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Numeracy Skills of Junior High School Students: A Comparative Study Based on Learning Approach Interventions

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Abstract
This study aims to determine the achievement and improvement of students' numeracy skills based on the Realistic Mathematics Education (RME) approach intervention. This research used a quasi-experimental method with a pretest-posttest control group design. The research sample consisted of two classes, namely the experimental class that used the RME approach and the control class that used conventional methods. The instrument used was a numeracy description test question on the material of the Two-Variable Linear Equation System. The results showed that the achievement and improvement of students' numeracy skills, who learned through the realistic mathematics education approach, were better than students who learn through conventional approaches. This shows that learning with a realistic mathematics education approach can facilitate the numeracy skills of junior high school students. It is hoped that future researchers can apply the realistic mathematics education approach to other mathematical skills.

Keywords: Comparative study, Intervention, Numeracy skill, Realistic mathematics education.

1. INTRODUCTION

Mathematics is one of the basic disciplines that has an important role in the development of science and technology. Its role cannot be underestimated because mathematics not only functions as a tool for performing numerical calculations, but also acts as a means of developing a logical, systematic, and analytical way of thinking (Marpaung, 2024). As a universal language used in almost all branches of science, mathematics contributes significantly in modeling, analyzing, and solving various complex problems, both in academic, professional, and daily life contexts. mathematics is not only a technical skill, but also a thinking tool that allows individuals to develop critical and effective problem-solving abilities in dealing with the dynamics of problems in various fields of life (Sudi, 2022).

Given the importance of this role, mathematics education is not only one of the compulsory subjects in schools, but must also be designed as an integral part of the formation of students' character and intellectual competence. Starting from primary to secondary education levels, mathematics

learning should focus on developing deep conceptual understanding, strengthening reasoning skills, and applying knowledge in real contexts (Utami, 2023). Therefore, mathematics education does not only aim to transfer knowledge, but also to form a scientific mindset that can support successful lifelong learning and improve the quality of human resources in the era of globalization.

In the context of learning at the Junior High School level, mathematics education should not only focus on mastering concepts and procedures, but also be directed at forming students' numeracy. Numeracy can be defined as a person's ability to formulate, apply, and interpret mathematical concepts in various life contexts, both in everyday situations and in decision-making processes that require quantitative and analytical reasoning (Fatwa et al., 2019). According to the definition of OECD (2024) that numeracy is not only related to the ability to calculate, but also includes the skills of thinking logically, reasoning mathematically, and communicating mathematical ideas and solutions clearly, effectively, and relevant to the context.

Numeracy consists of several main aspects that are interrelated and play a role in building a complete mathematical understanding (Hasanah et al., 2022). First, students must be able to understand mathematical concepts, principles and relationships. This means that they not only recognize formulas or rules, but also understand the meaning behind them and how the concepts are interconnected, such as the relationship between fractions, decimals, and percentages. Second, students need to be able to apply their mathematical knowledge and skills to solve real-life problems. This demonstrates their ability to choose appropriate strategies, calculate accurately and adapt mathematical approaches to the context of the problem at hand, such as calculating discounts when shopping or determining travel time on a trip. Third, numeracy also includes the ability to think logically and use mathematical reasoning to justify solutions and make appropriate judgments (Rahmawati, 2020). By integrating these aspects into the learning process, it is hoped that students will not only master mathematics procedurally, but also be able to understand and use mathematics meaningfully in real life (Sari et al., 2023).

The results of the Program for International Student Assessment (PISA) survey show that the numeracy skills of Indonesian students are still relatively low. In PISA 2018, the average math score of Indonesian students was 379, far below the OECD average of 489. This situation worsened in PISA 2022, where Indonesia's score decreased to 366, while the OECD average also decreased to 472 (OECD, 2024). Indonesia's low score indicates that mathematics learning in schools has not fully succeeded in developing these aspects in students (Larasaty et al., 2018). This shows that mathematics learning in Indonesia has not been able to fully equip students with the ability to relate mathematics to real life (Komala & Monariska, 2023).

