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ANALYSIS OF STUDENTS' ERRORS IN SOLVING MATHEMATICAL CRITICAL THINKING PROBLEMS ON JUNIOR HIGH SCHOOL

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ABSTRACT

Critical thinking ability is one of the important competencies that students must have in facing challenges in the information age. This research aims to identify the types of errors made by class VII junior high school students in solving critical thinking skills questions on algebra material. This research uses a qualitative descriptive approach with the research subjects were 32 students in class VII.7, data collection was carried out through written tests containing critical thinking questions. It was found that several students made mistakes in solving algebra material questions, namely 1) Not understanding the concept of algebra definition; (2) The settlement process is not systematic; (3) There is no resolution process, go straight to the answer; (4) Do not understand the meaning of the question; (5) Weak in analyzing and arguing (6) Difficulty modeling problems in algebraic form; (7) Not understanding how to calculate operations and the properties of algebraic operations; (8) No identification of questions, no collection and compilation of data in the questions; (9) Not familiar with complex multiple choice questions. This research shows that students' critical thinking skills in solving algebra problems are still low. This is caused by several factors, such as a lack of in-depth understanding of concepts, lack of process skills, and less effective study habits. To improve students' critical thinking abilities, improvements in learning need to be made, such as strengthening understanding of concepts, developing process skills, and improving study habits.

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INTRODUCTION

Mathematics is the queen of science, the parent of all sciences, and the foundation of various life activities. However, it is often considered a difficult subject due to its abstract nature (Angela, F.; Roza, Y., 2024). Algebra is one of the mathematical materials. Indeed, algebra is

often considered a challenging subject for students, yet it is an essential foundation for developing mathematical critical thinking skills (Drijvers, et.al, 2011; Jupri, 2014; Marisa, G.;Syaiful;Hariyadi, 2020). Algebra is not merely a collection of formulas and counting operations; it is a gateway to a profound comprehension of the underlying patterns, relationships, and structures that underlie various phenomena.

The acquisition of algebraic knowledge is comparable to the acquisition of a knife in the realm of mathematics. Its capacity to simplify complex problems, generate patterns, and identify elegant solutions renders it a valuable instrument in a multitude of fields, including science, technology, economics, and business. The capacity to solve problems in everyday life is inextricably linked to the ability to think critically. Furthermore, effective critical thinking abilities enable individuals to respond to the complexities of the modern era in a rational manner, facilitating the formulation of solutions to the challenges it presents (Syahbana, 2019). This aligns with the assertion that mathematics is a discipline capable of providing support across various scientific domains and of addressing a multitude of issues through mathematical reasoning (Anggraini et al., 2022).

One of the mathematical thinking skills is critical thinking. According to Ennis (2011), critical thinking is the process of analyzing information and situations deeply and logically to make the right decision. It is reasonable and reflective thinking in making decisions about things that are believed or done. Critical thinking skills allow us to understand situations better, find creative solutions, and make informed decisions. This assertion aligns with the perspective of Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2017), who posit that critical thinking abilities are essential for navigating everyday life challenges.

The integration of mathematical critical thinking in learning settings is not yet optimal. In general, critical thinking remains a significant area for improvement. Some researchers have posited that the results of research conducted by Fatmawati, Mardiyana, and Triyanto (2014) indicate that students exhibit low levels of critical thinking skills. Additionally, Pertiwi (2018) asserts that students' mathematical critical thinking skills are situated within the low category. This is evidenced by the fact that the average score for each indicator of critical thinking is below 50%, particularly in the domains of evaluation and inference. In accordance with the findings of the observations conducted by Andini and Warmi (2019), it was determined that 0% of the students answered based on the Minimum Completeness Criteria (KKM), 8% answered in a manner that was nearly aligned with the KKM, and the remaining 92% answered below the KKM. The average percentage of total indicators was found to be 41.54%, indicating that the critical thinking skills of the students were in the low category.

