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The Challenges of Junior High School Students in Solving Fraction Problems Based on Newman's Error Analysis

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Abstract: This study aims to analyze the type of errors made by eighth-grade students in solving fraction problems at a public junior high school in Lembata Regency, East Nusa Tenggara. The analysis was conducted using the Newman Error Analysis (NEA). The research employed a qualitative descriptive method with nine eighth-grade students as the subjects. The instruments used included a written test consisting of 17 questions and interview guidelines based on the five stages of error identified in NEA: reading, comprehension, transformation, process skills, and encoding. The analysis revealed no errors in the reading stage, indicating that students were generally able to read and extract relevant information from the problems correctly. However, significant errors began to appear in the subsequent stages. In the comprehension stage, 16.84% of students failed to interpret the question correctly or misunderstood essential information, potentially leading to incorrect solution steps. Transformation errors occurred in 26.94% of cases, where students struggled to convert verbal information into a mathematical representation. In the process skills stage, 27.27% of students made mistakes in performing basic mathematical operations, such as fraction calculations. The highest error rate was observed in the encoding stage, where 28.96% students were unable to correctly write the final answer, even after processing the question appropriately. These findings indicate that students face difficulties not only in conceptual understanding but also in procedural fluency and mathematical expression.

Keywords: difficulty, fraction, newman error analysis, process skills, encoding.

▪ INTRODUCTION

According to Eidam (2023), education is a process of nurturing and developing individuals with a focus on upholding human dignity. Schools play a vital role in bringing this concept of education to life. Education is not limited to teaching skills needed to face the complexities of life, but also includes the development of aspects that support human values. One important aspect is mathematics learning, as it significantly contributes to the development of students' thinking skills and problem-solving abilities. The process of learning mathematics aims to build a deep understanding of mathematical concepts. Therefore, foundational concepts must be firmly established so that students can more easily grasp advanced material (Nurhayati et al., 2020). Problem solving in mathematics is an essential skill that every individual must acquire. For this reason, teachers are expected to accommodate student diversity through learning approaches that are relevant to students' daily lives (Arjudin et al., 2024). However, mathematics is often perceived as a difficult subject by students, which leads many of them to struggle with understanding various concepts, especially fractions. Some students view fractions not as whole numbers, but merely as symbols that need to be manipulated in specific ways. This difficulty is generally caused by students' tendency to rely more on memorization than on building a solid conceptual understanding (Cendekiawaty & Sugiman, 2020).

Empirical evidence from various international studies indicates that difficulties in understanding fractions are a global challenge, not merely a local issue in Indonesia. Data from the Programme for International Student Assessment (PISA) 2018, as analyzed by

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the OECED (2020), revealed that more than 50% of 15 year old students in OECD member countries failed to correctly solve mathematics problems involving the concepts of fractions or proportions at or below level 2 the minimum proficiency level required for full participation in modern society. In this context, Indonesia is among the countries with a high proportion of students performing below the basic proficiency level in problems involving fractions and other rational number representations.

Fraction material is included in both the Merdeka curriculum and the 2013 curriculum, and it is considered one of the fundamental topics in mathematics (Ramadianti et al., 2020). Although it is important, fractions are widely recognized as one of the most challenging areas in mathematics education. One effective way to help students overcome these difficulties is by presenting fraction problems in realistic contexts, making the concepts more concrete and less abstract (Mostert & Hickendoorff, 2023). A solid understanding of fractions is crucial, as it serves as a key predictor for success in more advanced mathematical learning. However, students often struggle with fractions due to their unique and complex nature (Hwang & Riccomini, 2021). Mastery of fractions is also essential for learning algebra, geometry, and other higher-level mathematical domains. Unfortunately, the lack of contextual and real-world-oriented instructional approaches tends to worsen students' misconceptions about fractions. A deep and thorough understanding of fractions is vital, as it forms the foundation for grasping rational numbers and engaging with more advanced mathematical concepts such as algebra (Jordan et al., 2024).

Challenges in learning fractions go beyond conceptual understanding and are reflected in the consistent errors students make when performing fraction operations. For example, students often mistakenly subtract numerators and denominators directly without considering equivalence, or add fractions to whole numbers without first converting them to like terms (Lee, 2024). These kinds of mistakes suggest that students do not have a strong grasp of the underlying structure and fundamental principles of fractions, and instead rely on shallow, non-conceptual strategies. Therefore, it is important to conduct a more in depth analysis of students' cognitive processes in solving fraction problems, focusing not only on their final answers but also on the sequence of mental steps involved in reaching those answers.

