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Newman's Error Analysis: The Errors of 4th Grade Students in Solving TIMSS Problems

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Abstract

Indonesian students who have low ability in mathematics require a lot of testing of international standard questions to practice their problem-solving and reasoning skills. Error analysis is needed to analyze the causes of student errors and how determine preventive solutions in the future. This study aims to determine the errors of fourth-grade students at SD Negeri 36 Lubuk Sirih Ilir Village in solving TIMSS (Trends in International Mathematics and Science Study) problems. A qualitative approach was used to collect qualitative descriptive data on students' errors. The ability of each student is categorized based on the TIMSS benchmark, and the errors made are analyzed by Newman's Error Analysis (NEA). The analysis activity steps for this study are collecting data, reducing, presenting, and drawing conclusions. Ten TIMSS problems that have been selected based on the content domains were tested on students, and the results showed that the abilities of eight students were in a low category, while one person with medium ability and one with very high ability. When students answered the TIMSS problems, they made the most errors in the numbers, measurement, and geometry domains. All students gave incorrect answers to number 6, one of the measurement and geometry problems, meanwhile, in number 3, a problem of numbers domain, one participant answered correctly. According to the NEA, errors in understanding problems and process skills were the most common errors. The types of mistakes made by students can be an evaluation for teachers in determining strategies when asking questions in mathematics class.

Keywords: Error Analysis; Mathematics; Newman's Error Analysis; TIMSS

Abstrak

Kemampuan siswa Indonesia di bidang matematika yang rendah membutuhkan banyak pengujian soal standar internasional untuk melatih kemampuan pemecahan masalah dan penalaran mereka. Analisis kesalahan dibutuhkan untuk menganalisis penyebab kesalahan siswa dan bagaimana menentukan solusi pencegahan ke depannya. Penelitian ini bertujuan untuk mengetahui jenis-jenis kesalahan peserta didik kelas IV SD Negeri 36 Desa Lubuk Sirih Ilir dalam memecahkan soal TIMSS (*Trends in International Mathematics and Science Study*). Pendekatan kualitatif digunakan untuk mengumpulkan data kualitatif deskriptif tentang kesalahan peserta didik. Kemampuan setiap peserta didik dikategorikan berdasarkan tolak ukur TIMSS dan kesalahan yang dilakukan dianalisis dengan *Newman's Error Analysis* (NEA). Langkah-langkah analisis yang dilakukan adalah pengumpulan data, reduksi, penyajian, dan pengambilan kesimpulan. Sepuluh soal TIMSS yang sudah diseleksi berdasarkan domain materi diujikan kepada peserta didik dan hasilnya menunjukan bahwa kemampuan delapan peserta didik berada pada kategori rendah sedangkan satu orang berkemampuan sedang dan satu lainnya memiliki kemampuan sangat tinggi. Ketika menjawab soal TIMSS, peserta didik melakukan kesalahan paling banyak pada domain materi bilangan serta pengukuran dan geometri. Pada salah satu soal pengukuran dan geometri yaitu nomor 6, semua peserta didik memberikan jawaban yang salah. Sedangkan pada soal materi Bilangan nomor 3, hanya satu peserta yang tidak melakukan kesalahan dalam menjawab. Berdasarkan NEA, kesalahan dalam memahami soal dan keterampilan proses adalah kesalahan yang paling banyak dilakukan. Jenis kesalahan yang dilakukan siswa bisa menjadi evaluasi bagi guru dalam menentukan strategi dalam aktivitas bertanya di kelas matematika.

Kata Kunci: Analisis Kesalahan; Analisis Kesalahan Newman; Matematika; TIMSS

Introduction

One of the aims of learning mathematics is to develop problem-solving students. Students are expected to have mathematical abilities that can be applied in solving problems they face in real life. In problem-solving learning, students are encouraged to develop thinking and reasoning skills using intellectual skills in solving a problem. Developing problem-solving skills and abilities is also the main focus of the 2013 curriculum, including learning mathematics (Junitasari, Roza & Yuanita, 2021). However, in Indonesia, the skills and ability to solve mathematical problems are still low, and students tend to imitate their peers in solving problems. This ultimately makes students less actively involved and think creatively in the learning process (Hendriani & Gusteti, 2021).

