
Error analysis in answering system of linear equation with two variables questions based on Newman error indicator

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ABSTRACT

This study focuses on the forms of errors made by students in solving math problems, especially on the material of a two-variable system of linear equations. The purpose of this research is describing detail the form of errors made by students based on error indicators according to the Newman Stages. The data collection technique used is observation, in 32 students. By collecting data in the form of written test results from students, the forms of errors made by students were obtained, including: at stage (1) the form of the error was wrong in writing down known information, incomplete in writing down the information contained in the question, and wrong in determining the information in question, at stage (2) it is not appropriate to write a mathematical model from known information, and does not use variable symbols to simplify calculations, at stage (3) does not operate similar variables, substitutes wrong values, does not apply rules of operation, miscalculations, and did not get the final result of the calculation process, at stage (4) did not change the variable symbol into the form that the question asked, did not provide information on the final answer, and wrote conclusions but did not match what the questions asked.

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1. INTRODUCTION

Mathematics is often needed in everyday life. Therefore, mathematics is an important to learn. Peraturan Menteri No. 21 of 2016, it is stated that mathematics should be given to students since studying at the elementary school level. It is intended that students as early as possible have a logical, analytical, creative, critical and thorough attitude, and do not easily give up in solving problems (Permendikbud, 2016). These abilities are provided to students so that students can obtain, manage, and utilize information in order to survive in an ever-changing and competitive life. However, in reality, ability of student to master mathematics has not been satisfactory. This is indicated by the low student learning outcomes in mathematics. The results of academic research through PISA 2018, for the mathematics category, rank of Indonesia is 73 from 79 countries (Tohir, 2019).

Mathematics is considered as the most difficult subject by most students. The number of materials and formulas that need to be memorized is the reason that is often put forward by

students. Solving systems of linear equations is a common situation in many scientific and technological problems (Kumari et al., 2021). In addition, the system of linear equations with two variables is one of the materials that must be mastered by students in SMP/MTs at the same level (Zulfah, 2017). A system of linear equations with two variables is often shortened to SELTV. The basic competency is that students explain SELTV solutions in contextual problems (Pangaribuan, 2018). Every child in the United States is required to take an algebra class to graduate high school. The system of linear equations is standard in all algebra classes that every student must master (Lagasse, 2012). This material is a discussion of the relationship between one variable and another. In addition, the SELTV material is also a requirement for learning mathematics to continue to the next level (Nurbaiti et al., 2017). Solving linear equations is a very important concept in algebra and often causes confusion for students (Saraswati et al., 2016). However, currently, students' interest in mathematics is lacking because it is considered a difficult subject to understand, especially in SELTV (Rachmawati et al., 2019). Therefore, there are still many students who have difficulty or often make mistakes in solving SELTV.

Research that has discussed about difficulties of solving SELTV, that are: in terms of the solo taxonomy, students still often make mistakes in solving on SELTV questions, especially those with the most errors at the multistructural level (Azmi & Soro, 2021), at the junior high school level there are still many students who make mistakes in solving problems of SELTV (Prabawati, 2021), and students of SMPN 1 Sambu still have many difficulties in solving SELTV questions (Safitri, 2019). The four difficulties found in (Widyastuti et al., 2017), are understanding the problems, changing the problem into mathematical models, determining problem solving strategies, and doing mathematical procedures. The three difficulties found in (Priatna, 2019) (Azmi & Soro, 2021) are understanding the concept, doing mathematical operations, and analyzing the problem. The results of the research in (Ernawati, 2020) showing that three difficulties found are in concept, principle, and skills.

Based on the findings showing that there are still many students who have difficulty and also make mistakes in solving SELTV questions. Therefore, analyzing the difficulties experienced by students is very important. It is also supported by the results of an interview with one of the mathematics teachers at SMPN 1 Tegaldlimo, information was obtained that students often get low grades in mathematics, especially in math problems that are related to everyday life, for example in the Two Variable Linear Equation System material, so this research was conducted to find out the forms of student errors, in order to obtain information where students have difficulty, and what is expected is that students get the right solution in the future.

