Errors in solving math problems based on newman type

Fitrianto Eko Subekti and Desy Puspita Sari
Mathematics Education Department, Universitas Muhammadiyah Purwokerto, Indonesia
E-mail: fitriantoekosubekti@ump.ac.id

Abstract. The research aims to identify the types of mistakes students make in solving math problems in straight-line equation materials based on Newman type. The study subjects were 34 students of Grade VIII G SMP Negeri 2 Baturaden. Data retrieval techniques using tests. The data is analyzed with the Newman stage. The results showed 1) the highest percentage of errors on question number two was 93.08%; 2) the highest percentage of student errors at the encoding stage of 69.16%; and the lowest at the Transformation stage of 53.36%; 3) some of the mistakes made include: errors in understanding the problem, inaccuracies placing symbols in the problem-solving process, do not write down the complete information on the question; do not use formulas correctly, do not use proper calculation procedures, and did not write the final result correctly because students were still mistaken in doing calculations.

1. Introduction
Education is an important part of improving competitiveness by improving the quality of human resources [1]. Education changes the mindset to make improvements towards improving self-quality [2]. The development of advanced science and technology requires people to understand and train themselves in solving problems in daily life [3]. Solving problems in everyday life is inseparable from mathematics. Mathematics became a basic science used in various areas of life. Mathematics fosters critical, logical, systematic, meticulous, effective, and efficient thinking skills in solving problems [1]. To hone these thinking skills, skills are needed to solve mathematical problems [4]. Problem-solving requires students to be able to set the right strategies for planning solutions, and this is very difficult for students who do not understand the problem [5]. Learning mathematic is also not only required to master the concept of mathematics, but to be able to apply the concept of mathematics in life [6]. In studying mathematics, students are expected to formulate and express their thoughts in oral, written, and diagrammatic forms [7]. Students should also be able to see the problems encountered and plan the right strategies to solve everyday problems using math knowledge [8]. Lack of knowledge causes laziness in solving math problems [9]. This can result in an error in solving a math problem.

Student error is a form of student incomprehension of the question given [8, 10-11]. To find out how far students have mastered the material, it can be seen from the student's error in solving the problem [4]. Basic mistakes students often make in the form of understanding the concept and interpreting questions and diagrams [12]. This has an impact on students' inability to build plans from conceptual knowledge to determine solutions to problems [13].

Identifying students' mistakes in working, can help figure out the part of the mistakes they make [8, 14]. Also besides, it can also provide information about the student process in solving problems [15].
Students’ mistakes in solving math problems, impacting low math learning outcomes [16]. Lack of student thoroughness, understanding of concepts, and lack of training are some of the contributing factors to the mistakes made by students [17]. Correcting mistakes and overcoming difficulties can improve learning quality and minimize mistakes so that learning achievement can improve [4]. Analysis of students' mistakes in solving problems aims to know the difficulties experienced by students so that improvements can be made in the future [18]. Using Newman Error Analysis (NEA), teachers can devise effective and appropriate teaching strategies to address student mistakes [8, 19].

Analysis of errors using Newman’s stages is as follows [20].

a. Reading, read and recognize mathematical symbols
b. Comprehension, understand symbols and math problems
c. Transformation, able to convert information into symbols, graphs, operations, or mathematical sentences correctly
d. Process skill, able to properly implement calculations and procedures
e. Encoding, can write answers correctly in the form of numbers, symbols, or words

In solving math problems, students will have difficulty. The difficulty experienced by students allows for errors in solving math problems. By analyzing the mistakes made by students, teachers can make improvements in learning activities to help students understand the material. Also besides, students can also minimize making the same mistakes if they find the same problem. The study aims to look at the percentage of errors students make in solving problems and identify the types of errors from the answers of Grade VIII students of State Junior High School 2 Baturraden by analyzing errors using Newman’s stages.

2. Method

The research conducted is quantitative descriptive research, which is analyzing students' mistakes to see the types of mistakes made in solving math problems judging by the answer to the test, and presented a percentage of the mistakes made by students. The research was conducted in grade VIII G SMP Negeri 2 Baturraden school year 2019/2020 on the material of straight-line equations.

