Students’ Critical Thinking Skill in Solving Geometry Problems Viewed from Their Emotional Intelligence

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Abstract. Critical thinking skills are important in solving geometric problems. The intelligence aspect also influences problem-solving. Therefore, this study aimed to describe students’ critical thinking skills in solving geometric problems in terms of emotional intelligence. This research was a qualitative descriptive study with 6 students as the research subject. Researchers used triangulation methods to collect data and determine the validity of the data, namely questionnaires, tests, and interviews. The results showed that as many as 32.26% of students who had low emotional intelligence could not do all the questions correctly, 32.26% of students who had medium emotional intelligence could not work on the questions with indicators of identify existing biases and compile and analyze arguments, and 35.48% of students who have high emotional intelligence cannot work on questions with indicators of make conclusions and analyze the veracity of statements. This was due to a lack of understanding of the definitions, formulas, concepts, and existing information to find information used in solving problems. So, it is necessary to provide more complex practice questions and emphasize understanding of the concept of geometry so that students can use ideas to solve non-routine questions.

Keywords: Critical thinking, Emotional Intelligence, Geometry Problem Solving.

1. Introduction

Students are required to have communication skills, creative thinking, critical thinking, and collaboration in facing the development of the 21st century as the major learning skills needed by students in solving complex problems in everyday life [1]. Learning mathematics emphasizes skills [2]. Learning mathematics has the main objective regarding the skill needs of students, namely to make students ready to face various kinds of problems that exist in real life [3]. Everyday life has a lot to do with geometry, so solving geometric problems requires this skill.

Learning mathematics is emphasized in education so that students have critical thinking skills [4]. The definition of critical thinking itself is the process of making decisions to form a mental which has an important role in solving a problem [5]. Students who can think critically, enable them to be more ready to learn independently, and be able to process information logically [1]. Students can respond appropriately, make things more focused, and be able to distinguish important and unimportant information if they have critical thinking skills [6]. The more students can formulate problems, solve problems, and formulate arguments with the knowledge they have, the more students will have high mathematical critical thinking skills [1]. Students will develop advanced mathematical thinking skills when they are solving problems called critical thinking [6]. Critical thinking skills need a deliberate,
structured, and repeated effort because they cannot be obtained instantly to have deep developed thinking [7]. To develop and encourage critical thinking skills, it is necessary to choose an appropriate topic [8]. Students’ mathematics achievement can be improved by developing good critical thinking skills [9], so that they can be used in knowing the extent to which problems are specifically defined to solve problems with various references obtained [10]. However, in reality, the student’s critical thinking skills are relatively low. This is under the participation of junior high school students in Indonesia in Trends in International Mathematics and Science Study (TIMSS) which has produced unsatisfactory results since 1999 [11].

Each student’s critical thinking ability is different in solving every problem. One of the effects of high or low critical thinking skills is emotional intelligence. Students ‘emotional intelligence needs to be concerned with realizing mathematics learning that can optimize students’ potential [12]. The critical thinking skills possessed by each student are not the same in problem-solving geometry because the levels of emotional intelligence of students are also different. The definition of emotional intelligence is the ability in a person to regulate their emotions properly according to indicators of that intelligence so that they have good emotions and can regulate them into positive intelligence [13]. Emotional intelligence is used to manage emotions that exist in oneself and others [14]. The goals of an organization or group are created in a synergy innovation in teamwork based on emotional intelligence; self-management skills and others influenced by one’s emotional intelligence; maintaining good working relationships and interactions in life that are influenced by social skills [15]. Emotional management, self-understanding, and empathy skills are often associated with emotional intelligence. Self-potential in honing skills based on self-regulation, self-help, motivation, social skills, and empathy is determined by emotional intelligence [16]. A good person’s emotional intelligence will be more creative than someone who has poor emotional intelligence [17]. Students who do not have the enthusiasm and only think about the final result are characteristics of students whose emotional intelligence is not good enough in learning mathematics [18]. Therefore, this study says that mathematics must be developed as an important competency in educating students to think critically and integrate the knowledge of mathematics and technology so that students do not only think about the final answer so that this research hopes to provide knowledge about the causes of low critical thinking skills, based on the level of emotional intelligence. Because in other studies it is known that the ability to think critically in mathematics is significantly influenced by students’ emotional intelligence [19]. Based on this, the researcher wanted to analyze the critical thinking skills of grade VIII junior high school students in solving geometry problems in terms of students’ emotional intelligence. The novelty in this research is that critical thinking skills are analyzed based on the level of students’ emotional intelligence.