2. METHOD

This research is a qualitative descriptive study that aims to describe the form of errors made by students in solving math problems on the SELTV material based on Newman's procedure. Newman (1977, 1983) designed Newman's Error Analysis as a simple mathematical literacy diagnostic procedure for students attempting to answer a mathematics problem (White, 2005).

Newman described the five consecutive steps a person needs to go through in attempting to answer a written mathematical task, that are: Reading, Comprehension, Transformation, Process Skill, and Encoding (Singh et al., 2010). Over time, Newman's steps was reduced to four steps because of the infrequent error in the first step. The four steps that are still used are Comprehension (become Understanding), Transformation, Process Skill, and Encoding (become Writing Answer) (Dj Pomalato et al., 2020). While there are many other procedures available, Newman's procedure became popular among teachers because it was simple and easy to use.

Based on this description, in this study, four Newman's steps will be used. (1) Understanding, at this stage, the student is said to have made a mistake if students does not understand the meaning of the question. Error understanding can be detected when students write down what they know and what is asked in the questions, and it is called misunderstanding (2) Transformation, the students is said to make an error in this phase if the student has understood the problem but he cannot determine the procedure to be used to solve the problem, and it is called transformation error. (3) Processing skills, the student is said to have made a mistake in this stage if the student has determined the right procedure to solve the problem but cannot carry out the procedure until he find the final answer, and it called operation error. (4) Writing answer, the student is said to make an error in this phase if the student cannot write the answer from the calculation results into the desired form of the question, and it is called conclusion error.

The data used in this study is the test results in solving SELTV of 8A grade students of SMPN 1 Tegaldlimo, consisting of 32 students, most of whom got scores below the standard on SLETV material. The test questions used are shown in Figure 1.

1. Dalam sebuah tempat parkir terdapat 90 kendaraan yang terdiri dari mobil beroda 4 dan sepeda motor beroda 2. Jika dihitung roda keseluruhan ada 248 buah. Biaya parkir sebuah mobil Rp5.000,00, sedangkan biaya parkir sebuah sepeda motor Rp2.000,00. Berapa pendapatan uang parkir dari kendaraan yang ada tersebut?
2. Diketahui harga 4 buah buku tulis dan 2 buah pensil Rp13.000,00 harga 3 buah buku tulis dan sebuah pensil Rp9.000,00. Harga 5 buah buku tulis dan 2 buah pensil adalah
3. Harga sepasang sepatu dua kali harga sandal. Ardi membeli 2 pasang sepatu dan 3 pasang sandal dengan harga Rp420.000,00. Jika Doni membeli 3 pasang sepatu dan 2 pasang sandal, Doni harus membayar sebesar

Figure 1. SELTV material test questions

Translate of Questions:

1. In a parking area, there are 90 vehicles consisting of cars with 4-wheels and motorcycles with 2-wheels. The total number of wheels is calculated are 248 pieces. Car parking fee is Rp5.000 and motorcycles parking fee is Rp2.000. How much is the parking income from the existing vehicles at that time?
2. The price of 4 books and 2 pencils is Rp.13.000. The price of 3 books and 1 pencil is Rp9.000. What is the cost of 5 books and 2 pencils?
3. The price of shoes is twice the price of sandals. Ardi bought 2 shoes and 3 sandals at a price Rp420.000. If Doni buys 3 shoes and 2 sandals, how much will it cost?

Data from the research results were collected and analyzed using the flow model technique developed by Miles and Huberman (Sugiyono, 2015). The first stage is to reduce the data, the data from the class 8A test results, totaling 32 students, on the SELTV material is reduced to determine the research subject. In the subject determination test, the researcher reduced the data to find a research subject that was in accordance with the subject selection procedure in Figure 2.

