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Students' Error Analysis in Solving Word Problems in Exponential Number Topic Based on Newman's Error Analysis (NEA) Theory

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abstract

In mathematics, students usually experience errors in solving word problems. Previous studies found that students' skills in solving word problems were not good enough. Therefore, exploring students' errors to be a consideration in designing efforts to minimize these errors is necessary. This study aimed to describe the errors made by students in solving word problems in exponential numbers based on Newman's theory. Based on Newman's view, there are five stages of students' error: reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. This research is a descriptive qualitative study involving grade nine with two students in each category, namely high, medium, and low levels of mathematics ability. The data collection was conducted through documentation and interview. The study's data analysis involved data reduction, data display, and conclusion drawing. Based on the data analysis, it could be concluded that: 1) students with the high mathematical ability still committed errors in the transformation, process skill, and encoding stages, 2) students with moderate mathematical ability were still experiencing errors in the transformation, process skill, and encoding stages, but one of the subjects also made errors at the reading and comprehension stages, 3) students with the low mathematical ability experienced quite a lot of errors in solving the word problems, namely at the comprehension, transformation, process skill, and encoding stages but one of the subjects also made errors at the reading stage. These findings could be used as consideration in planning teaching and learning activities to minimize the occurrence of similar errors in students with various levels of mathematical ability.

Keywords:
Newman's Error Analysis, Exponential Numbers, Mathematics Word Problems

INTRODUCTION

Mathematics is considered one of the most important sciences and dominates almost all levels of education, from elementary to college. Mathematics also plays an essential role in the life and development of science and technology. Those are important and essential because one of the general goals of mathematics is to prepare students to use the mathematical mindset in everyday life (Amalia, 2017). Therefore, it can be said that mathematics is a significant knowledge to be taught in school.

According to Cornelius in Abdurrahman (2003: 253), the five reasons that we need to learn mathematics because of the following: (1) a clear and logical means of thinking, (2) a means to solve problems in everyday life, (3) a means to recognize patterns of relationships and generalization of experience, (4) a means for the development of creativity, (5) a means for increasing awareness of cultural development. However, a learning process does not always run smoothly and successfully, considering that the child's ability to receive material is also different. Some students have high and medium skills, and some have low skills. Some of these skills result in children's success in learning and experiencing differences.

Mathematical ability is performing mental activities such as thinking, reasoning, and using all the knowledge to solve mathematical problems (Men, 2017). Students' mathematical abilities vary and are categorized in the form of levels (Men, 2017). This study classified students' mathematical skills into high, medium, and low. Each of those levels may experience different errors in solving mathematics problems.

In Newman's opinion in White (2005), errors in the work of mathematical problems are categorized into five types of errors, namely: (1) reading errors, (2) comprehension errors, (3) transformation errors, (4) process skill errors, and (5) encoding errors. In the process of problem-solving, according to Newman's theory, there are two kinds of obstacles that hinder a student from arriving at the correct answer. Those obstacles are (1) problems in linguistic fluency and conceptual understanding that correspond with the level of simple reading and understanding meaning of problems, and (2) problems in mathematical processing that consists of transformation, process skills, and encoding answers (Prakitipong & Nakamura, 2006). The use of problem-solving stages with Newman procedures is expected to help determine the variety of student errors. Therefore, Newman's theory can be used as a reference in analyzing student errors and knowing the causes, especially in math word problems.

There are still many students who have difficulty solving math word problems. Solving mathematical problems in the form of word problems requires the ability to calculate or calculate and needs reasoning power (Umam, 2014). So, students can know what the matter means, and all the information about what is known and asked, aspects of solving the word problem are quite a lot. Students must be able to understand the intentions and problems that will be solved, compile the mathematical model, and relate the problem with the learning material that has been studied so that they can solve it using the knowledge that has been owned (Umam, 2014).

Several studies have investigated the causes of students' difficulties in solving math word problems. Students can have trouble doing the stages of solving problems because they are not used to writing down problem information, are less careful in determining solutions strategies, are inaccuracy in doing calculations, and are less precise in writing conclusions (Sutama et al., 2020). In addition, Timutius et al. (2018) reveal the difficulty of students lies in the process of solving, not understanding problems, misrepresentation in identifying images, incomplete completion, and understanding of the concept of material. The difficulty of most math problems does not lie in calculations but in knowing how to clarify the problem so they can solve it. Students always want to get the final result directly without making a simple mathematical model of the problem (Kania, 2018).

Another study of Nursyahidah et al. (2018) states that the errors made by students are: wrong in converting the information given into mathematical models, students cannot determine formulas, students being wrong in the selection of concepts, errors in interpreting solutions, students do not make conclusions, and errors in calculations. The reason why students make errors is to pay less attention to problems, forget formulas, lack understanding of the material, and be less thorough in doing calculations.