The critical thinking abilities of seventh grade students in junior high school are still evolving, as they are in the period of cognitive development that bridges the gap between elementary school and the next stage of their academic careers (Herawati & Kadarisma, 2021). In the process, students encounter difficulties in learning mathematical algebra material. Student learning outcomes in mathematics remain below the minimum completeness criteria. Mathematics is still considered a difficult subject, and students report feeling bored, which has resulted in relatively low critical thinking skills. (Balok et al., 2023).

Based on the aforementioned description, the researcher intends to analyze the errors of seventh grade junior high school students in solving algebraic form problems with critical thinking ability indicators. The purpose of this study is to describe the difficulties and factors that cause difficulties experienced by students in solving algebraic form problems with critical thinking ability indicators. Researchers hope that this research can provide benefits for students, teachers, and researchers by enabling them to identify and overcome the difficulties experienced by students.

METHOD

This study employs a qualitative descriptive approach to elucidate the nature of student errors in solving algebraic problems, with a particular focus on the mathematical critical thinking skills of junior high school students. The research was conducted at SMP Negeri 1 Cihampelas, with 32 students from class VII.7 serving as the research subjects. The research data were in the form of written answers obtained from the written test results. The instruments provided to the students consisted of five questions in the form of descriptions pertaining to mathematical critical thinking skills.

RESULTS AND DISCUSSION

Results

The responses of students in class VII.7 of SMPN 1 Cihampelas were analyzed to identify common errors in solving mathematical critical thinking problems. The following examples illustrate the types of errors observed in each question.

Question number 1. Given a rectangle as shown in the following image:

$(4x + 6)cm$

5 cm

a. What is the perimeter of the rectangle for x = 3?

b. Is it permissible to utilize negative values for the x variable? If so, how many such values are possible, and what are the underlying reasons for this?

