KnE Social Sciences | The 4th International Conference on Science, Mathematics, Environment, and Education | KNE Publishing

Research Article

Scaffolding Technique in Teaching Algebraic Calculation Operation Concepts for Junior High School Students with Diverse Emotional Intelligence

Era Hervilia[1]*, Sri Subanti[2], Ikrar Pramudya[1], and Farida Nurhasanah[1]

[1]Department of Mathematics Education, Faculty of Teacher Training and Education, Sebelas Maret University, Indonesia
[2]Faculty of Mathematics and Natural Sciences, Sebelas Maret University, Indonesia

Abstract.
Mathematics is one of the sciences that plays a role in the development of the educational process. It is considered as an essential subject. In mathematics, prerequisite concepts are the foundation for understanding subsequent topics or concepts. This study aims to examine whether there is an influence of scaffolding usage on student errors at SMPN 1 Saradan in class VIII D in the algebraic calculation operation material with various emotional intelligence. Sampling was done using random sampling technique. The participants were 3 students from class VIII D. This study uses one independent variable, which is the use of scaffolding (X), and one dependent variable, which is student errors (Y). The data used in this study are questionnaires with 30 respondents, pre-test and post-test, and interviews. This research uses quantitative descriptive method. The data analysis technique used in this study is the paired sample t-test analysis. The results of this study revealed a significance value (Sign.) of 0.012, which means it is lesser than 0.05. Therefore, it can be concluded that H0 is rejected, and H1 is accepted, indicating a significant influence between scaffolding usage (X) and student errors (Y). It is also supported by the results of student responses on the pre-test and post-test, indicating changes in the high, moderate, and low emotional intelligence categories. From the Newman error stages, this may indicate that the training or intervention provided has an impact on students' understanding and development of emotional intelligence.

Keywords: scaffolding, algebraic calculation operation, emotional Intelligence

Corresponding Author: Era Hervilia; email: erahervil-iaa25@student.uns.ac.id

Published 27 May 2025

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICoSMEE 2023 Conference Committee.

1. INTRODUCTION

Mathematics is one of the sciences that plays a role in the development of the educational process (1). Mathematics is considered a very important subject (2). In mathematics, there are prerequisite concepts as the foundation for understanding subsequent topics or concepts (3). To understand abstract structures and relationships, it is necessary

to have a grasp of the prerequisite concepts beforehand, which must be thoroughly mastered to comprehend the subsequent concepts (4). In the process of learning mathematics, it is important for teachers to use the appropriate approach to teach algebraic calculation operation concepts to junior high school students (5).

Algebra is a branch of mathematics that studies the structure of mathematics and the relationships between mathematical objects through symbols and mathematical statements (6). Mathematical algebra is formally introduced to junior high school (SMP) students, specifically algebraic calculation operations taught in grade VIII (7). Junior high school students tend to make mistakes when working on abstract algebra problems (8). This is based on the preliminary study results indicating that no student could solve algebraic calculation operation word problems with 100% accuracy. This may reflect the level of difficulty or challenges faced by students in understanding and applying algebraic concepts.

One of the theories used to identify the location of student errors in solving word problems is the Newman method (9). Similarly, the learning outcomes that will be investigated are limited to learning outcomes in error indicators based on Newman in the subject of mathematics, specifically algebraic calculation operation material (10). Efforts to overcome the occurrence of errors made by students involve providing scaffolding to those who make mistakes in solving problems.

One effective approach is to use the scaffolding technique (11). Scaffolding is a form of assistance provided by others to students to help them solve problems (12). The purpose of providing scaffolding to students who make mistakes is to make them aware of their errors, so that they can correct them using various emotional intelligence. Through an approach that considers emotional intelligence, students will be more engaged in the learning process, strengthen their understanding, and improve their learning achievement in mathematics (13). Many students experience difficulties, resulting in errors when communicating their mathematical knowledge. One of the influential factors is emotional intelligence (14).