Furthermore, Muntaha et al. (2020) explained that capable students have difficulty understanding the steps of mathematical modeling. The problem is caused because students cannot assume verbal sentences, especially those containing the same two variables. In addition, students have not been able to explain why they choose symbols contained in mathematical equations or models. The research conducted by Asriyani et al. (2020) concluded that student errors are caused by: haste to read and understand problems, lack of rigor in the calculation process, and lack of understanding of basic concepts of calculations, algebra, calculation, and fractional reduction. Murtiyasa et al. (2020) explained students' errors in solving math word problems based on PISA frameworks. Those errors give incorrect answers on shape and space, uncertainty and data, and change and relationship categories.

Previous studies found that one of the mathematics topics in which students experienced errors and misconceptions is exponential numbers. They experienced errors and misconceptions in simplifying exponential expressions, mainly negative signs (Cangelosi et al., 2013). Another study stated that students still experience procedural, conceptual, and computational errors in solving problems in exponential numbers topic (Effendi, 2022). Moreover, based on an interview with teachers in the research setting, students' understanding of the concepts of exponential numbers is less maximal, particularly in an online learning setting.

The exponential number is a topic taken at the junior high school level of grade nine, with the primary material in exponential numbers and roots. Furthermore, the contents are exponential numbers, multiplication on the exponential numbers, division on the exponential numbers, zero power, negative power, and roots (Subchan et al., 2018). In solving the problem of exponential numbers, the key is to understand the nature of the number itself. There are properties of multiplication and division of exponential numbers and properties of numbers with zero power, negative power, and roots.

Based on the background outlined above, mathematics word problems and exponential numbers are challenging for students. However, there are still limited studies focusing on investigating errors in the topic of exponential numbers with mathematics word problems. Therefore, this study aimed to examine students' errors in solving math word problems in the exponential number topic based on Newman's theory that is reviewed from the students' mathematical abilities.

METHODS

This study uses descriptive qualitative research to determine the errors made by students carefully working on word problems using Newman procedures and reviewing students' mathematical abilities. This study was conducted at a public Islamic lower secondary school. In this study, the subjects used were six students in grade nine. The reason for choosing six students as the subject is because the research process took place during the CoViD-19 pandemic, so it was impossible to involve students on a large scale or in one class.

Table 1. Student Grouping Criteria

Interval	Ability Level
$x < \bar{x} - \frac{1}{2}$ SD	Low
$\bar{x} - \frac{1}{2}$ SD $\leq x \leq \bar{x} + \frac{1}{2}$ SD	Middle
$x > \bar{x} + \frac{1}{2}$ SD	High

Information:

x = Student score

$\bar{x}$ = Average student score

SD = Standard deviation

The research subjects were selected based on students' learning outcomes on the exponential number topic, categorized into high, medium, and low mathematical abilities. Moreover, good communication skills are another criterion (the mathematics teacher's recommendation). These categories are grouped by finding the average value and standard deviation and determining group boundaries. The group boundary is defined according to the HW (2018) presented in Table 1. Two students from each category were taken based on interviews with teachers with communicative, active criteria and a place to live close to the school. Table 2 shows the six subjects of this study.

Table 2. Research Subjects

Student Initial	Category
ANS	High (S-T1)
MIN	High (S-T2)
DW	Middle (S-S1)
W	Middle (S-S2)
APR	Low (S-R1)
SP	Low (S-R2)

The data collection methods used in this study were documentation and interview. The documentations collect data about student errors based on students' written works in solving math word problems in exponential numbers. Interviews collect additional information that can be used as data reinforcement from analyzing students' written works. The instruments (mathematics word problems in exponential numbers topic and interview protocol) are already validated by two experts: a mathematics education lecturer from a university and a certified mathematics teacher from a school.

The validity of the data in this study is the triangulation method, by using documentation of students' written works and interviews as reinforcement of answers from the result of the written test. The analysis carried out in this study is based on the indicators of Newman's theory errors, namely reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. Moreover, Jha (2012), Singh et al. (2010), and White (2005) presented indicators of errors in solving problems in the form of descriptions based on Newman procedures as explained in Table 3.

Table 3. Factors and Indicators of Student Error

Error Factors	**Indicators**
Reading	1. Unable to recognize and or read symbols in problems. 2. Cannot interpret the meaning of words, symbols, or terms in the problem.
Comprehension	1. Unable to understand the information known in the matter in full. 2. Unable to understand what is being asked in full.
Transformation	1. Unable to create mathematical models of the information obtained. 2. Do not know the formula needed to answer the question. 3. Do not see the calculation operation required to solve the problem.
Process Skill	1. Do not know the steps used to answer the problem.
Encoding	1. Cannot determine the outcome of the problem with the steps that have been used. 2. Unable to show the result of the problem correctly. 3. Unable to write final answers to conclusions.