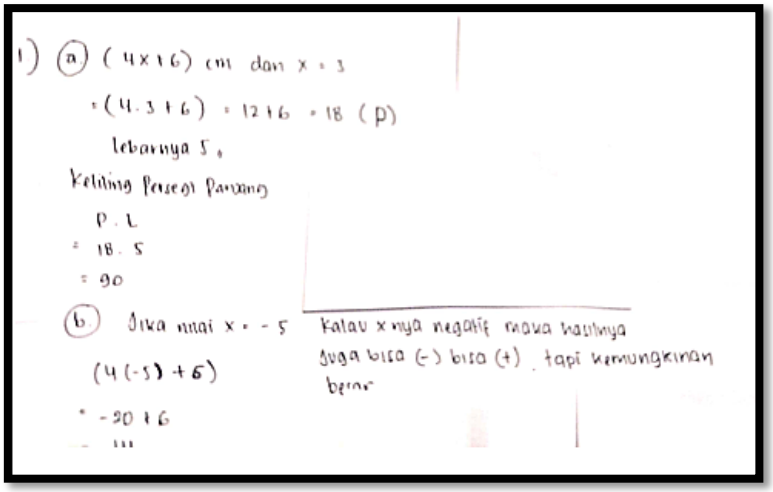

Figure 1. Errors in Answering Question Number 1

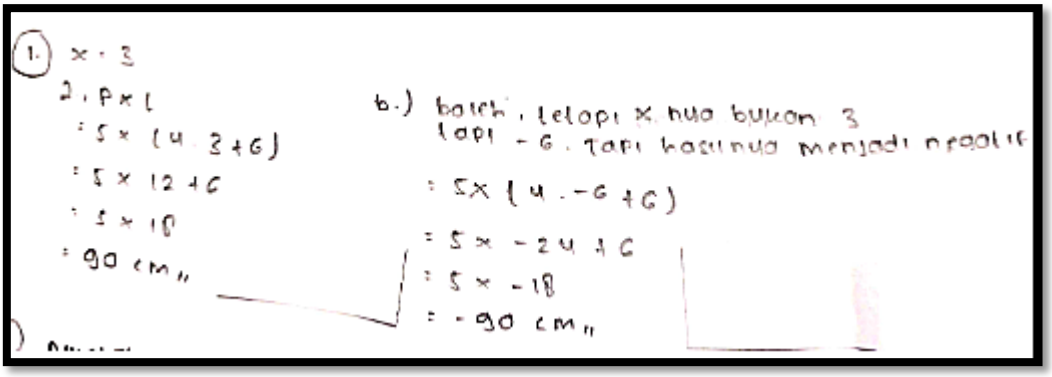

Figure 2. Errors in Answering Question Number 1

Figures 1 and 2 represent one of the student responses to critical thinking problem number 1. These figures illustrate the analysis of questions, answers, and arguments. Both students in part of problem 1a demonstrate errors in the use of the formula for the perimeter of a rectangle, which they use the formula for the area of a rectangle. The student's response to part b of the problem listed the permitted values for negative x, resulting in a negative perimeter value. The errors can be attributed to a lack of understanding of the concept of the perimeter of a rectangle and a failure to consider values with negative x. This limits the ability to analyze and provide complete arguments.

Question number 2. Kalief participated in the selection of the mathematics olympiad and was presented with a question comprising 50 items. Each correct response was awarded a score of 4, while incorrect responses were assigned a score of -1 and unanswered items received a score of 0. If Kalief answered 44 items correctly and received a score of 71, how many items did Kalief answer correctly? Collect the necessary data and organize the information required to determine the score.

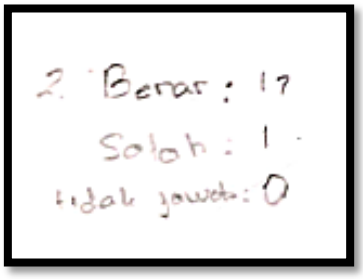

Figure 3. Errors in Answering Question Number 2

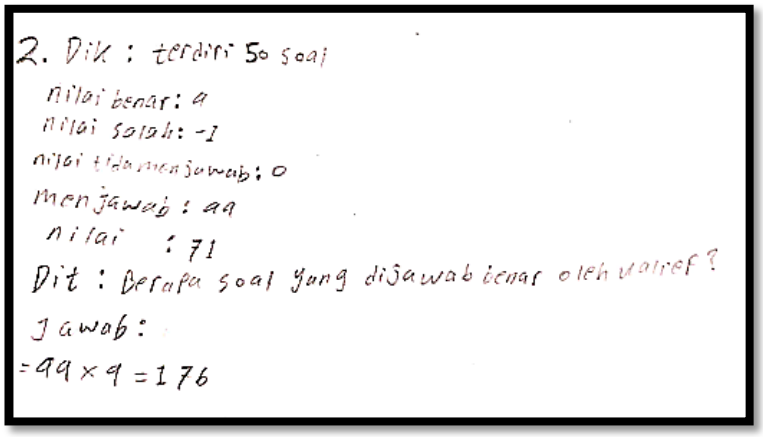

Figure 4. Errors in Answering Question Number 2

Figures 3 and 4 illustrate the errors in students' responses to question number 2 about critical thinking skills, specifically in relation to the collection of data and the compilation of necessary information. In Figure 2, students demonstrate an ability to provide correct responses to many of the questions, as well as incorrect responses and responses that are not answered. However, it is evident that students do not consistently adhere to the process of data collection and information compilation. In particular, there is a lack of clear indication of the data information that should be recorded in the problem first, and there is no discernible process that leads to the intended answer. With regard to the response in Figure 4, students swiftly determined that all of the questions were answered correctly, resulting in a score of four. Consequently, the answer was not verified or compared with the score indicated in the problem. The errors that occurred can be attributed to students' lack of comprehension of the question's objective and their failure to record and organize complete data.

