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Newman and Scaffolding Stages in Analyzing Student Errors in Solving Algebraic Problems

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Abstract

Algebra is a branch of mathematics that is abstract in form, *so* students *make errors in solving Algebra problems*. *This research aims* to describe (1) the *error* form made by students in solving algebraic operation story problems based on the Newman stage *and* (2) the scaffolding form given to students who make errors in solving problems of algebraic form operations. This *qualitative research is descriptive with research subjects of 3 class VIII students* at MTs Unggulan Singa Putih. The results of the study state that: (1) the errors form on the reading step is students cannot read the problems by beheading or stopping correctly, *and* on the comprehension step, the students *need to learn* the meaning of the problem. *In* the transformation step, the students *need help to model* variables appropriately. *In* the process skill step, the students *need help* to *operate* algebraic forms appropriately. *On* the encoding step, the students cannot answer correct conclusions; (2) the scaffolding forms given to students *are* students requested to recheck or reread the results of their work, students are given questions that lead students to think more about the problem and give praise to motivate students to improve their work.

Keywords: Algebraic Operation; Error; Newman's Step; Scaffolding.

Introduction

Mathematics is a subject published at all levels of education, from elementary to high school (Hutajulu et al., 2019; Meiliasari et al., 2021) l. Based on the Law of the Republic of Indonesia number 20 of 2003 concerning the National Education System Chapter X Article 37 paragraph 1 states that the primary and secondary education curriculum must contain mathematics (Aguilar et al., 2022; Inganah et al., 2023; Saundarajan et al., et al., 2020). Students at the elementary school education level only know arithmetic (Tokgoz et al., 2021). In contrast, students only know number symbols that represent specific numbers (Turidho et al., 2021), while at the Junior High School education level, students begin to be introduced to abstract letter symbols where the letter symbols represent specific numbers called Algebra (Ngado et al., 2020; Rahmawati & Soekarta, 2021; Syaifuddin et al., 2022).

Algebra is one of the branches of mathematics, algebraic material at the Junior High School education level, namely the operation of algebraic forms given in class VII (Curriculum, 2013) (Anjarwati et al., 2023; Pratiwi et al., 2021). Junior High School students tend to experience mistakes when doing abstract algebra problems. This is based on the results of a preliminary study conducted by researchers at MTs Unggulan Singa Putih, Prigen, and Pasuruan, which showed that students needed help to solve the problem of algebraic shape operation story 100% correctly.

The Newman stage method is one theory that can be used to discover the location of students' mistakes in doing story problems (Saundarajan et al. et al., 2020). This is to White's statement, which states that the analysis of errors based on the Newman stage has high credibility in finding out the mistakes made by students in doing math assignments (Sari et al., 2018; Sugianto, Darmayanti et al., 2022; Sulistiawati & Surgandini, 2019). The effort to overcome the occurrence of mistakes students make is by scaffolding students who experience mistakes in doing questions.

Scaffolding is a form of assistance provided by others to students to assist them in solving problems (Sah et al., 2023; Vamsi et al., Kishore, 2019; Wood et al., 1976). The purpose of giving scaffolding to students who make mistakes is so that students realize where the mistakes they have made so that students can correct the mistakes they have made (Ardıç & İşleyen, 2018; Sekaryanti et al., 2022; Sinaga et al., 2021). Based on this, this study aims to (1) describe the forms of mistakes made by students in solving algebraic form operation story problems based on Newman stages (2) describe the scaffolding form given to students who experience errors in solving algebraic form operation story problems.

Research Methode

This research is a qualitative descriptive research. The purpose of descriptive research is to systematically describe the facts and characteristics of the object and subject under study precisely (Yuliana et al., 2021). This study's purpose is to describe the mistakes made by students in doing mathematical problems of algebraic form operation material based on the Newman stage and its scaffolding. The study subjects were three students of class VIII MTs Unggulan Singa Putih, Prigen, and Pasuruan, each of whom came from the upper, middle, and lower groups. The grouping of students' mathematical abilities is based on the range of grades, which are categorized according to (Annisa & Kartini, 2021).

Data analysis was carried out by focusing the research on three selected subjects based on the results of the I test score in the form of an algebraic form operation story. Subject 1 (SU_1) is a subject of the upper group, while subject 2 (SU_2) is a subject of the middle group, and subject 3 (SU_3) is a subject of the lower group. Then, the results of the work of the three subjects were analyzed for errors based on the indicators of the Newman stages test questions I can see in Figure 1.

