

ANALYSIS OF STUDENT ERRORS BASED ON NEWMAN'S STAGES IN SOLVING QUESTIONS ON SOCIAL ARITHMETIC

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ABSTRACT

This research aims to determine the types of errors made by students in solving story problems on social arithmetic material based on Newman's Stages. This study uses a descriptive qualitative approach that focuses on identifying and analyzing students' errors in solving story problems on social arithmetic. The subjects of this study were 20 students of grade VII of SMPN 3 Gununghalu. Data were collected by giving a written test in the form of story problems on social arithmetic material. Data were analyzed using Newman's Stages consisting of reading errors, understanding errors, transformation errors, process skill errors, and encoding errors. The analysis was carried out by categorizing student errors at each stage, then described qualitatively. Based on the results of the analysis, data on student errors was obtained based on Newman's theory, namely reading errors by 19 students (10%), comprehension errors by 26 students (10%), transformation errors by 38 students (13%), process skill errors by 41 students (14%), and encoding errors by 36 students (12%). These errors occur because students are less able to read the questions, are less careful, do not understand the meaning of the questions, do not follow the steps of the problem-solving procedure regularly, and do not pay attention to writing/notation when answering questions.

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Penelitian ini bertujuan untuk mengetahui jenis-jenis kesalahan yang dilakukan siswa dalam menyelesaikan soal cerita pada materi aritmetika sosial berdasarkan Tahapan Newman. Penelitian ini menggunakan pendekatan kualitatif deskriptif yang berfokus pada identifikasi dan analisis kesalahan siswa. Subjek penelitian ini adalah siswa kelas VII SMPN 3 Gununghalu yang berjumlah 20 orang. Data dikumpulkan melalui pemberian tes tertulis yang berupa soal cerita pada materi aritmetika sosial. Data dianalisis dengan Tahapan Newman yang terdiri dari kesalahan membaca, kesalahan pemahaman, kesalahan transformasi, kesalahan keterampilan proses, dan kesalahan menulis/notasi. Analisis dilakukan dengan mengkategorikan kesalahan siswa pada setiap tahapan, kemudian dideskripsikan secara kualitatif. Berdasarkan hasil analisis diperoleh data kesalahan siswa berdasarkan teori Newman yaitu kesalahan membaca 19 siswa (10%), kesalahan pemahaman 26 siswa (10%), kesalahan transformasi 38 siswa (13%), kesalahan keterampilan proses 41 siswa (14%), dan kesalahan menulis/notasi 36 siswa (12%). Kesalahan tersebut terjadi karena siswa kurang mampu membaca soal, kurang teliti, kurang memahami maksud soal, tidak mengikuti langkah-langkah prosedur penyelesaian soal secara teratur, dan kurang memperhatikan tulisan/notasi pada saat menjawab soal.

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INTRODUCTION

Education is an important part of human life and must develop according to the needs of society. Along with the development of the era, of course there are changes in science and technology, this is what makes the demand for human resources must increase (Yuliana et al., 2022). Therefore, the education system must be able to adapt and adjust to the needs of society. One of the roles of education is to maintain cultural values and social order that are able to adapt to the development of the times. In today's era, education is one of the important things and its existence needs to be considered, because basically education is very much needed by various groups of society. In this context, formal education in schools plays an important role in shaping character and improving students' abilities, including the ability to think logically, systematically and critically through subjects such as mathematics. Mathematics is a fundamental discipline that has a significant role in various aspects of life. This science not only functions as an analytical tool, but also contributes to the development of systematic, clear, accurate and efficient thinking patterns (Lastari & Kartini, 2022).

Mathematics lessons help students hone their thinking skills, especially when they face challenging problems that require appropriate solution strategies (Savitri & Yuliani, 2020). In mathematics learning, students are not only encouraged to understand abstract concepts, but are also trained to solve various complex problems. Thus, this process aims to develop students' abilities in facing existing challenges. This problem-solving process requires students to analyze information, connect various ideas, and make the right decisions based on available data. Therefore, mathematics not only functions as a calculation tool, but also as a means to train high-level thinking skills. When students are accustomed to facing problems that are considered difficult, they indirectly develop perseverance, accuracy, and strong reasoning skills, which are very useful in everyday life and in facing challenges in various other fields of science.