Goleman revealed that the concept of emotional intelligence and an individual's success is not solely dependent on intellectual intelligence (IQ) but is also greatly influenced by the ability to manage and understand emotions. Emotional intelligence is the students' ability to control themselves, have resilience when facing problems, control impulses, motivate themselves, regulate mood, empathize, and build relationships with others (15). Emotional intelligence refers to an individual's ability to recognize,

understand, manage, and express emotions, both their own and those of others. This not only enhances students' understanding but also helps them develop confidence, motivation, and collaborative skills that are crucial in learning mathematics (16).

Based on this, the purpose of this research is to: Determine whether there is an influence of scaffolding usage on student errors in algebraic calculation operation material with various emotional intelligence, by comparing the errors made by students in the pre-test and post-test based on the Newman method.

2. METHOD

This research is a quantitative descriptive study. The purpose of descriptive research is to systematically describe the facts and characteristics of the objects and subjects being studied accurately (17). This is in line with the purpose of conducting this research, which is to determine whether providing scaffolding can reduce the errors made by students in solving mathematics problems on algebraic calculation operation material based on the Newman stages.

The population in this study is the students of class VIII D at SMPN 1 Saradan, with a total of 30 students. The sample or research subjects are 3 students from class VIII D at SMPN 1 Saradan, Madiun Regency, each coming from the high, medium, and low groups. The sampling technique used is random sampling technique. Random sampling technique means that the sampling from the population is done with certain conditions and criteria in the population members (18).

Scaffolding is an approach in education designed to assist students in their learning process (19). Scaffolding involves the support provided by teachers or adults to help students develop their understanding and skills (8). Scaffolding can be implemented at various levels and typically consists of three main levels (20): 1) Level One: External Scaffolding, at the first level, teachers or adults provide concrete external support to students. This may include guidance, directions, tangible examples, or direct assistance in completing tasks. The goal is to help students comprehend the concepts or tasks they are facing; 2) Level Two: Shared Responsibility Scaffolding, at the second level, teachers or adults begin to share responsibility with students. They provide guidance and support while giving students more opportunities to actively participate in the learning process. This can involve asking students to formulate their own questions, think independently, or attempt problem-solving with minimal assistance; 3) Level Three:

Independent Scaffolding, the third level is where students become more independent in their learning. At this level, teachers or adults provide students with more space to take initiative and manage their learning independently. Students are able to use the skills and knowledge they have acquired throughout the process to complete tasks or solve problems on their own. It's important to note that these three levels of scaffolding can vary depending on the educational context and the students' developmental stages (21). Scaffolding aims to help students build their understanding gradually, so they can ultimately develop independent learning skills (22).

There are 2 variables in this study. Variable X and variable Y. Variable X is the independent variable, while variable Y is the dependent variable (23). In this study, variable X is the influence of providing scaffolding, while variable Y is the dependent variable, which is students' learning errors.

The data collection methods used in this study are questionnaires, tests, and interviews. The emotional intelligence questionnaire filled out by students of class VIII D at SMPN 1 Saradan, consisting of a total of 25 statement items, is designed to measure various aspects of students' emotional intelligence at that grade level. The resulting data can be categorized into 3 emotional intelligence categories. The test used in the study includes pre-test and post-test with 4 algebraic calculation operation material questions, and the results or scores from the pre-test and post-test will be analyzed using SPSS 25 for Windows to determine whether there is a significant effect on the implementation of scaffolding learning. The interview used in this study includes questions to clarify the test results of students based on the Newman error indicators.

One-group pre-test post-test design is an experimental research conducted on only one group that is selected randomly, and there is no control for the stability and clarity of the group's condition before the treatment is given (24). Before conducting data analysis with the paired sample t-test, there is a prerequisite test, namely the normality test. The normality test aims to determine whether the data being analyzed is normally distributed or not. The normality test is very important because it is related to the requirements for the data analysis technique. The test tool used to perform the normality test in this study is the Shapiro-Wilk test using SPSS version 25.

