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APPLICATION OF NEWMAN'S ERROR ANALYSIS TO IDENTIFY STUDENTS' ERRORS IN SOLVING FRACTION PROBLEMS

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ABSTRACT (10 PT)

Mathematics is a subject that has been taught since elementary school with the aim of training students to think critically, logically, systematically, and solve problems. In fact, many students experience difficulties in learning mathematics, especially in fractional material This study aims to identify mistakes made by elementary school students in solving fractional problems using Newman's Error Analysis (NEA). Through a descriptive qualitative approach, this study analyzes the results of student work on fractional questions based on five stages of NEA: reading error, comprehension error, transformation error, process skills error, and encoding error). Data was collected through written tests and interviews, involving students from UPI Laboratory Elementary School, Pelita Bangsa Elementary School, and SDN 272 Sukasari. Student errors are then grouped by NEA stages to identify the most mistakes made by students. The results of the study showed that students made mistakes at all stages of the NEA. The most common mistakes experienced by students are at the comprehension error and process skill error stages. There are still many students who are not able to represent fractions with pictures and students also still make many mistakes in the fraction operation process. Based on the results of the research, it was concluded that students still had difficulties in fractional material by seeing the mistakes made by students when working on fractional problems. It is necessary to improve students' conceptual understanding and procedural skills in fractional materials.

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INTRODUCTION

Mathematics is considered one of the important foundations in education, serving to develop students' logical, analytical, and systematic thinking skills. However, many students find this subject difficult and scary, as expressed by various researchers ((Siregar & Restati, 2017);

(Rafiah et al., 2020); (Astika Desanti et al., 2023)). Among the various topics taught, fractions are often seen as complex material. The concept of fractions requires an in-depth understanding of numbers as well as mathematical skills for application in a real context. Difficulty understanding fractions often has an impact on errors in the problem solving process, both in interpreting information, making calculations, and compiling answers ((Suciati & Wahyuni, 2018); (Yuni Astuty & Wijayanti, 2005); (Murtiyasa & Wulandari, 2020); (Suardi et al., 2022)).

The problem of error in solving fractional problems is not only related to a lack of mastery of mathematical concepts, but also includes difficulties in the broader thought process. Newman (1977) explained that mathematical problem solving includes five stages, namely reading, comprehension, transformation, process skills, and encoding. Incompetence in one or more of these stages may result in errors in the final result. Therefore, it is very important for educators to understand the types of errors contained in students' thinking processes in order to design effective and appropriate learning strategies ((Sumartini, 2016); (Ayu Novitasari1 , 2022)).

Understanding in detail the types and locations of student errors is crucial to improve the effectiveness of mathematics learning. By knowing the aspects that need to be improved, it is hoped that teachers can establish more appropriate teaching methods to support students. One useful approach in this context is error analysis. Through this analysis, teachers can identify where students face difficulties when solving problems, which allows adjustments in teaching and more targeted interventions. In addition, this tool also serves as a diagnostic tool to evaluate the effectiveness of learning and develop more adaptive follow-up strategies ((Rahayu et al., 2022).

Newman's Error Analysis (NEA), introduced by M.A. Newman in 1977, aims to analyze the types of errors in solving mathematical problems systematically. This method divides students' mistakes into five related stages, including errors in reading questions, understanding problems, transforming information into mathematical forms, performing calculation procedures, and writing final answers (Newman, 1977). By understanding the relationship between these stages, educators can more easily find the source of the difficulties experienced by students, especially in story problems.

The implementation of NEA helps teachers in mapping the difficulties faced by students more systematically. For example, if a student is having difficulty with a fraction problem, the NEA approach can show whether the problem arises from a lack of understanding of the question instructions or an inability to convert information into mathematical operations. This approach is also important for educational research because it provides insight into the characteristics of mistakes experienced by students, so that it can be used to design data-driven remedial learning strategies (Khoerunnisa & Aqwal, 2020).