There are many topics in elementary, junior high, high school and others. One of the topics that must be studied in junior high school grade VII is social arithmetic. Social arithmetic is a branch of mathematics that focuses on financial calculations and trade that are relevant in everyday life. Thus, social arithmetic plays an important role in helping individuals understand and manage the economic aspects they face (Paramitha & Yunianta, 2017). The scope of material in social arithmetic covers various aspects, including purchase and sale prices, profit and loss, percentage of profit and loss, discount, and simple interest. Thus, this material provides a comprehensive understanding of important financial concepts. In fact, there are still a number of students who have difficulty in solving social arithmetic problems. They tend to think that this material is difficult to understand. This indicates the need for a more effective approach in teaching to improve students' understanding (Sugondo & Bernard, 2021).

Undoubtedly, this will have dire consequences and become a worrying phenomenon for the development of the world of education, especially mathematics education in the future. Students achieve poor mathematics learning outcomes due to a lack of internal factor skills, especially seen in their mistakes when solving mathematics problems. Teachers must assess the mistakes made by students when solving problems during the learning process. According to Karnasih (Sunardiningsih et al., 2019), students often lack attention during the problem-solving process, and some give wrong answers. Students should be trained to solve math problems sequentially and clearly. This exercise should show students' mistakes and allow teachers to act accordingly. One way to identify the types of mistakes students make when working on math problems is to use the Newman procedure.

Research conducted by Aulia & Kartono, (2018), concluded that the errors made by students in the set material can be categorized into three types, namely conceptual, procedural, and technical errors. The most frequent error is conceptual error, with a percentage reaching 68.9%. This shows that the level of conceptual errors of students is in the "High" category. Conversely, procedural errors are the type of errors that are least often made, with a percentage of only 11.1%, which shows that this error rate is in the "Very low" criteria. Finally, technical errors were recorded with a percentage of 20.0%, which is included in the "Low" category. Similar research was also conducted by Hasanah et al., (2022), concluded that male subjects with high ability made two types of errors when completing all questions, namely at the planning implementation stage and the re-checking stage. Meanwhile, male subjects with moderate ability only made one error on the first question, which occurred at the re-checking stage. Male subjects with low ability also made two errors on the first question, namely at the planning implementation and re-checking stages.

On the other hand, female subjects with high ability did not make any errors in completing all questions. However, female subjects with moderate ability made two errors in completing all questions, namely at the planning implementation and re-checking stages. Female subjects with low ability recorded three errors in completing all questions, which occurred at the planning, plan implementation, and re-checking stages. Cognitive errors identified in this study include errors in general understanding of questions, use of formulas and calculations, rushing in working on questions, lack of accuracy, forgetfulness factors, and lack of time management. Similar research was also conducted by Upu et al., (2022), revealed that the errors made by students in solving story problems can be categorized based on Newman's stages. These errors include errors in understanding, transformation errors, process skill errors, and notation errors, with percentages of 47.37%, 5.7%, 26.31%, and 21.05%, respectively. From the results of this study, it is clear that various types of errors made by students are visible. These findings will certainly make it easier for teachers to take action according to the needs to correct errors made by students.

Newman's stages are one of the relevant and widely used approaches to identify student errors in solving math problems. This theory was developed by M.A. Newman who stated that the problem-solving process consists of five important stages, namely: reading, understanding, transformation, process skills, and writing or coding (Dewi & Kartini, 2021). Each of these stages has a significant role in achieving a comprehensive understanding of the problem at hand. Mistakes that occur at each of these stages can hinder students from obtaining the correct solution, by using this approach teachers and researchers can systematically identify students' weak points and design learning interventions that are more in line with what is needed.

There have been many studies on the analysis of students' errors in solving mathematics problems. However, most of these studies are still limited to general error grouping and have not applied Newman's Stages in detail, especially in the context of social arithmetic material. In fact, the characteristics of story problems in social arithmetic require reading skills, understanding context, and skills in converting information into mathematical models. Therefore, this study is important to provide a comprehensive picture of the types and causes of students' errors based on their stages of thinking. The results of this study are expected to contribute to teachers in designing more effective learning and developing remedial strategies that are appropriate to the types of errors made by students. In addition, the findings of this study can be used as a reference in the development of diagnostic assessment instruments based on Newman's Stages. This is especially relevant for social arithmetic material. The frequency of errors made by students in solving social arithmetic problems can be used as an indicator to

measure students' understanding of the material. Based on this statement, the researcher intends to conduct research on "Analysis of Student Errors Based on Newman's Stages in Solving Questions on Social Arithmetic".