The data is taken using tests. The test problem with straight-line equation material consists of 3 question numbers. The stages of data analysis are: (1) correcting students' answers in solving math problems; (2) analyze students' answers to solving math problems using Newman stages; (3) calculate the percentage of each mistake made by the student and present it in the form of a diagram, and (4) analyze and identify the types of mistakes made by students in solving math problems.

To calculate the percentage of each type of error can be calculated with the following formula [21].

\[ P_i = \frac{E_i}{N \times M_i} \times 100 \]

Description

\[ P_i \]: percentage error item problem to-\( i \)
\[ E_i \]: the total error score on the question item to-\( i \)
\[ N \]: many of the students
\[ M_i \]: maximum error score on the item to-\( i \)

The classification of students' level of errors in solving problems was present in table 1 below [22].

| No | Percentage | Classification |
|----|------------|----------------|
| 1  | 0% ≤ \( P \) ≤ 20% | Very Low |
| 2  | 20% < \( P \) ≤ 40% | Low |
| 3  | 40% < \( P \) ≤ 60% | Enough |
| 4  | 60% < \( P \) ≤ 80% | High |
| 5  | 80% < \( P \) ≤ 100% | Very High |
3. Result and Discussion

The analysis of students' test results is based on an analysis of Newman's stage errors by showing the percentage for each question on each error. Researchers describe every mistake made by students. Table 2 below presents a recapitulation of the percentage error of the analysis results on student answers.

| Type Newman   | Percentage of Each Number (%) | Average (%) | Classification |
|---------------|-------------------------------|-------------|----------------|
|               | 1                             | 2           | 3              |                |
| Reading       | 26.46                         | 94.08       | 43.12          | 54.55          | Enough         |
| Comprehension | 37.24                         | 99.96       | 50.96          | 62.72          | High           |
| Transformation| 38.42                         | 99.84       | 21.84          | 53.36          | Enough         |
| Process Skill | 41.10                         | 98.19       | 58.15          | 65.81          | High           |
| Encoding      | 56.16                         | 73.32       | 78             | 69.16          | High           |
|               | 39.88                         | 93.08       | 50.41          |                |                |

From the table above obtained a percentage of 34 students on each error in each question number. Here is a diagram of the percentage of mistakes students make on each question number.

Diagram 1. Percentage Of Number 1
Diagram 2. Percentage Of Number 2
Diagram 3. Percentage Of Number 3

It can be seen that the percentage of errors in resolving question number 2 is very high compared to errors in resolving question numbers 1 and 3. Question number 2 is a question that type of writing an opinion or idea of a question or statement. Meanwhile, question types number 1 and 3 ask students to look for straight-line gradients and look for straight-line equations. From the answers written, almost all students have difficulty in solving question number 2. The difficulty caused the error in resolving the problem. Errors in resolving problems are analyzed by displaying 2 students on each error.

3.1 Analysis of student error at Reading stage
Here are two students' answers to question number 2.

Figure 1. Reading stage student answer representative
In Figure 1, students simply write down the word 'enough' without writing down a supportive reason as a form of opinion that the information on the question is sufficient to determine the cut point between the Y-axis and the k-line. From the answers written, it appears that students still do not understand the intent of the question. The question is presented a picture of two lines that are perpendicular to each other, which is the key to answering the question. Judging by the answers given, students do not yet understand. Student incomprehension can occur because students do not know the meaning of the perpendicular symbol so can not answer, or know the meaning of the symbol perpendicularly, but do not know how to use it to answer questions.

Figure 2. Reading stage student answer representative

Students wrote their opinion that the information on the question is sufficient to determine the cut point between the Y-axis and the k-line. Students re-illustrate the chart by adding an extension of the k-line, so that a cut point is obtained between the Y-axis and the k line. From the answer, the student's understanding after reading the question is wrong, not using the information of two lines that are perpendicular to each other (Figure 2).

3.2 Analysis of student errors at the Comprehension stage

Here are two students' answers at number 1.

Figure 3. Comprehension stage student answer representative

From the answer, students do not understand the intent of parentheses on the formula of straight-line equations. Students multiply only to variable x only. It should be $y-4=1/2(x-(-1)) \leftrightarrow y-4=1/2x+1$ . Mistakes are made because students are not conscientious and do not understand the intent of the parentheses symbol in the formula, which should be multiplied one-on-one with the elements contained in parentheses (Figure 3).