This condition was also evident at a junior high school in Malaka Regency. Interviews with the school's math teacher revealed that most students had difficulty solving word problems and were unable to analyze and communicate their solutions independently. This suggests that the current learning environment has not facilitated numeracy skills development. Consequently, students' numeracy skills remain low. This low level of student numeracy skills has also been revealed in previous research. For example, Ate & Lede (2022) concluded that students' ability to solve numeracy problems is still low. Students' numeracy skills are limited to the understanding level (Tanudjaya & Doorman, 2020). The higher the measurement indicator, the lower the student's numeracy ability (Son, Talan, Mone & Jelahu, 2023).

To improve numeracy, a more contextual and applicable learning approach is needed, which emphasizes concept understanding, application in real situations, and the development of critical thinking and problem-solving skills (Masriyani et al., 2022). In addition, training and professional development for mathematics teachers are key in implementing learning strategies that are effective and relevant to students' needs. Therefore, more intensive efforts are needed to improve the quality of mathematics learning that not only focuses on procedural mastery, but also on the development of critical thinking skills, problem solving, and the application of mathematical concepts in real-life contexts (Putri et al., 2023).

One solution, to facilitate students' numeracy skills is through the Realistic Mathematics Education approach. This approach was developed by Hans Freudenthal and emphasizes that mathematics is a human activity rooted in reality or contexts that students can imagine (Aulia & Prahmana, 2022). RME departs from the principle that students should not be directly given formal definitions or formulas, but rather encouraged to build their own understanding through experience and exploration of real-world contexts. In learning, students are actively involved to discover, reason, and reflect on mathematical concepts by using situations that are relevant to their lives (Eftiana, 2024).

This approach reflects some of the main interrelated characteristics of RME. *First*, use of context, where learning starts from situations that students can recognize and imagine to foster motivation and engagement. *Second*, using models or representations (use of models), where students develop mathematical understanding through informal to formal representations, or from horizontal modeling to vertical modeling. *Third*, active student contributions, meaning that students are considered the owners of knowledge and the teacher acts as a facilitator who appreciates students' strategies and ways of thinking. *Fourth*, interactivity, which encourages discussion, group work, and sharing ideas between students as part of the knowledge construction process. *Finally*, intertwinement between mathematical topics, where various concepts are not taught separately, but are interconnected in a complete problem-solving context (Kamsurya & Masnia, 2021). Through the application of these characteristics, RME directly supports the development of numeracy because it not only emphasizes mastery of procedures, but also understanding of meaning, communication, and application of mathematics in various real-life situations (Kedhi et al., 2024).

Furthermore, RME develops two types of mathematical modeling, namely horizontal mathematics and vertical mathematics. Horizontal mathematics refers to the process of connecting real-world situations or concrete contexts into mathematical forms. In RME, students start from contextual problems, then use informal reasoning or their own strategies to mathematize the problem. Meanwhile, vertical mathematics is the process of developing mathematical ideas from informal to formal or abstract forms. It includes symbolic manipulation, use of formulas, and formal reasoning to solve problems (Treffers, 1987).

These two processes complement each other and are at the core of meaningful learning in RME, as they allow students to understand not only how to solve problems, but also why the strategy works and how it can be applied to other contexts. Thus, RME not only strengthens mastery of mathematical concepts, but also directly encourages the development of true numeracy, namely the ability to understand, apply, and assess mathematics in the context of real life in a reflective and meaningful way (Tutiareni et al, 2021).

Many researchers have studied the effectiveness of realistic mathematics education, but there are still few who look at its effect on numeracy skills. For example, research by Sudi (2022) concluded that the implementation of a realistic mathematics learning approach was effective in improving the numeracy skills of eighth-grade students, as evidenced by the higher average numeracy skills of experimental class students compared to control class students. Another study conducted by Mali and Son (2023) showed that the achievement and improvement in mathematical problem-solving skills of students who learned through a realistic mathematics education approach were better than those who learned through conventional learning.

