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Description of Students' Mathematical Critical Thinking Ability on Circle Material in Class VIII of SMP Negeri 09 Lebong

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ABSTRACT

Mathematical critical thinking ability is the capacity to investigate, discover, connect, and assess every aspect of a problem carefully and thoughtfully to arrive at the best solution. This study aims to describe students' mathematical critical thinking abilities regarding circles in Grade VIII at SMP Negeri 09 Lebong. This research is a qualitative descriptive study with 20 student participants. Three students were interviewed: one with high ability, one with medium ability, and one with low ability. Data collection methods included tests, interviews, and documentation. The research instruments consisted of test items and interview guidelines. The data analysis technique involved data collection, data reduction, data presentation, and conclusion. The results of the study show that high-ability students met all indicators of mathematical critical thinking: Interpretation, Analysis, Evaluation, and Conclusion. Medium-ability students met two indicators: Interpretation and Analysis. Low-ability students were unable to meet the indicators of mathematical critical thinking: Interpretation, Analysis, Evaluation, and Conclusion.

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1. INTRODUCTION

Education has a significant impact on all aspects of social life, making it an essential skill for every individual. Education is a key factor influencing a nation's ability to develop, particularly in improving the quality of its human resources [1]. Through education, individuals gain knowledge, skills, and values that enable them to participate in societal development actively.

Starting with the ability to understand something and continuing throughout life, education is crucial for everyone. All daily life activities are influenced by it. On the other hand, education is a deliberate effort to act in ways one wishes to influence, and to influence others, whether one acts alone, in a group, or within a community. Therefore,

education is the act of educating someone about a subject they previously knew nothing about [2]. Thus, education not only serves as knowledge transmission but also as a structured process for developing learners' intellectual and social competencies.

In educational settings, mathematics is a compulsory subject from elementary school through middle school, high school, and even university [3]. It is a mandatory field of study in educational settings. Mathematics is far more applicable to real life than simply being an academic subject [4]. Studying mathematics can help someone become more creative and accustomed to thinking methodically, scientifically, logically, and critically [5]. Therefore, mathematics learning plays a strategic role in shaping students' higher-order thinking skills, particularly critical thinking skills.

According to Kowiyah [6], states that to understand mathematics, one must state the problem, plan the process of solving it, examine the steps involved in solving it, and make a statement if the information gathered is insufficient. This requires critical thinking exercises. Students must be able to think critically to master mathematics, as its components are complex and varied. Jannah et al. [7] state that applying critical thinking in mathematics learning can reduce the risk of errors when solving problems, thus producing more accurate answers. Therefore, students should practice their critical thinking skills to become accustomed to considering arguments and points of view. These arguments indicate that critical thinking is not an additional skill in mathematics learning but a fundamental component that determines students' success in problem-solving.

According to Masek and Yamin [8], critical thinking is the ability to analyse and interpret data while asking meaningful questions. In line with this view, Rudinow and Barry [9] stated that critical thinking, which is related to analysis, research, and evaluation, is the capacity to prioritise reasonable beliefs. Therefore, it is important to train students to think critically about mathematics. Susanti [10] agrees that critical thinking is the activity of considering an idea or concept to solve a problem through stages of understanding and analysis of the related issue. Fitriana [11] revealed that mathematical critical thinking skills involve managing information by integrating mathematical knowledge, reasoning, and proof to solve problems, especially in the context of mathematics learning. According to the previous explanation, students' ability to think mathematically critically requires a combination of knowledge, reasoning, and tactics to evaluate and assess information logically [12]. This aligns with what Gunawan et al. [13] state, that the ability to use reason when making judgments or holding beliefs that lead to a goal is known as critical thinking. Based on these theoretical perspectives, mathematical critical thinking can be understood as a structured cognitive process that involves interpretation, analysis, evaluation, and solving mathematical problems.