Data analysis techniques include data reduction, presentation, and conclusion drawing. Data reduction, namely simplifying the data obtained from the result of student work and interviews. Presentation of data, namely presenting data obtained from the result of student errors. Then in the last stage, conclusions are drawn from the data obtained. The research procedure is illustrated in Figure 1.

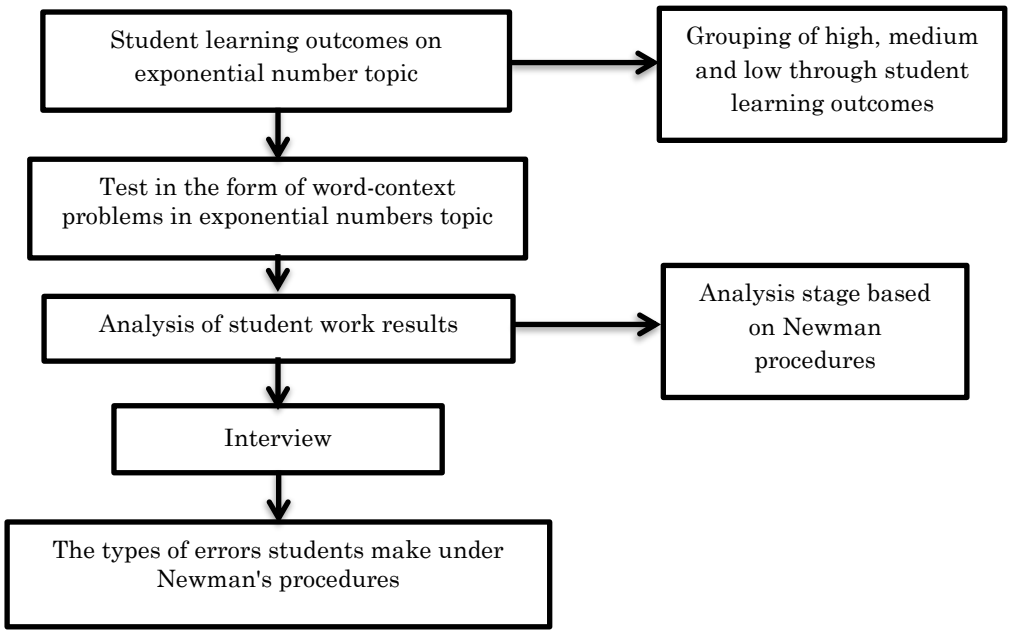

Figure 1. Research Procedure

RESULT AND DISCUSSION

Written test questions are given to the six students selected based on their category of mathematical ability. Problems with the problem include the material of grade 9 that relates to everyday life.

1. Find the value of the following numbers: 4^2 x 3^3 x 6
2. A study known as amoeba S reproduces by dividing two times every 15 minutes. How many amoebae S for one day if in 1 observation there are four amoebae?
3. The intensity of the sound of human conversation is 106 times the intensity of the human voice whispering. While the power of the sound taking off is 1014 times the intensity of a human whisper. How many times is the intensity of the sound of an airplane taking off compared to the sound of human speech?

From the data obtained, researchers can present the results of the analysis into three parts based on Newman's theory and reviewed from the student's mathematical ability, namely errors made by students at high levels of mathematical ability, errors made by students at moderate level of math ability, and errors made by students at low category levels.

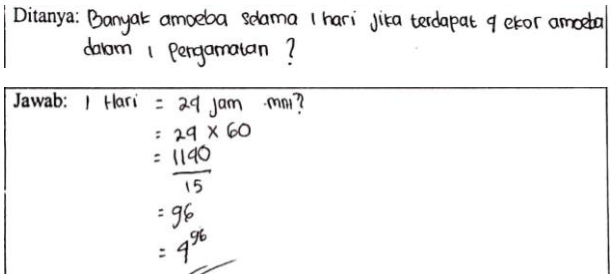

Figure 2. The result of the written work of S-T1 on question number 2

Based on the answer to problem number 2 in Figure 2, it is seen that S-T1 can read the problem and write down the information about the problem. Furthermore, in the transformation process, S-T1 can work on the problem according to mathematical procedures at the beginning of work. However, for the next step, S-T1 makes the error that is to missing 1 step using the formula in solving the problem and drawing conclusions or determining the results also make errors.