METHOD

This study uses a descriptive qualitative approach with the aim of describing in depth the various types of errors made by students in solving story problems on social arithmetic material, based on Newman's Stages. The subjects in this study consisted of 20 seventh grade students at SMPN 3 Gununghalu. To collect data, this study used a written test method.

The purpose of this test is to identify the location of student errors through the Newman analysis stage. The test used is an essay with a weight of 3 points, which focuses on social arithmetic questions. The following is the form of questions from the written test.

1. Satu lusin pulpen dibeli seharga Rp18.000. Setiap pulpen lalu dijual dengan harga Rp1.800 per buah. Jadi, berapa untung yang bisa diperoleh dari penjualan 1 lusin pulpen tersebut?
2. Pak Ali membeli sepeda motor tosa seharga Rp. 8.125.000,00. Sepeda motor tersebut diperbaikidan kemudian dijual seharga Rp. 9.500.000,00. Jika biaya perbaikan Rp. 375.000,00, presentase keuntungan yang diperoleh pak Ali?
3. Seorang pedagang es jus membeli 12 buah durian untuk bahan jualannya. Dia kemudian membayar pakai 3 lembar uang Rp100 ribuan, dan mendapatkan uang kembalian Rp30.000. Jika si pedagang itu hanya membeli 8 buah durian, dia harus membayarkan uang berapa?

Picture 1. Social Arithmetic Test Questions

The validity of the instrument was tested based on content validity. Validity was carried out by expert teachers, namely mathematics teachers at SMPN 3 Gununghalu school. According to Sukardi (Astuti et al., 2016) content validity is the degree to which an evaluation test can measure a range of measurable substances. To find out how students' errors are classified, the data obtained were analyzed using Newman's theory using the following indicators:

Table 1. Student Error Indicators Based on Newman's Error Procedure

No	Stages in Newman's error analysis	Error Indicator
1	Read	• Not careful • Students are unable to read or recognize the symbols in the questions • Students are unable to interpret the meaning of each word, term or symbol in the questions
2	Understand	• Students are unable to understand everything they know completely • Students are unable to fully understand what is being asked

3	Transformation	• Students are unable to create mathematical models from the information presented • Students change the information contained in the problem into a mathematical model but not correctly • Errors in computation
4	Process Skills	• Students are unable to carry out the procedures or steps that will be used to solve the problem • Careless in the calculation process • Writing notations (negative signs, symbols, equal signs, etc.) incorrectly
5	Writing/Encoding	• Not writing variables/units • • Incorrect use of units • Students do not write conclusions

Source: (Dewi & Kartini, 2021)

Newman analysis is used to examine the location of students' errors in solving problems, which include reading errors, comprehension errors, transformation errors, process skills errors, and coding errors. During the exam, students are given the freedom to work according to their abilities. In data analysis, researchers analyzed test data from all students who took the written exam and found student errors, then grouped student errors based on Newman's five Stages, described the forms of errors that appeared at each stage, and interpreted the common causes of errors made by students. In its implementation, this study did not use a hierarchical approach where errors were only analyzed at the first point where students failed, but instead used a non-hierarchical (parallel) approach. This means that each question is analyzed thoroughly at all Newman stages, so that one student can experience more than one type of error on one question. This approach was chosen considering that each stage in the process of solving mathematics problems is an important part that stands alone, and failure at one stage does not necessarily close the possibility of errors at other stages. Thus, this approach provides a more comprehensive picture of student error patterns and becomes a stronger basis for improving learning.

RESULTS AND DISCUSSION

Result

The researcher conducted an analysis of the data obtained from the students' answers. Furthermore, the analysis of students' errors was carried out based on the predetermined categories. The research instrument consisted of three social arithmetic questions in the form of essays. Newman's analysis technique was applied to analyze the errors made by students. The error categories consist of five types, namely: Reading errors, understanding errors, transformation errors, process skill errors, and coding errors. The errors made by students can be seen in the following table.