This paper will discuss the application of Newman's Error Analysis (NEA) in detecting errors in grade VI elementary school students in solving math problems, especially those related to fractions. Using the NEA, this investigation will detail which stages hold challenges for students, whether in reading, comprehending, transforming, calculating, or writing answers. Understanding the mistakes at these stages is essential so that teachers can improve teaching strategies that support a thorough understanding of mathematical concepts (Newman, 1977; (Aura Yolanda et al., 2024)).

The selection of fractional topics in this article is based on the fact that the material often results in significant errors at the primary education level. Grade VI students often have difficulty with fractional operations, whether in addition, subtraction, multiplication, or division. In addition, the switch between regular fractions to decimals and percent also invites confusion. Research shows that more than 60% of elementary school students repeatedly make mistakes in fractional questions, related to immature understanding of the concepts taught ((Khoerunnisa & Aqwal,

2020)). Therefore, the application of NEA in fractional learning in grade VI is very important to provide an understanding of the types of errors and support constructive learning improvement.

This study aims to identify the types of mistakes made by grade VI elementary school students in solving fraction problems based on Newman's Error Analysis (NEA). Through the analysis to be carried out, the researcher hopes to find the stages where students experience difficulties, both in reading, understanding, transforming, calculating, and writing answers. Identifying this error is fundamental so that the learning interventions provided can be more appropriate and in accordance with the needs of students. The results of this analysis will provide recommendations for the development of better remedial learning strategies and effective reinforcement of materials ((Khoerunnisa & Aqwal, 2020); (Khoerunnisa & Aqwal, 2020)). Thus, the NEA is expected to not only be able to detect errors, but also contribute to improving the quality of mathematics education at the elementary level.

METHOD

This study uses a qualitative descriptive approach with the aim of identifying and describing the types of mistakes made by grade VI students in solving fractional problems, using Newman's Error Analysis (NEA) as the framework for analysis. The subjects in this study are students SD Laboratorium UPI, SD Pelita Bangsa, and SDN 272 Sukasari which is purposively chosen. Data was collected through two main techniques, namely a written test in the form of fractional questions and an NEA-based interview. The results of students' work on the test were analyzed using five stages of error according to Newman (1977), namely reading error, understanding the problem (comprehension error), transforming information into mathematical forms (transformation error), errors in calculation procedures (process skills error), and errors in delivering final answers (encoding error). This technique allows researchers to group errors based on the student's stages of thinking and identify the stages that are the most sources of errors. Thus, the results of this analysis can provide useful information for teachers in designing learning strategies that are more effective and responsive to student needs ((Khoerunnisa & Aqwal, 2020)).

RESULTS AND DISCUSSION

Results

The research was carried out on SD Laboratorium UPI, SD Pelita Bangsa, and SDN 272 Sukasari. The fractional material used in this study is the concept of fractions (writing fraction symbols and making fraction drawings), comparing fractions, sequencing fractions, fraction operations (addition, subtraction, multiplication, and division). The form of the question is an essay.

Table 1. Number of Students

Number	School name	Number of students
1	SD Lab UPI	21
2	SD Pelita Bangsa	29
3	SDN 272 Sukasari	33
	Total	**83**

From figure 1, it can be explained that the number of students in the SDN 272 Sukasari there are 33 student, SD Lab School UPI 21 student, SD Pelita Bangsa 29 student. The highest student

score is 100 and the lowest is 0. There were 2 students who got a score of 100 and 2 students got a score of 0. Most students are on an average score of 10 – 50.