P : "How do you solve the problem?"
S-T1 : "First look for the amount of time one day in minutes, then it divides itself every 15 minutes so the one-day time is divided by 15 to find n and the result is 96, and the result is 4 to the power of 96."
P : "After looking for it, you immediately found the answer? **No further steps**?"
S-T1 : "Emm.. **kinda forget**, miss."

Based on the interview results, the S-T1 can read and understand the problems that have been given. However, there are shortcomings and errors due to forgetting to present transformation, process skills, and concluding orally and in writing. The cause of students making errors in process skills is that students fail how to work on problems, make erros in determining formulas, and are not careful in the calculation process.

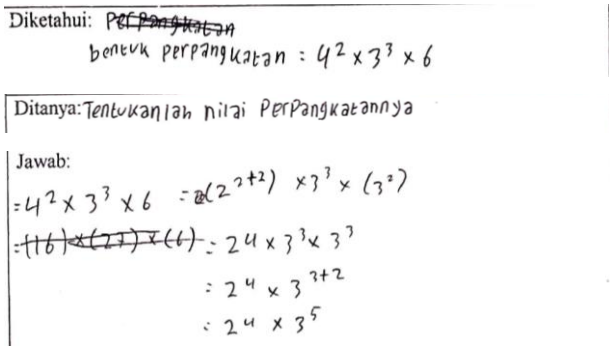

Figure 3. The written work of S-T2 on question number 1

Based on the answer to problem number 1 in Figure 3, the S-T2 can read the problem and write down the information he saw. Furthermore, in the transformation section, it can be seen that the subject has worked on the existing problem, but there are still errors in the use of formulas or the properties of the exponents. In addition, the subject has not solved the problem according to what is asked.

P : "How do you find that power value?"
S-T2 : "Calculation of 4^2 x 3^3 x 6."
P : "Take a look at your work. **Have you found the solution to the problem**?"

S-T2 : "Oh yeah, **not yet**, miss."
P : "See your answer again. **Why 4^2 can be (2^{2+2}) and six becomes 3^2?**"
S-T2 : "I **kinda forgot about it**."
P : "How can you forget?"
S-T2 : "Rarely open my book, miss."

Based on the interview results, information is obtained that the S-T2 can read and understand the problems contained in the question. But in getting an answer, the S-T2 uses steps with formulas or properties of exponential numbers that are still incorrect and do not perform calculations following what is sought. In drawing conclusions or answers, there are also errors. The subject is aware of errors in the results of solutions that have not been through calculations and errors like the exponential numbers due to forgetting and less opening the book to be relearned.

From the discussion results above, it can be concluded that students with high-category mathematical skills still make some errors in working on word-context problems. According to Newman's theory, the errors made are at the transformation stage, the process skills stage, and the encoding stage. This is in line with Rohmah (2018) research, which shows that some students are capable of still making some errors in solving a given problem. The error lies in the transformation of problems, the skill of processing, and the withdrawal of conclusions (Murtiyasa & Wulandari, 2020).

Errors Analysis of Students' with a Moderate Level of Mathematics Ability

The results show that in solving problem number 1, the S-S1 still makes some errors, namely: the subject does not write down what is asked precisely and does not make a transformation first in search of answers. The subject immediately writes the solution without the calculation steps, and the written response is inappropriate.

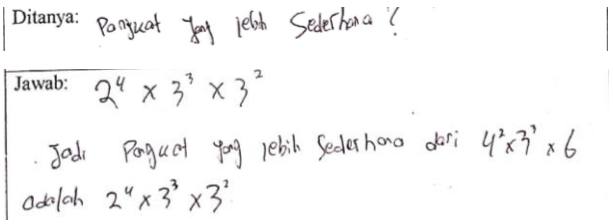

Figure 4. The result of subject S-S1 work on problem number 1

Based on the results of the interview, the errors made by the subject increased in reading errors. It is because they are wrong in reading the problem that has been corrected and wrong in interpreting a word or sentence.
P : "So what is the correct question being asked??"
S-S1 : "**Determine the result** miss."
P : "Try to see your work, is it correct or not, **that's what was asked in the question**"
S-S1 : "Yes miss **I was wrong, I thought it was the same** miss."
P : "If that is asked in terms of the result of the operation, how do you solve the problem??"
S-S1 : "Calculated miss."
P : "What counts?"
S-S1 : "It's 4^2 x 3^3 x 6."

P : "Here you know how, **why don't you count your answers?**"
S-S1 : "Oh yes miss, **it means i forgot**."

