25 (1), 2024, 236-247

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Scaffolding for Algebra Errors From the Perspective of Emotional Quotient

Era Hervilia[1*], Sri Subanti[2], Ikrar Pramudya[1], & Purwo Setiyo Nugroho[3]

[1]Department of Mathematic Education, Universitas Sebelas Maret, Indonesia

[2]Department of Mathematics and Natural Science, Universitas Sebelas Maret, Indonesia

[3]Ph.D. Student, Institute for Population and Social Research, Universitas Mahidol, Thailand

Abstract: Mathematical understanding, particularly algebra, is essential in education. One effort to reduce student errors in learning can be achieved through an in-depth study of the relationship between students' emotional intelligence and the learning process. Emotional intelligence in learning mathematics is the ability to control one's emotions, manage, and express emotions towards others. Emotional intelligence is crucial for understanding the lessons delivered by the teacher. This research aims to investigate the relationship between student errors and the level of emotional intelligence by applying scaffolding to middle school students. The method used in this study is the correlational research method because it aims to determine the relationship between variable X (emotional intelligence) and variable Y (errors). The study population consisted of eighth-grade students at SMPN 1 Saradan in the 2022/2023 academic year, distributed in one class with a total of 30 students. From this class, 3 students were randomly selected as samples using purposive sampling technique. The instruments used in this research were an emotional intelligence questionnaire about mathematics and a mathematics error test on algebra material. The data processing and analysis technique in this study used correlation tests. The results of the correlation test in this study show that there is a significant relationship between emotional intelligence in mathematics and students' mathematical errors, with a correlation coefficient of 0.887, indicating a strong correlation. Based on these results, the conclusion can be drawn that students with high, moderate, and low emotional intelligence will produce better mathematics learning outcomes with the application of scaffolding. This activity is crucial, especially for teachers to understand students' difficulties and errors, aligning with the teachers' ability to better recognize students' characteristics.

Keywords: emotional quotient, newman's errors, algebraic arithmetic operations, scaffolding.

▪ INTRODUCTION

Mathematics plays a very important role in shaping and developing human life and the future success of an individual (Tang, 2021). Mathematics is one of the subjects that must be taught at all levels of education, because mathematics has an important role for other sciences (Yadav, 2020). Mathematics, as one of the disciplines taught at every level of school education, is expected to contribute to the development of critical, systematic, logical, and creative thinking skills, as well as the ability to work effectively in collaboration. This aligns with Uno's opinion (Kamid, et al., 2021) that mathematics learning is a mental activity aimed at understanding the meaning within relationships and symbols, which are then applied to real-life situations. Learning mathematics involves understanding what it is and how to use it in making decisions to solve problems. In Indonesia, the importance of mathematics is reflected in the goals of mathematics education according to the school mathematics curriculum, which is the mastery of mathematical literacy to understand the world around them and to succeed in life or career. However, to this day, students still consider mathematics to be a complex and difficult subject (Langoban, 2020). Students consider mathematics to be a difficult and

Era Hervilia
*Email: erahervilia25@student.uns.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v25i1.pp236-247
Received: 21 June 2024
Accepted: 29 July 2024
Published: 04 August 2024

boring subject, which leads to many students making mistakes (Aguilar, 2021). This mindset adds to the difficulty students face in solving math problems because they lack the desire to understand mathematical concepts. Therefore, students must first understand these concepts in order to solve problems and be able to apply this learning in the real world. Furthermore, students' mathematical errors in solving math problems will be directly related to the performance they demonstrate (Dwita and Retnawati, 2022). Thus, identifying and addressing mathematical errors effectively will indicate success in the learning process. Factors that influence mathematical errors include external and internal factors. Internal factors within the students themselves have a significant impact on their mathematical errors (Permata, 2020). One internal factor is the understanding that students possess. A student's understanding of mathematics affects how an individual approaches their mathematics lessons (Lijie, et al., 2020).