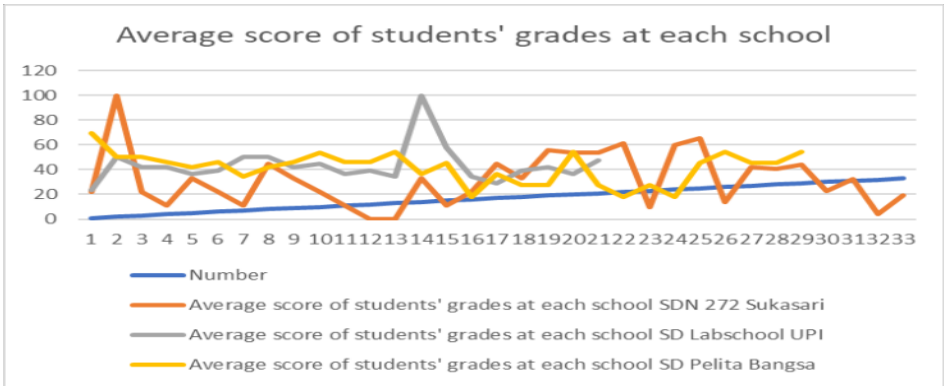

Figure 1. Average Student Score

The following is a description of the form of mistakes students make in solving fractional questions based on the following five NEA stages:

1. Reading Error:
    a. Students do not pay attention to the question order: students are asked to sort the fractions from smallest to largest but order from largest to smallest.
    b. Students are less careful in writing operation marks when rewriting questions.
    c. Students do not read the questions thoroughly.
    d. Students are asked to compare 2 fractions with the signs ">", "<" but only answer with the signs ">", "<" without writing down the fractions that are compared
2. Comprehension Error;
    a. Students are not able to represent fractions in pictures.
    b. Students do not understand the difference between numerators and denominators.
    c. Students only pay attention to the numerator when comparing fractions.
    d. Students sort the fractions based on the numerator.
3. Transformation Error;
    a. Students make fractional drawings that are not as expected
    b. Students do not use proper procedures
    c. Process errors
    d. Students ignore necessary surgeries
4. Process Skills Error:
    a. Students do not equate denominators first when comparing and sorting fractions.
    b. Students directly add denominators and numerators in the fraction summation operation.
    c. Students divide fractional images beyond or expected denominators.
    d. Students shade the parts on the fractional picture beyond the numerator.
    e. An error in the rules of the addition operation.

f. Results of integer fraction operations.

5. Encoding Error:
   a. The student has calculated correctly, but the final answer is not written in complete or does not answer what is asked of the question.
   b. Writing fractions in an incorrect form.
   c. Immediate final answer without steps.

From figure 2, it appears that "Process Skills Error" has the highest number of students who experience errors, indicating that the calculation process is the weak point of the majority of students. Other categories of errors, such as "Comprehension Error" and "Transformation Error," were also seen to have a significant number of students, suggesting that understanding and transforming questions is an important aspect of learning.