Based on the figure of the work of S-S2 on problem number 2, the subject can understand the problem's purpose and all the information contained in the problem. However, the next step is transformation. The subject of S-S2 has done the calculation with the necessary formula, but the process is still incomplete. So it can be said that the subject experienced errors in transformation and process skills. Consequently, in writing the answer to the subject, S-S2 also experienced errors due to the incomplete quality process.

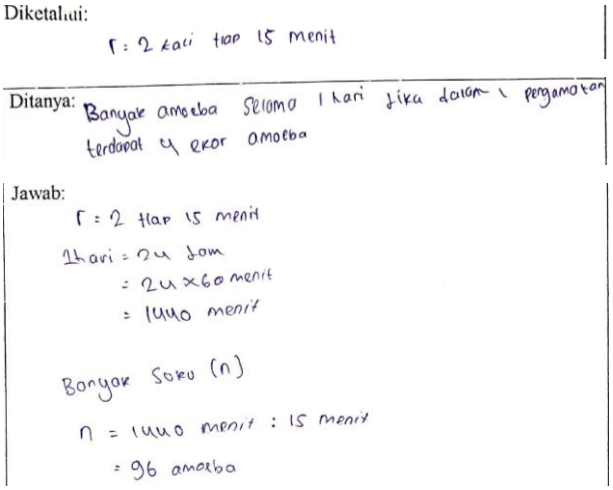

Figure 5. The result of subject S-S2 work on problem number 2

After seeing the interview results, It obtained information that the subject feels confused in working on the problem, so the subject does not solve it until it is finished to find the correct answer.

P : "Then **what makes you confused**?"
S-S2 : "**How to solve it** miss."
P : "That's your answer is already there."
S-S2 : "Yes there is miss, **but I'm not sure**."
P : "Means that next time you will try to do more questions, so that you understand very well how to do the questions."
S-S2 : "Yes miss."

The subject made an error starting at the transformation stage, namely in solving the problem the subject did not finish until he found the answer. The cause students make errors during the transformation stage because they do not understand the problem, so they cannot determine the operation used to solve the problem and do not know the formula or operation used (Murtiyasa & Wulandari, 2020).

Based on the discussion above, it can be concluded that students with moderate category mathematical skills still make some errors in working on a word problem. Of the two subjects studied, generally in the category is making errors in the stage *of transformation*, *process skill*, and answer writing (*encoding*). However, one of the subjects' errors in the five indicators of error in Newman's theory, namely adding errors in the reading stage and understanding the problem (*comprehension*). This is in line with

Yusuf & Fitriani's (2020) research, which states that students with mathematical skills do not understand the operation to solve problems, which means that students' errors lie in the understanding and transformation stages, where an error in the early stages will cause the following error. Students with moderate levels make errors in the form of misunderstanding the problem, which results in the incorrect use of the solution formula (Savitri & Yuliani, 2020).

Errors Analysis of Students' with a Low Level of Mathematics Ability

Based on the image of the subject's work S-R1 at number 1, it can be seen that the subject made a mistake from the initial stage to the final step, where subject R1 experienced an error in reading the problem command to write down the known and asked experienced an error. Furthermore, in quality and problem-solving, the subject also experienced errors.

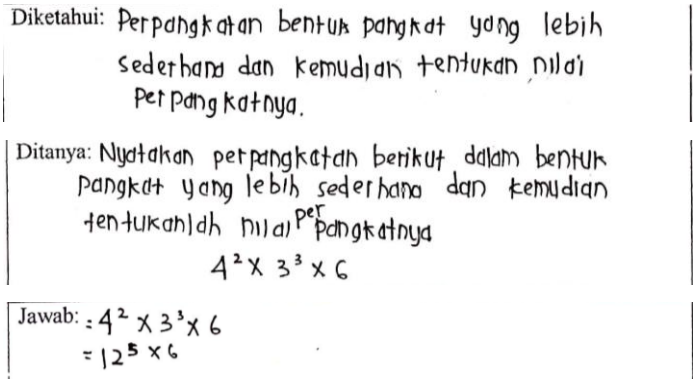

Figure 6. The written work of S-R1 on problem number 1

P : "I already told you about the error in that question. the problem is this, determine the values of 4^2 x 3^3 x 6."
S-R1 : "Yes miss"
P : "So what is asked in the question?"
S-R1 : "**Simplifying the exponential expression miss**?"
P : "Come on, that's clearly an error in the question, so it determines the value of the exponential expression."
S-R1 : "**I think it's the same** miss."
P : "That's different. How to solve it?"
S-R1 : "**I don't know** miss."
P : "why don't you know?"
S-R1 : "it's hard miss."

Through interviews with the subject, S-R1 obtained information that the subject has difficulty interpreting a word or sentence in the question, has errors in mentioning what is asked about the question, and has difficulty solving the problem. This finding is in line with Laily's (2014) opinion that reading skills play a significant role in the general steps of how students can solve a math word problem.