Errors made by students when solving mathematical problems, particularly word problems involving fractions, can be categorized based on specific stages of cognitive processing. Kusmayadi et al. (2022) identified five types of errors using Newman's Error Analysis (NEA): reading, comprehension, transformation, process skills, and encoding. Reading errors were noted among some female students, although these mistakes did not always lead to further errors. Comprehension errors stemmed from difficulties in recognizing essential information presented in the text or images. Transformation errors were seen when students were unable to develop suitable mathematical representations. Errors related to process skills involved the incorrect use of formulas, whereas encoding errors occurred when students failed to express or finalize answers accurately.

NEA is recognized as a relevant and effective method for identifying student error because it systematically breaks down the cognitive stages involved in problem solving, from reading to encoding. In contrast to frameworks like the SOLO taxonomy, which emphasize the complexity of student responses, NEA offers a step-by-step structure that pinpoints exactly where students struggle during the problem-solving process. This

approach is particularly well suited for fraction word problems, as these tasks require the gradual engagement of multiple cognitive skills: reading the question, grasping the meaning of fractions within the context, converting verbal information into mathematical expressions, executing calculations, and producing the final answer. Therefore, NEA not only reveals specific types of student errors but also serves as a basis for developing focused intervention strategies (Shinariko et al., 2020).

Errors made by students in learning mathematics are influenced by a combination of internal and external factors. As noted by Anggriani et al. (2023), internal factors such as students' motivation and their attitudes toward the subject play a significant role in determining academic performance. On the other hand, external factors include access to learning resources, the effectiveness of teaching methods, and support from family. Yuberta et al (2022) reinforce this view by identifying learning interest as the most impactful internal factor behind serious learning challenges, while the social environment emerged as the most significant external contributor. These insights emphasize the importance of using a holistic diagnostic tool like NEA to explore the dynamic relationship between students' cognitive processes and the broader learning environment.

Students often face various challenges when working on mathematical problems, especially those that are non-routine in nature. According to Kusumadewi and Retnawati (2020), many students are not familiar with tasks that demand higher-order thinking skills. They frequently struggle to identify important keywords, have difficulty translating problems into mathematical models, are uncertain about the steps to take, and make computational mistakes that lead to inaccurate conclusions. These issues indicate that students' difficulties extend beyond conceptual misunderstandings and also involve confusion in logical and systematic reasoning. As a result, there is a need for a diagnostic method that not only categorizes error types but also examines the cognitive stages where these errors emerge.

Considering the complexity of fraction concepts, the systematic nature of cognitive errors, and the various factors influencing success in mathematics learning, Newman's Error Analysis is deemed the most appropriate framework for this study. This approach provides structured and detailed insights into the location and type of student errors, which can ultimately inform the design of more effective instructional interventions. Based on the above background, the research question formulated in this study is as follows: What is the profile of students' errors in solving word problems on the topic of fractions based on the stages of Newman's Error Analysis (NEA)?

▪ METHOD

Participants

The participants in this study were eighth-grade students from a junior high school in Lembata Regency, located in the East Nusa Tenggara Province of Indonesia. The sample comprised a group of nine students selected purposively based on their semester grades, reflecting a range of mathematical abilities from high to medium to low. The selection ensured that each ability level was equally represented, allowing the researcher to explore variations in student errors across different levels of proficiency. In addition to academic criteria, the students chosen were those who actively participated in learning and were willing to take part in follow-up interviews.

Research Design and Procedures

This study adopted a qualitative approach with a case study design, which allowed for an in-depth exploration of students' errors in solving fraction word problems through the lens of Newman's Error Analysis (NEA). The research procedure began with the development of instruments, including the construction of a test blueprint aligned with relevant competencies and indicators. Seventeen test questions were created, consisting of both abstract items and word problems related to fractions. Interview guidelines were also prepared, based on the five cognitive stages outlined in NEA: reading, comprehension, transformation, process skills, and encoding.

Instruments

To ensure quality, the instruments were validated by experts validation including a mathematics education lecturer and an experienced junior high school mathematics teacher. The aspects validated included content, construct, and language. Based on their feedback, some problems were revised for better contextual clarity, while no conceptual flaws were identified. The written test was administered in a classroom setting under the direct supervision of the researcher, with students given ninety minutes to complete the test. On the following day, individual in-depth interviews were conducted to gain further insight into the students' problem-solving processes. Each interview lasted approximately five to seven minutes and was audio-recorded and transcribed verbatim for analysis.