Researchers describe the development of critical mathematical thinking skills using the circle material. This is because the characteristics of circles can support students in honing their mathematical critical thinking skills, such as by prompting them to examine relationships among concepts like area, circumference, and the elements of a circle [14]. These concepts are related to each other and require the application of appropriate formulas. In addition, the circle material helps students learn to recognise problems and approach them methodically, enabling them to understand ideas more thoroughly than

simply memorising formulas [15]. Furthermore, the circle material encourages students to think critically to choose the most effective solution by allowing them to apply various approaches. In line with the opinion [16], which argues that the challenges of circular materials require more sophisticated thinking at each stage, students must be able to think critically. Based on the previous description, circle material can be used to describe critical thinking skills. Thus, circle material is appropriate for exploring and describing students' mathematical critical thinking abilities in a more focused context.

This research is important to conduct with students to describe their critical thinking skills during mathematics lessons. However, empirical descriptions of students' mathematical critical thinking abilities, especially in circle material at the junior high school level, remain limited and warrant further investigation. The author intends to conduct a study entitled "Description of Students' Mathematical Critical Thinking Skills on Circle Material in Class VIII of SMP Negeri 09 Lebong.

2. METHOD

The type of research determined is descriptive qualitative. The implementation took place at SMP Negeri 09 Lebong, precisely in Karang Anyar, Lebong Tengah District, Lebong Regency, Bengkulu Province. This study aims to describe students' mathematical critical thinking abilities regarding circle material in class VIII at SMP Negeri 09 Lebong. The research was carried out in the even semester, dated March 7, 2025, to April 7, 2025. The subjects determined were 20 students of class VIII. A qualitative descriptive approach was chosen because it allows researchers to explore and describe students' critical thinking processes in depth, using both written and verbal data. The instruments used were test questions and interview guides. Data were collected by utilising tests, interviews, and documentation. The test questions consisted of 4 items that included indicators of mathematical critical thinking abilities. Each test item was designed to represent the indicators of interpretation, analysis, evaluation, and conclusion. Based on the results of the written test for 20 students, three students were selected who demonstrated varying levels of mathematical critical thinking. An interview was then conducted to explore critical thinking abilities in mathematics. The selection of these three subjects was intended to provide a more detailed description of the characteristics of critical thinking at different ability levels.

Based on the questions given, the study provides scores. The scores obtained by students will be calculated using the mathematical critical thinking ability score data as described [17] with the following formula:

$$\text{final score} = \frac{total\ score\ obtained}{maximum\ score} x\ 100\% \quad (1)$$

This scoring procedure was used to standardise students' results and facilitate categorisation. Then, each student's score was categorised as low, medium, or high according to the categories in Table 1 below. The categorisation criteria were applied to assess students' levels of mathematical critical thinking systematically.

Table 1. Categories of mathematical critical thinking skills

No	Interpretasi(%)	Categories
1	68,76 – 100	High
2	37,6 – 68,75	Medium
3	0 – 37,5	Low

3. RESULTS AND DISCUSSION

The following are the test results and their categories. The presentation of these results aims to provide an overview of students' mathematical critical thinking abilities based on the predetermined indicators.

Table 2. Results of Students' Mathematical Critical Thinking Ability Test

Student/subject initials	Categories	Indicator	Mathematical Ability	Think	Critical	Amount	Score
MA	High	4	4	4	4	16	100
AS	Medium	4	4	0	0	8	50
RW	Low	0	0	0	0	0	0

Table 2 shows the distribution of students' scores based on the four indicators of mathematical critical thinking: interpretation, analysis, evaluation, and conclusion.

3.1. Results

This study used circle questions validated by a validator. Table 2 above shows that students are categorised into low, medium, and high groups. Each student's percentage score determined the categorisation. Through test results and interviews, students' critical thinking skills can be identified as follows:

1. Highly Able Students

Students in the high category demonstrated the ability to fulfil all four indicators of mathematical critical thinking.

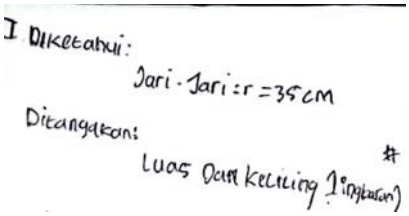

Figure 1. MA subject's answer Interpretation Indicator

Based on the interview and test results conducted with Subject No. 1, it was concluded that Subject No. 1 met the "Interpretation" indicator. Subject No. 1 wrote down what he knew and what was asked in the questions perfectly and accurately. This indicates that the student understood the problem thoroughly before proceeding to the solution stage.