Table 2. Classification of Student Errors based on Newman's Stages

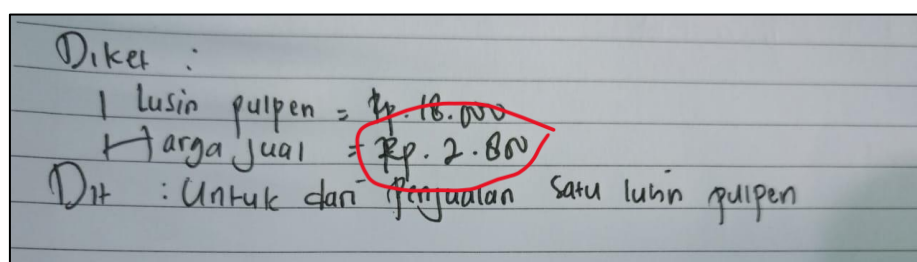
Question No	Error type					Total Errors
	Read	Understand	Transformation	Process Skills	Encoding	
1	5	6	11	10	13	54
2	6	8	15	13	11	57
3	8	12	12	18	12	63
Amount	19	26	38	41	36	174
Percentage	10%	10%	13%	14%	12%	58%

Based on the results of the analysis of 20 students who worked on 3 questions, the data obtained were the results of the number and percentage categorized by Newman Analysis. From table 3, it was obtained that the most common mistakes made by students were process skill mistakes, namely 41 students or around 14% of the total mistakes made. Then, those who also made many mistakes were transformation mistakes as many as 38 students (13%), coding mistakes as many as 36 students (12%), understanding mistakes as many as 26 students (10%), and the least mistakes made by students were reading mistakes as many as 19 students (10%). These findings indicate that most students have difficulty in carrying out mathematical procedures even though they are able to understand and transform information from questions.

Discussion

In this section, the discussion will focus on the types of errors made by students in solving social arithmetic problems, based on the analysis that has been done. Examples of identified errors will be explained in detail, including error categories according to Newman's Stages. Thus, the characteristics of these errors and the factors that may influence students' understanding of social arithmetic material can be understood.

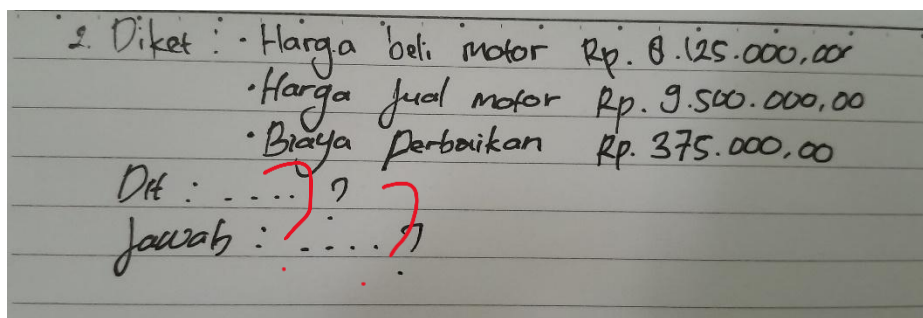
Based on the data obtained from the students' answers, the researcher conducted an analysis of each question that had been worked on. For example, S-4 showed an error in reading question number 1. This error also occurred in several other students on the same question. Analysis of the students' answers indicated an error in reading the information, which resulted in an error in providing the answer. The error can be seen in the picture below.

**Picture 2.** Student Answer No. 1

It can be seen from the student's answer that the student made a mistake in reading the information in the given question. The student should have written the known selling price as Rp. 1,800, but the student wrote Rp. 2,800. This error in reading the information will have an impact on the process of answering the question and will cause an error at the end later. This statement is in line with the findings Familani (Candraningsih & Warmi, 2023) which shows that errors in reading can result in errors in students' answers. The information obtained by

students cannot be used to solve the questions correctly. Besides that, (Rahmawati et al., 2021) stated that reading errors are often caused by students' inability to understand the meaning of the questions they read correctly. Inaccuracy in reading questions not only has an impact on the subsequent calculation process, but also has the potential to cause errors in the final answer as a whole. This indicates that students' ability to understand the contents of the questions, especially in recognizing and extracting relevant data, still needs to be improved. In addition, these errors can be an indicator of weaknesses in students' numeracy literacy skills, which should be a concern in the mathematics learning process in the classroom.