2. Method

Qualitative descriptive research is what is used in this research. The design in this research is shown in Figure 1.

![Figure 1. The Research Design.](image)

The material in this study is the geometry chapter on flat shapes. The research subjects of the high, medium, and low emotional intelligence were two students who were selected based on the results of students’ written answers using snowball sampling. This study used a written test instrument to determine students ‘critical thinking skills and students’ emotional intelligence questionnaire. Deep interviews were also conducted by researchers on the subject. The validity of the data was seen using
the triangulation method. Students are classified into the high, medium, and low emotional intelligence categories based on the outcomes of the emotional intelligence questionnaire used by the researcher. After that, students’ critical thinking abilities for each category of emotional intelligence can be known according to the analysis of students’ answers.

3. Result and Discussion

3.1 Result

The four-question essay test was given to measure students’ critical thinking skills based on indicators of critical thinking skills, namely identify existing biases, compile and analyze arguments, analyze the veracity of statements, and make conclusions. Researchers provide an emotional intelligence questionnaire that is used to determine the category of students’ emotional intelligence in one class. Each category was taken by two students to analyze the results of the answers to the students’ critical thinking skills. The percentage of the number of students in each category of student emotional intelligence is shown in Table 1.

Table 1. The Percentage of the Number of Students in Each Category of Student Emotional Intelligence

| Category of Emotional Intelligence | Total students | Percentage |
|-----------------------------------|----------------|------------|
| High                              | 11             | 35.48      |
| Medium                            | 10             | 32.26      |
| Low                               | 10             | 32.26      |

Two students were drawn from each category of emotional intelligence to see the results of their answers. This student intake is also based on the consideration of the mathematics teacher to provide the information expected by the researcher. Besides, researchers conducted in-depth interviews to determine the students’ critical thinking skills to what extent they solve geometric problems. Indicators of students’ critical thinking skills that are met for each category of emotional intelligence are shown in Table 2.

Table 2. Fulfilled Indicators in Each Category of Emotional Intelligence

| Category of Emotional Intelligence | Indicators of Critical Thinking Skills |
|-----------------------------------|---------------------------------------|
| High                              | Identify existing biases               |
| Medium                            | Compile and analyze arguments          |
| Low                               | Make conclusions                       |
|                                  | Analyze the veracity of statements     |
|                                  | None                                   |

An explanation of the results of the critical thinking skills test and student interview results is as follows.

3.1.1 Identify Existing Biases

The question of identifying the biases can be seen in figure 2.
Students with medium emotional intelligence are the first subject is seen in Figure 3.

The results of the interviews with the first subject can be seen in Table 3.

Table 3. Results of interviews with the first subject.

| Numbr | Question                                                                 | Answer |
|-------|--------------------------------------------------------------------------|--------|
| 1     | Do you understand the problem is the problem?                             | Yes, Ma’am. |
| 2     | What information do you know? Try to explain it!                         | It is known that the length of FO = 32 cm, FE = 10 cm, DO = 13 cm, CO = 14 cm, and BC = 16 cm, we put it in the picture then we calculate the area. |
| 3     | What area do you need to find?                                           | Trapezoid and kite, Ma’am. |
| 4     | Is the formula you used correctly?                                       | Yes, Ma’am. |
| 5     | Why is that? Where did you get it?                                       | Search first for the first diagonal and second diagonal. The first diagonal is equal to CE and the second diagonal is found from two times CO. Then find CE from EO + CO = 36, and 2 times CO is equal to 28. After that divide by two is equal to 504. The area of the trapezoid has the formula a plus b is divided into two, and the result times high. The value of a 42 plus the value of b 10, then divided by 2. The result times high 13 is equal to 338. |
| 6     | Is your answer correct?                                                  | Yes, Ma’am. |

