Enhancing Numeracy in Statistics with Realistic Mathematics Education (RME)

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Abstract. Numeracy, the ability to apply mathematical concepts to solve real-life problems, is essential for students. This study aims to describe students' numeracy after learning using the Realistic Mathematics Education (RME) approach in 10th-grade statistics. A qualitative descriptive research method was employed, involving 31 students from class X at Senior High School 9 Yogyakarta. Data collection methods included numeracy tests, interviews based on test results, and observations of lesson implementation. The numeracy test data were analyzed by calculating each student's score and categorizing them as high, medium, or low. Interview data were analyzed by describing and summarizing the interview results. Observation data on lesson implementation were analyzed by calculating the percentage of lesson implementation. The findings indicate that students' numeracy skills improved after using the RME approach. The average score on the numeracy test for the statistics material was 84.58, with 30 students classified as having high numeracy skills and one student in the medium category. Based on numeracy indicators, 94.33% of students effectively analyzed information presented in various forms (graphs, tables, charts, diagrams, etc.), 85% used mathematical symbols to solve everyday problems, and 72.33% interpreted these analyses to make predictions and decisions.

Keywords: Mathematics, Numeracy, Realistic Mathematics Education, Statistics.

1 Introduction

In everyday life, numeracy will always be involved. Examples of numeracy often occur when shopping, taking out a loan from the bank, and seeking medical treatment. Therefore, people need to learn to understand numeracy. Numeracy is a skill that applies to the concept of numbers in everyday life [1]. Numeracy skills refer to the mathematical understanding of information in tables, graphs, and charts. Further, numeracy is the ability to solve problems in real situations using numbers and mathematical symbols [2]. Then according to [3], numeracy is the skill of thinking to produce ideas, facts, and mathematical methods and tools to solve everyday problems. In addition, according to [4], numeracy is the ability to interpret data quantitatively, apply mathematical concepts, and perform arithmetic operations to solve real-world

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mathematical symbols to solve practical problems in different everyday contexts and (b) analyze information presented in various forms (graphs, tables, charts, etc.), then interpret the results to make predictions and informed decisions. Based on this definition, the indicators of numeracy in this study are: (a) using various numbers and mathematical symbols to solve practical problems in different everyday contexts, (b) analyzing information presented in various forms (graphs, tables, charts, etc.), and (c) interpreting the results to make predictions and informed decisions.

Recognizing the importance of numeracy, the Indonesian government launched the National Literacy Movement in 2016 to promote numeracy skills among students. Despite these, the Program for International Student Assessment (PISA) by the OECD reveals that Indonesian students' mathematical literacy or numeracy remains low, consistently ranking below the average of participating countries.

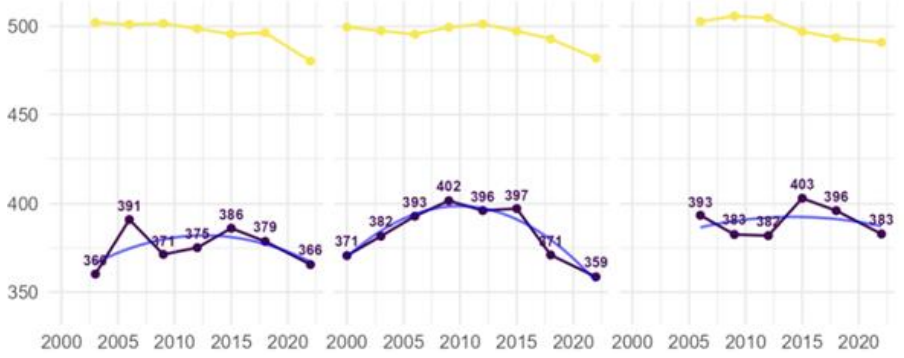


Fig. 1. Indonesia PISA Score Trends and OECD Average (23 countries) [6].

Based on the line diagram, Indonesian students' numeracy scores range from 360 to 391 and consistently fall below the OECD average. After the national literacy movement held by the Indonesian government, the PISA numeracy score has not improved.