Data Analysis

Data analysis was carried out using a qualitative descriptive approach. The transcripts and written test responses were first reduced and coded according to NEA stages. Each identified error was categorized using a structured coding rubric. Triangulation was conducted by comparing data from the tests, interviews, and observation notes to ensure validity. The researcher then interpreted the root causes of the errors based on the students' explanations and contextual clues. The analysis focused on nine students who had been carefully chosen to represent a diverse range of mathematical abilities. Their inclusion helped uncover a broad spectrum of error patterns, contributing to a richer understanding of the challenges students face when solving fraction problems.

This method was introduced by Anne Newman in 1977, a mathematics teacher in Australia. According to Newman, someone who wants to get the right solution for an arithmetic operation in the form of a story problem must go through the following hierarchy: Reading errors occur when students cannot read or recognize words, terms, such as average, sum, difference, or symbols used in the problem (Abdullah, et al. (2015). Comprehension errors occur when students can read the question but do not understand the meaning of the information conveyed or the context of the question. Transformation errors occur when students understand the content of a mathematical story but are unable to transform that information into a mathematical model. Process errors occur when students understand the problem and can create a mathematical model, but make errors in the calculation process. Coding errors occur when students have completed calculations correctly, but have not written down the final answer accurately, completely, and according to the requirements of the problem or question.

The following is an example of a fraction word problem, a student's solution, and an interview transcript adapted from Abdullah et al. (2015) using the analytical approach based on Newman's Error Analysis (NEA): Sarah has $3\frac{3}{4}$ liters of orange juice. She wants to pour the juice

into bottles that hold $\frac{5}{8}$ liter each. How many full bottles can she fill? Student's Written Solution: $3\frac{3}{4} \div \frac{5}{8} = \frac{15}{4} \div \frac{5}{8} = \frac{15}{4} \times \frac{8}{5} = \frac{120}{20} = 6$

Table 1. Interview transcript

No.	Questions from the teacher	No.	Students' Oral Responses
1	Can you explain what the question is asking?	1	It says Sarah has 3 and 3 quarters of juice and each bottle is 5 over 8, so I think we need to divide.
2	Okay, why did you choose to divide?	2	Because we want to find out how many bottles. So we divide the total juice by bottle size.
3	You wrote 15 over 4 divided by 5 over 8. Can you explain this step?	3	I changed the mixed number to 15 over 4, and then I divided by 5 over 8 by multiplying by the reciprocal.
4	Good. Then what is 15 times 8?	4	That is 120.
5	And 4 times 5?	5	20.
6	So, what is 120 divided by 20?	6	6.
7	Do you think your final answer is correct?	7	Yes, 6 full bottles.
8	What does the question ask?	8	How many full bottles?

NEA Stage Analysis

The steps for analyzing the student's error in solving the problem are as follows:

1. Reading: The student was able to read and identify all key information in the problem ($3\frac{3}{4}$ liters and $\frac{5}{8}$ liter), so no error occurred at this stage.
2. Comprehension: The student understood the meaning of the problem, finding the number of full bottles implies a division operation. No error occurred at this stage.
3. Transformation: The student correctly converted $3\frac{3}{4}$ to $\frac{15}{4}$ and correctly applied the reciprocal of $\frac{5}{8}$ as $\frac{8}{5}$. The mathematical transformation process was accurate, so no error occurred.
4. Process Skills: The student performed the multiplication of fractions: 15 × 8 and 4 × 5 to get $\frac{120}{20}$, which is numerically correct. However, there was a slight hesitation or lack of detailed explanation in the process, indicating a minor issue in articulating procedural understanding.
5. Encoding: The final answer was written correctly as "6 bottles" and was appropriate to the context of the problem. No error occurred.

Kenney, S., & Ntow, F.D. (2024) highlighted the effectiveness of the NEA framework in categorizing student errors and providing insights for more appropriate learning interventions. The written test and interview instruments can be seen in Table 2. The interview instrument based on Newman's 5 types of Error Analysis can be seen in table 3.