Students are expected to have problem-solving skills after studying mathematics, however, the mathematics learning activities carried out so far are still lacking in honing students' problem-solving skills, including at the elementary school level. This situation causes students to find it challenging to apply their mathematical abilities in solving a problem. Educators must integrate mathematics learning with students' mathematical knowledge, skills, and creativity to be actively involved and have meaningful learning experiences (Mulyati, 2016). When solving mathematical problems, students must pay attention to every step they take, starting from understanding the given problem, planning the right solution strategy, implementing the plan that has been prepared, and rechecking the process and the answers obtained (Rosita & Abadi, 2020; Yuwono, Supanggih & Ferdiani, 2018). Students still made some errors still when solving math problems (Istiqomah & Zakiyah, 2017; Yuwono, Supanggih & Ferdiani, 2018). Naturally, students who get high exam scores, as well as those in the medium and high groups, make errors when solving assigned math problems (Santoso, Yunita & Muslim, 2022). To determine the likelihood of errors made by students of any skill level, teachers must understand the description of the errors produced by each group of students. Error analysis is in line with the standards of mathematical practice, which include understanding issues, persevering in their solution, and paying attention to precision (Rushton, 2018). Therefore, it is necessary to analyze students' errors in working on a math problem so that a teacher can find the causal factors and solutions to prevent the recurrence of these errors.

One thing that can be done to analyze problem-solving skills is by giving math test problems. Internationally, students' problem-solving ability in each country is measured by providing test problems including the TIMSS (International Mathematics and Science Study) problems (Hadi & Novaliyosi, 2019; Jelita & Zulkarnaen, 2020; Prastyo, 2020). TIMSS is an international study that aims to find the trend or direction of development of mathematics and science knowledge from students or students around the world. TIMSS is conducted every four years since 1995 and tests two domains of students' abilities, namely the cognitive domain and the content domain (Prastyo, 2020). The TIMSS test developed by the International Association for the Evaluation of Educational Achievement (IEA) is tested on students in 4th grade in Primary School and 8th grade in Junior High School to compare the achievements of students from participating countries to assess cognitive dimensions, which have three components: the reasoning component, the applying component, and the knowledge component (Eridani & Wijayanti, 2019). According to Permendiknas (Minister of National Education Regulation) Number 22 of 2006, learning mathematics should give children the skills to comprehend concepts, reason, solve problems, communicate effectively, and recognize how practical mathematics is in their daily lives (Mahmudi, 2006; Manullang, 2014). Meanwhile, according to the National Council of Teachers of Mathematics (NCTM), the purpose of learning mathematics is to help students develop their problem-solving, communication, reasoning and proof, connection, and representational skills on a global scale (Manullang, 2014; Siagian, 2016; Ulya, 2016). Therefore, posing TIMSS problems to students in class is highly recommended to practice problem-solving and reasoning skills.

Indonesia has been a participant in TIMSS from 1999 to 2011. Eighth students took part in TIMSS while in 2015 the participants representing Indonesia in TIMSS were fourth students. During these years, the average point of Indonesia in TIMSS respectively was 403, 411, 397, 386, and 397 (Hadi & Novaliyosi, 2019; Prastyo, 2020), but in 2019 Indonesia did not take the TIMSS test. Overall, it can be seen that Indonesia is one of the lowest countries in the TIMSS. The average point obtained by Indonesia in TIMSS for five years is in the low ability category, which is between 100-474 (Hadi & Novaliyosi, 2019; Witri, Putra & Gustina, 2014). Indonesia's low achievement in TIMSS certainly has its root cause. So far, Indonesian students are accustomed to procedural problems and only use the numbers needed so they have not been able to solve a more complex mathematical problem (Jelita & Zulkarnaen, 2020). Students are unfamiliar with problems requiring high-level reasoning and thinking skills at school even though the TIMSS problem is a matter of Higher Order Thinking Skills (Hadi & Novaliyosi, 2019; Pribadi, Somakim & Yusup, 2015). Apart from these factors, further studies require finding many other causes.

Some previous researchers have analyzed students' errors in solving TIMSS problems (Darmawan & Ramlah, 2022; Isyam, Susanto & Oktavianingtyas, 2019; Jelita & Zulkarnaen, 2020; Nurhasada & Munandar, 2022; Prasetyo & Rudhito, 2016; Rahmawati, 2020; Susanti & Setianingsih, 2019; Wardhani, 2022; Widayanti & Kolbi, 2018; Witri, Putra, & Gustina, 2014). However, most of these researchers analyzed the errors of junior high school students. Only Witri, Putra, and Gustina (2014) analyzed elementary students' errors in solving TIMSS problems, but they have not explained and shown the types of errors made by students in detail. The researchers also only tested a few TIMSS problem domains, such as geometry and measurement (Prasetyo & Rudhito, 2016; Pribadi, Somakim & Yusup, 2015; Wardhani, 2022), Algebra (Isyam, Susanto & Oktavianingtyas, 2019; Khoiruddin & Murtiyasa, 2019; Nurhasada & Munandar, 2022), numbers (Susanti & Setianingsih, 2019), and data and probability (Rahmawati, 2020). The number of questions tested is also still limited, with only a few questions as tested by Jelita and Zulkarnaen (2020). Therefore, all these situations indicate the need to analyze students' errors in all TIMSS domains tested in primary schools in various regions in Indonesia, including district areas.