Interviews conducted with several 10th-grade students at SMA 9 Yogyakarta in August 2023 revealed that students struggled to understand and apply mathematical symbols when solving problems, leading to less-than-optimal learning outcomes. In addition, students struggle to understand and identify contextual problems, suggesting that they are not yet accustomed to solving contextual or numeracy-based tasks. Observations and interviews with mathematics teachers, however, indicate that they have been utilizing the Problem-Based Learning (PBL) model and discussion methods in their teaching practices.

To enhance mathematical numeracy skills, it is crucial to implement a learning method to foster a creative and realistic learning process. . Students should not only perform calculations but also understand mathematical concepts and their applications in real-world contexts. One such approach is the Realistic Mathematics Education (RME) method. According to [7], the RME approach is a mathematics learning approach that has various ideas from students in exploring mathematical concepts through real-life problems as a reference for learning. One of the advantages of RME approach, highlighted by [8] noting that it can help students understand how mathematics relates

to real life and enable them to solve mathematical problems with teacher guidance. Similarly, [9] emphasizes that the RME approach allows students to experience and rediscover mathematical concepts, ideas, and theories from real-life problems, supported by teachers throughout the process.

There are five main principles in the RME approach, including [10]: 1) phenomenological exploration, a context that is truly by the student's circumstances, 2) using models and symbols for progressive mathematization as a bridge from the level of concrete knowledge to the level of formal knowledge, 3) using students' construction and productions: students are given the freedom to build their ideas based on how to solve a problem, 4) interactivity: teachers provide opportunities for students to improve their ability to communicate with others through discussion, 5) intertwinement: every concept in mathematics has a relationship.

The research conducted by [11] compared the influence of the RME and Scientific approaches on the numeracy of grade nine students. The findings showed that the average numeracy in the RME class was higher than that of Scientific. Statistical analysis at a significance level confirmed that the RME was more effective in enhancing students' numeracy. In addition, research [12] on the conducted literature study demonstrates that applying the Indonesian Realistic Mathematics (PMRI) approach with higher-order thinking skill questions improves students' numeracy.

Thus, this research is expected to improve students' enthusiasm for learning and numeracy skills. Based on this background, the researcher conducted a study entitled "Enhancing Numeracy in Statistics with Realistic Mathematics Education (RME)." This research aims to analyze students' numeracy after learning statistics using the RME approach in 10th grade.

2 Methods

This research employs a qualitative descriptive approach. According to [13], descriptive research is a type of research that aims to describe and interpret objects as they exist. The subjects in this study were 31 students in tenth grade at a public senior high school in Yogyakarta. The object of this research is students' mathematical numeracy abilities. The time of data collection was March - April 2023. The data collection methods included numeracy tests and interviews. The numeracy test consisted of three questions. The numeracy test and interview instruments were validated by two experts, a mathematics education lecturer and a high school mathematics teacher. The validation results indicate that the test questions and interview guidelines are valid and can be used for research.

The technique for analyzing numeracy test data is to determine the student's test score, namely the number of correct answer scores divided by the maximum score multiplied by 100. After obtaining the score, the low, medium, and high scores are categorized. According to [14], the categories are as follows

Table 1. Students' numeracy test score categories

interval	Value interval	category

value $\leq (\mu - \sigma)$	value ≤ 33	Low
$(\mu - \sigma) <$value $\leq (\mu + \sigma)$	$33 \leq <$value ≤ 67	Medium
value $> (\mu + \sigma)$	value >67	High

The researcher processed the interview data by first writing down the complete interview transcript and then summarizing the students' overall interview results. The researcher interviewed three students with different test result categories based on the student's scores.

3 Results and Discussion

The learning process utilized the RME approach by directly applying its core principles:

Phenomenological exploration. To begin the lesson, the teacher introduces a context relevant to the students' lives, such as data on TikTok users by age.

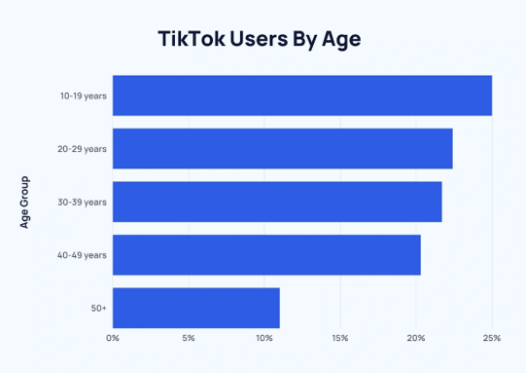


Fig. 2. Context of TikTok users by age as a starting point for learning

In Addition, TikTok data is also based on Gender.

