ngain_Score | Conclusion |
|---|---|---|---|---|
| Mann-Whitney U | 311,500 | 568,000 | 710,500 | |
| Wilcoxon W | 1,172,500 | 1,429,000 | 1,571,500 | |
| Z | -4,862 | -2,388 | -1,035 | Reject Ho |
| Asymp. Sig. (2-tailed) | 0,000 | 0,017 | 0,301 | |

Considering Table 7 above, based on decision-making on the Mann-Whitney test, we accept the null hypothesis if the Value of Sig. (2-tailed) is less than 0.05. Where by comparing the Value of Sig. (2-tailed) With the absolute level's Value ($\alpha = 0.05$), it can be said that the null hypothesis is rejected. This means that there is a difference in increasing the ability to understand mathematical concepts between students who study with the RME approach and students who learn by using conventional learning.

The results of the post-response self-determination scale can be used to measure the achievement of students' self-determination. This achievement is then seen based on the learning from the two classes. The self-determination scale consists of 40 positive and negative statements with seven response options. All of them are used to obtain a more detailed picture of the achievement of self-determination, the following is a description of student self-determination post-response data by category, which can be seen in Table 5, and learning can be seen in Table 8 below;

**Table 8.** Description of the post response self-determination data based on learning

| Statistics | RME Learning | Conventional Learning |
|---|---|---|
| | Post response | Post response |
| Maks | 231 | 228 |
| Min | 132 | 141 |
| Mean | 182,5 | 177,463 |
| Std. Deviation | 19.412 | 17.278 |

Considering Table 8, the average achievement of self-determination of students who take RME learning is seen to be higher than those who take conventional learning, with an average difference of 4.95. The distribution of self-determination achievement data in each learning group ranges from 19.412 to 17.278. This Value implies that the distribution of student achievement in classes that use RME data is more diverse or uniform than students in conventional learning groups. The following is a diagram of the average achievement of self-determination based on learning groups, as shown in Figure 3 below.

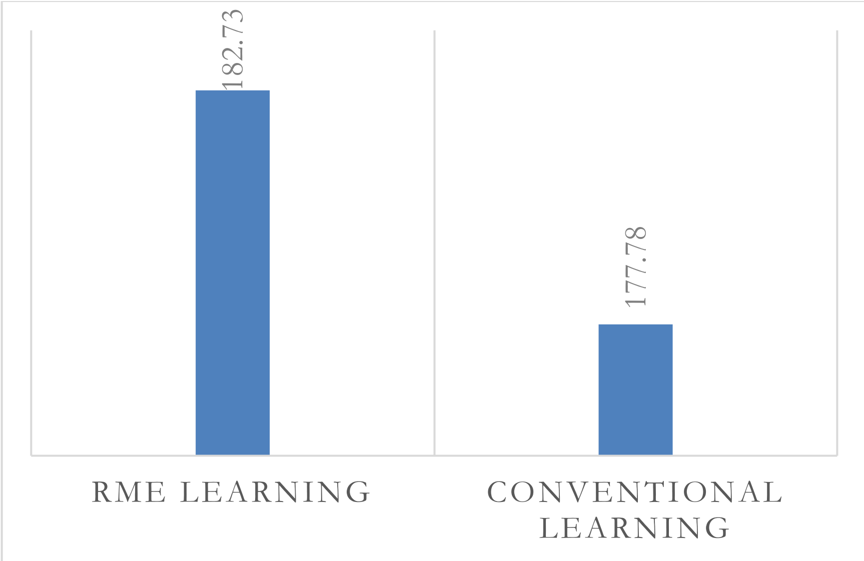


**Figure 3.** Comparison of the average achievement of self-determination by study group

The average achievement of student self-determination can be seen from several categories: Autonomy, Competence, and Relatedness. In the three categories, the average self-determination achievement of students who took RME was higher than that of conventional learning. The difference in the average achievement in the autonomy category is between RME learning and conventional learning, which is 0.65. The average difference in the competence category between RME learning and conventional learning is 1.35. At the same time, the average difference for the relatedness category between RME learning and conventional learning is 3.45. When viewed from the maximum score of achievement of self-determination in the autonomy category, students who take RME Learning are lower than students who take conventional learning. Meanwhile, in the category of competence and relatedness, the maximum score for achieving self-determination of students participating in RME learning was higher than students participating in conventional learning. More details can be seen in Table 9.