In analyzing students' mathematical errors, several methods can be used. Although the error analysis carried out can use the Polya steps (Rofi'ah, Ansori & Mawaddah, 2019; Sulistyaningsih & Rakhmawati, 2017), most researchers use the NEA method (Akbar, Hayati, Kurniawan & Hikmah, 2022; Asiasi, Masyhud & Alfarisi, 2022; Fatahillah, 2017; Fitriatien, 2019; Hidayat, Supratman & Lestari, 2022; Magrifah, Maidiyah & Suryawati, 2019; Mahmudah, 2018; Sudiono, 2017; Sunardiningsih, Hariyani & Fayeldi, 2019). According to this method, there are two types of barriers that prevent students from arriving at the correct answer when solving a problem: (1) issues with reading and comprehending the concepts expressed in the problem; and (2) issues with the calculation process, which includes transformation, processing skills, and writing answers (Yunus, Zaura, & Yuhasriati, 2019). Yunus, Zaura, and Yuhasriati (2019) also stated that this method could help to identify students' problem-solving processes. Furthermore, identification and analysis can be more focused, methodical, and orderly by applying Newman's Error Analysis (Clements, 1980). Although many studies have analyzed the mathematical errors of students with NEA, very few researchers use it when analyzing errors in TIMSS problems (Alimuddin, Ilham & Jubaedah, 2020; Rahmawati, 2020; Susanti & Setianingsih, 2019). However, Susanti and Setianingsih (2019) only tested the TIMSS in the domain of the number and Rahmawati only in the data and probability domains, while Alimuddin, Ilham and Jubaedah (2020) took only three respondents. Thus, a more in-depth analysis of student errors is needed when working on TIMSS questions

Considering the above conditions and facts, this study aims to analyze how students' abilities in solving the three domains of TIMSS problems, how the answers given by students, and what types of errors were made by students based on Newman's Error Analysis (NEA).

Method

This research was qualitative research with a descriptive qualitative method where the researcher would describe each data or findings obtained in words. The research approach, which was a qualitative one, was to produce descriptive data regarding the types and causes of the students' errors in the form of written words. This research was conducted using *purposive sampling* on ten fourth-grade students at SDN 36 Lubuk Sirih Ilir Village because they aged 9 - 10 years old, which corresponds to the age of the TIMSS trial subjects at the elementary level. Lubuk Siri Ilir village was chosen due to its location in Manna District, South Bengkulu Regency, Bengkulu Province, where TIMSS questions have not been tested.

The data collection technique in this study was 10 TIMSS problems in a written form consisting of 50% of the domain of the number, 30% of the measurement and geometry domain, and 20% of the data domain. These problems were taken from the previous period's TIMSS problems, therefore, the problems have been validated.

Before conducting an error analysis, all students' answers were assessed to determine their ability category based on the TIMSS benchmark.

$$\text{Student's Point} = \left\{\frac{\text{Student's Score}}{\text{Maximal Score}} \text{ x } 700\right\} + 100$$

Points obtained by students were adjusted to the following categories (see Table 1):

Table 1. Ability Category Based on the TIMSS Benchmark

Point	The Category of Ability
100-474	Low
475-549	Medium
550-624	High
625-800	Very High

(Witri, Putra & Gustina, 2014)

After knowing the category of students' abilities, each student's answer was analyzed for errors by using Newman's Error Analysis (NEA) type analysis. Newman specifically divides five errors in solving math problems: errors in reading problems, understanding problems, transforming problems, processing skills, and writing answers (Harahap & Zahari, 2021; Istiqomah & Zakiyah, 2017). The indicators for each of these errors were shown in the following Figure 1.

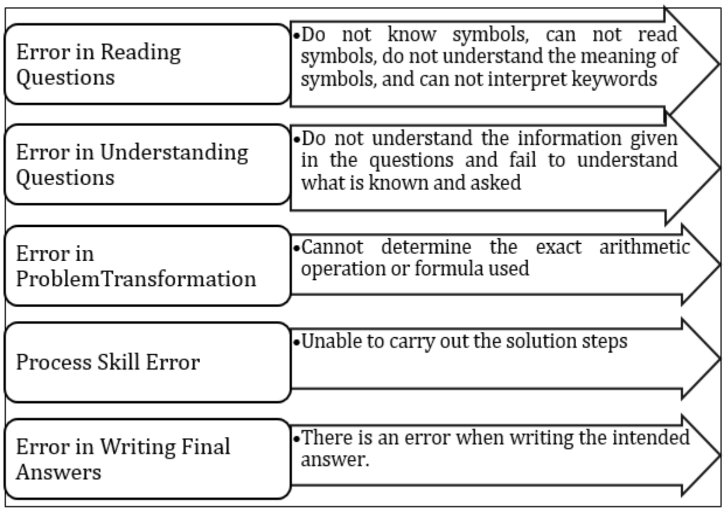


Figure 1**.** Error Indicators Based on NEA
(Annisa & Kartini, 2021; Harahap & Zahari, 2021)

The data obtained were analyzed using the Milles and Huberman model, namely doing data reduction for selecting and reducing the data of each student's answer, presenting data results in tables or graphs, and drawing conclusions to answer research problems.