Table 2. Written test instruments

I.	Find the results of the addition and subtraction of numbers as follows in the simplest form!				
1	$\frac{1}{4}+\frac{2}{4}$	3	$\frac{3}{4}+\frac{1}{2}$	5	$\frac{7}{8}-\frac{1}{3}$
2	$\frac{3}{7}+\frac{1}{4}$	4	$\frac{3}{4}-\frac{1}{4}$	6	$6\frac{3}{5}-\frac{1}{3}$
II	Find the results of multiplication and division of the following numbers in the simplest form!				
7	$\frac{3}{5}\times\frac{2}{5}$	9	$\frac{5}{6}\times 2\frac{2}{9}$	11	$\frac{1}{5}\div\frac{1}{7}$
8	$\frac{3}{4}\times\frac{4}{5}$	10	$\frac{3}{4}\div\frac{1}{4}$	12	$3\frac{3}{4}\div\frac{2}{3}$
III	Solve the following questions with the final result in its simples form!				
13	At a party, there are 3 liters of syrup. If each guest gets $\frac{3}{5}$ liter, how many guests can be served?				
14	Ani has $\frac{3}{4}$ liter of oil. She used $\frac{1}{2}$ liter for cooking. How many liters are left?				
15	There is $1\frac{1}{3}$ liters of syrup. The first guest takes $\frac{1}{4}$ litre, the second guest takes $\frac{1}{3}$ liter. How many liters of syrup are taken?				
16	A tailor has $2\frac{1}{2}$ meters of fabric. He needs $\frac{5}{6}$ meters to make one shirt. How many shirts can he make?				
17	During a race, Edo completed $\frac{3}{4}$ of the race route in 30 minutes. How much time will it take to complete the entire route if his speed remains constant?				

Table 3. Interview instrument

No.	Error Type	Question
1	Reading Error	• Can you read this question out loud? • Are there any words in the question that are difficult for you to read or recognize? • Have you seen or used words like these before? Where?
2	Misunderstanding	• Retell in your own words what happened with this problem! • What do you think the question is asking you to do? • How do you know that is what the question means?
3	Transformation Error	• What did you do to answer this question? • How did you turn the question into a mathematics problem? • Were you confident about your first step? Why?
4	Process Error	• Show how you solve this problem! • Can you explain each step you took, one by one? • Why did you choose that particular method and strategy?
5	Answer Writing Error	• What is the final answer? How do you know it is correct? • How did you write your final answer? • Did you double-check your answer? What did you check for?

The above instruments are used during interviews, which take place after students have completed the written test.