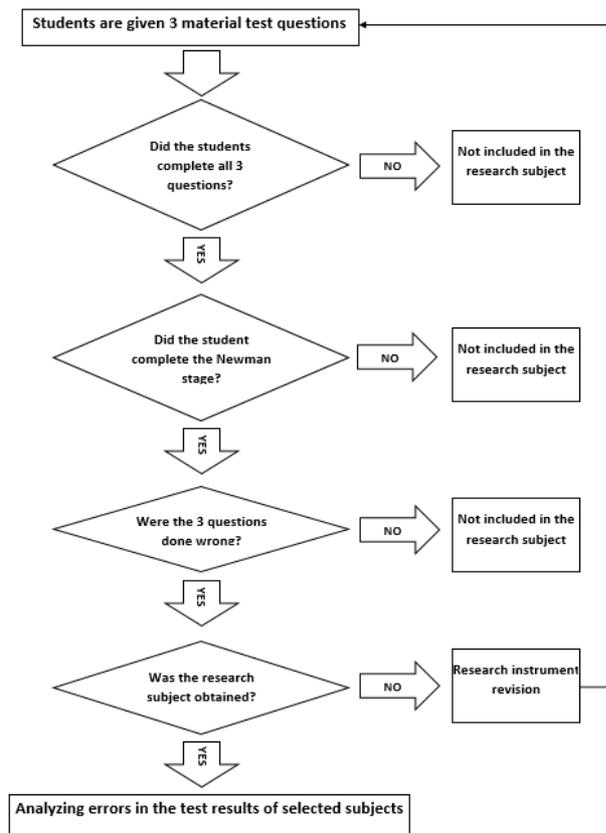


Figure 2. Flowchart of research subject selection

The second stage is presenting the data, in this study the presentation of the data is in the form of elaboration and depiction of the errors made by students in solving math problems on SELTV material. The third stage is drawing conclusions, at the final stage of this research conclusions will be drawn about the forms of errors made by students in working on math problems with SELTV material (Miles et al., 2014).

After finding the research subjects and analyzing their answers, interviews were conducted on the subjects to confirm the answers to the tests they wrote, with questions such as the following (White, 2018):

- 1) Tell me what the question is asking you to do.
- 2) Tell me how you are going to find the answer.
- 3) Show me what to do to get the answer. "Talk aloud" as you do it, so that I can understand how you are thinking.
- 4) Now, write down your answer to the question.

3. RESULTS AND DISCUSSION

The results of the error analysis of grade 8A students in solving the SELTV test questions are presented in Table 1 and the results of students' answers to each question are illustrated by the diagram in Figure 3.

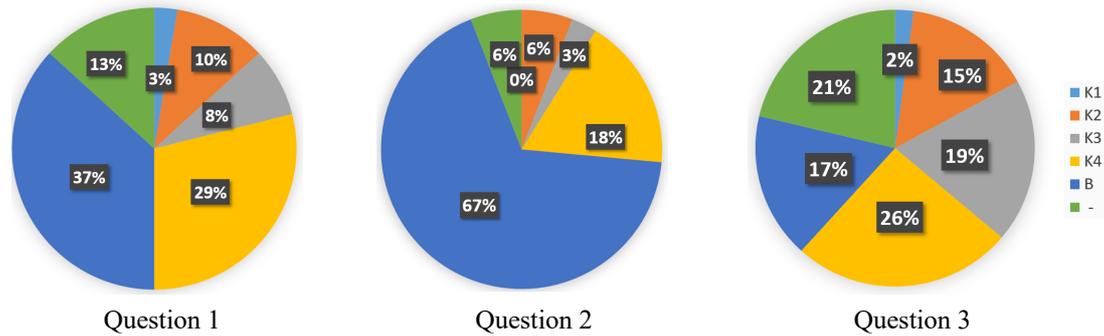


Figure 3. The results of the error analysis of students in solving SELTV

Referring to the subject selection procedure, there were four students who were the research subjects. The four research subjects were students with absent numbers 11, 14, 23, and 32, with details as follows.