According to Kilpatrick (1969), problem-solving is a very important part of the mathematics curriculum. According to Priyanto, et al., (2015), problem-solving in school mathematics is usually manifested through word problems. Word problems are questions presented in the form of a story and are related to everyday life. Arruan (2023) stated that when solving problems in the form of word problems, students must first understand the content of the word problem. Then, they can draw conclusions about the object to be solved and represent it using mathematical symbols until the final stage, which is the solution. According to Unson (2021), when students are faced with word problems, they experience difficulties that lead to errors in solving the problems. Therefore, in tackling mathematical problems, students must first plan the procedures they will use.

The procedure that can be used to analyze students' errors in solving word problems is the Newman Error Analysis (NEA) procedure. Newman errors are classified into: (1) reading errors; (2) comprehension errors; (3) transformation errors; (4) process skill errors; and (5) encoding errors (Singh, 2010). According to (Atmowardoyo and Salija, 2018), the problems faced by students can be viewed as external stimuli. In information processing theory, the problems students encounter enter the sensory register. Information processing theory consists of several parts, including the information storage part and the cognitive processing part. The information storage component consists of the sensory register, short-term memory, and long-term memory. Meanwhile, the cognitive process components are attention, perception, retrieval, rehearsal, and encoding.

Based on the initial researcher's observation on February 22, 2020, at SMPN 1 Saradan regarding algebraic operations with a randomly selected student, it was found that the student struggled to understand the problem well, resulting in errors. Therefore, addressing students' errors in solving mathematical story problems is essential. According to (Anghileri 2006), educators are effective if they can provide assistance to learners using various approaches that promote active engagement. According to Bikmaz, et al., (2010), providing assistance when learners encounter difficulties in solving problems is referred to as the scaffolding stage.

Categorizes scaffolding into three hierarchical levels (Van, 2010). These levels are organized based on the amount of student-teacher interaction and the potential to enhance and contribute to student understanding. The lowest level, level 1, primarily aims to structure instructional settings to support student learning with minimal teacher-student interaction. Level 2 consists of hierarchical practices that require more interaction with students. The highest level, level 3, involves developing representational tools, making

connections, and generating conceptual discourse. Therefore, the objective of this research is to obtain information on how scaffolding can be provided for students' errors in solving mathematical story problems, specifically focusing on algebraic operations, with the hope of reducing errors in solving story-type mathematical problems.

In recent years, many studies have utilized the emotional quotient (Bru-Luna, et al. 2021). Another internal factor that can influence students' mathematical errors is emotional intelligence (Maryani, 2020). The roles of motivation, interest, and emotion are very important for learning (Furco, 2010). This results in a situation where when students lack motivation, their learning process is rarely initiated, and when they feel discouraged, their learning process can easily be halted. Based on previous literature, it is known that emotional intelligence plays a significant role in the learning process of students, including in the field of mathematics. Therefore, this study will examine whether there is a significant correlation between mathematical emotional intelligence and the mathematical errors made by students. Students may appear lazy, easily discouraged, indifferent, bored, and apathetic (Goleman, 2018). Thus, it can be said that students' emotional intelligence in mathematics plays a role in their mathematical errors. Previous research, such as the study conducted by Susi Sihombing, has explored the relationship between mathematical errors and students' emotional intelligence (Sihombing, 2021) it states that there is a very significant relationship between learning achievement and the mistakes someone makes. Furthermore, emotional intelligence directly influences students' mathematics learning outcomes (Prafitriyani, et al., 2019). Therefore, in improving students' achievement or learning outcomes, scaffolding for mathematics errors and emotional intelligence (EQ) are necessary. The relationship between these two variables should be considered when designing and organizing the learning process to contribute to its effectiveness (Putra, 2020). Thus, it can be concluded that the relationship between these two variables needs to be identified by teachers in order to optimize students' learning achievement (Hidayah, et al., 2022). Based on the issues outlined above, the hypothesis of this research is that there is a significant relationship between mathematical emotional intelligence and students' errors. This study aims to examine middle school students' mathematics errors in relation to their mathematical emotional intelligence.