**Table 9.** Description of self-determination post response data based on categories and learning

| Category | Statistics | Learning with RME | Conventional Learning |
|---|---|---|---|
| | | Post response | Post response |
| Autonomy | maks | 44 | 47 |
| | min | 20 | 22 |
| | Mean | 33, 28 | 32, 63 |
| | Std. Deviation | 4, 899 | 5, 151 |
| Competence | maks | 45 | 40 |
| | min | 22 | 24 |
| | Mean | 33, 20 | 31, 85 |
| | Std. Deviation | 4, 675 | 4, 084 |
| Relatedness | maks | 54 | 52 |
| | min | 35 | 30 |
| | Mean | 44, 28 | 40, 83 |
| | Std. Deviation | 4, 755 | 4, 863 |

Paying attention to Table 9 provides information that the distribution of data on the achievement of self-determination in the autonomy category for students who take conventional learning is more diverse or uniform than that of students who take RME lessons. For the average score in the autonomy category, students who study with the RME approach are higher than students who study with conventional learning, but the average difference between the two lessons is not too big. Likewise, the distribution of self-determination achievement data for the competence category of students participating in RME learning is more diverse or uniform than students who take conventional learning. The difference in the data distribution between the two studies is minimal. The average Value of self-determination achievement in the competence category of students who study with the RME approach is higher than students who study with conventional learning. At the same time, in the distribution of data on the achievement of self-determination in the relatedness category, students who take regular learning are more diverse or uniform than students who take lessons with the RME approach. The difference in the data distribution between the two studies is minimal. For the average Value of self-determination achievement in the relatedness category, students who study with the RME approach are higher than students who study with conventional learning. The following shows the average Value of student self-determination achievement by category and learning in Figure 4 below.

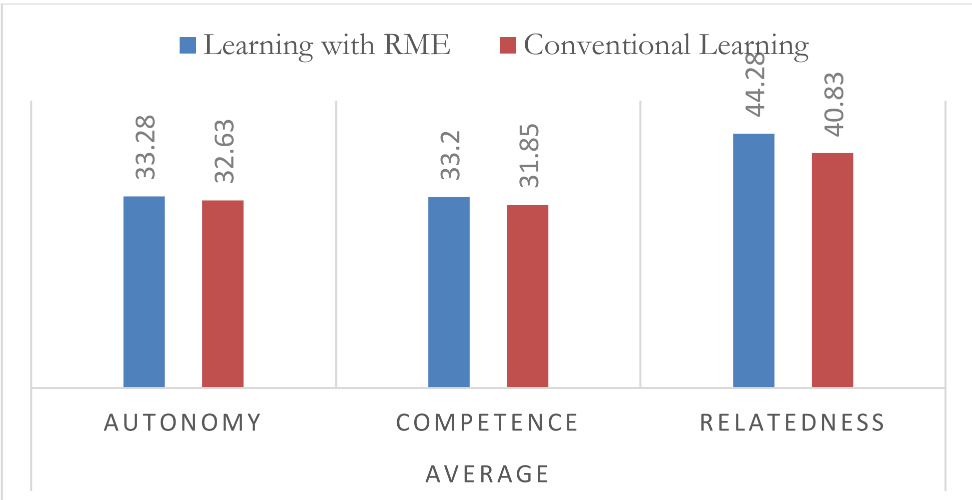


**Figure 4.** Comparison of average self-determination achievements by category and learning

The discussion of descriptive statistics above can explain that the average achievement of self-determination of students who take lessons with the RME approach and students who take regular classes looks different. To be sure, an inferential statistical test can be carried out to see the difference between the average self-determination achievements of students who take lessons with the RME approach and those who take regular classes. The difference in the achievement of self-determination can be seen in the learning and each category.