- S1 (subject 1) : student with absent number 11,
- S2 (subject 2) : student with absent number 14,
- S3 (subject 3) : student with absent number 23, and
- S4 (subject 4) : student with absent number 32.

Table 1. The number of students attending mathematics courses

Roll number	Mistakes Made			Roll number	Mistakes Made		
	Problem 1	Problem 2	Problem 3		Problem 1	Problem 2	Problem 3
1	B	B	K2,K3	17	B	B	B
2	-	K2,K3	-	18	B	B	K2, K3, K4
3	B	B	B	19	B	B	K4
4	-	-	-	20	B	B	K3,K4
5	K2,K3	B	-	21	B	B	K4
6	K4	B	K4	22	K4	B	-
7	B	B	K2,K3	23	K2,K3,K4	K2, K4	K2,K3,K4
8	-	B	-	24	K4	B	K2,K3,K4
9	B	B	B	25	-	-	-
10	K4	B	K3,K4	26	K4	B	-
11	K1, K2, K3, K4	K4	K2,K3,K4	27	B	B	B
12	B	B	B	28	K4	K4	-
13	B	B	B	29	K4	B	-
14	K2,K4	K4	K1, K2, K3, K4	30	B	B	K4
15	-	K4	-	31	B	B	B
16	K4	B	B	32	K4	K4	K4

Information:

- K1 : Misunderstanding
- K2 : Transformation error
- K3 : Operation error
- K4 : conclusion error
- B : answer the question correctly
- : did not answer the question

Based on the results of the analysis on the answers to the four subjects, it was found a description of the forms of errors in each Newman Stages which are described in the discussion:

(1) At the understanding stage, students should write down the information in the questions.

It should be before answering the problem student first present the problem into mathematics with for example by making is known and asked from the questions that exist. Of the four research subjects, S1 and S2 made mistakes at this stage on questions number 1 and 3 which can be seen in Figure 4 and Figure 5.

3. misal Sandal = a
sepatu = b

Figure 4. Form of error at the understanding stage (1)

Diket : Parkir = 90
Mobil beroda 4
Sepeda beroda 2
Parkir Mobil = 8000
Parkir Sepeda = 2000

Figure 5. Form of error at the understanding stage (2)

Translate **Figure 4**:

Considering Sandals = a
Shoes = b

Translate **Figure 5**:

Parking = 90
Cars with 4-wheels
Motorcycles with 2-wheels
Car parking fee is Rp5.000
Motorcycles parking fee is Rp2.000

From Figure 4 and Figure 5, it can be seen that the subjects write down information from the question test, but not the correct information. The form of errors found by the research subjects was inaccurate or incomplete in writing down the information that was known on the questions, and wrong in determining what was asked in the questions.

(2) The transformation stage is the stage where students develop ideas and choose the formula that will be used to solve the problem. At this stage, of the four subjects, there were three subjects who made mistakes, namely: S1 and S2 made a transformation error on questions number 1 and 3, while S3 on all questions.

$a = 2 \times b$
 $2b + 3a = 420.000$

Figure 6. Form of error at the transformation stage (1)

$\text{mobil} = 4 \quad \text{Sepeda} = 2$
 dalam tempat parkir ada 90 mobil dan sepeda
 jadi mobil = 45
 sepeda = 45

Figure 7. Form of error at the transformation stage (2)

Translate Figure 7:

Cars = 4 motorcycles = 2

In the parking area there are 90 cars and motorcycle, so cars = 45 and motorcycle = 45

From Figure 6 and Figure 7, it can be seen that subjects complete the transformation stage. They write mathematical models from information known but not the correct one. The form of errors found from the research subjects at the transformation stage was not being able to make mathematical models from known information, not using variable symbols to simplify calculations.

- (3) The operation stage is the stage where students carry out ideas using the formulas that they have set in the previous stage until they get the final result. At this stage, three subjects made the following mistakes: S1 and S3 on questions number 1 and 3, while S2 only on number 3.