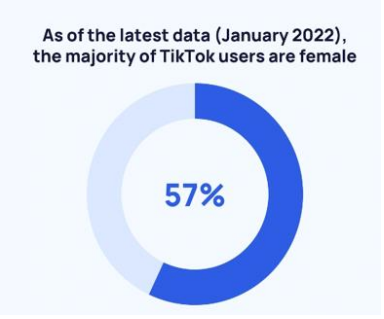


Fig. 3. TikTok user data based on gender

Examples of stimulus questions given by teachers are:

What do you see from the picture?
What information do you get after seeing the picture?
What is the conclusion from the information you get?

Another example is data on the decline in marriages in Indonesia.

Translation:
The following is a report on Indonesia's decline in marriage rates from 2013 to 2023.

Fig. 4. Data on the decline in marriage rates as initial context

Learning activities based on the RME approach that incorporate real-life contexts, such as trending social issues, help students understand mathematical concepts and their practical applications in everyday life. This is supported by the research [15], which shows that the Realistic Mathematical Education (RME) approach has a positive impact on students because the connection between material and everyday life makes students active and focused on following the learning process.

Using models and symbols for progressive mathematization. Students work on the Student Worksheet (*Lembar Kerja Peserta Didik*) provided by the teacher. Students work in groups of 4-5 people. This learning activity aims for students to solve problems in their own way, trying to use mathematical models and symbols. In addition, using models for progressive mathematization can train students to think critically, for example, when students analyze information from contextual questions. Research [16] shows that through the application of the RME approach, students' critical thinking skills can be improved.

Using students' own construction. Students are provided with opportunities to explore various approaches to solving problems. Then, the teacher asks the group to present the results of their discussion and compare them with other groups that use different approaches.

Interactivity. Students interact with group members in discussions. In addition, teachers also walk around to guide students if they have difficulty in group discussions.

Intertwinement. For example, teachers also invite students to discuss further problem-solving, how to respond to the use of social media in today's era, moral ethics, and social life.

The numeracy questions used in the test incorporated several contexts, including the decreasing number of unemployed individuals in Indonesia, sales data of *bakpia* (a traditional cake from Yogyakarta, Indonesia), and nutritional adequacy figures categorized by age. The test results show that students' numeracy abilities are in the high category after learning with RME. The following is a table of students' numeracy test results.

Table 2. Numeracy test results

Information	Results
Mean	84.58
High category	30 students (97%)
Middle category	1 student (3%)
Low category	-
Maximum	97
Minimum	67

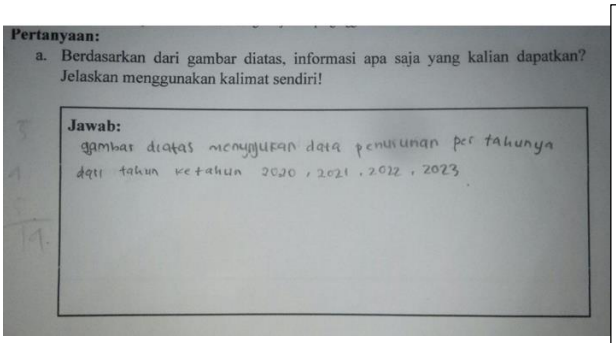
The table shows that the average student score is 84.58; 30 students reach the high category, and one student reaches the medium category.

Below is a table representing the numeracy indicators and their corresponding percentages.

Table 3. Numeracy indicator

Indicator	Description	Percentage (%)
Indicator 1	Using various types or symbols related to basic mathematics to solve everyday problems	94.33
Indicator 2	Analyzing information displayed in various forms (graphs, tables, charts, diagrams, etc.)	85.00
Indicator 3	Interpreting the results of analysis to predict and make decisions	72.33

Here are some examples of student answers that are still inaccurate. Below is an example of work on question 1 for the indicator involving analyzing information displayed in various forms (graphs, tables, charts, diagrams, etc.).