The research hypothesis is: Based on the learning achievement of self-determination, students who follow the RME approach are better than students who follow conventional learning. Before testing the difference between the two averages of achievement of self-determination based on learning, the first step is to test the data distribution's normality and the homogeneity of variance, can be seen in Table 10.

Pay attention to the data in Table 10. The degrees of freedom of the two classes, experimental and control, are less than 50 each. So, the analysis is taken to test the normality of the data using the Shapiro-Wilk normality test. Pay attention to the Value of Sig. of the two classes, namely, for the experimental class with a value of Sig. Namely 0.715, and the control class with a value of Sig. Ie 0.327. Comparing the two values of Sig. with a value of = 0.05 and according to the decision-making rules in the Shapiro-Wilk normality test, the conclusion is that the self-determination value based on learning for the experimental class and control class is normally distributed.

**Table 10.** Summary of normality test of self-determination achievement data based on learning

| Kelas | | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| Self-Determination Value Based on Learning | RME approach | 0,084 | 40 | .200* | 0,981 | 40 | 0,715 |
| | Conventional | 0,112 | 41 | .200* | 0,969 | 41 | 0,327 |

The next step is to test the homogeneity of the variance of the data on the achievement of self-determination of the two learning groups using Levene's test. The results of the homogeneity of variance test can be presented in Table 11.

**Table 11.** Test of homogeneity of variances self-determination value based on learning

| Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|
| 0,543 | 1 | 79 | 0,463 |

Based on the Table 11 test of homogeneity of variances, it is known that the significance value (Sig.) of the self-determination value variable in the experimental and control classes is 0.463. Because of the Value of Sig. More significant than (alpha), then as the basis for decision making in the homogeneity test, the conclusion is that the data variance of students' self-determination scores in the experimental and control classes is the same or homogeneous.

The next step is to test the difference between the two means. Statistical hypotheses were proposed to see the difference in the achievement of students' self-determination based on learning.

$H_0$: $\mu_1 = \mu_2$

$H_1$: $\mu_1 \neq \mu_2$

Information:

$\mu_1$: The average value of self-determination using the RME approach

$\mu_2$: The average value of self-determination using conventional learning

A statistical test to test the existence of these differences using the t-test. Statistical tests on the two proposed hypotheses can be seen in Table 12 below.

**Table 12.** Results of t-test differences in self-determination based on learning

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | |
|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference |
| Self-Determination Value Based on Learning | Equal variances assumed | 0,543 | 0,463 | 1,235 | 79 | 0,22 | 503,659 |
| | Equal variances not assumed | | | 1,234 | 77,519 | 0,221 | 503,659 |

Based on Table 12, it is known that the Value of Sig. Levene's test for equality of Variances is 0.463, which is greater than = 0.05; it can be interpreted that the data variance between the experimental and control classes is the same or homogeneous. So, the interpretation of the results of the t-test above is "Equal variances assumed," where the Value of Sig. (2-tailed) is 0.220, which is greater than the Value of = 0.05, so based on the decision-making rules in the independent sample t-test, it can be said that $H_0$ is accepted. So, the conclusion is that there is no difference in the average achievement of self-determination of students who study using the RME approach and students who learn using conventional learning. Furthermore, from Table 12 above, it is known that the "mean difference" value is 5.03659. This Value shows the difference between the average students who learn to use the RME approach and students who learn to use conventional learning, where the difference value is 182.5 – 177, 463 = 5.03659.