Based on the data obtained from the students' answers, the researcher conducted an analysis of each question that had been worked on. For example, S-1 showed an error in understanding question number 2, which was also experienced by several other students on the same question. Analysis of the students' answers indicated an error in understanding that resulted in the students being unable to find the right answer. The error can be seen in the image below.



Picture 3. Student Answer No. 2

Based on the answers given by students, it can be seen that students have difficulty in understanding the contents of the questions as a whole. This is indicated by the tendency of students to only write down known information without further analyzing what is actually being asked in the question. The answers written tend to be perfunctory, without any attempt to connect the available information with the steps to solve the problem that should be taken. In line with the findings expressed by Darmawan et al., (2018) students experience errors in understanding due to their inability to identify relevant information correctly. This results in misinterpretation. In addition, students often do not read the questions carefully, so important information can be missed. Lack of understanding of the overall meaning of the question also contributes to inconsistencies in identifying the knowledge they have. Finally, students are unable to explain exactly what is included in the question.

According to Rahmawati et al. (2021) errors in understanding can occur because students do not write down what is asked in the question. This condition indicates that students have not been able to identify the problem as a whole and do not understand the concept or correct solution strategy. As a result, students experience obstacles in solving problems, even potentially producing irrelevant or incomplete answers. This phenomenon shows the importance of strengthening understanding of problems and analytical thinking skills in the mathematics learning process.

Based on the data obtained from the students' answers, the researcher conducted an analysis of each question that had been worked on. For example, S-20 showed an error in transforming question number 3, which was also experienced by several other students on the same question. Analysis of the students' answers showed that they had not been able to transform the question into mathematical form correctly. The error can be seen in the image below.

(3) Diket: 12 Durian = $300.000 - 30.000 = 270.000$
 Uang dibayarkan = 300.000
 Uang kembalian = 30.000
 Dit: 8 Durian?
 Jawab: $\frac{\text{Total harga}}{\text{Durian}} = \frac{270.000}{8} = 33.750$

Picture 4. Student Answer No. 3

It is seen that students make mistakes at the transformation stage, namely when changing story problems into mathematical forms. This difficulty arises because students are not yet able to interpret the verbal information contained in the problem into an appropriate mathematical model. This difficulty arises because students are not yet able to interpret the verbal information contained in the problem into an appropriate mathematical model. Zulkarnaen (2020) revealed that students face difficulties in interpreting and verifying the mathematical models they create. In addition, they also have difficulty in applying the right ideas and techniques when modeling. This is in line with Darmawan et al. (2018) Students fail to plan solutions to problems, determine the wrong formula, and use mathematical operations incorrectly. As a result, students experience confusion in determining the right concept or formula to solve the problem. This inconsistency in the transformation process hinders the next steps in problem solving. As a result, students cannot continue solving the problem until it is complete. This kind of error reflects the suboptimal mathematical representation ability of students, which is an important aspect in the mathematical thinking process. Therefore, it is necessary to strengthen learning that emphasizes the ability to understand the context of the problem and change it into a symbolic form appropriately.

Based on the data obtained from the students' answers, the researcher conducted an analysis of each question that had been worked on. For example, S-14 showed an error in process skills on question number 3, which was also experienced by several other students on the same question. Analysis of the students' answers showed that they did not do the calculations correctly, or made errors in the calculations caused by previous errors. These errors can be seen in the image below.

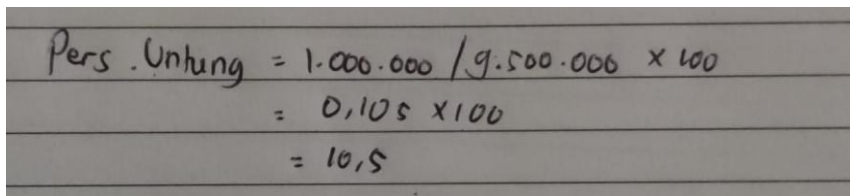
3. Diket: 12 Durian di bayar 3 Lembar 100.000 = 30.000
 Uang kembalian 30.000
 Dit: 8 buah durian berapa?
 Jawab:
 $= 12 \text{ Durian} : 300.000 = 300.000 / 12 = 25.000$
 $= 8 \text{ Durian} : 25.000 \times 8 = 200.000$