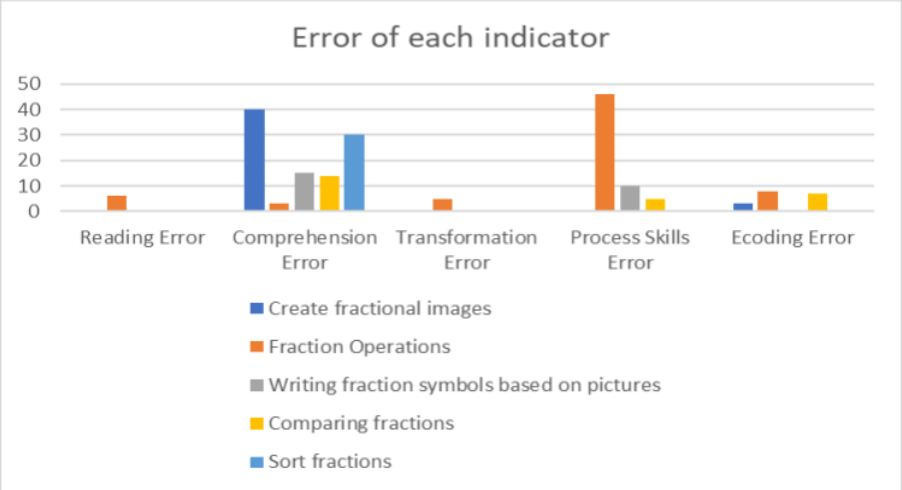

Figure 2. Number of Students Experiencing Type of Error

Figure 3 shows the students' attempts to compare two fractions without adjusting the denominator first. In the problem, students are asked to compare fractions, but this student makes a mistake by only comparing the numerator. Another mistake that students make in the same question is to only write the ">" or "<" signs. According to the Newman's Error Analysis (NEA) stage, this is an example of reading error, because students fail to understand the need to equalize denominators before comparing fractions. This mistake reflects a lack of conceptual understanding of the process of comparing fractions, where students must understand that fractions must have the same denominator in order to be easily compared. Lack of understanding of the concept of fractional comparison causes students to make mistakes in doing fraction comparison problems.

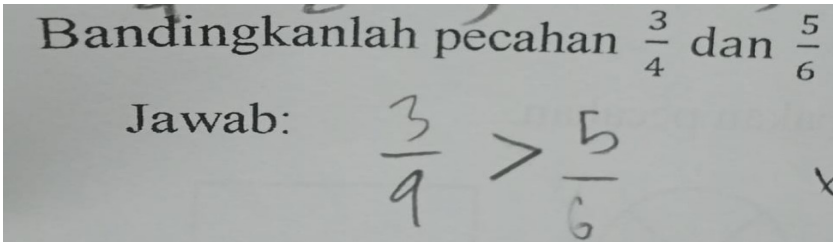

Figure 3. Students compare fractions without equalizing denominators

Figure 4 illustrates the students' response to the problem of addition and fraction subtraction but the students did not pay attention to all the signs of operation well. The question asks

students to perform a mixture of addition and subtraction operations, but students only perform addition operations. These errors are included in the reading error and transformation error in Newman Error Analysis (NEA). Students incorrectly applied mathematical operations according to the question request, showing a lack of precision when working on fraction operation problems. Although students have understood solving fractional operations when incorrectly applying the operation mark, it is a serious mistake. Students should understand that surgery marks have an important role when solving surgery questions.

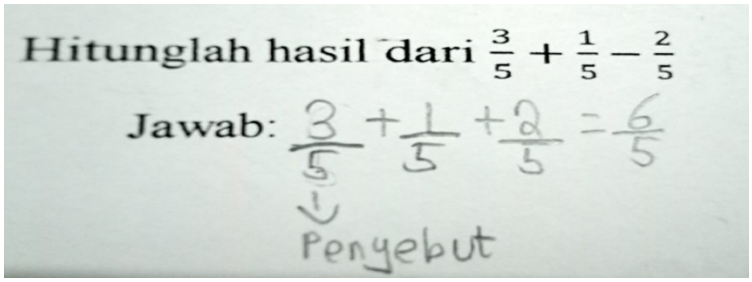

Figure 4. students do not pay attention to the question command (reduction to summation)

Figure 5 shows the students' attempts to visually represent the fractions, but students mistakenly divide the image into parts. Instead of dividing the picture into 5 equal parts but students instead make a rectangle then divide it by 4 and add 1 box to make it into 5 parts according to the question request. This error is included in the transformation error conprehension error in Newman Error Analysis (NEA). Students misrepresent fractions in the form of pictures which is a basic stage in understanding the concept of fractions is a serious mistake. In addition to the picture as in figure 3, there are other forms of misrepresentation of students such as dividing the image into more than 5 parts, shading all parts, and dividing the image into 8 parts then shading 5 parts. Stating the fractions through pictures correctly shows that the students have a good understanding of the numerator and denominator, and vice versa.