Here is the formula for students' emotional intelligence in the high, moderate, and low categories in Table 1 and the results of emotional intelligence scores in Table 2:

TABLE 1: Categorization of student intelligence boundaries.

No.	Interval	Category
1	$X < (mean) - 1.\ SD$	Low
2	$(mean) - 1.\ SD \leq X < (mean) + 1.\ SD$	Medium
3	$M + 1.\ SD \leq X$	High

(25).

TABLE 2: Categories of students' emotional intelligence.

Score	Category
$X < 62$	Low
$62 \leq X < 76$	Medium
$76 \leq X$	High

Table 1 above represents the formula for determining each category of students in one class, which are high, moderate, and low categories. Meanwhile, Table 2 reflects the categories of students' emotional intelligence that have been calculated based on the results of the emotional intelligence questionnaire. The table contains the processed questionnaire data used to classify students into specific emotional intelligence categories. The table contains assessments or measurements of the emotional intelligence components discussed earlier. In this regard, the table provides an overview of the extent to which students demonstrate specific skills or characteristics related to emotional intelligence. The scores are calculated using the emotional intelligence formula in Table 1, and the results from the formula in Table 2 indicate the scores used as a reference to categorize students into high, moderate, and low categories.

2. Pak Wicak mempunyai kebun yang berbentuk persegi panjang dengan ukuran panjang $(3x - 4)m$ dan lebar $(x + 1)m$. Keliling kebun tersebut $34m$, berapa luas kebun pak Wicak?

Figure 1: Pre-test and post-test questions.

The data analysis focused on three selected subjects based on pre-test and post-test scores in solving algebraic calculation operation word problems can provide profound insights into changes in student performance over a specific period. Subject 1 (SU1) is from the top group, while subject 2 (SU2) is from the middle group, and subject 3 (SU3) is from the bottom group. Then, the results of the work of these three subjects

were analyzed for errors based on the Newman stages indicators. The researcher's test questions can be seen in Figure 1.

In Figure 1, the pre-test and post-test questions are the same. The pre-test is administered before providing scaffolding, while the post-test questions are given after the scaffolding has been provided.

In the context mentioned by Newman, errors refer to the types of mistakes that can occur during the administration or taking of tests or assessments. Here is further explanation about each type of error mentioned: Reading Error, Reading Comprehension, Transformation Error, Weakness In Process Skill, and Encoding Error. Understanding these types of errors is crucial in the context of assessment and testing because they can provide insights into why someone may not achieve the expected results on a test. With this understanding, educators and assessors can more effectively help students or test takers address these errors and improve their outcomes.

The indicators used to analyze student errors with pre-test and post-test questions can be seen in Table 3.

After analyzing the errors based on the Newman error indicators, the study proceeded with interviews to clarify the answers given by students in the pre-test. The method of selecting participants involved categorizing them into high, moderate, and low groups based on students' emotional intelligence. Analyzing based on Newman errors can be a useful tool in understanding changes in student understanding and strengthening the argument that the use of scaffolding has an influence in reducing Newman errors. Both the pre-test and post-test were conducted using the same questions.

3. RESULTS AND DISCUSSIONS

Before the data is analyzed, the first step is to conduct a normality test. Based on the data analysis using SPSS version 25, it is found that the significance value indicates the normality of the data. The criteria used to determine normality state that the significance value (sign.) is considered normal if it is greater than Alpha (α = 5% or 0.05). Conversely, the criteria state that the value is not normal if the significance value (sign.) is less than Alpha (α = 5% or 0.05). The results of the normality test in this study are as follows :

In the table of normality test using the one-sample Shapiro-Wilk, the significance value (Asymp. Sign) is found to be 0.780 or 7.8%, which means that this value is greater than the Alpha value (α = 5% or 0.05). Therefore, it can be concluded that the data

Table 3: Indicators of error types based on Newman.