The results of written test answers and interviews with the first subject, the first subject can fully explain the information contained in the questions, but the first subject does not understand the questions in the question and cannot use known information to search for unknown information so that it can be applied to the solution formula or idea. Therefore, researchers suspect that the first subject cannot identify information that is not needed but is in the questions and information that is needed but not yet known in the questions. This causes the first subject to not meet the indicators of identifying existing bias.

3.1.2 Compile and Analyze Arguments

Question of compile and analyze the argument is seen in figure 4.
Students with low emotional intelligence are the second subject is seen in figure 5.

The results of interviews with the second subject can be seen in Table 4.

| Number | Question                                                      | Answer                                      |
|--------|---------------------------------------------------------------|---------------------------------------------|
| 1      | Do you understand the problem in question?                    | Yes, Ma’am.                                 |
| 2      | What information do you know? Try to explain it?              | In the problem, it is known that the height of the trapezoid to make the desired tablecloth is 18 cm and the desired area is 450. So that the appropriate number of parallel sides for this area is selected. |
| 3      | How to find it?                                               | Just experiment with 22, 27, and 28 Ma’am.   |
| 4      | Why is that? then how much?                                   | Because the questions are given the choice of the number of parallel sides 22, 27, and 28. But there is no correct answer for the area of ]450. So I took the one that was closer to 450, namely 27 with an area of more than 450, namely 486 Ma’am. |
| 5      | Are you sure it is correct?                                   | Yes, Ma’am                                  |

The results of written test answers and interviews with the second subject, the second subject could fully explain the information in the questions but the second subject did not understand the questions in question. Besides, the second subject had difficulty in applying this information in making ideas in preparing specific steps for completion. Therefore, the researcher suspects that the second subject cannot explain the results of the answer. This causes the second subject to not meet the indicators of compile and analyze the arguments.
3.1.3 Analyze the Veracity of Statements

The question of analyzing the veracity of statements is seen in figure 6.

![Diagram](image)

**Figure 6.** The question to Analyze the Veracity of Statements.

Students with high emotional intelligence are the third subject is seen in Figure 7.

![Image](image)

**Figure 7.** The Result of the Answer from the Third Subject.

The results of the interviews with the third subject can be seen in Table 5.

| Numb | Question                       | Answer   |
|------|--------------------------------|----------|
| 1    | Do you understand the problem? | Yes, Ma’am. |
What information do you get? Try to explain?

There is a picture of a kite with a diagonal length, then the result of the area of the triangle and the area of the kite has the same result.

What was the result after counting?

The results are not the same. This is because the area of the first two triangles is equal to 20 and the second triangle is equal to 30. Adding up the result is equal to 50 and the area of the kite is equal to 100. So, the result is different.

Is the formula correct?

Yes Ma’am, the formula for a triangle is the base times high and then divided into two. That the base is five and its high is eight and the other is 12.

Is it true that the base is 5?

The base is five Ma’am, like finding the area of a right triangle.

Are you sure it is correct?

Yes, Ma’am.

The results of written test answers and interviews with the third subject, the third subject can fully explain the information in the questions, but the third subject experienced a misconception between the area of a right triangle and an isosceles triangle. He understood it by finding the area of the triangle using the formula for the area of a right triangle. Therefore, researchers suspect that the third subject cannot identify the statement on the problem. This causes the third subject to not meet the indicators of analyzing the veracity of statements.

3.1.4 Make Conclusions

The question of the conclusion is seen in figure 8.