Question number 3. Consider the statement below:

a. 5x
b. Xy
c. 8
d. $3x^2 + xy + 6$
e. $\frac{2}{3}\sqrt{3}$

Which one is an algebraic form? Explain!

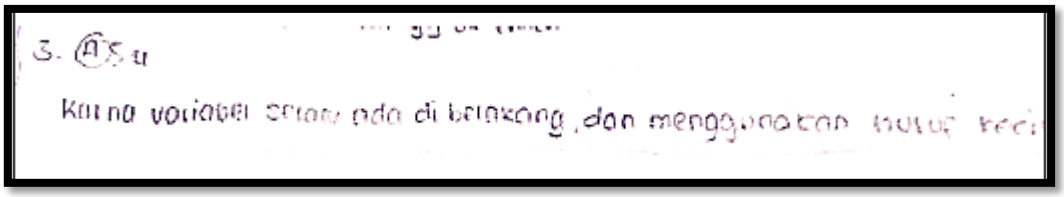

Figure 5. Errors in Answering Question Number 3

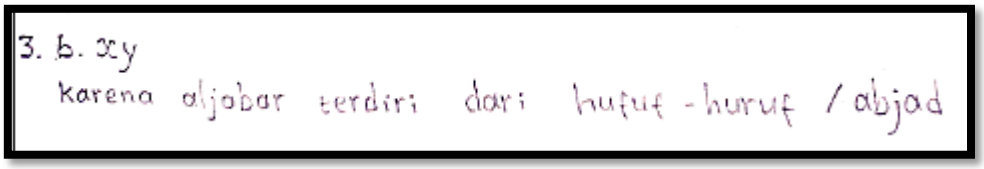

Figure 6. Errors in Answering Question Number 3

Question number 4. Three of the following algebraic forms are equivalent. Determine which algebraic form is not equivalent to the other three and explain why.

a. $7x + 7 - 2x + 3$
b. $5(x + 3) - 5$
c. $2x - 7x + 10$
d. $5x + 10$

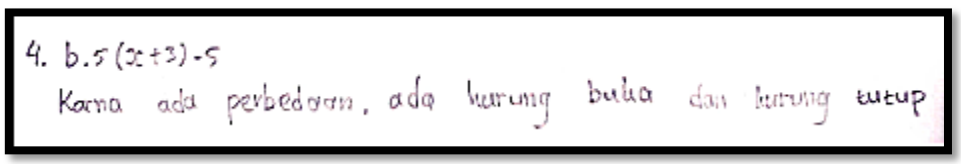

Figure 7. Errors in Answering Question Number 4

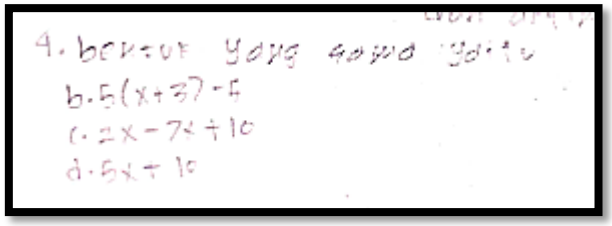

Figure 8. Errors in Answering Question Number 4

Figures 7 and 8 illustrate the discrepancies in student responses to question number 4 regarding critical thinking skills, accompanied by illustrative examples of responses that lack sufficient reasoning. Students tend to assume that algebraic forms that are not equivalent are identical without first simplifying or operating on them. This approach results in algebraic forms that are less complex, and the reasons provided only consider the position of open and closed parentheses. The error can be attributed to a lack of understanding of the fundamental principles governing algebraic operations, particularly with regard to their calculation and the properties inherent to such operations.

Question number 5. Kianna was instructed by her mother to procure cooking utensils. She proceeded to the grocery store with the objective of procuring cooking oil, rice, and flour. If the price of one liter of cooking oil is 17,500 Indonesian rupiah (IDR), one kilogram of rice is 15,000 IDR, and one kilogram of flour is 10,000 IDR, If Kianna is given 100,000 rupiah, what is the maximum amount that can be purchased for each item? Is the amount of money sufficient, or is there any remaining balance? Provide an algebraic representation of the calculation, accompanied by an explanation.