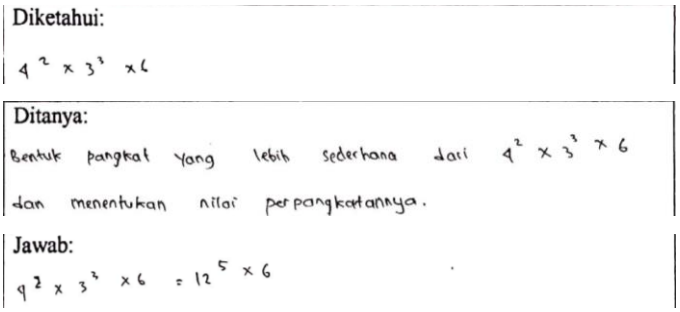

Figure 7. The written work of S-R2 on problem number 1

Based on the answer of subject S-R2 on question number 1 above, it can be known that the subject wrote what is known in the problem, but at the time of writing, the section asked the subject R2. There is still a slight error. The subject R2 wrote a question that has not been improved. The step of answering the subject question does not do the process, and the mathematical steps and answers written are also still not appropriate.

P : "So what is the question asked?"
S-R2 : "Form of a power that is simpler than 4^2 x 3^3 x 6 and determine the exponent value."
P : "After correcting the question, is that really what you asked?"
S-R2 : "Uh **I don't know** miss."
P : "what is being asked is the rank value. so how do you solve it?"
S-R2 : "**I don't know** miss."
P : "Why don't you know how to do it?"
S-R2 : "**Forget and it's hard** miss."

Based on the interview results, the subject does not correctly understand the information in the problem; the subject has difficulty working on it, so they cannot solve the problem asked. The subject also forgets a little and works on the original.

Based on the figure of the work of the subject S-R2 at number three, it can be seen that the subject can explain and write precisely what is known and asked about the question, but when answering the subject question is still wrong in the transformation. The solution steps are also still lacking, so in this case also experiencing errors. As a result, writing the answer also still experienced errors.

P : "Yes it's true what is known and asked. Now how do you solve such a problem?"
S-R2 : "Compared maybe?"
P : "How come? What do you compare it to?"
S-R2 : "I answered a bit earlier miss. Em is the sound of an airplane taking off compared to the sound of human conversation."
P : "What's the next step?"
S-R2 : "**Don't know** miss."

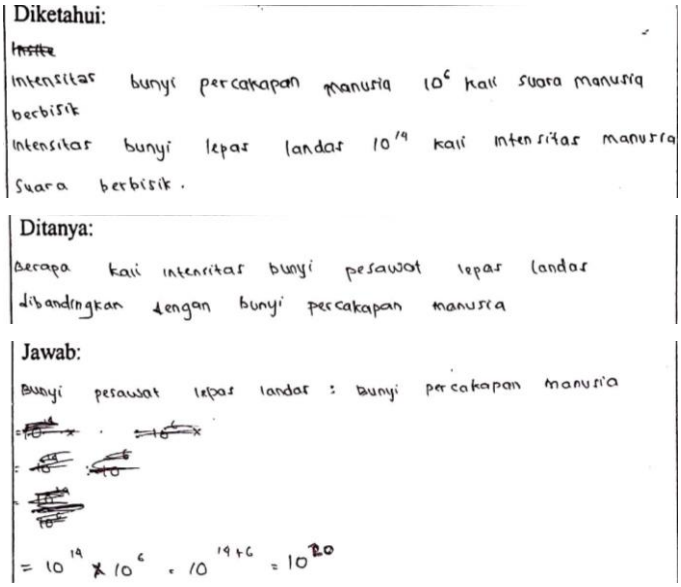

Figure 8. The written work of S-R2 on problem number 3

Based on the interview results, subject S-R2 has difficulty understanding the chosen formula. The subject was writing the steps of the calculation, many errors occurred, and the results of the answers were not appropriate. Apriliawan et al. (2013) state that students with low mathematical abilities tend to experience errors in applying concepts, applying formulas, experiencing errors in determining problem-solving procedures, errors in arithmetic operations, and solving problems. Students experience errors in solving word problems because they are less careful, are in a hurry, are not used to writing complete answers, do not understand the material, and do not understand the problem (Sari & Rejeki, 2021).

Thus, in solving the problem of the story of the material, students with low-category mathematical skills still make many errors in solving a problem. Murtiyasa et al. (2022) stated that in addition to students, undergraduate students also made many errors in solving math problems, one of which was in the interval estimation material in the statistics course. Based on the Newman theory stage, low-skilled subjects often experience errors in understanding the problem (*comprehension*), *transformation*, *process skills*, and writing answers (*encoding*). However, one of the subjects made a mistake at all five stages of Newman's theory by adding errors at the reading stage.