No	Error's Newman	Type Indicators
1	*Reading Error* Errors in reading a word can become crucial in a question, causing students to overlook important information provided in the problem.	• Students make mistakes in reading the given key words in the problem. • Students make mistakes in reading the symbols within the problem.
2	*Reading Comprehension* This is when students actually know the problem, but they fail to grasp the data presented in the question, resulting in their inability to process the solution to the problem.	• Students do not understand what is implied by the problem. • Students do not comprehend what is being asked in the question.
3	*Transformation Error* Students who already understand the concept related to the problem-solving, but they are unable to identify the required mathematical model to solve the problem, and they also cannot transform the sentences in the problem into mathematical expressions.	• Students are unable to translate the problem into correct mathematical sentences and vice versa. • Students make mistakes when connecting what they know using the formulas used.
4	*Weakness In Process Skill* Students can identify the model correctly, but they are unable to calculate accurately. Errors occur in the students' procedural skills when applying the rules, leading to mistakes in calculations.	• Students make mistakes when calculating the mathematical model. • Students do not write the final result correctly. • Writing the final result does not match the obtained calculation.
5	*Encoding Error* Students can calculate accurately, but they make mistakes when writing the symbols of the calculations or variables. Errors in using notation.	• Students do not use the correct notation. • Students do not write the appropriate variables for the problem. • Students do not write the final result.

Source : Indicators of Error Types Based on Newman

Table 4: One-Sample Shapiro-Wilk Test for Normality.

Asymp. Sig. (2-tailed)	A (α)	Keterangan
0.780	0.05	0.780 > 0.05 Normal

is normally distributed. After all prerequisites are met, the next step is to perform the paired sample t-test hypothesis. In this study, the proposed hypothesis is :

H0 : There is no significant effect of providing scaffolding (X) on student errors (Y).

H1 : There is a significant effect of providing scaffolding (X) on student errors (Y).

To determine whether there is an influence between variable X and variable Y, we can observe the significance value (Sign.). The significance value (p) less than 0.05 is used as the threshold to determine whether a result can be considered statistically

significant, indicating a significant influence of scaffolding on student errors. Conversely, if the significance value (Sign.) is greater than 0.05, there is no significant influence of scaffolding on student errors. To find out whether there is a significant effect, please refer to the table below:

TABLE 5: Hypothesis Test.

Model	Std.Error	t	Sig.
Scaffolding Usage	2.56147	-3.839	0.012

Based on the Table 5 above, the significance value (Sig.) is found to be 0.012, which means it is less than 0.05. Therefore, it can be concluded that H0 is rejected, and H1 is accepted, indicating that there is a significant effect of scaffolding usage (X) on student errors (Y).

In mathematics learning, especially in algebraic topics, students often encounter difficulties that result in errors when solving given problems. To determine whether using scaffolding can minimize the Newman errors made by students.

3.1. Analysis of Subject 1's Errors (SU_1)

The analysis of SU1's errors is based on SU1's answers in the pre-test and post- test. SU1's answers can be seen in Figure 2 and 3.

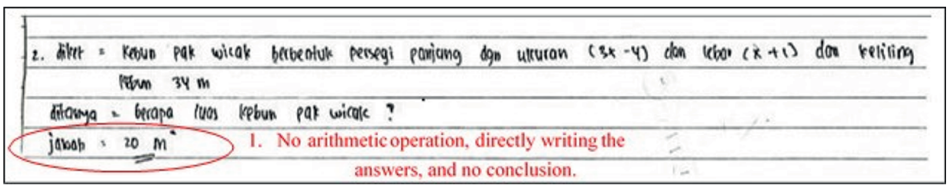

Figure 2: SU_1's answers on the pre-test.

Based on the interview results and SU1's pre-test answers, the errors made are in transformation, procedural skills, and drawing conclusions for the final answer.