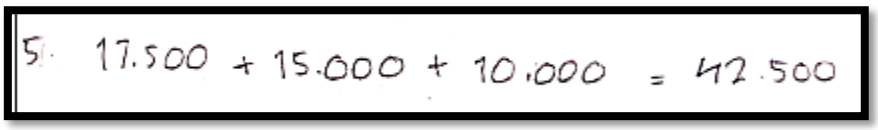

Figure 9. Errors in Answering Question Number 5

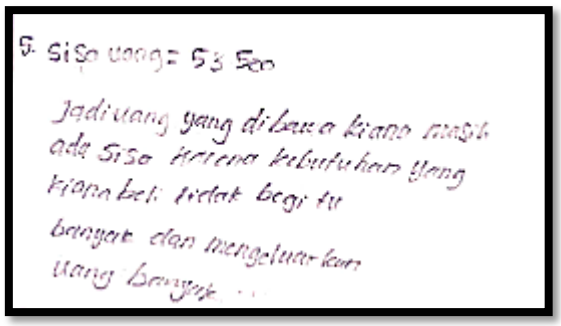

Figure 10. Errors in Answering Question Number 5

Figures 9 and 10 represent one of the student responses to the critical thinking skills problem, with the indicator of evaluating the problem-solving process in problem number 5. Upon examination of the answer sheet, it became evident that students had reached a conclusion without including the requisite calculation process. Additionally, they had attempted to evaluate the problem, although their solution was not in accordance with the expected algebraic form model.The errors that were identified included a lack of problem identification, difficulty in modeling problems into algebraic form, and a deficiency in analysis. It is evident that there is still a need for improvement in numeracy literacy.

The results should be clear and concise. The results should summarize (scientific) findings rather than providing data in great detail. Please highlight differences between your results or findings and the previous publications by other researchers.

Discussions

Table 1. Descriptive Statistics of Students' Critical Thinking Skills Scores

Statistics	
Nilai	
Mean	28.66
Std. Deviation	4.382
Minimum	16
Maximum	34

a. Multiple modes exist. The smallest value is shown

Table 1 indicates that the mean value is 28.66, the standard deviation is 4.382, the maximum value is 34, and the minimum value is 16, with a maximum value of 37. The percentage of students who demonstrated mastery of critical thinking problems for problem number 1 was 75%, for problem number 2 was 79%, for problem number 3 was 70%, for problem number 3 was 66%, and for problem number 5 was 88%.