The novelty of this research, in addition to seeing the impact of Realistic Mathematics Education on numeracy skills, can also be seen in the statistical analysis technique using the term achievement to compare students' numeracy skills posttests, and improvement to compare students' N-Gain scores. The hypothesis used is that the achievement and improvement of numeracy skills of students who learn through a realistic mathematics education approach is better than students who learn without a realistic mathematics education approach.

2. METHODS

The type of research used is quantitative research, in the form of quasi experiment. Experimental research is research conducted on variables whose data does not yet exist so that it is necessary to manipulate the process through the provision of certain treatments/treatments to research subjects which are then observed/measured for their impact. In this study, the experimental group used a realistic mathematics education learning model, while the control group used a conventional learning model (Tutiareni et al., 2021).

The research design used in this study is Pretest-Posttest Control Group Design, which is one type of quasi-experimental design that involves two groups of research subjects, namely the experimental group and the control group (Abraham & Supriyati, 2022).

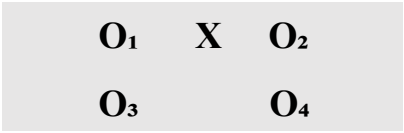

Figure 1. Pretest-posttest control group design.

Figure caption: O_1 & O_2 are the initial and final tests in the experimental group; O_3 & O_4 are the initial and final tests in the control group, while X is the treatment with the RME approach. The population in this study included all students enrolled in grade VIII of one of the junior high schools in Malaka district (Timor-Indonesia) in the 2023/2024 school year. The sample is part of the population to be studied (Sugiyono, 2019). Since there are only two classes in class VIII, class A is the experimental class that learns with the Realistic Mathematics Education (RME) approach, and class B as the control class that learns with conventional learning (Wibowo et al., 2022).

In this study, data analysis was carried out through several systematic and interrelated stages, with the aim of answering problem formulations and testing predetermined hypotheses. The first stage carried out is the data normality test. The normality test aims to determine whether the pretest and posttest data from each group, namely the experimental group and the control group, are normally or abnormally distributed. Normal distribution is the main requirement in the application of parametric statistical tests. To test this normality, the Shapiro-Wilk test was used. After ensuring that the data is normally distributed, the next step is to conduct a homogeneity test. This test is used to determine whether the variance between the experimental group and the control group is the same or homogeneous. Homogeneity of variance is an important prerequisite before testing the mean difference using the t-test. The homogeneity test was conducted using the F (Fisher) test.

The third stage in data analysis is to conduct hypothesis testing to determine the achievement and improvement of numeracy skills of students who learn with a realistic mathematics education approach better than students who learn conventional approach. This hypothesis testing was done in two parts. First, the achievement of numeracy skills was tested using the posttest results from both groups. The test used was the t-test of two independent samples (Wibowo et al., 2022).

In addition to testing achievement, this study also analyzed the increase in numeracy skills experienced by each group. For this purpose, the N-Gain calculation was used, which is the difference between the posttest and pretest scores divided by the difference between the maximum score and the pretest score. This N-Gain value provides a general overview of how much students' mathematical literacy skills have improved after being given treatment. Interpretation of the N-Gain value is done with high, medium, and low categories. After obtaining the N-Gain score from each student, the two independent samples t-test was conducted again to determine whether the improvement in numeracy skills in the experimental group was better than the control group. All stages of this data analysis were carried out using a significance level of 5%, meaning that testing decisions were taken based on a 95% confidence level. The entire data processing and analysis process used the help of SPSS version 22 statistical software, to ensure the accuracy and objectivity of the research results (Sugiyono, 2019).

3. RESULTS AND DISCUSSION

At the initial stage, both classes were given a pretest to measure their initial numeracy skills, with the material of the System of Linear Equations of Two Variables. Furthermore, the experimental class followed learning using the Realistic Mathematics Education (RME) approach that prioritizes understanding real-world contexts, group work, active discussions, and presentation of work results. Meanwhile, the control class learned with a conventional approach, namely the lecture method and regular problem exercises. After four learning meetings, both classes were given a posttest with the same questions as the pretest to see the achievement and improvement of numeracy skills after treatment.