Tabel 4. The Summary of Students' Errors

Subject	Question Number 1					Question Number 2					Question Number 3				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Subject T1								√	√	√					
Subject T2			√	√	√										
Subject S1	√	√	√	√	√			√	√	√			√	√	√
Subject S2			√	√	√			√	√	√					
Subject R1	√	√	√	√	√			√	√	√			√	√	√
Subject R2		√	√	√	√			√	√	√			√	√	√

Information:

1 : Reading Errors
2 : Comprehension Errors
3 : Transformation Errors
4 : Process Skill Errors
5 : Encoding Errors

CONCLUSION AND IMPLICATION

Based on the results of the analysis, it can be concluded that the student's error in solving the word-context problem in exponential numbers topic based on Newman's theory and reviewed from the students' mathematical ability as follows: (1) student with high mathematical abilities in solving word-problem exponential number did not make errors in question number 3. However, S-T1 experienced errors in question number 2. The error began at the transformation error stage. In contrast, S-T2 experienced an error in question number 1, where the error started at the transformation stage, (2) students with moderate mathematical abilities made the same errors in question number 2, and the error started at the transformation error stage. However, S-S1 in question number 1 also made errors starting at the reading stage, and in question number 3 made errors starting at the transformation stage.

Meanwhile, S-S2 also made an error in question number 1, where the error started at the transformation stage, (3) students with low mathematical ability in solving word-problems exponential numbers make the same errors in questions 2 and 3, where the error begins at the transformation error stage. However, S-R1 in question number 1 made an error starting at the reading stage. Meanwhile, S-R2 also made an error in question number 1, which started at the comprehension stage.

This study describes students' errors using Newman's theory of high, medium, and low math ability categories. The error made by students also varies according to the skills of each student. Errors made by students can be used as a consideration for teachers in planning teaching and learning activities. This study's results can be known as the location of errors made by students in solving word problems. So that teachers can evaluate and innovate in the development of more precise learning and build mathematical concepts in students to minimize the occurrence of similar errors and improve their mathematical skills.

REFERENCES

Abdurrahman, M. (2003). *Pendidikan Bagi Anak Berkesulitan Belajar*. Penerbit Rineka Cipta.

Amalia, S. R. (2017). Analisis Kesalahan Berdasarkan Prosedur Newman dalam Menyelesaikan Soal Cerita ditinjau dari Gaya Kognitif Mahasiswa. *Aksioma*, *8*(1), 17. https://doi.org/10.26877/aks.v8i1.1505

Asriyani, R. Y., Handayani, I., & Hadi, W. (2020). Students' Errors in Mathematical Problem-Solving Ability on the Triangular and Quadrilateral Materials at Junior High Schools (SMP) Jakarta. *Desimal: Jurnal Matematika*, *3*(2), 125–136. https://doi.org/10.24042/djm.v3i2.5728

Cangelosi, R., Madrid, S., Cooper, S., Olson, J., & Hartter, B. (2013). The negative sign and exponential expressions: Unveiling students' persistent errors and misconceptions. *Journal of Mathematical Behavior*, *32*(1), 69–82. https://doi.org/10.1016/j.jmathb.2012.10.002

Effendi, R. (2022). Analisis Kesalahan Menyelesaikan Soal Perpangkatan Dan Bentuk Akar Pada Siswa Kelas IX.6 SMPN 2 Lahat. *Jurnal Pendidikan Matematika Undiksha*, *13*(1), 39–47. https://doi.org/10.23887/jjpm.v13i1.41001

HW., S. (2018). *Statistika Deskriptif Parametrik Korelasional*. Muhammadiyah University Press.

Jha, S. K. (2012). Mathematics performance of primary school students in Assam (India): an analysis using Newman procedure. *International Journal of Computer Applications in in Engineering Sciences*, *2*(I), 17–21.