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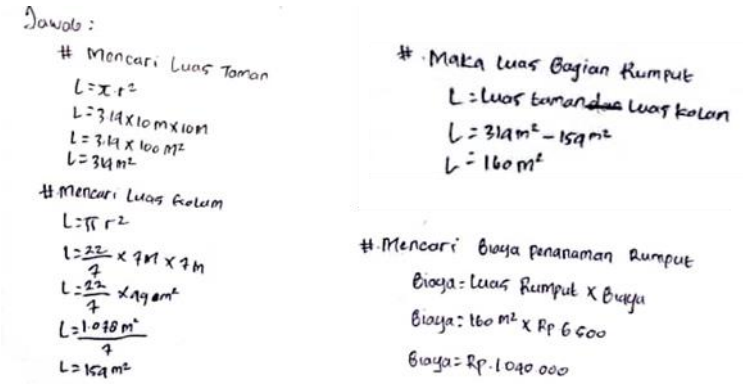

Figure 2. MA subject answers Analysis Indicators

Based on the interview and test results with MA subject No. 2, it was concluded that the subject had met the "Analysis" indicator. This is because the MA subject developed mathematical models and strategies for systematically, comprehensively, and accurately solving problems. The student was able to identify relationships among concepts in circle material and translate them into appropriate mathematical representations.

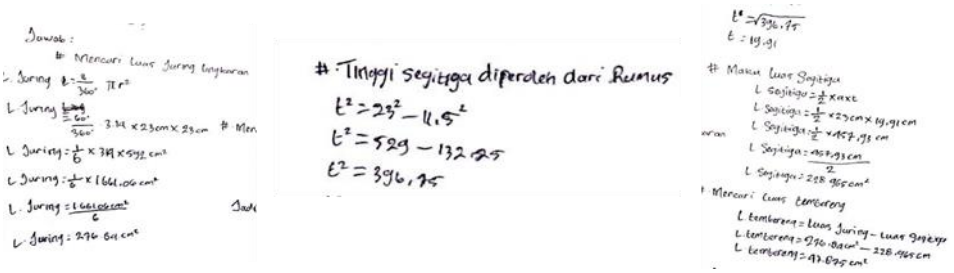

Figure 3. MA subject answers Evaluation Indicators

Based on the results of the interview and test with Subject No. 3, it was concluded that Subject MA had met the "Evaluation" indicator. This was because Subject MA had utilised appropriate strategies to solve problems accurately and completely, including calculations and explanations. The correctness of the calculations and the logical consistency of the solution steps indicate strong evaluative skills.

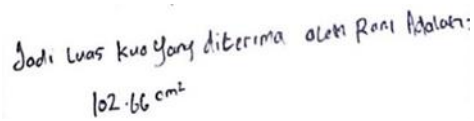

Figure 4. MA Subject Answers Conclusion Indicator

Based on the interview and test results with Subject No. 4, it was concluded that Subject MA had met the "Conclusion" indicator. This is because Subject MA drew accurate, complete, and contextually aligned conclusions. The conclusion provided was consistent with the problem context and supported by the solution process.

2. Students with Average Abilities

Students in the medium category were able to fulfil some, but not all, indicators of mathematical critical thinking.

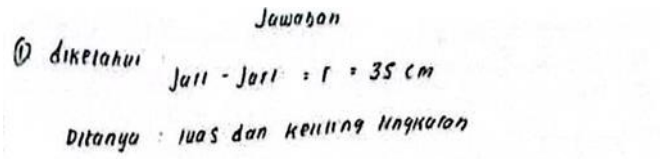

Figure 5. AS Subject Answers Interpretation Indicator

Based on the interview and test results with Subject AS No. 1, it was concluded that subject AS had met the "Interpretation" indicator. This was because Subject AS was able to write down, in her own words, what she understood and what was asked in the questions. This shows that the student was able to comprehend the problem, although not yet optimally.