Students' Achievement of Mathematical Numeracy Skills

The results of the calculation of the average posttest of the experimental class and control class, can show that, the average value of the posttest for the experimental class is 76, while the average value for the control class is 53,9.

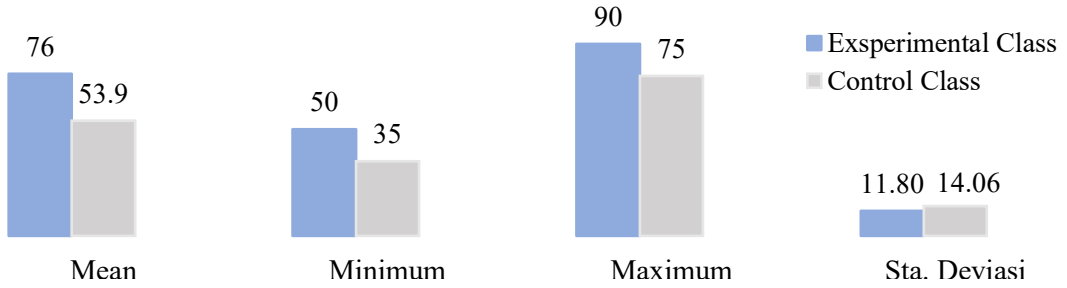

Figure 2. Calculation of average value of experimental class and control class.

The first stage carried out is the data normality test. The normality test aims to determine whether the pretest and posttest data from each group, namely the experimental group and the control group, are normally. Normal distribution is the main requirement in the application of parametric statistical tests. The results of the normality test can be seen in Table 1.

Table 1. Results of the normality test of students' numeracy ability data

	Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Numeracy skill	Experiment Class Pretest	.155	18	.200*	.928	18	.177
	Experiment Class Posttest	.188	18	.091	.906	18	.073
	Control Class Pretest	.152	18	.200*	.955	18	.507
	Control Class Posttest	.173	18	.165	.912	18	.092

Based on Table 1, the results of this test show that the significance value of the experimental class is obtained (pre-test 0.177 and post-test 0.073) and the control class (pre-test 0.507 and post-test 0.92) > 0.05, so the data from the pre-test and post-test of the experimental class and control class are normally distributed. The results of the homogeneity test can be seen in Table 2. It shows that the significance value of the Pretest of the experimental class and control class is $0.689 > 0.05$ and the posttest of the experimental class and control class is $0.296 > 0.05$, it can be said that both data have homogeneous or equal variances.

Table 2. Results of the homogeneity test of students' numeracy achievement

		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	.163	1	34	.689
	Based on Median	.068	1	34	.796
	Based on Median and with adjusted df	.068	1	32.656	.796
	Based on trimmed mean	.151	1	34	.700
Posttest	Based on Mean	1.261	1	34	.269
	Based on Median	1.070	1	34	.308
	Based on Median and with adjusted df	1.070	1	33.669	.308
	Based on trimmed mean	1.342	1	34	.255

Based on the results of data analysis, it is obtained that the pretest and posttest data from both classes are normally distributed and homogeneous, so they meet the requirements for hypothesis testing using the t-test. The result of the independent sample t-test can be seen in the Table 3.

Table 3. Results of the test of students' achievement in mathematical calculation skills

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Numeracy skills	Equal variances assumed	1.26	.27	5.09	34	.00	22.06	4.33
	Equal variances not assumed			5.09	33.0	.00	22.06	4.33

Based on Table 3, the value of $t_{count} = 5.09$, $df = 34$ and the significance level is 5%, then $t_{table} = 2.03$. Because $t_{count} = 5.09 > t_{table} = 2.03$, then the achievement of numeracy skills of students who learn through realistic mathematics education approach is better than students who learn using conventional approach.