Figure 4. Comprehension stage student answer representative
Students do not write down exactly the results of the substitution of the points and gradients of the lines that have been searched. Students also do not understand the intent of parentheses on the formula of looking for straight-line equations so in calculating straight-line equations is still wrong. Mistakes are made because students are not conscientious and do not understand the meaning of parentheses symbols in the formula, which should be multiplied one-on-one with the elements contained in parentheses (Figure 4).

### 3.3 Analysis of student errors at the transformation stage

Here are two students' answers on number 1.

![Figure 5. Transformation stage student answer representative](image)

In Figure 5, students write information on the question in graphic form. However, from the written answer, the new student describes the cartesius axis only, has not written down any information that is in question. In describing the cartesius system is also still incomplete. There is no naming on the X-axis and the Y-axis.

![Figure 6. Transformation stage student answer representative](image)

And in Figure 6, students write down the information on the question by writing down a known point. From the answer, students still haven't written down the correct point. Should write point A\((0,2)\), B\((-3,0)\), ..., etc.

### 3.4 Analysis of student errors at the Process skill stage

Here are two students' answers at number 1.

![Figure 7. Process skill level student answer representative](image)
Students do not use proper calculation procedures. From the answer, students are still wrong in using the formula of straight-line equations. It says \( y-4=1 \frac{1}{2}(x-(-1)) \rightarrow y-4=1 \frac{1}{2} x+1 \). Should be \( y-4=1 \frac{1}{2} (x-(-1)) \rightarrow y-4=1 \frac{1}{2} x+1 \frac{1}{2} \). Mistakes are made due to students not being conscientious and not understanding the meaning of parentheses symbols in formulas (Figure 7).

**Figure 8.** Process skill level student answer representative

Students do not use proper calculation procedures. From the answer, students are still wrong in using the formula of straight-line equations. In writing formulas and performing formula procedures are also incomplete. Mistakes are made due to students not being conscientious and not understanding the meaning of parentheses symbols in formulas (Figure 8).

3.5 Analysis of student errors at the encoding stage

Here are two students' answers on number 3.

**Figure 9.** Encoding stage student answer representative

Students write the wrong answer in search of an AB line gradient. Mistakes are made in calculating negative numbers so that the final answer is written is also incorrect. This is because students arewrong in determining the points that are substantiated in the formula and incorrect in counting (Figure 9).

**Figure 10.** Encoding stage student answer representative

The final answer that students wrote is still wrong. This happens because, in the calculation, students still make mistakes. In calculating negative numbers. Mistakes are made because students are mistaken in calculating negative numbers, which should be added but subtracted (Figure 10).
From the results of the analysis, the mistakes made by students in the form of errors in reading the intent of the problem, working on the problem with the wrong steps, and careless when doing calculations to write the results of the wrong calculation. In research conducted by Oktaviani, such errors are categorized in factual errors, procedural errors, and careless errors [22]. The ability of students to understand the intent of the question will determine the smooth process of working on the problem. If the student understands the intent of the question, then then the student can design a solution that will be used to answer the question. A mistake occurred because students were unable to interpret the word kuci on the question [23]. Or students cannot read and interpret the term tau symbol in the question [24].

4. Conclusion
Based on the results of the analysis, the percentage of errors in solving question number 2 is very high compared to errors in solving question numbers 1 and 3. The highest student error at the encoding stage was 69.16%; and the lowest at the Transformation stage of 53.36%. Mistakes Many students make mistakes in resolving questions that ask students to write their ideas or opinions on a statement or question. Many students have not been meticulous in doing calculations, some students still can not use the existing formula to solve the problem. Student mistakes include errors in reading the intent of the question, procedural errors, and careless errors.

Acknowledgment
We would like to thank Muhammadiyah Purwokerto University for providing support and facilities in this research.