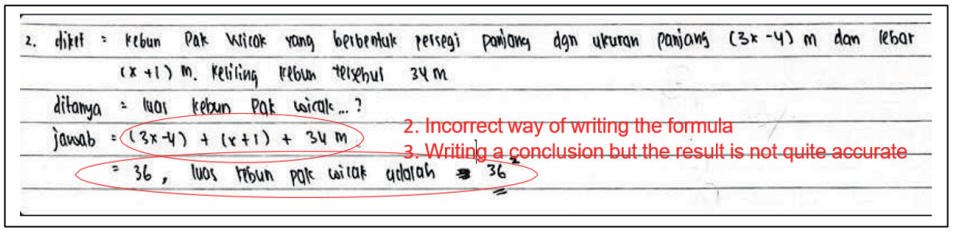

Figure 3: SU_1's answers on the post-test.

Based on SU1's post-test answers, the errors made are in transformation and procedural skills.

TABLE 6: SU_1 Errors in Pre-test and Post-test.

No	Types of Errors Based on Newman's Stages	Types of Errors
1	Transformation	Students do not use appropriate formulas.
2	Procedural Skills	Students make mistakes when calculating the mathematical model.
3	Drawing Conclusions	Students do not use the correct notation.

Students from the lower group made 3 errors in the pre-test at Newman's stages, namely in the transformation, procedural skills, and drawing conclusions stages. Meanwhile, they made 2 errors in the post-test at Newman's stages, namely in the procedural skills and drawing conclusions stages. This indicates that there is a change in errors after being given scaffolding learning.

3.2. Analysis of Subject 2's Errors (SU_2)

The analysis of SU2's errors is based on SU2's answers in the pre-test and post- test. SU2's answers can be seen in Figure 4 and 5.

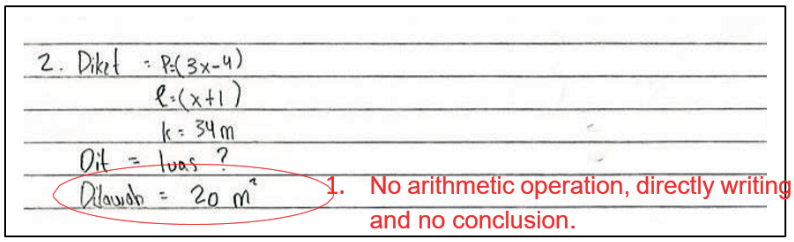

Figure 4: SU_2's answers on the pre-test.

Based on the interview results and SU2's pre-test answers, the errors made are in transformation, procedural skills, and drawing conclusions for the final answer.

Based on SU2's post-test answers, the errors made are drawing conclusions for the final answer.

Students from the lower group made 3 errors in the pre-test at Newman's stages, namely in the transformation, procedural skills, and drawing conclusions for the final answer stages. Meanwhile, they made 1 error in the post-test at Newman's stages,

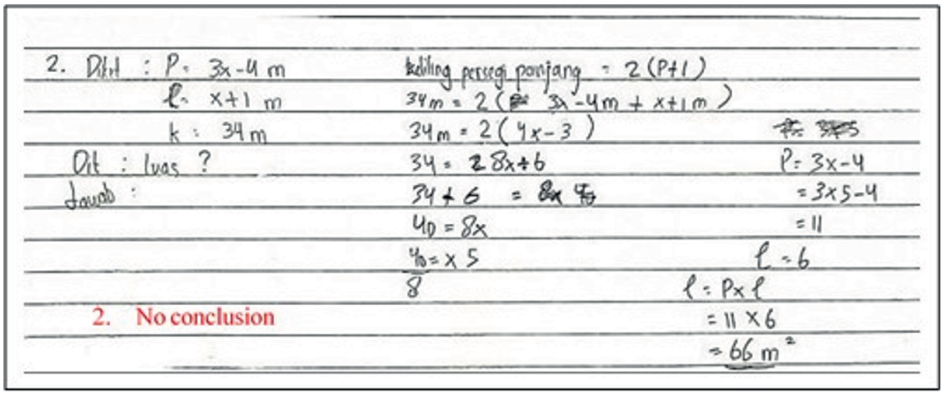

Figure 5: SU_2's answers on the post-test.