Results

The research was carried out by giving ten selected TIMSS problems that had been tested for their validity and reliability. The problems were translated into Indonesian and adapted to the context in Indonesia.

Students' Ability to Answering TIMSS Problems

After analyzing the ability of ten students at SDN 36 South Bengkulu to solve the TIMSS problem, the following categories of student abilities were found (see Table 2):

Table 2. Student Ability Based on TIMSS Benchmark

Students	Point	Category
A	345	Low
B	380	Low
C	310	Low
D	380	Low
E	415	Low
F	415	Low
G	328	Low
H	520	Medium
I	660	Very High
J	310	Low

From the Table 2, it can be seen that 80% of students were in the low, 10% medium, and 10% very high categories. Only one student was found to have the ability in the very high category. Students with low abilities already have basic mathematical abilities: make basic errors such as adding and subtracting integers; have an understanding of multiplication of one-digit numbers, and can solve simple word problems; have knowledge of simple fractions, geometric shapes, and measurements; and can read and complete simple bar charts and tables (Prastyo, 2020). However, they have not been able to solve more complex mathematical problems that are complex and challenging and require mathematical thinking and a significant amount of effort (Fox, 2006).

This low ability is because students do not understand the problems so the problem-solving process that is carried out seems original (Jelita & Zulkarnaen, 2020). Prasetyo and Rudhito (2016) explained that when students are in the very high ability category, they can already apply their understanding and knowledge to solve problems with higher difficulties and explain the answers again.

The materials tested at TIMSS for fourth grade in elementary school were numbers, measurement and geometry, and data. Students are expected to be able to perform basic arithmetic operations (addition, subtraction, multiplication, and division) on number material. In the measurement and geometry material, students are expected to be able to solve problems about flat shapes, area, circumference, volume, and the relationship of lines and angles, while in data material, students are expected to be able to understand the presentation of data and solve them (Prastyo, 2020).

When students' errors were analyzed, the percentage of correct and incorrect in each domain was shown in Table 3 below.

Table 3. The Correctness of Students' Answers

Problem Number	The Number of Students		The domain of Problems
	Correct	Incorrect	
1	60%	40%	Number
2	20%	80%	Number
3	10%	90%	Number
4	90%	10%	Number
5	20%	80%	Number
6	0%	100%	Measurement and Geometry
7	60%	40%	Measurement and Geometry
8	30%	70%	Measurement and Geometry
9	50%	50%	Data
10	40%	60%	Data

From the Table 3, it can be seen that the students made the most errors in problem number 6, a measurement and geometry domain. The ten students made errors when solving problem number 6, which can be seen in Figures 2 and 3 below.

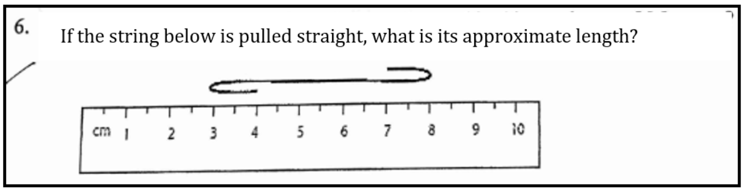


Figure 2. Problem Number 6

Four different answers were found from problem number 6: 10 cm (4 students), 8 cm (4 students), 9 cm (1 student), and 9.5 cm (1 student).

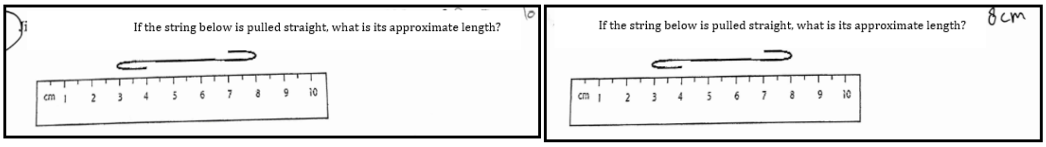


Figure 3. Students' Errors for Problem Number 6

The next problem that many students found wrong answers were problems number 2, 3 and 5, which were the domain of numbers problems in Figure 4.