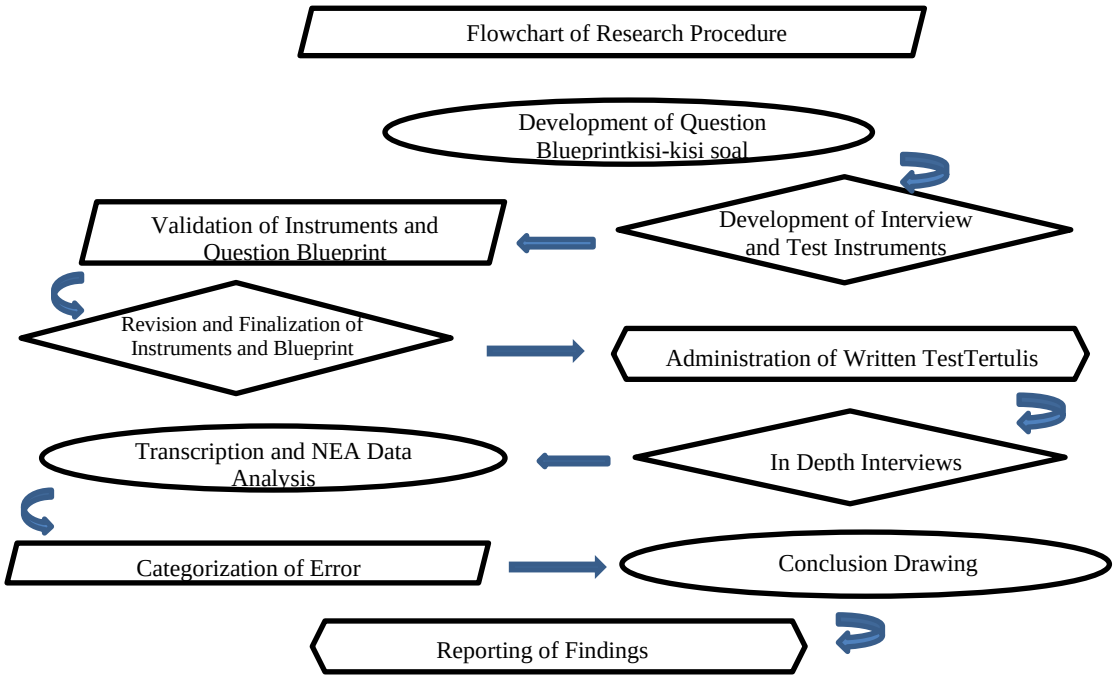

Figure 1. The following is the research flow diagram

The research process began with the development of a question blueprint, which served as the foundation for designing the written test instruments and interview guidelines. Once the instruments and blueprint were completed, the next stage involved expert validation to ensure the content relevance and clarity of the instruments in measuring students' mathematical abilities. Based on the validation results, the instruments were revised and finalized to be ready for data collection. The primary data were collected through the administration of a written test designed to elicit various types of errors in solving mathematical problems. Following the test, the researcher conducted in-depth interviews with selected students to explore the reasons behind their responses further and to identify the types of errors based on Newman's procedures, which include reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. The interview results were then transcribed and analyzed qualitatively to identify emerging patterns of errors.

The next stage involved categorizing the errors according to NEA classifications. This categorization served as the basis for drawing conclusions about the most dominant types of errors and their underlying causes. Afterward, the researcher synthesized the findings and compiled them into a final report. The report includes the main findings, implications, and recommendations for improving the teaching and learning of mathematics. Overall, this study aims to provide a deep understanding of students' mathematical errors and to contribute to the development of more effective instructional strategies.

▪ RESULT AND DISSCUSSION

Students made errors in solving fraction problems based on Newman's procedure, which includes five types of errors: reading, comprehension, transformation, process

skills, and encoding errors. No reading errors were found, but other types were still present.

Comprehension Error

The first identified error was a comprehension error, which occurs when students can read the problem but do not understand the meaning or context of the information given. The comprehension error can be shown in the following picture of the written test and interview results:

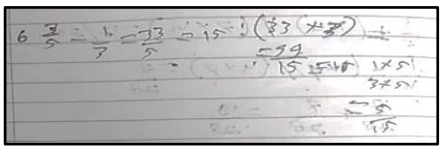

Figure 2. comprehension error

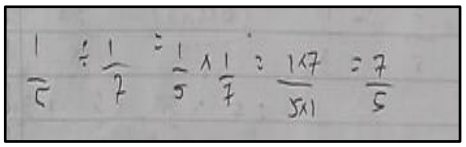

Figure 3. Comprehension error

The question in figure 2: Determine the result of $6\frac{3}{5} - \frac{1}{3}$ in its simplest form! Question for figure 3: determine the result of $\frac{1}{5} \div \frac{1}{7}$ in its simplest form!

Table 4. Transcript of student interview

No.	Questions from the teacher	No.	Students' Oral Responses
1	Can you read this question aloud?	1	Yes, sir. (student 3 reads as instructed)
2	Tell me in your own words about this question.	2	One-fifth divided by one-seventh is equal to one-seventh times one-seventh.
3	Why does division turn into multiplication?	3	so that it can be multiplied between the numerator and the denominator
4	Okay, thank you.	4	Thank you too

From the students' work in Figures 2 and 3 and the interview results, it is clear that students can read the problems well but do not fully understand the steps to solve fraction problems correctly. Although the final answer in Figure 2 is correct, the student does not understand the process of dividing fractions. This indicates a lack of conceptual understanding.

Transformation Error

The second error found is a transformation error, which occurs when students understand the math story but cannot convert it into a mathematical model. Transformation errors can be shown in the following figure and interview results:

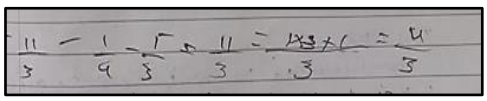

Figure 4. Transformation error

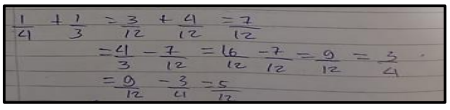

Figure 5. Transformation error

The questions in figures 3 and 4 are the same, namely: There is $1\frac{1}{3}$ liters of syrup. The first guest took $\frac{1}{4}$ liter, the second guest took $\frac{1}{3}$ liter. How many liters of syrup were taken?