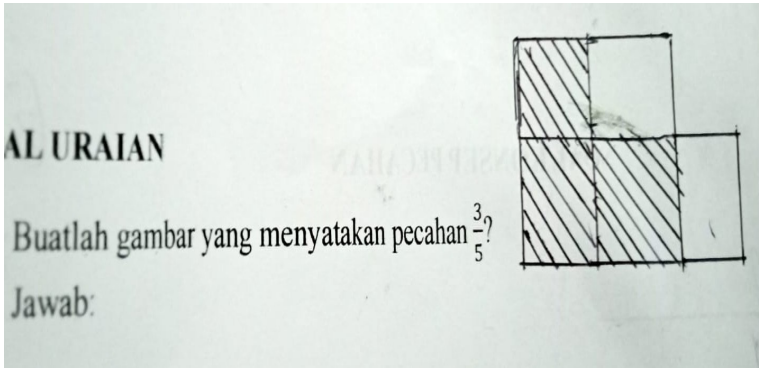

Figure 5. Students make the wrong fraction picture

Figure 6 shows the students' attempts to sort the fractions from the smallest to the largest. However, students misordered fractions because they were only based on numerators, without equalizing denominators first. This error includes comprehension errors in Newman Error Analysis (NEA). Students show a lack of understanding of the need to equalize denominators before sequencing fractions. To sort fractions correctly, students must realize that fractions with different denominators are equated with denominators first so that fractions can be sorted easily.

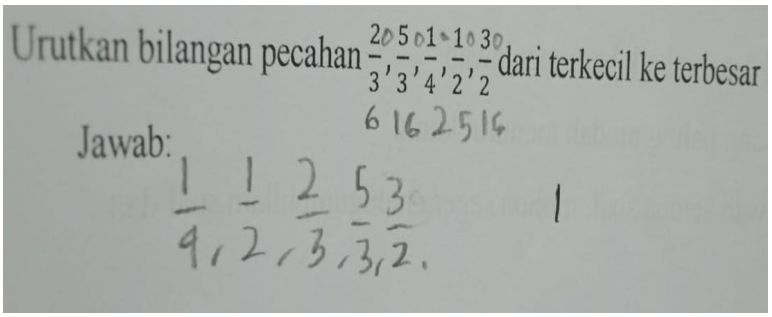

Figure 6. Students sort fractions without equalizing denominators

Figure 7 illustrates a student's response to a fractional operation, in which the student simply gives a final answer without showing the steps to obtain the answer. Students directly write down the results without showing the necessary calculations or operating procedures. These errors are included in the ecoding errors and process skill errors in Newman Error Analysis (NEA). The answers given by students are also not the result of the calculation of the question because the results are all integers. Students do not yet understand the process of completing fractional operations.

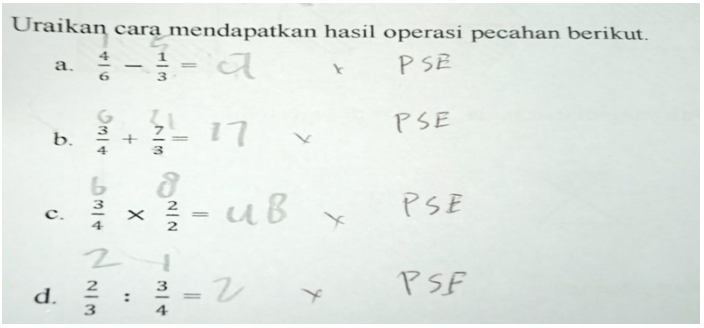

Figure 7. Students only write down their final grades without steps

Discussions

The most dominant error found in this study was Comprehension Error. This can be seen from several findings that show that students are often unable to accurately represent fractions in the form of images. For example, when asked to draw fractions, many students are unable to divide the picture into the number of parts that correspond to the denominator, divide unequally, and shade the parts that do not correspond to the numerator. Some students even make irrelevant images such as cube nets or cars. In addition, many students only write down the final grades in fractional operations without showing the process of working, which indicates a lack of understanding of the stages of completion ((Wawan et al., 2017)). There are still many students who do not understand the difference between numerators and denominators, so they write the entire part as the numerator and the shaded part as the denominator. When asked to compare fractions, many students only pay attention to the numerals, just like the way they compare integers, which suggests that their understanding of fractional structure is still weak. This error continues when they are faced with the task of sorting fractions, where students often sort fractions by the magnitude of the numerator without equalizing the denominator first. These errors indicate that a weak conceptual understanding of fractions is at the root of the errors that occur, affecting their ability to complete fractional operations effectively. Students' attitudes towards mathematics and conceptual understanding in mathematics are the best capital that students must have (Andamon & Tan, 2018).