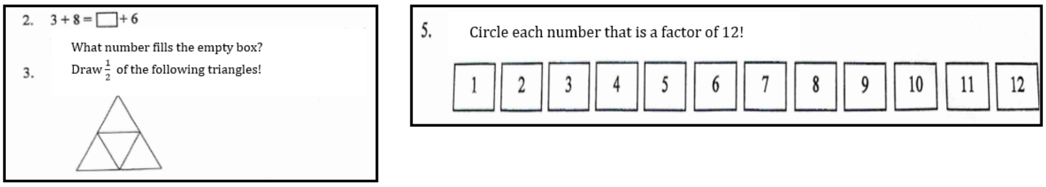


Figure 4. Problem Number 2, 3, and 5

There were eight students who were wrong in answering problem number 2. Seven of them added up the numbers 3 + 8 then added back with 6 so that the answer was obtained 17. While one student only answered 8 that is shown in Figure 5.

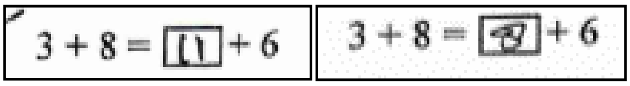


Figure 5. Students' Errors for Problem Number 2

Even though it was expected that students could apply the nature of the equation of the number of right and left numbers.

For problem number 3, it was found that there was only one student who answered correctly in drawing half of the triangle that is shown in Figure 6.

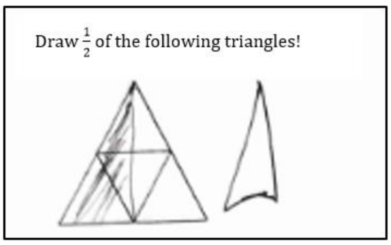


Figure 6. Students' Correct Answer for Problem Number 3

While nine other students made errors in answering this number 3. They only shaded 1 part of a small triangle (shown in Figure 7).

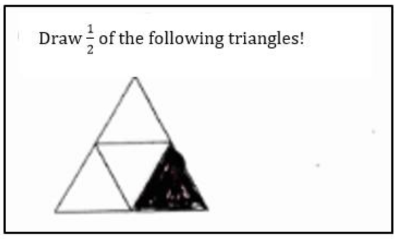


Figure 7. Students' Errors for Problem Number 3

In problem number 5 in Figure 8, there were 8 students who make errors in answering. However, six of them had been able to find several factors from 12.

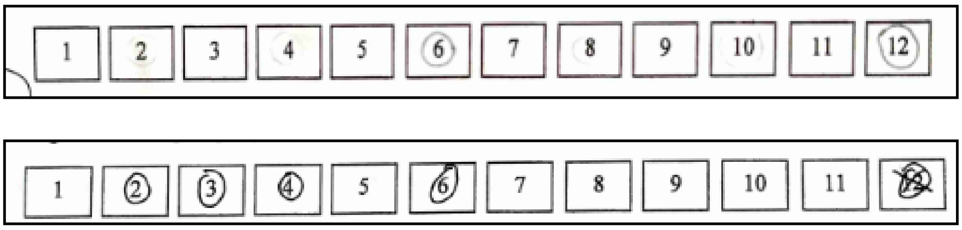


Figure 8. Students' Incomplete Answers for Problem Number 5

Meanwhile the other two were wrong in circling the factor of 12 like in Figure 9 below.

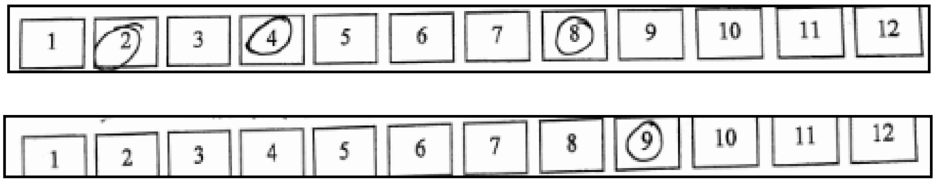


Figure 9. Students' Errors for Problem Number 5

In problem number 8 on measurement and geometry in Figure 10, there were 7 students who still made errors in determining the shape of the flat shape that was in the given car image. There were students who stated the shape of the tire with the word "round", glass in the form of "plot" and "box", and used nouns according to the picture shown such as "tire, flag, and glass".