Kania, N. (2018). Analisis Kesalahan Mahasiswa Pgsd Dalam Menyelesaikan Soal Pemecahan Masalah Matematis Berdasarkan George Polya. *Eduma : Mathematics Education Learning and Teaching*, *7*(1), 19-39 https://doi.org/10.24235/eduma.v7i1.2711

Laily, I. F. (2014). Hubungan Kemampuan Membaca Pemahaman Dengan Kemampuan Memahami Soal Cerita Matematika Sekolah Dasar. *Eduma : Mathematics Education Learning and Teaching*, *3*(1). https://doi.org/10.24235/eduma.v3i1.8

Men, F. E. (2017). Proses Berpikir Kritis Siswa SMA dalam Pengajuan Soal Matematika Berdasarkan Tingkat Kemampuan Matematika. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *8*(2), 191–198. https://doi.org/10.15294/kreano.v8i2.7192

Muntaha, A., Wibowo, T., & Kurniasih, N. (2020). Analisis Kesulitan Siswa dalam Mengonstruksi Model Matematika pada Soal Cerita. *Maju*, *7*(2), 53–58. https://ejournal.stkipbbm.ac.id/index.php/mtk/article/view/487

Murtiyasa, B., Ma'rufi, A., & Affendi bin Abdullah, M. A. (2022). Undergraduate students' errors on interval estimation based on variance neglect. *Jurnal Elemen*, *8*(1), 161–174. https://doi.org/10.29408/jel.v8i1.4529

Murtiyasa, B., Rejeki, S., & Ishartono, N. (2020). *Profile of Students' Error in Solving Mathematics Word Problems Based on PISA Frameworks*. *467*(Semantik 2019), 135–137. https://doi.org/10.2991/assehr.k.200827.131

Murtiyasa, B., & Wulandari, V. (2020). Analisis Kesalahan Siswa Materi Bilangan Pecahan Berdasarkan Teori Newman. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(3), 713. https://doi.org/10.24127/ajpm.v9i3.2795

Nursyahidah, F., Saputro, B. A., & Rubowo, M. R. (2018). A Secondary Student's Problem Solving Ability in Learning Based on Realistic Mathematics with Ethnomathematics. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *3*(1), 13. https://doi.org/10.23917/jramathedu.v3i1.5607

Rohmah, M., & Sutiarso, S. (2018). Analysis problem solving in mathematical using theory Newman. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 671–681. https://doi.org/10.12973/ejmste/80630

Sari, Y. R., & Rejeki, S. (2021). Analisis Kesalahan Berdasarkan Teori Newman dalam Menyelesaikan Soal Cerita Materi Pecahan pada Siswa Kelas VII. *Journal of*

Education Research, *3*(4), 1–12. https://doi.org/10.36653/educatif.v3i3.74

Savitri, D. A., & Yuliani, A. (2020). Analisis Kesalahan Siswa dalam Menyelesaikan Permasalahan Trigonometri Ditinjau dari Gender Berdasarkan Newman. *Jurnal Pembelajaran Matematika Inovatif*, *3*(5), 463–474. https://doi.org/10.22460/jpmi.v3i5.463-474

Singh, P., Rahman, A. A., & Hoon, T. S. (2010). The Newman procedure for analyzing Primary Four pupils errors on written mathematical tasks: A Malaysian perspective. *Procedia - Social and Behavioral Sciences*, *8*(5), 264–271. https://doi.org/10.1016/j.sbspro.2010.12.036

Subchan, Winarni, Mufid, M., Fahim, K., & Syaifudin, W. (2018). *Matematika SMP/MTs Kelas IX*. Pusat Kurikulum dan Perbukuan, Balitbang, Kemendikbud.

Sutama, S., Sofia, S., & Novitasari, M. (2020). Analisis Kemampuan Penyelesaian Soal Matematika Berorientasi Pisa Dalam Konten Perubahan Dan Hubungan Pada Siswa Smp. *Jurnal VARIDIKA*, *31*(2), 29–36. https://doi.org/10.23917/varidika.v31i2.10216

Timutius, F., Apriliani, N. R., & Bernard, M. (2018). Analisis Kesalahan Siswa Kelas IX-G di SMP Negeri 3 Cimahi dalam Menyelesaikan Soal Pemecahan Masalah Matematik pada Materi Lingkaran. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(3), 305. https://doi.org/10.22460/jpmi.v1i3.p305-312

Umam, M. D. (2014). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Cerita Matematika Materi Operasi Hitung Pecahan. *MATHEdunesa*, *3*(3), 131–134. Retrieved from https://jurnalmahasiswa.unesa.ac.id/index.php/3/article/view/12779

White, A. L. (2005). Active Mathematics in Classrooms: Finding Out Why Children Make Mistakes – And Then Doing Something to Help Them. *Journal of Science and Mathematics Education in Southeast Asia*, *15*(4), 15–19.

Yusuf, A., & Fitriani, N. (2020). Analisis Kesalahan Siswa SMP dalam Menyelesaikan Soal Persamaan Linear Dua Variabel di SMPN 1 Campaka Mulya-Cianjur. *Jurnal Pembelajaran Matematika Inovatif*, *3*(1), 59–68. https://doi.org/10.22460/jpmi.v3i1.p59-68