▪ METHOD

This research is a quantitative study with a descriptive correlational approach. The aim is to determine the relationship between mathematical emotional intelligence and students' mathematical errors. The population in this study consists of 30 students from class VIII D at SMP Negeri 1 Saradan, and the sample includes 3 students selected using purposive sampling technique. The research duration is approximately 1 year from the initial preparation to the beginning of the study.

Descriptive analysis is used to describe the profile of mathematical emotional intelligence and the types of mathematical errors that frequently occur, while Pearson correlation analysis is used to test the relationship between mathematical emotional intelligence and students' mathematical errors. The instruments in this study are the mathematical emotional intelligence questionnaire and the mathematical error test. The mathematical emotional intelligence questionnaire adapts items from Satriani to measure students' levels of mathematical emotional intelligence. The mathematical error test

consists of 4 essay questions formulated by the researcher based on the algebraic operations material that has been taught, and the validity of the test has been assessed by a mathematics expert lecturer.

This validity test is used to determine the validity of the emotional intelligence questionnaire. Based on the preliminary test, the emotional intelligence questionnaire with 25 items yielded r_calculate≤ r_table (r_table=0.361). Therefore, out of the 25 statement items in the emotional intelligence questionnaire, all 25 items are deemed valid. This reliability test is used to assess the reliability of the emotional intelligence questionnaire. The critical r_table value for n = 30 and Alpha = 0.05 is 0.361, All product moment correlation values for each statement are above 0.361, indicating that all statements are valid. The Cronbach's Alpha value is 0.870 (≥ 0.800), indicating that the emotional intelligence questionnaire has very high reliability.

In this research, the statistical technique used is first the validity test using the product moment correlation technique to determine the validity of the items in the emotional intelligence questionnaire by calculating the correlation coefficient (r) between each statement item and the total questionnaire score. Items are considered valid because $0.05 \leq 0.361$. Second, the reliability test uses the Cronbach's alpha technique to assess the reliability or internal consistency of the emotional intelligence questionnaire by calculating the Cronbach's alpha value for all the items in the questionnaire. The questionnaire is highly reliable because the Cronbach's alpha value is $0.870 \geq 0.800$. Third, the normality test uses the Shapiro-Wilk test to assess whether the data are normally distributed. The Shapiro-Wilk test is used because of the small sample size (population < 50). The data are normally distributed because the significance values for emotional intelligence ($0.878 > 0.05$) and student errors ($0.298 > 0.05$) are both above 0.05. Fourth, the correlation test uses the Pearson product moment correlation technique to assess the relationship between two variables, namely emotional intelligence and students' mathematical errors, by calculating the Pearson correlation coefficient and evaluating its significance. The relationship is significant because the value is $0.887 < 0.05$. By using these statistical techniques, the research aims to ensure that the instruments used are valid and reliable, and to analyze the relationship between the variables studied.

In this research, the steps taken are as follows: developing research instruments, consulting the developed learning instruments with validators, then selecting the research sample from the defined population using purposive sampling technique and distributing the mathematical emotional intelligence questionnaire. After that, the scaffolding learning model is applied, the mathematical error test is administered, interviews are conducted according to the semi-structured interview guidelines, and data analysis is performed to test the proposed hypotheses, followed by preparing the research report.

This research falls under the category of descriptive correlational research, which aims to determine the relationship and the degree of relationship between two or more variables without attempting to influence those variables. Therefore, there is no manipulation of variables involved. This study aims to investigate the relationship between emotional intelligence level (X) and mathematical errors (Y). The relationship design to be analyzed in this study can be seen in Figure 1.