$2x + 3y = 920.000$
 $2x + 3(60.000) = 920.000$
 $2x + 180.000 = 920.000$
 $2x = 920 - 180.000$
 $2x = 290.000$
 $x = 290/2$
 $x = 120$

Figure 8. Form of error at the operation stage (1)

Total parkir $49 \times 5000 + 47 \times 2000$
 $= 245.000 + 94.000$
 $= 339.000$

Figure 9. Form of error at the operation stage (2)

Translate Figure 9:

Park total $49 \times 5000 + 47 \times 2000$

$= 245.000 + 94.000$

$= 339.000$

$$\begin{array}{l} a = 2 \times b \\ 2b + 3a = 420.000 \\ \hline 2b + 4a = 2 \times 420.000 \\ \hline b + 2a = 420.000 \end{array}$$

Figure 10. Form of error at the operation stage (3)

The form of errors found by the research subjects at the operation stage based on Figure 8 was not being able to operate similar variables, Figure 9, not knowing the variables, resulting in substituting wrong values, miscalculations, and Figure 10, not getting the final result of the calculation process.

- (4) The stage of making conclusions is the last stage in the process of solving questions, where students write down the appropriate final answers. Of the four subjects, all of them made mistakes at this stage on questions number 1, 2, and 3.

$$x = 120$$

Figure 11. Forms of error at the stage of making conclusions (1)

Kasuluruhan biaya parkir ada 339.000 ribu

Figure 12. Forms of error at the stage of making conclusions (2)

harga sandal adalah 420.000

Figure 13. Forms of error at the stage of making conclusions (3)

Translate **Figure 12**:
Total of parking cost is 339.000 thousand

Translate **Figure 13**:
Price of sandals is 420.000

The form of errors found from the research subjects from Figure 11 was not changing the variable symbol into the form that the question asked about, from Figure 12 was not providing information on the final answer, and from Figure 13 was writing conclusions but not in accordance with what was asked for.

Based on the explanation, the subject get errors related to one another when he solved the problem. Some mistakes are made by the subject can affect the next stage in solving problem. (Dj Pomalato et al., 2020). The most mistakes made by each subject are mistakes in making conclusions. Each step taken at the time of solving the problem is equally important. If the student has completed the problem well in the first three stages, but at the stage of writing the final answer the student makes a mistake, then the student has not been able to answer what was asked of the question he was working on. This can be a special concern for teachers that teach

students to work on questions up to writing the final answer is something that needs to be emphasized.

4. CONCLUSION

Based on the results and discussion that have been described, the forms of errors made by students in solving SELTV questions based on Newman's stages are presented: At the stage of understanding, the forms of errors made by students are: wrong in writing information that is known in the problem, incomplete in writing the information contained in the question, and wrong in determining the information asked. In the transformation stage, the forms of errors made by students are: less precise in writing mathematical models from known information and do not use variable symbols to simplify calculations. At the process skills stage, the forms of errors made by students are: does not operate on similar variables, substituting the wrong value, does not apply the rules of operations on numbers, miscalculated, and did not get the final result of the calculation process. At the stage of writing the final answer, the forms of errors made by students are: does not change the variable symbol into the form that the question asks for, does not provide information on the final answer, and write a conclusion but it is not in accordance with the question asked. The efforts are conducted to overcome the students' error of 8A at SMPN 1 Tegaldlimo in solving problems of two variable linear equation systems, namely: study hard, read repeatedly, give practice questions, discuss or work in groups with friends, and runderstand the explanation from the teacher. Suggested ideas that can be used for further researchers are to analyze the factors that cause errors made by students, especially in class 8A SMPN 1 Tegaldlimo.