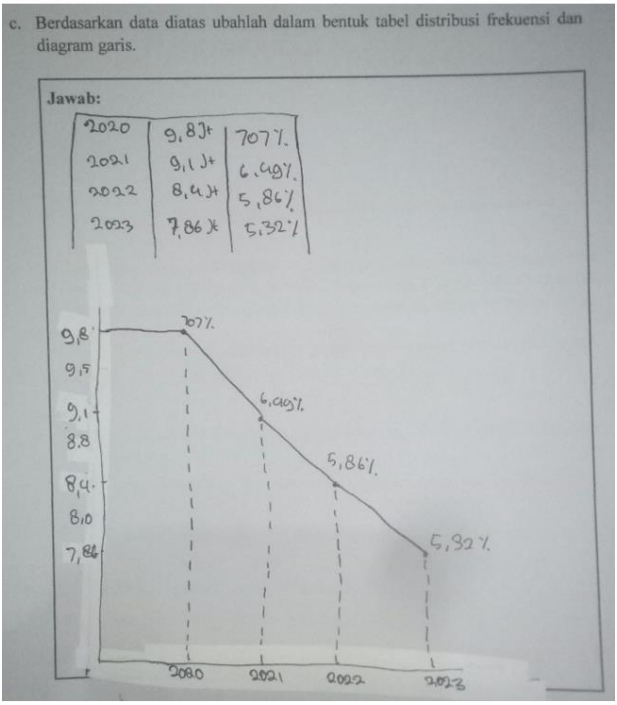


Translation:
Based on the picture above, what information do you get? Explain using your sentences.
Answer:
The image above shows the annual decline data from 2020, 2021, 2022, 2023.

Fig. 5. Example of incorrect student work related to analyzing information.

Figure 5 is an example of a student's answer that is not quite right. The student only explains the main idea of the information. Therefore, the student cannot be said to have numeracy, namely analyzing information displayed in various forms (graphs, tables, charts, and so on) because the student has not written down an explanatory idea which is very important in writing descriptive information.

Meanwhile, the following is the example answer number 1 for the indicator that uses various types or symbols related to basic mathematics to solve problems in everyday life.

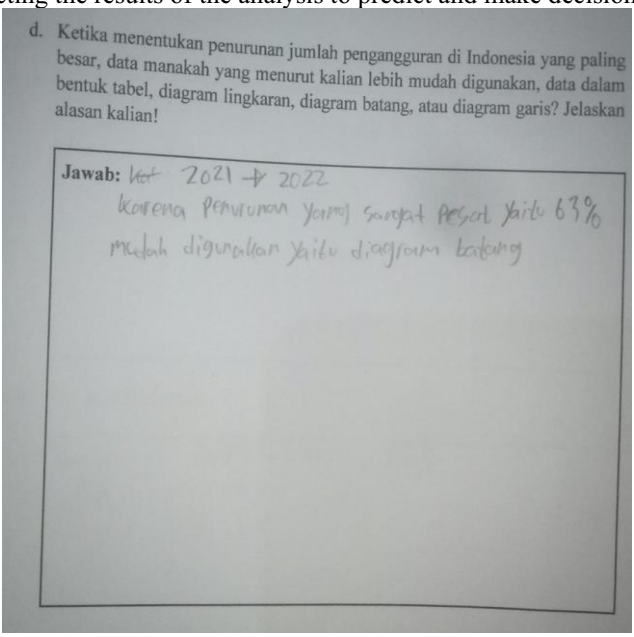


Translation:
Based on the data above, change it into a frequency distribution table and line diagram.

Fig. 6. Example of incorrect student work related to using mathematical symbols to solve problems.

Figure 6 above is an example of a student's incorrect answer. The student created a line diagram and a frequency distribution table without writing an explanation of the table header and caption on the line diagram.

In addition, here is an example answer to question number 1 for the indicator interpreting the results of the analysis to predict and make decisions.