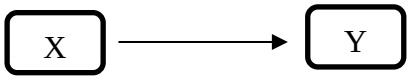

Figure 1. Research design

This research was conducted at SMP Negeri 1 Saradan, Madiun, Indonesia in June 2023. The population consisted of all students in class VIII D at the school, and the sample included 3 students from this class selected through purposive sampling. The instruments used in this research included an emotional intelligence questionnaire and a mathematics error test.

Data collection involved distributing the emotional intelligence questionnaire and administering the mathematics error test. The emotional intelligence questionnaire consists of 25 statement items. The categories of emotional intelligence include recognizing one's own emotions, managing one's own emotions, self-motivation, recognizing others' emotions, and building relationships with others. The indicators for recognizing one's own emotions, which include recognizing personal feelings and understanding the causes of these feelings, consist of 6 items. The indicators for managing one's own emotions, which include the ability to control emotions and express emotions appropriately, consist of 4 items. The indicators for self-motivation, which include sensitivity to others' feelings and the ability to accept others' perspectives, consist of 6 items. The indicators for recognizing others' emotions consist of 5 items. The indicators for building relationships with others, which include the ability to collaborate with others and communicate effectively, consist of 4 items.

The questionnaire contained statements rated on a 4-point Likert scale. The instruments are adapted from other research studies. The items for the emotional intelligence mathematics questionnaire were adapted from Satriani's work (Satriani, 2015). The language in the questionnaire was first consulted with validators to ensure it was suitable for middle school students' language proficiency.

The mathematics test instrument consists of 4 questions. The indicators include determining the solution of a linear equation with one variable, which consists of 2 questions and presenting real-world problems related to systems of linear equations with two variables (SPLSV), where students need to create a mathematical model from the given problem, consisting of 2 questions. An example of a question is Mr. Wicak has a rectangular garden with a length of (3x-4) meters and a width of (x+1) meters. The perimeter of the garden is 34 meters. What is the area of Pak Wicak's garden? Below in Table 1, the indicators for the students' mathematical emotional intelligence questionnaire are presented.

Table 1. Indicators of students' mathematical emotional intelligence questionnaire

Variable	Indicator	Total
Emotional Intelligence (X)	Recognizing Self Emotions	25
	Managing Emotions	
	Self-Motivation	
	Recognizing Others' Emotions	
	Building Relationships with the Environment	

The mathematics error test used consists of essay questions comprising 4 problems formulated by the researcher based on the learning sessions conducted on the "algebraic operations" material. Before being administered to students, this test was validated by a mathematics expert lecturer.

The data analysis techniques in this research involve several tests is validity test. The validity of the questionnaire instrument is assessed using the product moment correlation technique. After conducting the validity test, the correlation value (r) for each statement item is compared with the total score. If the calculated correlation coefficient r_calculated> r_table, the statement item is considered valid. However, if r_calculated≤ r_table, the statement item is considered invalid. The reliability test in this research is conducted using Cronbach's Alpha. Next, the normality test in this research is conducted using the Shapiro-Wilk test due to the small sample size (population < 50). In this normality test, compared to a significance level of 5% ($\alpha = 0.05$), if the significance value is greater than $\alpha = 0.05$, the data can be considered normally distributed. Next, to test the correlation or relationship between variables, parametric tests such as Pearson correlation or product moment correlation are used.

▪ RESULT AND DISSCUSSION

Emotional Intelligence of Students

Based on data from 30 students, the average score obtained was 69.33 with a standard deviation of 6.97, which is used to categorize the emotional intelligence of students as presented in Table 2.

Table 2. Categorization of students' emotional intelligence

Categorization Boundaries	Categories	f	%
$x < (\mu - 1.0\sigma)$	Low	4	13%
$(\mu - 1.0\sigma) \leq x < (\mu + 1.0\sigma)$	Medium	21	70%
$x \geq (\mu + 1.0\sigma)$	High	5	17%

Based on Table 2, it shows that, in general, the emotional intelligence of grade VIII students at the junior high school level falls into the medium category. Therefore, educators need to make efforts to enhance students' emotional intelligence through innovative mathematics teaching.