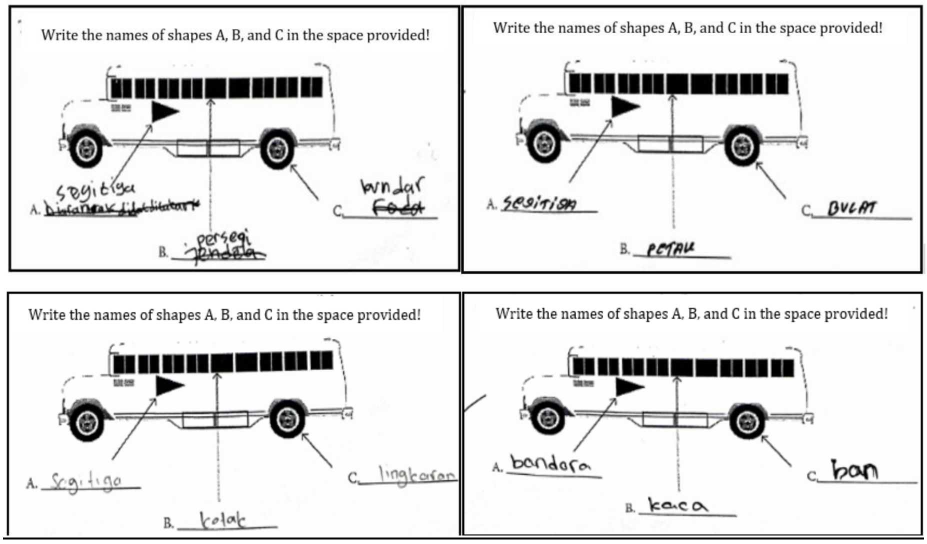


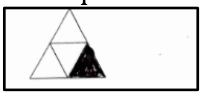
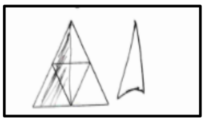
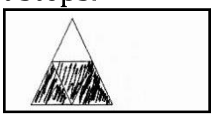
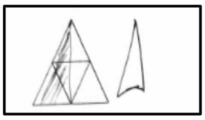
Figure 10. Students' Errors for Problem Number 8

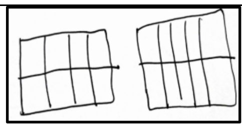
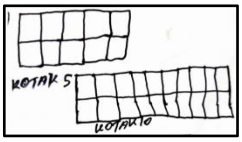
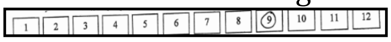
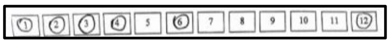
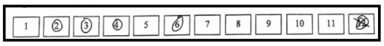
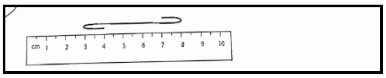
Students' Errors Based on NEA

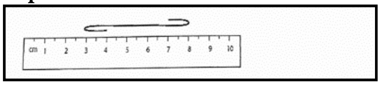
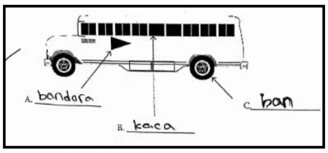
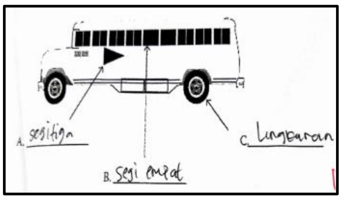
The errors made by students were then analyzed based on the type of Newman's Error Analysis (NEA) so that several things were found as shown in the Table 4 below.

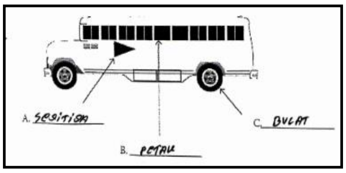
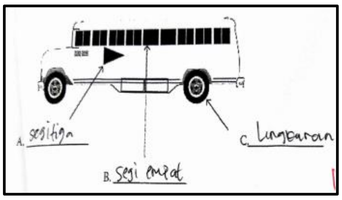
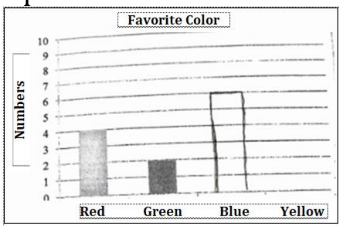
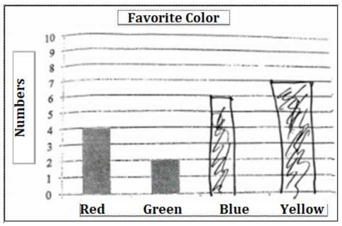
Table 4. Types of NEA Errors Made by Students

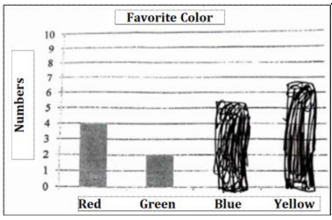
Problem Number	Students' Answers		The Type of Errors	Description
	Correct	Incorrect		
1	A, B, D, H, I and J	G	Process Skill Error	Students could not perform the steps of addition operations correctly on three- and two-digit numbers. 5.631+286 = 5877 (left to the right) should be 5.631+286 = 5.917 (right to the left)
		C, E, and F	Error in Writing Answers	Students were wrong in writing the final answer. 5.631+286 = 5.907 should be 5.631+286 = 5.917
2	F and I	A, B, C, D, E, G and J	Error in Understanding Problem	Students did not understand the information that was known and asked in the problems so that students could not write down the