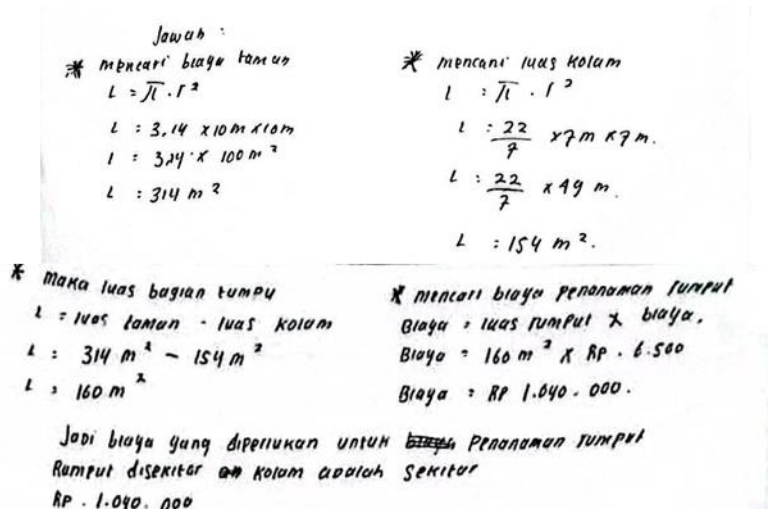

Figure 6. AS Subject Answers Analysis Indicator

Based on the interview and test results with Subject No. AS No. 2, it was concluded that the subject had met the "Analysis" indicator. Subject AS was able to create mathematical models and strategies to solve problems in a structured, comprehensive, and appropriate manner. However, the strategy's implementation was not entirely accurate.

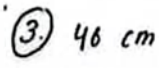

Figure 7. AS Subject Answers Evaluation Indicators

Based on the results of the interview and test with AS subject No. 3, it was concluded that the AS subject had not met the "Evaluation" indicator. This was because the

AS subject did not utilise strategies when solving problems. Errors in calculations and incomplete reasoning were still found at this stage.

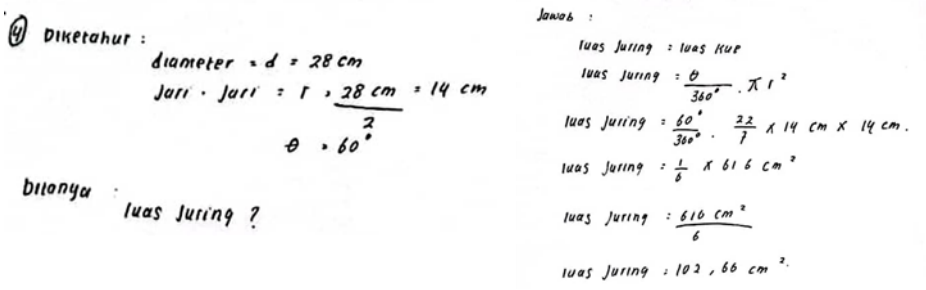

Figure 8. AS Subject Answers Conclusion Indicator

Based on the interview and test results with AS subject No. 4, it was concluded that AS subject had not met the "Conclusion" indicator. This was because the AS subject did not conclude the answers he had provided. The lack of a clear conclusion suggests the student had difficulty synthesizing the results of the solution process.

3. Low Ability Students

Students in the low category had difficulty meeting all four indicators of mathematical critical thinking.

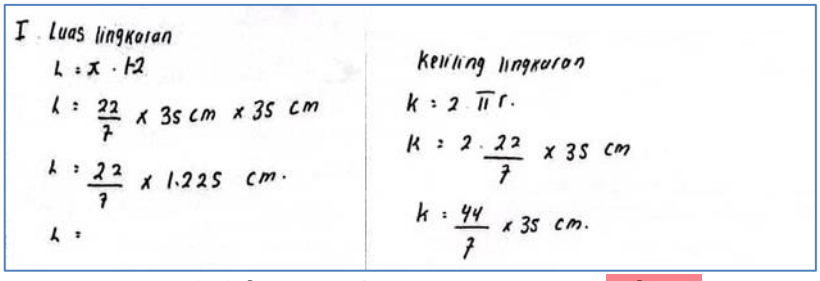

Figure 9. Subject RW Answers Interpretation Indicator

Based on the results of the interview and test with subject RW No. 1, it was concluded that subject RW had not met the "Interpretation" indicator. Because subject RW did not write down what he knew or what was asked, subject RW was given a score of 0 for the Interpretation indicator. This indicates that the student did not fully understand the problem presented.