The low category refers to students who have emotional intelligence less than one standard deviation below the mean (μ-1.0σ) (Wisner, 2012). In this study, there are 4 students who fall into this category, which represents 13% of the total population. The moderate category refers to students who have emotional intelligence scores between one standard deviation below the mean and one standard deviation above the mean (μ-1.0σ) ≤ x <(μ+1.0σ) (Ramadhanis, 2021). The majority of students, specifically 21 students or 70% of the total population, fall into this category. The high category refers to students who have emotional intelligence scores greater than or equal to one standard deviation above the mean x≥(μ+1,0σ). There are 5 students who fall into this category, representing 17% of the total population. This categorization helps in understanding the distribution of emotional intelligence among students, as well as in identifying groups of students who require special attention or intervention based on their level of emotional intelligence.

Scaffolding Learning Model

In this research, scaffolding was provided first, followed by a test. The scaffolding provided consisted of three levels: the first level is environmental provisions, the second level is explaining, reviewing, and restructuring, and the final level is developing conceptual thinking (Anghileri, 2006).

Scaffolding on understanding errors, transformation, process skills, and final answer writing for S1, S2, and S3 involved providing scaffolding in the form of developing conceptual thinking, which is the third level. At this level, the teacher assists students in building connections between concepts by creating opportunities for students and teachers to express their understanding (Parameswari, et al., 2018).

Students' Mathematics Errors

The types of errors identified are comprehension errors, transformation errors, process skill errors, and encoding errors (Oktafia, 2020). On average, S1, S2, and S3 mostly made process skill errors. This aligns with the opinion of (Rahmawati, 2018) that process skill errors occur when students can identify the appropriate operation or series of operations but do not know the steps required to execute these operations perfectly.

Table 3. Frequency of types of errors in the final mathematics test

Types of Errors	Frequency
Reading errors	-
Comprehension errors	4
Transformation errors	8
Process skill errors	13
Encoding errors	6

In this study, there were no reading errors. Students made 4 comprehension errors in understanding the math problems. There were 8 errors in converting information from the problem into equations or other mathematical forms. The most frequent errors occurred in processing skills, with a total of 13 errors, which included mistakes in the steps or procedures for solving the problems. There were also 6 errors in correctly writing the final answers.

Normality Test

Based on the data obtained from 30 students, a normality test using Shapiro-Wilk was conducted on emotional intelligence data. For clarity, the results of the normality test for the emotional intelligence questionnaire are presented in Table 4.

Table 4. Results of normality test for student errors and emotional intelligence using shapiro-wilk

Variable	Shapiro-Wilk			Decision
	Statistic	df	Sig	
Emotional Intelligence (X)	0.996	3	0.878	The data is normally distributed
Student Errors (Y)	0.871	3	0.298	The data is normally distributed

The details of the normality test results for each variable are as follows: emotional intelligence (x) with a Shapiro-Wilk statistic of 0.996, degrees of freedom (df) of 3, and significance (sig) of 0.878. Since the significance value (sig) of 0.878 is greater than 0.05, the emotional intelligence data is normally distributed. Additionally, student errors (y) have a Shapiro-Wilk statistic of 0.871, degrees of freedom (df) of 3, and significance (sig) of 0.298. Since the significance value (sig) of 0.298 is greater than 0.05, the student error data is also normally distributed. Therefore, based on the Shapiro-Wilk test results, the data for both emotional intelligence and student errors meet the assumption of normality (Korkmaz, 2023).

Based on Table 4, it can be seen that with a significance level of 0.05, both student errors and emotional intelligence data have significance values greater than 0.05, indicating normal distribution. Meanwhile, student concept comprehension has a significance value below 0.05. Based on the normality test results, it shows a spread of data in variables that are normally distributed, allowing parametric statistical tests to be conducted for hypothesis testing.