Bu Rina memberikan uang jajan kepada ketiga anaknya yaitu Ani, Bima, dan Cika. Uang jajan Ani adalah Rp1.000 lebih sedikit dari uang jajan Bima. Sedangkan uang jajan Cika adalah tiga kali lipat dari uang jajan Ani. Berapakah total uang jajan yang diberikan bu Rina kepada ketiga anaknya?

***Figure 1**. Test questions*

The indicators used to analyze students' errors with test questions can be seen in Table 2 (Kurniawati & Hadi, 2021).

***Table 2.** Error indicators based on Newman stages*

Error Types Based on Newman Stages	Indicator
Reading error	Students can not read questions with appropriate beheadings or pauses.
Comprehension error	Students do not understand and do not write down the information known and asked about the questions.
	Students write down known information and are asked questions but do not understand the meaning of the information.
Transformation error	Students do not write down variable calculations and cannot plan solutions to solve problems.
	Students can plan solutions and write down variables but not precise calculations.
	Students do not write down and cannot plan the operations or formulas that will be used to solve the problem.
	Students write down operations or formulas to solve problems but are not precise.
Process skill error	Students do not write down and cannot perform count operations.
	Students write down and perform count operations, but they are not precise.
	Students do not write down and cannot complete the count operation down to the simplest form.
Encoding error	Students do not write down the final answer
	Students write down the final answer, but it is incomplete and precise.

After analyzing errors based on error indicators, Newman continued with interviews and scaffolding in each research subject. The scaffolding used in this study is based on Anghileri's theory, which uses the second level of scaffolding, namely reviewing (Ivars et al., 2020; Sekaryanti et al., 2023; Sugianto, Cholily et al., 2022; Supiarmo et al., 2021). Subjects who have received scaffolding are given test II, a question about the story of the operation of algebraic forms. Test II questions can be seen in Figure 2.

Pak Hasan mengeluarkan sejumlah uang untuk membeli peralatan bangunan. Peralatan yang dibeli Pak Hasan adalah cat, kuas, dan paku. Harga paku yang dibeli Pak Hasan adalah Rp3.000 lebih mahal daripada harga kuas, sedangkan harga cat yang dibeli Pak Hasan adalah dua kali lipat dari harga paku. Berapakah total uang yang dikeluarkan Pak Hasan untuk membeli peralatan bangunan tersebut?

Figure 2. Test questions II Media Validation

Results and Discussion

In learning mathematics, especially in algebra, students often have difficulty solving problems given by the teacher. To learn more about the extent of students' difficulties in solving mathematical problems, the following will explain Newman's stages and the student scaffolding process.

Error Analysis and Scaffolding of Subject 1 (SU_1)

Error analysis and scaffolding to SU1 are based on the results of the SU_1 answer on test I. SU_1 answer results can be seen in Figure 3.

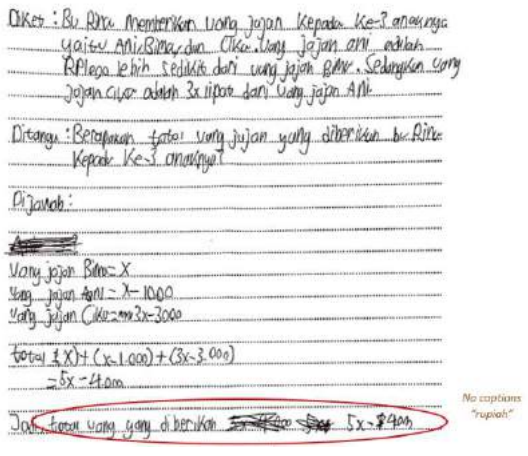

Figure 3. SU_1 answer results on test

Students from the upper group make mistakes while writing the final answer. The form of the mistake made is that the student cannot write down the conclusion of the answer completely. This is supported by the results of research conducted by Kulsum, which states that competent students make mistakes when writing the final answer (Darmayanti et al., 2022; Humaidi et al., 2022; Kulsum, 2019).

Error Analysis and Scaffolding of Subject 2 (SU_2)

Error analysis and scaffolding to SU_2 are based on the results of the SU_2 answers on test I. SU2 answer results can be seen in Figure 4.