Table 5. Transcript of student interview

No.	Questions from the teacher	No.	Students' Oral Responses
1	Can you read this question aloud?	1	I can read it sir. (student 1 reads as instructed)
2	Retell in your own words what happened with this problem!	2	$1\frac{1}{3}$ liters of syrup are available, then a guest comes to drink $\frac{1}{4}$ liter and
3	Show me how you solve this problem!	3	We write $1\frac{1}{3}-\frac{1}{4}-\frac{1}{3}$, then equalize the denominator
4	Why $1\frac{1}{3}-\frac{1}{4}-\frac{1}{3}$	4	Because we calculate what is taken sir
5	Okay. Thank you.	5	Yes sir

Based on Figures 4 and 5, students can read and understand the problem but struggle to turn it into the correct mathematical model. They often use the wrong operation, such as subtracting instead of adding. Interviews confirm that students understand the problem but cannot represent it mathematically.

Process Skill Error

Additionally, a third type of error found by the researcher is a process skill error, where students understand the problem and create a mathematical model but make mistakes in the calculation process. The examples of process skills errors are presented in Figure 6.

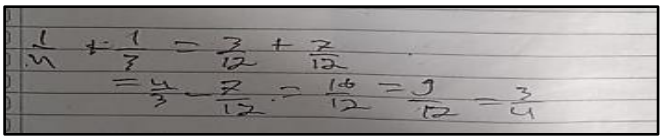

Figure 6. Process skills errors

Question in Figure 6: There is 1 1/3 liters of syrup. The first guest took 1/4 liter, the second guest took 1/3 liter. How many liters of syrup were taken? The transcript of the student interview can be seen in Table 6.

Table 6. Transcript of student interview

No.	Questions from the teacher	No.	Students' Oral Responses
1	Can you read this question aloud?	1	Excellent sir.
2	Retell in your own words what happened with this problem!	2	There is $1\frac{1}{3}$ liters of syrup, then a guest comes to drink $\frac{1}{4}$ liter and the second guest drinks $\frac{1}{3}$ liter, so we calculate the amount of

			syrup consumed by the first and second guests.
3	Show me how you solve this problem!	3	We write $\frac{1}{4}+\frac{1}{3}$, equalize the denominators, and add them up.
4	What is next?	4	Then $1\frac{1}{3}-\frac{12}{7}$.
5	Okay. Thank you.	5	Yes sir

Based on Figure 6, students understand the problem and create the correct model, but make mistakes in the calculation process. The fourth error found is a coding error, where students complete the calculation correctly but fail to write the final answer accurately or as required. Coding or writing errors can be shown in Figure 7, and the interview results are presented in Table 7. Question for figure 7: Determine the result of $\frac{7}{8}-\frac{1}{3}$ in its simplest form!

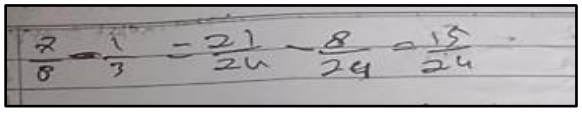

Figure 7. Coding error

Table 7. Transcript of student interview:

No.	Questions from the teacher	No.	Students' Oral Responses
1	Can you read this question aloud?	1	I can read it sir.
2	Retell in your own words what happened with this problem!	2	Seven-eighths less one-third. We are looking for the subtraction result of the fraction.
3	Show me how you solve this problem!	3	$\frac{7}{8}-\frac{1}{3}$, equalize the denominator and subtract.
4	How else?	4	Then the numerator is subtracted from the numerator, over the common denominator, resulting in $\frac{(21-8)}{24}=\frac{15}{24}$
5	Okay. Thank you.	5	Yes sir

Based on the student's answer in Figure 6, the student has completed the calculation correctly, but did not write the final answer correctly, as well as in the interview. This means that the student has completed the calculation correctly, but did not write the final answer accurately, completely, or in accordance with the question or question request. After completing the written test, the researcher conducted a follow-up to determine the results of the students' written tests through interviews. Table 8 presents an analysis of students' difficulties based on Newman's Error Analysis using data from the test results and interviews.