TABLE 7: SU_2 Errors in Pre-test and Post-test.

No	Types of Errors Based on Newman's Stages	Types of Errors
1	Transformation	Students do not use appropriate formulas.
2	Procedural Skills	Students make mistakes when calculating the mathematical model.
3	Drawing Conclusions	Students do not write the final result.

namely in drawing conclusions for the final answer stage. This indicates that there is a change in errors after being given scaffolding learning.

3.3. Analysis of Subject 3's Errors (SU_3)

The analysis of SU3's errors is based on SU3's answers in the pre-test and post-test. SU3's answers can be seen in Figure 6 and 7.

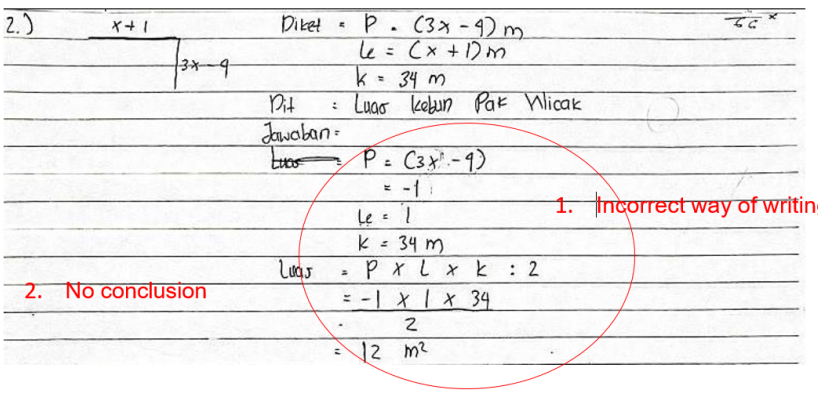

Figure 6: SU_3's answers on the pre-test.

Based on the interview results and SU3's pre-test answers, the errors made are in procedural skills and drawing conclusions for the final answer.

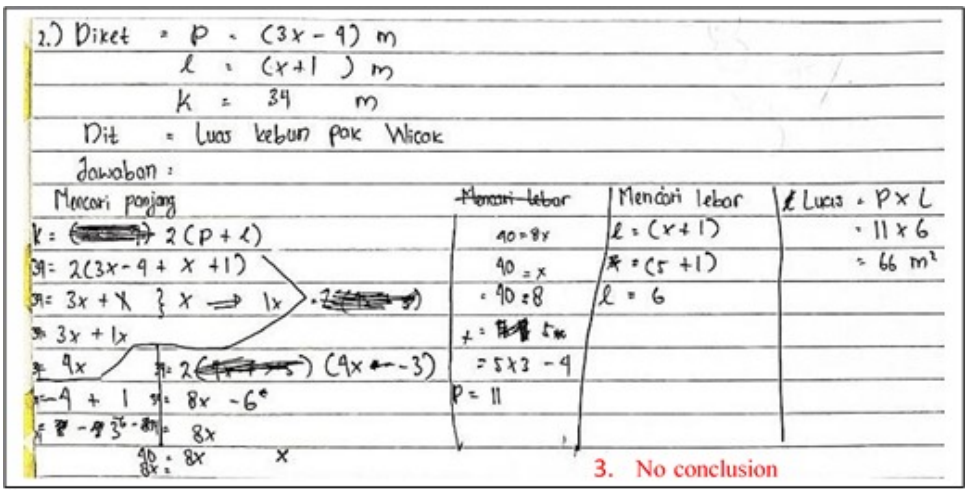

Figure 7: SU_3's answers on the post-test.

Based on SU3's post-test answers, the errors made are drawing conclusions for the final answer.

TABLE 8: SU_3 Errors in Pre-test and Post-test.

No	Types of Errors Based on Newman's Stages	Types of Errors
1	Procedural Skills	Students make mistakes when calculating the mathematical model.
2	Drawing Conclusions	Students do not write the final result.