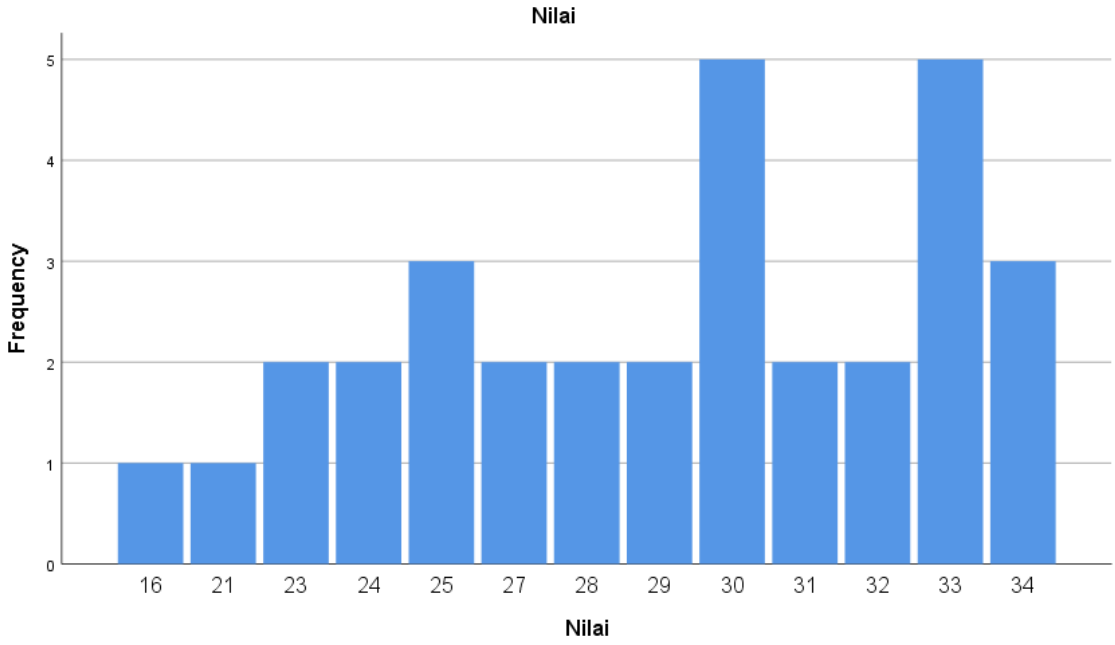

Figure 11. Diagram of Students' Critical Thinking Skills Scores

Figure 11 illustrates the distribution of the data, which is not concentrated in a single value. The lowest score is achieved by a single student, while the highest score is attained by three students. Six students achieve scores that are close to the mean.

In research conducted (Endah & Aini, 2019), the results of research on students' critical thinking ability tests in solving questions related to the main material of algebra, obtained an average score of 24.29, a standard deviation of 3.78, the highest score was 30 and the lowest score 20, the results of the scores of 28 students on critical thinking skills, there are 6 students who are in the high category with a score interval greater than 28.06, having a percentage score of

21.43%, there are 12 students who are in the medium category with a score interval between greater than equal to 28.06 and less than equal to 20.50 have a percentage value of 42.86%, and there are 10 students who are in the low category with a value interval of less than 20.50 having a percentage value of 35.71%.

The research results showed that the latest research group with an average score of 28.66 had better performance than the previous research group with an average score of 24.29 in solving critical thinking questions. There was a significant difference between the mean values of the two groups, with the newest group showing statistically higher results.

Although the two groups have different means, the range of scores in the two groups is also quite different. The latest research group has a wider range of values, namely 16-34, while the previous research group has a narrower range, namely 20-30. The standard deviations in both groups show almost the same level of variability, but the more recent study group has more extreme highs and lows.

CONCLUSION

The preceding discussion has yielded the following conclusions regarding the errors made by students: (1) A lack of comprehension of the concept of an algebraic definition; (2) A lack of systematicity in the solution process; (3) Absence of a solution process that directly leads to the answer; (4) A lack of comprehension of the purpose of the problem; (5) Weakness in the analysis and argumentation; (6 (1) Difficulty modeling problems into algebraic form; (2) Inability to calculate operations and the properties of algebraic operations; (3) Failure to identify the problem, collect and compile data; (4) Inability to solve complex multiple choice questions.

Furthermore, the mean value is 28.66, the standard deviation is 4.382, the maximum value is 34, and the minimum value is 16, with a maximum value of 37. The percentage of students who demonstrated mastery of critical thinking problems for problem number 1 was 75%, for problem number 2 was 79%, for problem number 3 was 70%, for problem number 3 was 66%, and for problem number 5 was 88%. The data is distributed in a dispersed manner, with no single value dominating the others. Among students who achieved the lowest scores, only one individual scored below average. Conversely, three students scored the highest. Among students who scored within the average range, six individuals were identified.

This research shows that students' critical thinking skills in solving algebra problems are still low. This is caused by several factors, such as a lack of in-depth understanding of concepts, lack of process skills, and less effective study habits. To improve students' critical thinking abilities, improvements in learning need to be made, such as strengthening understanding of concepts, developing process skills, and improving study habits.

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