The results of this study indicate that mathematics learning using a realistic mathematics education approach significantly helps students learn because they are more enthusiastic and interact with each other in their peer groups. In the experimental class, the researchers used a realistic mathematics education approach, namely by applying the characteristics of RME, one of which is learning that begins with a real-world context or problem. Learning with the RME approach resulted in students being more active in learning and collaborating with their peer groups, so that the teaching and learning process was easier for students to understand (Trinanda et al., 2024).

Realistic mathematics education is a learning approach that helps students explore mathematical concepts through solving real-world problems or situations, making mathematics more meaningful and relevant to them. The learning process through a realistic mathematics approach does not begin with definitions, concepts, and examples, but always begins with a problem or context. Based on this context, students are guided to create definitions, concepts, and solutions within that context. Teachers guide students to create mathematical models based on the presented context. When students are asked to create mathematical models from a given context, they are not merely solving problems but are engaging in a mathematical thinking process, a process that illustrates the relationship between the real world and the mathematical context. During this process, students demonstrate active engagement, comparing solutions, and explaining their thinking to their peers. This process is a concrete form of

horizontal mathematics, where students learn to build connections between the real world and mathematical symbols.

One context used in RME learning is shopping. This shopping context is used to connect their everyday experiences with the mathematical concepts they are learning. Through this context, students not only learn mathematics abstractly but also understand that mathematics plays a crucial role in helping them solve real-life problems. Figure 4 shows an excerpt from the context used. Through this context, students are introduced to real-life situations related to the concepts of arithmetic, comparison, and mathematical modeling.