It is impossible to isolate this improvement from the learning environment that the RME technique provides, where challenges are contextually presented to foster a positive learning environment among students. RME aims to make mathematics education more enjoyable and significant for students by exposing them to challenges in real-world settings. RME begins with selecting challenges that are pertinent to the experiences and knowledge of the students. After that, the instructor facilitates the pupils' resolution of the contextual problems. It is thought that this contextual problem-solving exercise will improve students' cognitive achievement, particularly concerning their grasp of mathematics (Bonotto, 2008).

The ideal technique to teach mathematics is to provide students with real-world experience by having them solve problems that they encounter daily, or in other words, by having them solve contextual problems. These findings are also in line with some previous research findings, such as Laurens et al. (2018); Cahyaningsih and Nahdi (2021); Yuanita et al. (2018); Putri et al. (2019), which show that the RME approach contributes to improving students' ability and understanding in mathematical learning. The results of this study were similar to the research conducted by Palinussa et al. (2021) and Misu et al. (2019) that the application of Realistic Mathematics Education significantly affects the improvement of the ability to understand mathematical concepts and the achievement of self-determination.

## CONCLUSION

The influence of the RME approach on the ability to understand mathematical concepts and achieve self-determination is in the very high category. The application of the RME approach can improve the ability to understand mathematical concepts and achieve self-determination in elementary school students. There is a difference in increasing the ability to understand mathematical concepts between students using the RME approach and those using conventional learning. There is no difference in self-determination between students using the RME approach and those using conventional learning. Based on these findings, the RME approach contributes to growing and developing students' cognitive and affective abilities in mathematics learning. However, this research only focuses on two cognitive and affective aspects, namely the ability to understand concepts and achieving self-determination. Further research needs to be carried out to determine the role of the RME approach in improving cognitive and other aspects. Apart from that, to test the effectiveness of the RME approach in mathematics learning, it is also necessary to make variations in the use of the RME approach, such as using interactive media or comparing it with other innovative learning models.

## DAFTAR PUSTAKA

Angraini, L. M., & Wahyuni, A. (2020). The effect of concept attainment model on mathematical critical thinking ability. *International Journal of Instruction*, *14*(1), 727–742. https://doi.org/10.29333/IJI.2021.14144A

Bakar, M. A. A., & Ismail, N. (2020). Mathematical instructional: A conceptual of redesign of active learning with metacognitive regulation strategy. *International Journal of Instruction*, *13*(3), 633–648. https://doi.org/10.29333/iji.2020.13343a

Bonotto, C. (2008). Realistic mathematical modeling and problem posing. In W. Blum, P. Galbraith, M. Niss. H. W. Henn (Eds.), *Modelling and applications in mathematics education* (pp. 185-192). New York: Spinger.

Booysen, T., & Westaway, L. (2022). Exploring visual representations of multiplication and division in early years South African mathematics textbooks. In. N. Fitzallen, C. Murphy, V. Hatisaru, & N. Maher (Eds.), *Mathematical confluences and journeys (Proceedings of the 44th Annual Conference of the Mathematics Education Research Group of Australasia, July 3–7)* (pp. 90–97). Launceston: MERGA.

Cahyaningsih, U., & Nahdi, D. S. (2021). The effect of realistic mathematics education on elementary students' critical thinking skills. *Journal of Physics: Conference Series*, *1764*, 012127. https://doi.org/10.1088/1742-6596/1764/1/012127

Chasanah, C., Riyadi, R., & Usodo, B. (2020). The effectiveness of learning models on written mathematical communication skills viewed from students' cognitive styles. *European Journal of Educational Research*, *9*(3), 979–994. https://doi.org/10.12973/EU-JER.9.3.979

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. London: Routledge. https://doi.org/10.4324/9780203029053

Deci, E. L., & Ryan, R. M. (2004). *Handbook of self-determination research*. New York: University Rochester Press

Febriana, R. (2021). Application of the RME approach to improve students' mathematical concepts understanding. *Tarbawi: Jurnal Ilmu Pendidikan*, *17*(2), 118–125. https://doi.org/10.32939/tarbawi.v17i2.1006

Freudenthal, H. (2002). *Revisiting mathematics education: China lectures*. Dordrecht: Kluwer Academic Publishers.