The impact of mistakes made by students on the fractional learning process is very significant. A lack of understanding of the basic concepts of fractions can cause students to have difficulty

learning more complex fractions, which can ultimately hinder the development of their overall mathematical understanding. Additionally, most students tend to write down the final answer without showing the steps they took in the completion process, and it's possible that some students are just copying answers from their friends. This reflects weaknesses in problem-solving abilities and shows the need to develop critical thinking skills (Firdaus et al., 2015). Repeated mistakes in answering math problems can lead to a loss of students' confidence and cause them to conclude that math is a difficult subject. These impacts are detrimental not only in the context of fractional learning, but also in mathematics subjects in general, which can reduce students' interest and motivation to learn further.

In dealing with mistakes made by students in fractional learning, teachers need to apply various strategies that can strengthen students' understanding. First, it is important to reinforce the basic concept of fractions with the help of the right visual aids, so that students can see firsthand how fractions work. In addition, students need to be trained to represent fractions through images with different results, which helps them understand how to interpret fractions visually. Repeated exercises on how to compare fractions, sort fractions, and steps in performing fraction operations are also essential to improve their skills. Constructive feedback should always be provided so that students are aware of the mistakes they make and are given direction on how to correct them. Furthermore, always associating fractional material with daily life can make learning more relevant and interesting for students. Additionally, the use of learning software or applications can increase the appeal of learning for alpha-generation students who are familiar with technology. With a diverse and well-rounded approach, learning will become more engaging, effective, and relevant, which will hopefully improve students' understanding significantly (Javed, 2023).

The analysis of the causes of mistakes made by students in fractional learning reveals several factors that contribute at each stage. In Reading Error, students experience difficulties because they do not understand the question request and lack concentration when doing the assigned assignment. On the other hand, Comprehension Error occurs because students do not have a solid foundation about the concept of fractions, as well as a lack of practice in doing problems related to fractions. In addition, in Transformation Error, students show a lack of understanding of the importance of equalizing denominators when adding and subtracting fractions, as well as in comparing and sorting fractions. Process Skills Error arises because students are less skilled in following the correct mathematical steps when solving problems. Finally, in Encoding Errors, students tend to assume that the end result is more important than the process or steps taken to achieve that outcome. The implications of this analysis suggest that there needs to be reinforcement of the basic concept of fractions, the application of varied learning methods, and consistent practice and feedback to help students understand and correct mistakes. The use of adequate tools, the integration of contextual learning, and the use of technology are also important to increase the attractiveness and effectiveness of learning, so that students can strengthen their understanding of fractions.

The most dominant error found in this study was Comprehension Error. This can be seen from several findings that show that students are often unable to accurately represent fractions in the form of images. For example, when asked to draw fractions, many students are unable to divide the picture into the number of parts that correspond to the denominator, divide unequally, and shade the parts that do not correspond to the numerator. Some students even make irrelevant images such as cube nets or cars. In addition, many students only write the final grades in fractional operations without indicating the process of working, which indicates a lack of understanding of the stages of completion. According to Piaget (1970), the understanding of mathematical concepts is highly dependent on the cognitive ability of students to internalize and structure new knowledge based on existing schemas. There are still many students who do

not understand the difference between numerators and denominators, so they write the entire part as the numerator and the shaded part as the denominator. When asked to compare fractions, many students only pay attention to the numerals, just like the way they compare integers, which shows that their understanding of fractional structure is still weak ((Sunariah & Rijal, 2017);). This error continues when they are faced with the task of sorting fractions, where students often sort fractions by the magnitude of the numerator without equalizing the denominator first. These errors suggest that a weak conceptual understanding of fractions is at the root of the errors that occur, affecting their ability to complete fractional operations effectively ((Wawan et al., 2017)).