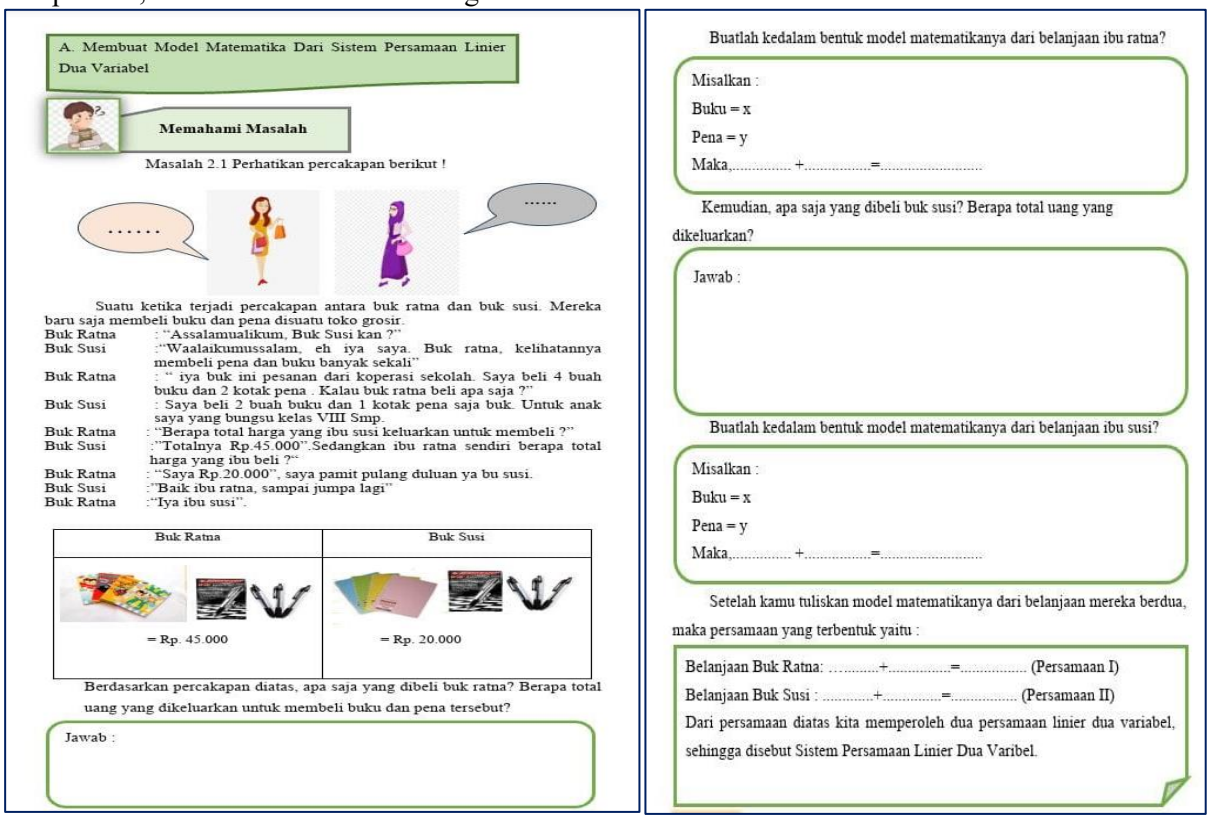

Figure 4. Shopping activity.

Based on Figure 4, the problem illustrates a situation where Mrs. Ratna and Mrs. Susi are shopping in a store. From this situation, students are asked to develop a mathematical model. This context closely aligns with students' everyday experiences. Shopping is an activity they frequently see and experience directly. This allows students to see how mathematics helps in important decision-making, such as pricing goods, calculating profits, and analyzing income. Through the process of modeling and solving systems of linear equations in two variables, students not only learn algebra but also develop logical and critical thinking skills in an economic context.

This approach is the spirit of the RME Approach, which refers to Hans Freudenthal's theory, which states that mathematics is a human activity, not just a collection of formulas. Learning should begin with real-world or contextual problems, where students can construct their own understanding through exploration, discussion, and bringing reality into the classroom to develop deeper meaning and understanding of mathematics. This is in accordance with the principle of guided reinvention proposed by Gravemeijer (1994), where students are directed to rediscover, mathematical concepts based on experience and contextual problems.

Students' Improvement of Mathematical Numeracy Skills

Data from the N-Gain test results of improving students' numeracy skills in experimental and control classes. The results of the N-Gain Score calculation can be seen in the Figure 3.

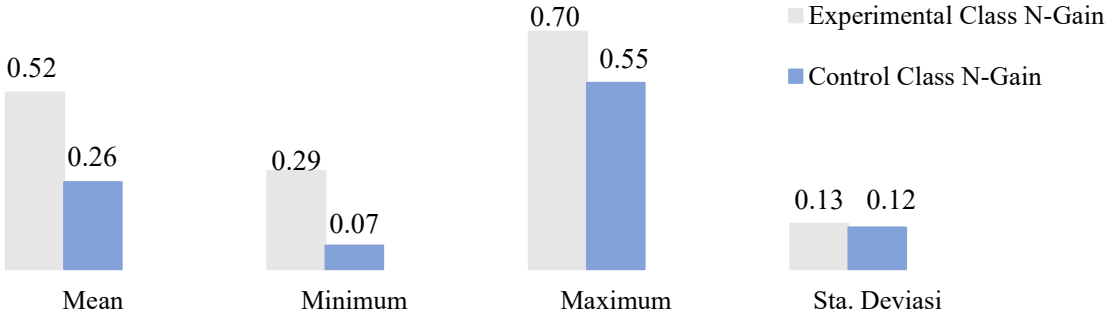

Figure 3. Calculation of N-Gain score of experimental and control class.

Based on Figure 3, the calculation result of the average value of N-Gain score for the experimental class is 0.5210, while the calculation result for the control class shows that the average value of N-Gain score is 0.2563. Based on the N-Gain calculation, the increase in students' numeracy skills in the experimental class is classified in the medium to high category, while in the control class the increase is only in the low category.

Similar to the achievement test, that before conducting the hypothesis test, the normality test was first carried out, and the homogeneity of the data on the improvement (N-gain) of students' numeracy ability as a requirement for parametric statistical tests. The results of the N-Gain Score Normality test can be seen in the Table 4.