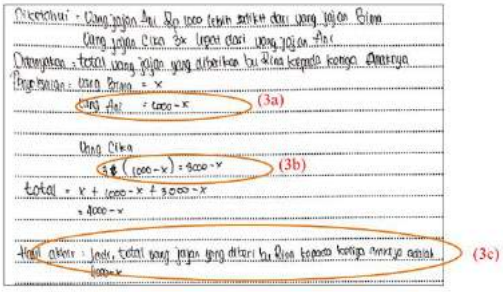

Figure 4. SU_2 answer results on test I

Based on the interview results and the SU_2 answers, the mistakes made were at the stage of transformation, process skills, and writing the final answer. The results of the analysis of the form of error and scaffolding given to SU_2. Students from the middle group make mistakes at the transformation stage, process skills, and write the final answer (Gunawan et al., 2023; In'am et al., 2023). This is by the results of Kulsum's research, which states that capable students are making transformation errors, process skills errors, and final answer writing errors (Khoiriyah et al., 2022; Kulsum, 2019; MM Effendi et al., 2022; Rakes & Ronau, 2019).

Error Analysis and Scaffolding of Subject 3 (SU_3)

Error analysis and scaffolding to SU_3 are based on the results of SU_3 answers on test I. SU_3 answer results can be seen in Figure 5.

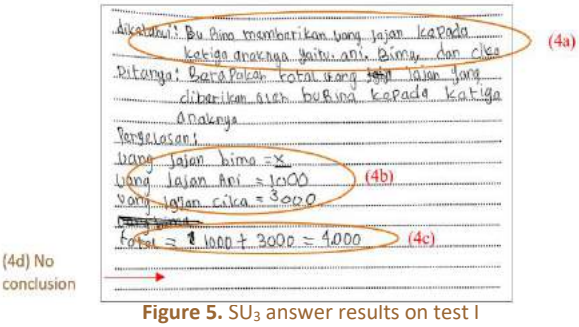

Figure 5. SU_3 answer results on test I

Students from the lower group make mistakes at all stages of Newman, namely at the reading, studying, transformation, process skills, and final answer writing stages. This is to the results of Kulsum's research, which states that low-ability students make reading errors, understanding errors, transformation errors, process skills errors, and final answer writing errors (Abdullah et al., 2015; Kulsum, 2019; Qomariyah et al., 2023).

SU_1, SU_2, and SU_3 Error Analysis on Test II After Scaffolding

After scaffolding, The three research subjects were given test II questions. After that, the subject answer sheet is evaluated and analyzed to obtain the following data.

- Subject 1 (SU1) did nothing wrong
- Subject 2 (SU2) did nothing wrong
- Subject 3 (SU3) committed transformation errors, process skill errors, and final answer writing errors.

The mistake that students from the upper group make is the mistake of writing the final answer. Meanwhile, the mistakes made by students from the middle group are transformation errors, process skills errors, and final answer writing errors. Students from the lower group made mistakes at all stages of Newman, namely reading errors, misunderstanding errors, transformation errors, process skill errors (Setiawati et al., 2023; Wati et al., 2023), and final answer writing errors.

The form of error at the reading stage is that students cannot read the questions with proper correction or pause. Meanwhile, the form of mistakes made by students at the understanding stage is that students do not know the meaning of the questions correctly (Astuti et al., 2023; Rofiah et al., 2023). At the transformation stage, the form of error made by students is that students cannot do the proper distribution of variables. At the process skill stage, the form of error that the student makes is that the student cannot perform the operations of addition, subtraction, or multiplication of algebraic forms. Meanwhile, the form of error made by students at the stage of writing the final answer is that the student does not write the conclusion or the student writes the conclusion, but it is not complete and appropriate

Conclusion

Suggestions that can be given to educators are (1) at the reading stage can apply scaffolding types of verbalising, prompting and probing questions, and interpreting students' actions and talk to overcome reading errors to lower group students, (2) at the understanding stage can apply scaffolding types of looking, prompting and probing questions, and interpreting students' actions and talk to lower group students to overcome misunderstanding errors, (3) at the transformation stage, they can apply scaffolding types of prompting and probing questions and interpreting students' actions and talk to middle group students to overcome transformation errors, but for lower group students who are still unable to apply this type of scaffolding, educators must train the ability to do variable shaping appropriately, (4) at the process skill stage, they can apply scaffolding type prompting and probing questions and interpreting students' actions and talk to middle group students who make process skill mistakes, but the type of scaffolding still cannot be applied to lower group students, then educators must train the ability to perform algebraic form operations (algebraic form operation requirements), (5) at the stage of writing the final answer can apply scaffolding Types of looking, prompting and probing questions, and interpreting students' actions and talk to upper and middle group students to overcome errors in writing final answers, but these types of scaffolding cannot yet be applied to lower group students, so educators must train and remind students to write complete and precise descriptions in doin.

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