The impact of mistakes made by students on the fractional learning process is very significant. A lack of understanding of the basic concepts of fractions can cause students to have difficulty learning more complex fractions, which can ultimately hinder the development of their overall mathematical understanding. Additionally, most students tend to write down the final answer without showing the steps they took in the completion process, and it's possible that some students are just copying answers from their friends. This reflects weaknesses in problem-solving abilities and demonstrates the need for the development of critical thinking skills ((Pertiwi et al., 2023)). Repeated mistakes in answering math problems can lead to a loss of students' confidence and cause them to conclude that math is a difficult subject. These impacts are detrimental not only in the context of fractional learning, but also in mathematics subjects in general, which can reduce students' interest and motivation to learn further.

In dealing with mistakes made by students in fractional learning, teachers need to apply various strategies that can strengthen students' understanding. First, it is important to reinforce the basic concept of fractions with the help of the right visual aids, so that students can see firsthand how fractions work. In addition, students need to be trained to represent fractions through images with different results, which helps them understand how to interpret fractions visually. Repeated exercises on how to compare fractions, sort fractions, and steps in performing fraction operations are also essential to improve their skills. Constructive feedback should always be provided so that students are aware of the mistakes they make and are given direction on how to correct them. Furthermore, always associating fractional material with daily life can make learning more relevant and interesting for students. In addition, the use of learning software or applications can increase the attractiveness of learning for alpha generation students who are familiar with technology (Adillah et al., 2023)). With a diverse and well-rounded approach, learning will become more engaging, effective, and relevant, which will hopefully significantly improve students' understanding of fractions.

The analysis of the causes of mistakes made by students in fractional learning reveals several factors that contribute at each stage. In Reading Error, students experience difficulties because they do not understand the question request and lack concentration when doing the assigned assignment. On the other hand, Comprehension Error occurs because students do not have a solid foundation about the concept of fractions, as well as a lack of practice in working on problems related to fractions ((Amir & Andong, 2022)). In addition, in Transformation Error, students show a lack of understanding of the importance of equalizing denominators when adding and subtracting fractions, as well as in comparing and sorting fractions. Process Skills Error arises because students are less skilled in following the correct mathematical steps when solving problems. Finally, in Encoding Errors, students tend to assume that the end result is more important than the process or steps taken to achieve that outcome. The implications of this analysis suggest that there needs to be reinforcement of the basic concept of fractions, the application of varied learning methods, and consistent practice and feedback to help students understand and correct mistakes. The use of adequate tools, the integration of contextual

learning, and the use of technology are also important to increase the attractiveness and effectiveness of learning, so that students can strengthen their understanding (Rybak, 2021).

CONCLUSION

This study succeeded in identifying five types of mistakes made by students in fractional learning based on the Newman's Error Analysis (NEA) framework, namely Reading Error, Comprehension Error, Transformation Error, Process Skills Error, and Encoding Error. The most dominant error found was Comprehension Error, in which students showed a lack of understanding of the basic concepts of fractions, including the difference between numerators and denominators and how to represent fractions in the form of pictures.

The impact of this error is significant, hindering students' understanding of the concept of fractions and more complex mathematical operations. Therefore, recommendations are given for teaching that focuses on strengthening conceptual understanding, the use of visual aids, as well as various evaluation methods. The implementation of diverse learning strategies, support from schools, and the improvement of an integrated curriculum will be important steps to address these mistakes. By improving students' basic understanding of fractions, it is hoped that their mathematical skills can develop better, resulting in effective and meaningful learning. This research offers valuable insights for educators and curriculum developers in an effort to improve the quality of mathematics teaching at the primary education level.

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