Students from the lower group made 3 errors in the pre-test at Newman's stages, namely in procedural skills and drawing conclusions for the final answer stages.

Meanwhile, they made 1 error in the post-test at Newman's stages, namely in drawing conclusions for the final answer stage. This indicates that there is a change in errors after being given scaffolding learning.

For each type of error made by the students, the researcher applies all types of scaffolding. This is because in scaffolding, the researcher uses all levels initially and then analyzes which level of scaffolding is appropriate for the students' level of understanding. The researcher begins with the independent level, which is level three, then level two, and finally level one. The research results indicate that high, moderate, and low-category students, with various types of errors made by the students, obtained level one scaffolding, in which students can understand if the teacher or adult provides

concrete external support to them. This may include guidance, directions, tangible examples, or direct assistance in completing tasks.

In this study, the researcher takes on the role of a teacher. However, when applied to the classroom learning process, the teacher's role involves providing assistance to students when implementing scaffolding in the classroom. The learning model used is the application of the scaffolding process in the classroom. In this study, scaffolding is applied after the students have completed the pre-test.

Scaffolding is a teaching strategy used to assist students in understanding challenging subject matter. In this research, the learning process begins with a pre-test, which is an assessment given to students before they commence learning algebraic operations. The pre-test is employed to measure students' initial understanding of the subject matter. Once the pre-test is completed, the data from the pre-test results are used to determine the extent to which students comprehend the material.

The implementation of scaffolding takes place after the pre-test, following the steps as previously explained. The teacher will utilize the pre-test data to design an appropriate teaching approach. Scaffolding may involve individual or small group instruction, providing additional guidance, offering examples, or providing supplementary reading materials to aid students in grasping concepts or skills that may be challenging for them.

The goal is to assist students in overcoming barriers they face in understanding the subject matter and enable them to achieve a better understanding. Therefore, the implementation of scaffolding after the pre-test is a strategy designed to enhance students' comprehension and help them achieve improved learning outcomes. The results of the post-test or final evaluation are used to assess the success of this scaffolding approach.

The results of this study show that students with low emotional intelligence, as seen from the pre-test results, exhibited the following issues: no arithmetic operation, directly writing the answers, and no conclusion. However, the post-test results after receiving scaffolding indicate that there was an incorrect way of writing the formula and writing a conclusion, though the result is not quite accurate. In the pre-test, there were 3 errors, and in the post-test, there were 2 errors for students with low emotional intelligence. For students with moderate emotional intelligence (medium-level emotional intelligence), the pre-test results also revealed issues such as no arithmetic operation, directly writing the answers, and no conclusion. However, the post-test results after receiving scaffolding showed that there was no conclusion. In the pre-test, there were

3 errors, and in the post-test, there was 1 error for students with moderate emotional intelligence. For students with high emotional intelligence, as seen from the pre-test results, the issue was an incorrect way of writing the formula. However, the post-test results after receiving scaffolding showed that there was no conclusion. In the pre-test, there was an error in writing the formula, and in the post-test, there was only a lack of conclusion.

The significance of using different levels of emotional intelligence results in the conclusion that, in terms of error levels, emotional intelligence has shown improvement after receiving scaffolding. To determine whether this improvement is statistically significant, it can be calculated using the pre-test and post-test scores for students in the high, moderate, and low emotional intelligence categories. The results from the SPSS calculations indicate that the significance level is 0.012, which means that scaffolding has a significant impact on the errors made by students.

4. CONCLUSION

Based on the research results that have been conducted, it can be concluded that there is a significant relationship between the use of scaffolding and student errors at SMPN 1 Saradan. The influence of scaffolding is also evident from the students' answers in the pre-test and post- test, as seen from the errors at Newman's stages, indicating changes in errors made by students with various emotional intelligences. This means that teachers can effectively utilize scaffolding in the learning process. Scaffolding can have a positive impact on the learning process if both teachers and students can apply it effectively.

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