Table 4. Results of data normality test on improvement of students' numeracy skills

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
Numeracy skills	1	.126	18	.200*	.930	18	.191
	2	.186	18	.099	.907	18	.075

Based on the test results in Table 4, it shows that the significance value of the N-Gain of the experimental class is 0.191 and the control class is $0.075 > 0.05$, so the N-Gain data of the experimental class and control class are normally distributed.

The results of the calculation of the Normality Test N-Gain score of the experimental class and control class can be seen in the Table 5.

Table 5. Results of the homogeneity test of students' numeracy improvement

		Levene Statistic	df1	df2	Sig.
Numeracy skills	Based on Mean	.596	1	34	.446
	Based on Median	.675	1	34	.417
	Based on Median and with adjusted df	.675	1	32.906	.417
	Based on trimmed mean	.697	1	34	.410

Based on the results of the N-Gain homogeneity test in Table 5, it shows that the significance value of N-Gain is $0.446 > 0.05$, so this can be said that the N-Gain data has a homogeneous or equal variance. Data on the improvement of students' numeracy skills in experimental and control classes, obtained using the normalized gain (N-Gain) formula. This data analysis uses independent sample $t-tests$. Based on the results of the calculation, the results are obtained in the Table 6.

Table 6. Results of the test on improving students' mathematical calculation skills

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Numeracy skills	Equal variances assumed	.59	.45	6.14	34	.00	.27	.04
	Equal variances not assumed			6.14	33.77	.00	.27	.04

Based on Table 6, obtained $t_{count} = 6.14$, df = 34 and the significance level is 0.05, then $t_{table} = 2.03$. Because t_{count} $(6.14) > t_{table}$ (2.03), then the improvement of mathematics numeracy skills of students who learn through realistic mathematics education approach is better than students who learn through conventional learning. This is in line with previous research conducted by Fauzan, et al. (2024) which states that there is an increase in the numeracy skills of students who learn with a realistic mathematics education approach. Learning with a realistic mathematics education approach, invites students to discuss and argue with their group mates, so that students can solve mathematical problems well in groups or individually. Learning with a realistic mathematics education approach, greatly facilitates students, in learning mathematics and students more easily understand the material, in order to improve students' numeracy skills. Ndiung, et al. (2019) stated that realistic mathematics education is very well used in the learning process because it can help students to improve students' numeracy skills.

The increase is seen from the normalized gain (N-Gain) value, which shows a significant increase in the experimental class with moderate to high categories. Meanwhile, the control class showed an increase that tended to be low. RME strongly emphasizes the use of real-life contexts and activities that help students develop literacy skills. This is in accordance with the indicators of numeracy formulated by OECD (2024), namely: understanding, applying and reasoning mathematics.

Based on experimental class learning, students become more active, involved in discussions, and able to solve contextual problems with the RME approach. This is supported by Hans Freudenthal's theory, that mathematics is a human activity. Realistic in RME does not only mean relating to the real world, but also the context that students can imagine. This helps students to not only memorize, but also understand and make meaning of mathematical concepts. Fauzan, et al. (2024) also supports that contextual problems in the RME approach make learning more meaningful and relevant, thus increasing student motivation and learning literacy. This discussion is reinforced by Aulia & Prahmana (2022), who found that RME-based e-modules were effective in improving students' numeracy skills, particularly in connecting concepts to real-world contexts. Therefore, RME can be an appropriate approach to apply in mathematics learning at the junior high school level, particularly in improving students' numeracy skills.

4. CONCLUSION

Based on the results and discussion, it can be concluded that the achievement and improvement of numeracy skills of students who learn through a realistic mathematics education approach are better than those who learn through a conventional approach. This indicates that learning mathematics through a realistic mathematics education approach can facilitate students' mathematical literacy skills. Problems related to students' mathematical literacy skills can be addressed through learning interventions using a realistic mathematics education approach.

It is recommended that future researchers who apply the RME approach use problems that exist in the students' environment and can be applied in developing other mathematical abilities, so that the benefits are not limited to numeracy alone, but encompass mathematical competence as a whole.

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