Galimullina, E., Ljubimova, E., & Ibatullin, R. (2020). SMART education technologies in mathematics teacher education—Ways to integrate and progress that follows integration. *Open Learning: The Journal of Open, Distance and e-Learning*, *35*(1), 4–23. https://doi.org/10.1080/02680513.2019.1674137

Gravemeijer, K. (1994). *Developing realistic mathematics education*. Utrecht: Freudenthal Institute.

Hammoudi, M. M. (2020). Measurement of students' mathematics motivation and self-concept at institutions of higher education: evidence of reliability and validity. *International Journal of Mathematical Education in Science and Technology*, *51*(1), 63–86. https://doi.org/10.1080/0020739X.2019.1670369

Harsy, A., Carlson, C., & Klamerus, L. (2021). An analysis of the impact of mastery-based testing in mathematics courses. *Primus*, *31*(10), 1071–1088. https://doi.org/10.1080/10511970.2020.1809041

Ishtiaq, M. (2019). Book review Creswell, J. W. (2014). Research design: Qualitative, quantitative and mixed methods approaches (4th ed.). Thousand Oaks, CA: Sage. *English Language Teaching*, *12*(5), 40-41. https://doi.org/10.5539/elt.v12n5p40

Johnson, E. L. (2018). A new look at the representations for mathematical concepts: Expanding on lesh's model of representations of mathematical concepts. *Forum on Public Policy Online*, *2018*(1).

Juandi, D., & Tamur, M. (2021). The impact of problem-based learning toward enhancing mathematical thinking: A meta-analysis study. *Journal of Engineering Science and Technology*, *16*(4), 3548–3561.

Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2018). How Does realistic mathematics education (RME) improve students' mathematics cognitive achievement? *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 569-578. https://doi.org/10.12973/ejmste/76959

Lohbeck, A. (2018). Self-concept and self-determination theory: Math self-concept, motivation, and grades in elementary school children. *Early Child Development and Care*, *188*(8), 1031–1044. https://doi.org/10.1080/03004430.2016.1241778

Malik, N. A., Salman, M. F., Ameen, K. S., & Abdullahi, K. (2020). Basic school pupils' attitude towards the use of bridge IT mobile application for learning mathematics. *Anatolian Journal of Education*, *5*(2), 131–142. https://doi.org/10.29333/aje.2020.5211a

Misu, L., Budayasa, I. K., Lukito, A., Hasnawati, & Rahim, U. (2019). Profile of metacognition of mathematics education students in understanding the concept of integral in category classifying and summarizing. *International Journal of Instruction*, *12*(3), 481–496. https://doi.org/10.29333/iji.2019.12329a

Niswah, U., & Qohar, A. (2020). Mathematical reasoning in mathematics learning on pyramid volume concepts. *Malikussaleh Journal of Mathematics Learning (MJML)*, *3*(1), 23–26. https://doi.org/10.29103/mjml.v3i1.2400

Noviani, J., Syahputra, E., & Murad, A. (2017). The Effect of realistic mathematic education (RME) in improving primary school students' spatial ability in subtopic twodimension shape. *Journal of Education and Practice*, *8*(34), 112–126.