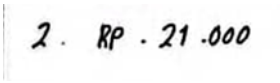

Figure 10. Subject RW Answers Analysis Indicators

Based on the results of the interview and test with subject RW No. 2, it was concluded that subject RW had not fulfilled the "Analysis" indicator. Because subject RW answered but did not write down the mathematical model or strategy used to solve the

problem, subject R was given a score of 0 for the Analysis indicator. The absence of a clear problem-solving strategy reflects limited analytical ability.

Figure 11. RW Subject Answers Evaluation Indicators

Based on the interview and test results with subject RW No. 3, it was concluded that subject RW had not met the "Evaluation" indicator. Because subject RW did not answer this question, subject RW was given a score of 0 for the Evaluation indicator. This shows that the student was unable to apply or assess an appropriate solution strategy.

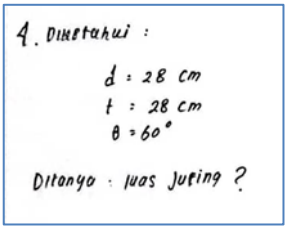

Figure 12. Subject RW Answers Conclusion Indicator

Based on the interview and test results with subject RW No. 4, it was concluded that subject RW had not yet met the "Conclusion" indicator. Because subject RW did not conclude, subject R was given a score of 0 for the Conclusion indicator. The inability to conclude demonstrates weaknesses in synthesising and finalising problem-solving outcomes.

3.2. Discussion

As a result of the tests and interviews conducted regarding mathematical critical thinking skills with the subjects, the researcher collected the following data:

1. Highly Able Students

   Students who meet all four indicators—interpretation, analysis, evaluation, and conclusion—are considered to have high abilities. MA students accurately record what is understood and asked in the problem, demonstrate that they understand the problem, determine the correlation between questions, statements, and concepts in the problem, solve problems using appropriate approaches, complete calculations correctly, and demonstrate the ability to draw appropriate conclusions in the conclusion indicator. These findings indicate that high-ability students not only understand mathematical concepts but also organise their thinking systematically and logically in problem-solving situations.

   This finding is in line with the findings of Jannah et al. [18] which shows that students with high abilities can accurately write what is understood and asked in the question and understand the meaning of the question, students can solve problems by writing the correlation between the concepts they use, namely by formulating a

mathematical model of the problem, students can show that children can write problem solving in a way that is easy to understand. Students can show that children can fully conclude the problem using text or written words. The consistency between this study and previous findings strengthens the assumption that mastery of all critical thinking indicators characterises students in the high category.

This finding is in line with the findings of Rihi et al. [19], which revealed that students with high skills are students who can pass all the indicators, namely, students can describe what is understood and asked, students can describe the concepts used in solving problems correctly, students can describe the strategies used, and students can conclude their knowledge. Thus, the ability to integrate interpretation, analysis, evaluation, and conclusion becomes the main distinguishing factor of high-ability students.

This research also aligns with the findings of Purwati et al. [20], which state that students with high critical thinking skills can solve limit problems involving algebraic functions appropriately and precisely; as an achievement indicator, they can write what they understand from the problem, input information, solve problems, and produce conclusions supported by reasonable reasons. Therefore, high mathematical critical thinking ability is reflected in completeness, accuracy, and logical consistency throughout the problem-solving process.

2. Students with Average Abilities

Interpretation and analysis are two measures of students' mathematical critical thinking skills, both of which are categorised as moderate. AS students accurately record what is understood and asked in the problem, students can demonstrate that they understand the problem, are not able to determine the relationship between questions, statements, and problem concepts, students are not able to solve problems using appropriate approaches and complete calculations appropriately and students are not able to demonstrate the ability to produce conclusions by drawing appropriate conclusions in the Conclusion indicator. This indicates that moderately able students possess initial comprehension skills but experience difficulties in the deeper analytical and evaluative stages.