Reference
[1] Apriliawan A, Gembong S, and Sanusi S 2013 Analisis kesalahan penyelesaian soal uraian matematika siswa mts pada pokok bahasan unsur-unsur lingkaran JIPM (Jurnal Ilmiah Pendidikan Matematika) 1
[2] Widodo S A 2013 Analisis kesalahan dalam pemecahan masalah divergensi tipe membuktikan pada mahasiswa matematika Jurnal pendidikan dan pengajaran 46
[3] Lusiana R 2017 Analisis kesalahan mahasiswa dalam memecahkan masalah pada materi himpunan ditinjau dari gaya kognitif JPPM (Jurnal Penelitian dan Pembelajaran Matematika) 10
[4] Widodo S A and Sujadi A A 2015 Analisis kesalahan mahasiswa dalam memecahkan masalah trigonometri SOSIOHUMANIORA: Jurnal Ilmiah Ilmu Sosial dan Humaniora 1
[5] Abdullah A H, Abidin N L Z, and Ali M 2015 Analysis of students' errors in solving Higher Order Thinking Skills (HOTS) problems for the topic of fraction Asian Social Science 11
[6] Oktaviana D 2017 Analisis tipe kesalahan berdasarkan teori newman dalam menyelesaikan soal cerita pada mata kuliah matematika diskrit Edu Sains: Jurnal Pendidikan Sains dan Matematika 5 p 22-32
[7] White A L 2010 Numeracy, literacy and Newman’s error analysis Journal of Science and Mathematics Education in Southeast Asia 33 p 129-148
[8] Adu E, Assuah C K, and Asiedu-Addo S K 2015 Students’ errors in solving linear equation word problems: Case study of a Ghanaian senior high school African Journal of Educational Studies in Mathematics and Sciences 11 p 17-30
[9] Putra H D, Thahiram N F, Ganiati M, and Nuryana D 2018 Kemampuan pemecahan masalah matematis siswa SMP pada materi bangun ruang JIPM (Jurnal Ilmiah Pendidikan Matematika), 6 p 82-90
[10] Haryanti M D, Herman T, and Prabawanto S 2019 Analysis of students’ error in solving mathematical word problems in geometry In Journal of Physics: Conference Series 1157 p 042084
[11] Nuryadin A and Lidinillah D A M 2014 Analysis of Fifth Grade Students’ Performance in Solving Mathematical Word Problem Using Newman’s Procedure p 139-46
[12] Ali S R B 2017 Analysis of Numerical Understanding Analysis for Primary School International Journal of Academic Research in Business and Social Sciences 7 p 713-28
[13] Khalo X and Bayaga A 2015 Analysis of errors due to deficient mastery of prerequisite skills, facts and concepts: A case of financial mathematics The Independent Journal of Teaching and Learning 10 p 98-113
[14] Zamzam K F and Patricia F A 2018 Error Analysis of Newman to Solve the Geometry Problem in Terms of Cognitive Style In University of Muhammadiyah Malang's 1st International Conference of Mathematics Education (INCOMED 2017)
[15] Rohmah M and Sutiarso S 2018 Analysis problem solving in mathematical using theory Newman EURASIA Journal of Mathematics Science and Technology Education 14 p 671-81
[16] Syafmen W 2015 Identifikasi kesalahan siswa dalam menyelesaikan soal matematika di SMA (studi kasus SMA N. 11 Kota Jambi) Kreatif 17
[17] Rahman A A 2018 Analysis of student’s answer error in learning mathematics using newman analysis IOSR Journal of Research & Method in Education 8 p 77-82
[18] Junaedi I 2012 Tipe kesalahan mahasiswa dalam menyelesaikan soal-soal geometri analitik berdasar Newman's Error Analysis (NEA) Journal Kreano 3 p 125-33
[19] White A L 2009 Numeracy, literacy and Newman’s error analysis Mathematics: Of Prime Importance p 249-57
[20] Rr Chusnul C, Mardiyyana S, and Retno D 2017 Errors analysis of problem solving using the Newman stage after applying cooperative learning of TTW type In American Institute of Physics Conference Series 1913
[21] Kristofora M and Sujadi A A 2017 Analisis kesalahan dalam menyelesaikan masalah matematika dengan menggunakan langkah Polya siswa kelas VII SMP PRISMA 6 p 9-16
[22] Oktaviani M 2017 Analysis of students’ error in doing mathematics problem on proportion. In Proceedings of the 2nd Asian Education Symposium (AES 2017) p 172-7
[23] Sumule U, Amin S M, and Fuad Y 2018 Error analysis of Indonesian junior high school student in solving space and shape content PISA problem using Newman procedure. In Journal of Physics: Conference Series 947 p 012053
[24] Santoso D A, Farid A, and Ulum B 2017 Error analysis of students working about word problem of linear program with NEA procedure In Journal of Physics: Conference Series 855 p 1-8