Picture 5. Student Answer No 3

From the picture above, it can be seen that the student did not subtract the amount of Rp300,000 from the change of Rp30,000. This error resulted in the answer obtained not being in accordance with the results that should have been. In fact, the subtraction step is an important element in solving problems correctly. According to Darmawan et al. (2018) process skills arise when students are not aware of the errors made in arithmetic operations and are unable to carry out the operations correctly. This is in line with the findings of Rosmiati & Maya (2021) which

state that errors in process skills occur due to students' lack of ability to apply the necessary ideas and their skills in performing calculations. As a result, students are unable to solve the problem properly. These process skill errors are caused by errors in computation and negligence in the calculation process, which reflect students' weaknesses in manipulating mathematical concepts. These errors indicate that students are not yet accustomed to carrying out problem-solving procedures systematically, so that errors often occur in the calculation stage. In addition, this error also indicates that students do not fully understand the logical flow in solving contextual problems involving simple calculations. Therefore, it can be concluded that the type of error made is included in the category of process skills errors, which require more attention in learning so that students become accustomed to applying solution procedures systematically and carefully.

Based on the data obtained from the students' answers, the researcher conducted an analysis of each question that had been worked on. For example, S-5 showed an error in coding on question number 2, which was also done by several other students on the same question. Analysis of the students' answers showed that they made a mistake at the end of the answer by not adding a percent sign (%). The error can be seen in the image below.



The image shows a handwritten calculation on lined paper. The text is as follows:

$$\begin{aligned}\text{Pers. Untung} &= 1.000.000 / 9.500.000 \times 100 \\ &= 0,105 \times 100 \\ &= 10,5\end{aligned}$$

Picture 6. Student Answer No 2

It can be seen from the picture above that students are actually able to solve the questions correctly procedurally, starting from understanding the information provided to doing the calculations correctly. However, at the end of the answer, students forget to write the percentage unit (%) as a marker that the results obtained are in the form of a percentage. Coding errors, as stated by (Rahmawati et al., 2021) are caused by students' inability to write the final answer in accordance with the expected conclusion. This negligence shows that even though the understanding of the concept and the steps for solving are correct, students are still not careful enough in writing the final answer completely. This type of error is usually not due to a lack of understanding of the concept, but rather due to a lack of care or not being used to rechecking the results of their work. Therefore, it is very important for students to be trained not only in the aspect of understanding the concept, but also in the accuracy and neatness in presenting answers. This aims to prevent errors that can actually be avoided.

Based on the initial objective of the study, namely to analyze the errors of grade VII junior high school students at SMPN 3 Gununghalu in solving problems on social arithmetic material, then from the results of the data analysis, it can be found that the errors made by students are in 5 aspects, namely errors in reading questions, errors in understanding problems, transformation errors, process skill errors, and errors in writing answers. Based on the research that has been conducted, it can be seen where the students' errors lie based on the 5 categories mentioned previously. The researcher hopes that this can be a reference for related teachers to act in accordance with the errors made by students so that the efforts made will function properly.

CONCLUSION

Based on the results of the analysis of errors made by grade VII students in solving social arithmetic problems based on Newman's Stages, it can be concluded that students experience all five types of errors. The types of errors in question include reading errors, understanding errors, transformation errors, process skill errors, and coding errors. From this analysis, the most common errors made by students are process skill errors. In this case, students have understood the initial concept in solving math problems, seen from students who make errors in reading, it can be said to be quite low, but there are still many students who make mistakes, especially in process skills. Errors in process skills in finding conclusions are quite high. Based on the description above, students need to be given questions in the form of stories often. This aims to train students to be more accustomed, so that the mistakes they make can be reduced. In addition, being accustomed to being given story problems can hone students' conceptual understanding skills and sharpness in solving math problems, especially story problems. This study provides an overview that error analysis based on Newman's stages can help teachers identify students' weak points more specifically, so that learning can be directed at more targeted improvements. Further researchers are advised to develop more varied instruments and involve interview or observation data so that error analysis can be carried out more deeply and comprehensively. In addition, a learning approach based on understanding context and strengthening the ability to read math problems needs to be strengthened in the learning process in the classroom.

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