This aligns with the findings of Faiziyah and Putra [21]. The subject understands the given problem by noting what is understood and what is asked (interpreting). The subject can identify the relationships among statements, questions, and problem concepts by writing mathematical models and producing accurate descriptions (analysis). The subject is less able to answer questions accurately, particularly regarding evaluation and inference indicators. These similarities suggest that errors at the evaluation stage often originate from incomplete analytical processes.

This is in line with research by Agnes [22], which found that students with "moderate" critical thinking skills can meet the interpretation and analysis indicators but do not meet the evaluation and inference indicators. Students with moderate critical thinking skills can understand questions well and formulate mathematical sentences/models well, but still show errors when carrying out calculations. If errors

occur during calculations, the stage of formulating conclusions will also be less accurate. Thus, weaknesses in calculation accuracy and in the implementation of strategies significantly affect the ability to draw valid conclusions.

3. Low Ability Students

Low-ability students are those who have not met the requirements for the four indicators: interpretation, analysis, evaluation, and conclusion. Subject RW did not write down what was asked and what was known for the first indicator, namely, interpretation. Furthermore, by creating a model and formulating an appropriate decomposition, subject RW was able to determine the correlation among statements, questions, and concepts in the problem, as indicated in the analysis indicator. In the evaluation indicator, subject RW was unable to solve the problem using techniques, and in the conclusion indicator, subject RW was unable to conclude. These findings indicate that low-ability students experience difficulties starting from understanding the problem to completing the solution process.

This finding aligns with Astiati and Ilham [23], who found that low-ability students were unable to meet the four indicators. This opinion aligns with the findings of Kartin et al. [24], which revealed that low-category subjects did not meet all relevant indicators. This shows that, when completing the test, students' critical thinking skills were categorised as poor. The inability to fulfil even the initial interpretation stage suggests that foundational conceptual understanding may still be limited.

This also aligns with the findings of Nahdia et al. [25], who found that subjects with low critical thinking abilities did not fully meet all indicators, including interpretation, analysis, evaluation, and inference. Therefore, improving students' mathematical critical thinking skills requires instructional strategies that strengthen conceptual understanding, analytical reasoning, and structured problem-solving practices from the early stages of learning.

4. CONCLUSION

As the results of the research carried out, it was concluded that: interpretation indicators, out of 20 students, 6 students were able to fulfill the desired indicators of answering questions correctly, while 1 student was able to fulfill the interpretation indicator but was incomplete and 13 students were not able to fulfill the interpretation indicator because the students did not write down what was understood and asked in the question. For analysis indicators, out of 20 students, 3 students were able to fulfill the desired analysis indicators from the correct answer to the problem solving while 7 students have fulfilled the analysis indicators but the answer to the problem solving is not correct and incomplete and 10 students have not fulfilled the analysis indicators because students are not yet able to formulate mathematical models, or utilize strategies in solving problems, For evaluation indicators, out of 20 students 1 student has been able to fulfill the desired evaluation indicators from the correct answer to the problem solving while 7 students have fulfilled the evaluation indicators but students use incomplete and inappropriate strategies when solving problems and 12 students have not fulfilled the

evaluation indicators because students have not been able to utilize strategies in solving problems and for the conclusion indicator, out of 20 students 4 students have been able to fulfill the desired conclusion indicators from the correct answer to the problem solving, while 16 students have not fulfilled the conclusion indicator because students do not formulate conclusions in their solutions.

The results of this study indicate that students with high ability can fulfil all indicators of mathematical critical thinking skills, namely: Interpretation, Analysis, Evaluation, and Conclusion. Students with medium ability can fulfil two indicators of mathematical critical thinking skills: Interpretation and Analysis. Students with low ability are students who have not been able to fulfil the indicators of mathematical critical thinking skills, namely: Interpretation, Analysis, Evaluation, and Conclusion.

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