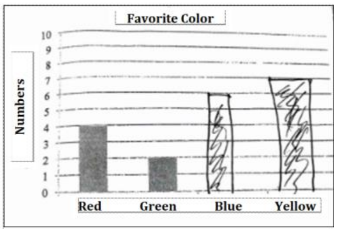
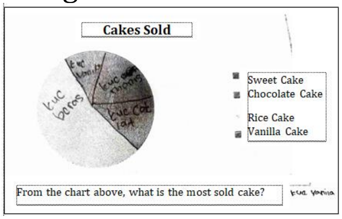
Problem Number	Students' Answers		The Type of Errors	Description
	Correct	Incorrect		
				answers to the problems correctly. 3 + 8 = **11**+ 6 should be 3+ 8 = **5** + 6
		H	Error in Problem Transformation	Students were wrong in determining the formula used in solving the problem. 3 + 8 = **8** + 6 should be 3+ 8 = **5** + 6
3	I	A, B, C, D, E, G, H and J	Error in Reading and Understanding Problem	Students did not understand the symbols and meanings of the pictures on the problems and could not understand what was being asked in the problems.  should be 
		F	Process Skill Error	Students could not solve problems with the right and correct steps.  should be 
4	A, B, C, D, E, F, G, H and J	F	Error in Reading Problem	Students could not read the meaning of the picture in the problem so they could not understand what the problem was asking so that the final answer of the student was not exactly what the problem asked for.

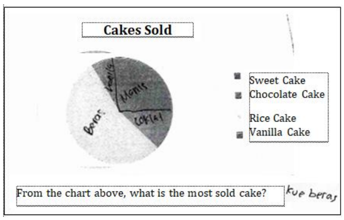
Problem Number	Students' Answers Correct	Students' Answers Incorrect	The Type of Errors	Description
				 should be 
5	C and G	H and J	Error in Understanding Problem	Students did not understand the meaning of the factors asked in the problem so that the answer was wrong  should be 
		A, B, D, E, F, and I	Error in Problem Transformation and Process Skill	Students could not determine the correct and correct way to find the factors of a number and did not use the correct steps in determining the number of factors so that not all factors were found.  should be 
6	-	A, B, D, F , I and J	Error in Reading Problem	Students could not read the meaning of the picture about the relationship between the length of the string and the number on the ruler.  should be **5 cm**
		C, E, G, and H	Error in Problem Transformation	Students were not able to determine how the arithmetic operation was to calculate the length of the

Problem Number	Students' Answers Correct	Students' Answers Incorrect	The Type of Errors	Description
				rope in the picture so they only answer according to the number that indicated the position of the end of the rope  should be **5 cm**
7	B, D, E, F, H and I	A, C, G and J	Error in Understanding Problem	Students could not understand what was being asked. The angle was more than 90^0 and less than 180^0  should be 
8	F, H, and I	C	Error in Understanding Problem	Students could not understand what form was asked in the problem. The shape in problem should be connected to flat shapes, not the name of the object in the picture.  should be 
		A, B, D, E, G, and J	Process Skill Error	Students already understood that the answer

Problem Number	Students' Answers Correct	Students' Answers Incorrect	The Type of Errors	Description
				was to connect the shape in the car image with the appropriate flat shape, but there were one or two that were not quite right in the name of the flat shape. For example, Square for square and round for circle.  should be 
9	C, E, G, H, and I	A,B,D and F	Error in Understanding Problem	Students did not understand the problem being asked that what was asked is to complete the existing graph. Students also only drew one graph.  should be 
		J	Process Skill Error	The student was not correct in the process of describing the graph.

<table>
<thead>
<tr><th rowspan="2">Problem Number</th><th colspan="2">Students' Answers</th><th rowspan="2">The Type of Errors</th><th rowspan="2">Description</th></tr>
<tr><th>Correct</th><th>Incorrect</th></tr>
</thead>
<tbody>
<tr><td></td><td></td><td></td><td>and Writing Final Answer</td><td>

should be

</td></tr>
<tr><td>10</td><td>E, F, H, and J</td><td>A, B, C, D, G, and I</td><td>Error in Writing Final Answer</td><td>Students were wrong in writing the final answer.


should be

</td></tr>
</tbody>
</table>

From Table 4, it can be seen that student I, who was very high ability, made an error in problem transformation in question number 6 and error in writing final answers in question number 10. meanwhile, student h having medium ability made error in understanding question number 3 and 5 and error in problem transformation in question number 2 and 6. For other low ability students make mistakes at all stages of NEA. The errors made in Table 4 can be grouped as follows:

Table 5. Grouping the Types of Errors

Problem Number	Reading Problems	Understanding Problems	Transformation	Process Skills	Writing Answers
1				√	√
2		√	√		
3	√	√		√	
4	√	√			
5		√	√	√	
6	√		√		
7		√			
8		√		√	
9		√		√	√
10					√

From the Table 5, it could be seen that the most errors made by students were errors in understanding problems and process skills.