To test hypotheses in this study, parametric statistical tests will be used. The hypothesis test employed will be the Pearson correlation or product moment correlation test. The results of the correlation test will be explained in Table 5.

Table 5. Results of product moment correlation test

Research Variables		**Kecerdasan Emosional (X)**	**Student Errors (Y)**
Emotional Intelligence (X)	Coefficient value	-	0.887**
	Significance level		Strong
	Significance value		0.018
	Significance value		0.05 (5%)
	Decision		Significance
Student Errors (Y)	Coefficient value	0.887**	-
	Significance level	Strong	
	Significance value	0.018	
	Significance value	0.05 (5%)	
	Decision	Significance	

The results of the product-moment correlation test indicate a significant relationship between emotional intelligence and student errors. Here are the detailed correlation test results for the two research variables: Emotional intelligence (x) and student errors (y) have a correlation coefficient of 0.887, indicating a strong level of significance, with a significance value of 0.018, since the significance value (0.018) is less than the significance level of 0.05 (5%), the result is significant. This means there is a strong and significant relationship between emotional intelligence and student errors. Then, student errors (y) and emotional intelligence (x) have a correlation coefficient of 0.887, indicating a strong level of significance, with a significance value of 0.018. Since the significance value (0.018) is less than the significance level of 0.05 (5%), the result is significant. This indicates that student errors also have a strong and significant relationship with emotional intelligence (Kant, 2019). Overall, the correlation test shows that there is a strong and significant relationship between emotional intelligence and student errors (Syahidah, Rena et al., 2023).

Based on the correlation analysis between variables in Table 5, the correlation coefficient (koefisien korelasi) between X and Y is 0.887. This value indicates a strong (high) relationship between variables X and Y. The correlation coefficient is positive, indicating a direct relationship between emotional intelligence and student errors. Emotional intelligence is one of the factors within students that contributes to student errors (Murtafiah, et al., 2022). Therefore, it can be said that the higher the emotional intelligence, the lower the student errors (Hasnah, 2018). On the contrary, the lower the emotional intelligence, the higher the student errors. This aligns with the findings of (Chang and Tsai 2022) research suggests that emotional intelligence directly influences student errors. Students with high emotional intelligence are adept at self-motivation and emotional regulation, enabling them to focus their attention on mathematics learning and reduce errors effectively.

The results of this study are in line with other research, such as Zahriatul Efriza's study, which states that there is a significant impact of emotional intelligence on students' mathematics achievement (Efriza, 2022). The results of this study are in line with other research, such as Zahriatul Efriza's study, which states that there is a significant impact of emotional intelligence on students' mathematics achievement (Wulandari, R., & Suryadi 2016). Other research findings showed that emotional intelligence influenced the understanding of mathematical concepts (Islami, et al., 2020). Next, Sri Maryani's research states that this research aims to obtain information about the influence of emotional intelligence on students' mathematical problem-solving ability (Maryani, Pramudya, and Slamet 2019).

The uniqueness of this research compared to other studies is that it specifically examines student errors in relation to emotional intelligence, a topic that has not been previously investigated. Most existing research focuses on the relationship between emotional intelligence and problem-solving skills or student learning outcomes. Therefore, the novelty of this study lies in its exploration of the relationship between emotional intelligence and student errors.

▪ CONCLUSION

Based on the data analysis, it can be concluded that there is a partial relationship between emotional intelligence in mathematics and student errors. This is indicated by the results of the Pearson product-moment correlation analysis. Furthermore, there is a relationship between emotional intelligence in mathematics and student errors among class VIII D at Junior High School. This is indicated by the results of the Pearson product-moment correlation analysis, which means that emotional intelligence in mathematics has a strong influence on student errors among class VIII D at Junior High School. Therefore, emotional intelligence in mathematics and student errors are factors that contribute to supporting students' understanding of mathematical concepts.

Based on the conclusions drawn above, it is recommended for future research to diversify the research variables, expand the study population, and develop improved research instruments.

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