Table 8. Table of error type accumulation based on analysis

Error type	Students									Number of errors	Percentage (%)
	1	2	3	4	5	6	7	8	9		
Read	-	-	-	-	-	-	-	-	-	-	-

Understand	2	5	7	10	3	3	2	9	9	50	16.84
Transformation	9	8	9	10	7	8	6	12	11	80	26.94
Skills Process	12	10	10	11	4	5	5	12	12	81	27.27
Encoding	10	10	10	12	5	6	5	13	15	86	28.96
Total	**33**	**33**	**36**	**43**	**19**	**22**	**18**	**46**	**47**	**297**	**100.00**

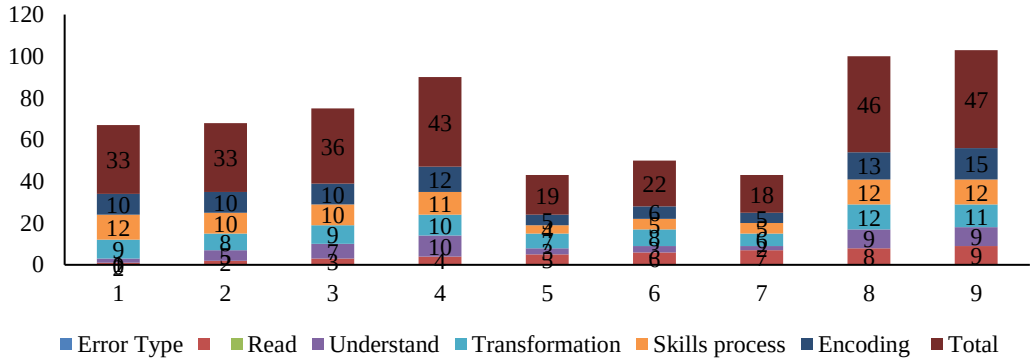

Figure 8. Diagram of newman's error analysis results

Among 297 student errors in solving mathematics problems, analysis using Newman's Error Analysis (NEA) identified four categories: comprehension (16.84%), transformation (26.94%), process skills (27.27%), and encoding (28.96%). No errors were found at the reading stage, indicating that students possess adequate basic literacy skills. Thus, the primary difficulties emerge from the stages of interpreting the problem, modeling it mathematically, performing calculations, and presenting the final answer. Encoding was the most dominant type of error (28.96%), indicating that students often made mistakes in writing their final answers, such as using incorrect units, providing contextually irrelevant responses, or presenting answers with an illogical structure. This aligns with the study by Kenney & Ntow (2024), which highlighted students' struggles in clearly expressing their mathematical solutions.

Process skills errors accounted for 27.27%, reflecting mistakes in procedural steps, such as manual calculations or incorrect use of formulas. Transformation errors made up 26.94%, suggesting that students, especially those with lower academic performance struggled to construct appropriate mathematical models from verbal information, as emphasized by Arifin et al. (2023). Comprehension errors were relatively lower at 16.84%, yet remain crucial as they relate to students' initial ability to understand the purpose of the question. This finding is consistent with (Suradi & Djam'an, 2021)

Lubis and Jupri (2023) reported findings that differ from much of the existing research. They found that students' comprehension did not significantly predict their success in solving word problems. This contradicts numerous other studies, including the present one, which emphasize comprehension as a fundamental stage in Newman's Error Analysis (NEA) framework. Although NEA has proven effective in identifying student errors across sequential stages from comprehension to encoding, its components may not apply equally to all types of errors. The results from Lubis and Jupri suggest that comprehension does not universally influence students' problem-solving performance. Therefore, while NEA remains a valuable diagnostic tool, it should be supplemented with

additional methods, such as think-aloud protocols or real-time cognitive observations, better to capture the dynamic nature of students' thought processes. In practical application, teachers should not only focus on strengthening students' reading comprehension but also enhance their ability to transform problems, apply procedures correctly, and most importantly, communicate their mathematical thinking effectively. These efforts are essential to minimize encoding errors and improve overall problem-solving outcomes.

This study has several limitations that need to be acknowledged to ensure a proper interpretation of the results. The primary limitations lie in the very small sample size, which involved only nine (n=9) students. Such a small sample reduces of statistical power of the findings and significantly limits their generalizability. In other words, the result of this study cannot be directly applied or generalized to a broader student population, whether in terms of geographic, social, or academic contexts. In addition, research was conducted in a precise location, only one school in Lembata regency, which further restricts the scope of the findings. The unique characteristics of the school, students' background, and local learning environment may have influenced the result. Therefore, these findings may not represent the condition or responses of students from other areas or schools with different profiles. Another limitation concerns the nature of the test items used in this study. The instrument did not evenly cover all types of mathematical operations, such as addition, subtraction, multiplication, addition, and division. This imbalance may have affected the accuracy of assessing students' overall numeracy skills. As a result, students' abilities in certain types of operations that were underrepresented in the test may not have been adequately measured, which reduces the comprehensiveness of the analysis. Given these limitations, the interpretation of the study's findings should be approached with caution. Future research is recommended to involve a larger and more diverse sample, include schools from various regions, and use a more balanced instrument that covers the full range of mathematical operations in order to gain a more complete understanding of students' numeracy skills.