Translation:
When determining the most significant decrease in unemployment in Indonesia, which data do you think is easier to use: data in the form of a table, pie chart, bar chart, or line chart? Explain your reasons.
Answer:
2021 →2022
Due to the very rapid decline of 63% it is easy to use, namely the bar chart.

Fig. 7. Example of incorrect student work related to decision making.

The figure 7 above shows an example of a student's incomplete answer. The student only provided the decision without explaining, which failed to clarify the reasoning behind the answer for the reader.

This study conducted interviews with students by selecting subjects based on their numeracy test scores. The scores were categorized into three groups based on low, medium, and high student performance. One student was chosen from each category, resulting in three interview subjects. The evaluation results revealed that 30 students fell into the high category and one into the medium category. Therefore, the researcher selected three students, two from the high and medium categories. The reason for choosing these three students was to obtain a representative overview of the class's varying levels of numeracy skills.

Overall, the interview findings indicate that subjects S05, S08, and S02 demonstrate high numeracy skills in statistics when taught using the Realistic Mathematics Education (RME) approach. While these subjects could effectively extract information from

data, they encountered difficulties in several key areas, such as the appropriate use of mathematical symbols, formulating well-structured explanations for their decisions, and writing comprehensive conclusions.

For instance, subject S05 could identify information from the data but did not fully construct coherent conclusions and supporting reasons, resulting in responses that lacked depth. Meanwhile, subject S08 noted that although they did not struggle with stating information, they were not accustomed to using mathematical symbols due to a lack of emphasis during the learning process. Similarly, subject S02 faced challenges in using mathematical symbols and decision-making, compounded by time constraints that hindered the completeness of their responses.

In summary, although all three subjects demonstrated high numeracy skills, there is still room for improvement—particularly in using mathematical symbols, formulating comprehensive explanations, and time management when solving problems. The RME approach is considered highly beneficial as it helps students connect mathematical concepts with everyday life and enhances critical thinking skills, even though further efforts are needed to improve effectiveness in certain aspects of the problem-solving process. After carrying out the learning process using the RME approach, the results showed that this method can improve students' numeracy. This study is in line with the research of [17] at Secondary School 6 Purworejo, which found that RME-based differentiated learning can help improve students' numeracy skills. In addition, it agrees with the research [18] at Senior High School 1 Sedayu, which demonstrated that the RME learning model positively affects numeracy literacy skills. Similarly, [19] conducted a study in which 231 Greek kindergarten students were divided into an experimental group, which received instruction based on RME principles, and a control group, which followed the standard curriculum; the results revealed that RME significantly enhanced the mathematical competence of young children, with no notable differences due to gender, age, or nonverbal cognitive ability.

Some researchers have also combined RME with other methods. For example, [20] investigated the effectiveness of a combined Virtual Realistic Mathematics Education (VRME) approach in enhancing mathematical literacy among 6th-grade students, using an experimental design with 20 participants; the results indicated improvements in dimensions of mathematical literacy (employing, interpreting, and formulating), although the interpret dimension showed the least progress. In addition, [21] developed and tested an instructional process that integrates RME with the DAPIC (define, assess, plan, implement, and communicate) problem-solving process to enhance mathematical literacy among secondary school students. Their five-step approach involves posing real-life problems, collaborative problem-solving, discussion, developing formal mathematics, and applying knowledge. It significantly improves students' mathematical literacy compared to traditional teaching methods. These studies support the findings of this research, demonstrating that RME instruction enhances students' numeracy by utilizing real-world contexts. This approach helps students construct mathematical knowledge, making mathematics learning more meaningful.

4 Conclusion

After learning using RME, the students' numeracy test results on statistics material obtained an average of 84.58, with 30 students in the high numeracy ability category and one student in the medium category. Based on numeracy indicators, indicator 1 analyzes information displayed in various forms (such as graphs, tables, charts, or diagrams), reaching 94.33%; indicator 2 uses various kinds or symbols related to basic mathematics in solving problems in everyday life, reaching 85%, and indicator 3 interprets the results of the analysis to predict and make decisions reaching 72.33%. Thus, RME can be applied in mathematics instruction, particularly statistics, by using contexts that align with the student's characteristics and incorporating local culture to enhance their numeracy skills.

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