REFERENCES

- Azmia, S., & Soro, S. (2021). Analisis kesalahan siswa dalam menyelesaikan soal cerita materi sistem persamaan linear dua variabel ditinjau dari Taksonomi Solo pada siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 5(2), 2001–2009. <https://doi.org/10.31004/cendekia.v5i2.681>
- Dj Pomalato, S. W., Ili, L., Ningsi, B. A., Fadhilaturrahmi, Hasibuan, A. T., & Primayana, K. H. (2020). Student error analysis in solving mathematical problems. *Universal Journal of Educational Research*, 8(11), 5183–5187. <https://doi.org/10.13189/ujer.2020.081118>
- Fatio, N. A., Fatimah, S., & Rosjanuardi, R. (2020). The analysis of students' learning difficulties on system of linear equation in two variables topic. *Journal of Physics: Conference Series*, 1521(3), 391–398. <https://doi.org/10.1088/1742-6596/1521/3/032062>
- Kumari, K., & Poonia, R. K. (2021). A study of solving system of linear equation using different methods and its real life applications: *Journal of University of Shanghai for Science and Technology*, 23(07), 723–733. <https://doi.org/10.51201/jusst/21/07197>
- Lagasse, A. (2012). *An Analysis of differences in approaches to systems of linear equations problems given multiple choice answers*.
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data Analysis* (3rd ed.). SAGE Publications, Inc.

- Nurbaiti, N., Salmawaty, S., Subianto, M., & Wafdan, R. (2017). Math instructional media design using computer for completion of two-variables linear equation system by elimination method. *Jurnal Natural*, 17(1), 1. <https://doi.org/10.24815/jn.v17i1.5968>
- Pangaribuan, F. (2018). Students' abstraction in solving system of linear equations with two variables. *Journal of Physics: Conference Series*, 1088. <https://doi.org/10.1088/1742-6596/1088/1/012071>
- Permendikbud. (2016). Peraturan Menteri Pendidikan dan Kebudayaan tentang Standar Isi Satuan Pendidikan Dasar dan Menengah. Mendikbud.
- Prabawati, M. N. (2021). Analisis kesalahan siswa sekolah menengah pertama di kota tasikmalaya dalam menyelesaikan soal literasi matematis pada materi SPLDV. *Jurnal Penelitian Pendidikan Dan Pengajaran Matematika*, 7(2), 117–128. <https://doi.org/10.37058/jp3m.v7i2.3661>
- Priatna, B. A. (2019). *Students' difficulties analysis in solving systems of linear equations in two variables*. 56–61.
- Rachmawati, Y. I., Sugandi, E., & Prayitno, L. L. (2019). Senior High School students' ability in posing system of linear equations in two variables problems. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 4(1), 57–65. <https://doi.org/10.23917/jramathedu.v4i1.6954>
- Safitri, A. (2019). *Analisis kesulitan siswa berdasarkan teori polya ditinjau dari gender dalam menyelesaikan soal Sistem Persamaan Linear Dua Variabel (SPLDV) Di SMP Negeri 1 Sambu*.
- Saraswati, S., Putri, R. I. I., & Somakim. (2016). Supporting students' understanding of linear. *Journal on Mathematics Education*, 7(1), 21–32.
- 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(July 2015), 264–271. <https://doi.org/10.1016/j.sbspro.2010.12.036>
- Sugiyono. (2015). Sugiyono, 2015.pdf. In *Statistika untuk Penelitian*.
- Tohir, M. (2019). Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015 (Indonesia's PISA Results in 2018 are Lower than 2015). *Open Science Framework*, 2(January), 1–2. <https://doi.org/10.17605/OSF.IO/8Q9VY>
- 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.
- White, A. L. (2018). Australian mathematics literacy perspectives: Assessment. *Southeast Asian Mathematics Education Journal*, 8(1), 69–82. <https://doi.org/10.46517/seamej.v8i1.65>
- Widyastuti, P. D., Mardiyana, & Saputro, D. R. S. (2017). The analysis of students' difficulties in solving systems of linear equations in two variables. *4 Th ICRIEMS Proceedings*, 243–248.

Zulfah, Z. (2017). Analisis kesalahan peserta didik pada materi persamaan linear dua variabel di Kelas VIII MTs Negeri Sungai Tonang. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 1(1), 12–16.