The GASING method, which begins with the concrete stage, continues to the abstract stage, and ends with mental calculation, provides a gradual and systematic approach. This approach supports students comprehensively, from understanding the meaning of the problem to producing accurate answers, thus helping to reduce or prevent the five types of errors identified in Newman's Error Analysis. Concrete Stage: This stage uses real teaching aids to build students' initial understanding through visual and kinesthetic experiences. By using concrete objects and hands-on activities, students can more easily grasp the terms used in fraction problems, as the context is demonstrated in a tangible way (Reading Error). Manipulating physical objects also helps students understand the meaning of the problem, including the relationships between parts of a fraction (Comprehension Error). This stage builds a foundation of visual and concrete understanding so that students not only know the steps to solve a problem but also comprehend the meaning of the fractions themselves (Pratiwi et al., 2021).

Abstract Stage: In this stage, students begin working with mathematical symbols, such as numbers and operations, without the use of concrete objects. It helps them transform word problems into mathematical representations (Transformation Error). Once students can convert problems into mathematical form, they are guided to perform operations on fractions in written form (Process Skill Error). This stage develops

symbolic understanding and procedural skills, enabling students to go beyond rote memorization of formulas and to understand the reasoning behind each calculation (Nubatonic et al., 2023). Mental Calculation Stage: At this stage, students are trained to perform fractional calculations mentally, without writing or using tools. Students who have become familiar with the patterns of fraction operations and who think quickly are more capable of writing or expressing the final answer accurately (Encoding Error). This stage sharpens students' logical thinking speed and accuracy, and reduces their dependence on written steps, which can often lead to errors in notation or copying (Wayeni et al., 2024).

▪ CONCLUSION

The analysis of errors in solving fraction problems among eighth-grade students in Lembata Regency reveals more than just percentages; it uncovers critical gaps in students' mathematical thinking that demand targeted instructional responses. While reading errors were virtually nonexistent, the prominence of errors in the understanding (16,84%), transformation (26,94%), process (27,27%), and encoding (28,96%) stages indicates a multifaceted challenge that spans comprehension, conceptual reasoning, procedural fluency, and metacognitive control.

The fact that the highest proportion of errors occurred during the encoding stage, where students performed calculations correctly but failed to express final answers in line with the problem's demands, points to a serious metacognitive gap. This suggests students are not in the habit of reviewing or validating their answers, an essential component of mathematical proficiency. Therefore, interventions should not only focus on teaching content but must deliberately cultivate self-monitoring and reflective habits. Teachers can integrate structured routines for error checking and self-correction, ensuring students become more meticulous in completing and revising their work.

Equally pressing are the transformation and process errors, which stem from a limited grasp of underlying concepts and weak procedural fluency. These indicate that many students operate on memorized procedures without understanding their purpose or how to adapt them to varied contexts. This calls for concept-rich instructional strategies such as the GASING method, which scaffolds learning through a sequence of concrete, pictorial, and abstract representations, an approach proven effective in strengthening both conceptual and procedural understanding.

Errors at the understanding stage further emphasize students' struggle to interpret information in word problems, signaling a need for explicit instruction in mathematical literacy. Teachers should guide students in breaking down and translating contextual problems into mathematical language, possibly through think-alouds, collaborative discussions, or visual mapping techniques. Taken together, these findings underscore the power of Newman's Error Analysis as a diagnostic framework that can inform not only what students are getting wrong but why they are struggling. Instructional strategies, therefore, should not be generic. They must be deliberately aligned to these four error domains: Understanding, emphasize contextual reading and problem interpretation strategies; transformation, strengthen conceptual clarity through visual models and guided abstraction; Process, build procedural fluency through deliberate practice and scaffolded problem types; Encoding, cultivate reflective practice and answer checking routines. Ultimately, a responsive and evidence-based approach that addresses these

specific learning barriers will equip students with deeper mathematical competence, foster independent problem solving, and reduce the recurrence of critical errors, especially in foundational topics like fractions that are vital for future mathematical learning.

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