Discussion

This study is in accordance with previous findings, namely the most errors when students work on TIMSS problems, namely errors in understanding problems (Rahmawati, 2020). Errors in understanding the problems will affect other errors because when students cannot understand what information and what is being asked in the problems, they will make errors when transforming problems and processing steps or calculations to solve the problem (Istiqomah & Zakiyah, 2017). The factors that caused this error were further investigated by Istiqomah and Zakiyah (2017) and Rahmawati (2020) by conducting interviews with students. However, this study has not been able to conduct follow-up interviews with ten children who have completed the TIMSS problems due to the current state of the Covid-19 pandemic. Therefore, the factors that caused them to make the errors above certainly cannot be explained further because the data needs to be re-confirmed with the respondents. Istiqomah and Zakiyah (2017) found that the reason students did not understand the problems was due to inaccuracy when reading the problems, while the error in transforming the problems in the problems was due to incomprehension of the problems, inaccuracies, and errors in choosing the solution method.

Although previous studies have used Newman's Error Analysis (NEA) in analyzing student errors, the results of this study focus on analyzing errors on TIMSS questions in all content domains (Alimuddin, Ilham & Jubaedah, 2020; Rahmawati, 2020; Susanti & Setianingsih, 2019). The results of this study can certainly add references to the types of student errors in each content domain so that a teacher can determine teaching strategies and ask questions to prevent these errors from happening again. The results of this study also suggest that students have difficulty responding to the problems that are posed. Using this NEA model, it was possible to identify the problems from the students' error analysis. The students' perception of the error demonstrated that they have not yet developed the necessary abilities for evaluating and producing higher-order thinking capabilities. This result is consistent with the previous TIMSS assessment (Hadi & Novaliyosi, 2019; Prastyo, 2020), which found that Indonesian Students obtained the lowest points. It shows that they were difficult to answer TIMSS Problems consisting of higher-order thinking problems to evaluate and create critical thinking skills.

The findings of this study also show that learning and teaching higher-order thinking skills present a number of difficulties. Teachers, especially those in the district, are crucial in ensuring that students can develop Higher-Order Thinking Skills (HOTS) in mathematics. The learning process ought to include a separate section on subjects related to the growth of higher-order thinking abilities (Alhassora, Abu & Abdullah, 2017). The curriculum and lesson plan must make reference to this activity in precise detail. Nuryadin and Lidinillah (2014) added that giving non-routine problems can stimulate students' higher-order thinking skills. However, teachers mostly teach math routine problems to students in the mathematics classroom because of the limited availability of non-routine questions in the source books they use (Sanidah & Sumartini, 2022), posed math multiple-choice questions (Sari & Aripin, 2018), and closed-questions (Febrilia, 2019; Sapitri, Utami & Mariyam, 2019). As a result, students are not accustomed to solving problems that require higher-order thinking processes and mathematical creativity. Siskawati (2021) recommends several things to avoid errors, namely teaching how to identify everything that is known in the problem and writing it down on the answer sheet, rewriting the problem on the answer sheet, writing down all the steps and answering in full, solving problems sequentially, and concluding answers correctly. However, for further research, it is necessary to analyze the causes of students making these errors. In-depth interview techniques with larger samples need to be applied in future research.

Conclusion

Based on this research, it can be concluded that the ability of fourth-grade students at SD Negeri 36 Lubuk Sirih Ilir Village, Manna District, South Bengkulu Regency, Bengkulu Province, in solving TIMSS problems is still in the low category. The majority of students made errors during solving TIMSS problems in numbers, measurement and geometry domains, primarily in problem number 6 regarding how to measure a thing. After analyzing, these errors using the NEA method, most students faced difficulties in reading, understanding the problems, and doing process to solve the problems. As a result, the answer obtained is wrong. The limitations of this study are the limited number of samples and have not yet produced data on the factors that cause students to make errors. Whether the factors that cause students to make many errors when solving these TIMSS problems need to be investigated further using deep interviews. Testing the TIMSS problems needs to be done with a larger sample distribution and diverse demographics so that there will be many findings that can be used as evaluation material in supporting the improvement of Indonesian students' abilities according to international standards.

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