Palinussa, A. L., Molle, J. S., & Gaspersz, M. (2021). Realistic mathematics education: Mathematical reasoning and communication skills in rural contexts. *International Journal of Evaluation and Research in Education*, *10*(2), 522–534. https://doi.org/10.11591/ijere.v10i2.20640

Putri, S. K., Hasratuddin, H., & Syahputra, E. (2019). Development of learning devices based on realistic mathematics education to improve students' spatial ability and motivation. *International Electronic Journal of Mathematics Education*, *14*(2), 393-400. https://doi.org/10.29333/iejme/5729

Rejeki, S., Adnan, M., Ahmad, C. N. C., & Murtiyasa, B. (2023). An integrated RME and PIL mathematics module for technical vocational high school learning: A need analysis. *European Journal of Education and Pedagogy*, *4*(2), 161–167. https://doi.org/10.24018/ejedu.2023.4.2.485

Samura, A. O., & Darhim, D. (2023). Improving mathematics critical thinking skills of junior high school students using blended learning model (BLM) in geogebra assisted mathematics learning. *International Journal of Interactive Mobile Technologies*, *17*(02), 101–117. https://doi.org/10.3991/ijim.v17i02.36097

Samura, A. O., Darhim. D., Juandi, D., Said, A. M., & Malaka, M. (2021). Improving the creative thinking ability of junior high school students through geogebra assisted learning community in mathematics. *International Journal of Interactive Mobile Technologies*, *15*(22), 84–98. https://doi.org/10.3991/IJIM.V15I22.24797

Takaria, J., & Palinussa, A. L. (2020). Mathematical self-concept among prospective teachers. *International Journal of Evaluation and Research in Education*, *9*(4), 799–806. https://doi.org/10.11591/ijere.v9i4.20464

Thomas, M. L., Brown, G. G., Patt, V. M., & Duffy, J. R. (2020). Latent Variable modeling and adaptive testing for experimental cognitive psychopathology research. *Educational and Psychological Measurement*, *8*(1), 155-181. https://doi.org/10.1177/0013164420919898

Tuluk, G. (2020). Knowledge of slope concept in mathematics textbooks in undergraduate education. *Journal of Curriculum and Teaching*, *9*(3), 161-171. https://doi.org/10.5430/jct.v9n3p161

Turmudi, T., Susanti, E., Rosikhoh, D., & Marhayati, M. (2021). Ethnomathematics: Mathematical concept in the local game of tong tong galitong ji for high school. *Participatory Educational Research*, *8*(1), 219–231. https://doi.org/10.17275/per.21.12.8.1

Ulfah, A. S., Yerizon, Y., & Arnawa, I. M. (2020). Preliminary research of mathematics learning device development based on realistic mathematics education (RME). *Journal of Physics: Conference Series*, *1554*(1), 012027. https://doi.org/10.1088/1742-6596/1554/1/012027

Ulusoy, F. (2021). Prospective early childhood and elementary school mathematics teachers' concept images and concept definitions of triangles. *International Journal of Science and Mathematics Education*, *19*(5), 1057–1078. https://doi.org/10.1007/s10763-020-10105-6

Uyen, B. P., Tong, D. H., Loc, N. P., & Thanh, L. N. P. (2021). The effectiveness of applying realistic mathematics education approach in teaching statistics in grade 7 to students' mathematical skills. *Journal of Education and E-Learning Research*, *8*(2), 185–197. https://doi.org/10.20448/JOURNAL.509.2021.82.185.197

Weber, K., Dawkins, P., & Mejía-Ramos, J. P. (2020). The relationship between mathematical practice and mathematics pedagogy in mathematics education research. *ZDM - Mathematics Education*, *52*(6), 1063–1074. https://doi.org/10.1007/s11858-020-01173-7

Yuanita, P., Zulnaidi, H., & Zakaria, E. (2018) The effectiveness of realistic mathematics education approach: The role of mathematical representation as mediator between mathematical belief and problem solving. *PLoS ONE*, *13*(9), e0204847. https://doi.org/10.1371/journal.pone.0204847

Zubainur, C. M., Johar, R., Hayati, R., & Ikhsan, M. (2020). Teachers' understanding about the characteristics of realistic mathematics education. *Journal of Education and Learning (EduLearn)*, *14*(3), 456–462. https://doi.org/10.11591/edulearn.v14i3.8458