The question of Make the Conclusion.

Students with low emotional intelligence are the fourth subject is seen in Figure 9.

The results of the interviews with the fourth subject can be seen in Table 6.
Table 6. Results of Interviews with the Fourth Subject.

| Number | Question                                                                 | Answer                                                                 |
|--------|--------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1      | Can you understand the problem with the question?                        | Yes Ma’am.                                                             |
| 2      | What was asked in the question? Try to explain?                          | Search for what is not yet known in the image.                        |
| 3      | What’s that unknown?                                                    | It’s tall.                                                             |
| 4      | How is the formula for the shape?                                       | a plus b then divided by two. After that, the result times high and that is equal to the area of the trapezoid bu. |
| 5      | Are you sure you got it right?                                          | Yes ma’am                                                             |
| 6      | How do you answer?                                                      | Using the formula earlier. This means that the value of a is 18 + 12 = 30 and the value of b is 24.7. The two of them are added and divided by 2. After that, multiply the height in question and the area is 360. |
| 7      | Then how many results and what conclusions did you make?                | So, the height is 13.16.                                               |

The results of written test answers and interviews with the fourth subject, the fourth subject was able to fully explain the information in the questions, but the fourth subject was unable to understand the problems in the questions. It is also wrong to apply the information known to the problem to the constructed formulas. The fourth subject did not solve the problem based on the questions asked and misunderstood the concept of the sum of the parallel sides of the trapezoid. Therefore, the researcher suspects that the fourth subject cannot apply the information and understand the questions in the questions to conclude the answer. This causes the fourth subject not to meet the indicators to make conclusions.

3.2 Discussion

Written test with the first subject who has medium emotional intelligence and interview results showed that the first subject had not been able to apply known information to the questions to find information that had to be sought to solve the questions and did not understand the questions in question. The first subject did not provide the necessary information to calculate the area of the shape of the kite and trapezoid. But the first subject immediately started by writing down the area formula for the kite and trapezoid. We recommend that the first subject when determining a calculation must write down what is known first, to make it easier for them to apply this information to the formulas they compiled. The first subject has difficulty in finding information that is not yet known but is needed from linking known information because from the beginning the first subject did not write down the information that must be there. The first subject did an unwritten calculation to find this information, causing many errors. Researchers suspect that the first subject does not understand the information that is known on the questions to find unknown information to solve the problem. Based on this, the first subject experienced an error in identifying the existing bias. The decision taken by the first subject did not write down all the information influenced by the self-regulation of the first subject (self-control and self-innovation). Where this is a component of students’ emotional intelligence indicators, there is a positive relationship between emotional intelligence and students’ critical thinking skills [20]. Therefore, students will optimally achieve critical thinking skills if students are allowed to get a variety of critical thinking math problems [21].

The second subject who has low emotional intelligence does not understand the problems and formulating ideas or specific problem-solving steps has difficulty applying the information on the questions. The second subject calculates the area of the trapezoid 3 times because the second subject misunderstands the side dimensions, namely 22 cm and 27 cm or 22 cm and 28 cm. The second subject
assumed there were three choices of parallel side sizes, are two times 22, two times 28 cm, or two times 27 cm. Understanding the wrong information makes the second subject not get the right answer. This happened because the second subject misunderstood the concept of the number of parallel sides of the trapezoid. Researchers suspect that the second subject lacks an understanding of the problem and information on the problem and misunderstands the concept to take ideas to solve the problem so it cannot provide a reason for answering the question correctly. Following other studies which explain that the low critical thinking shown by students because they cannot give reasons precisely [22]. This can happen because students lack the practice of contextual questions so they are not accustomed to conveying ideas from questions that are different from examples of routine problems [23]. In other studies, it is also known that critical thinking skills are important for students to help rational thinking in making decisions to express ideas [24]. Based on this, the second subject does not fulfill the indicators of compile and analyze arguments. This is consistent with other research results obtained that analyzing the argument has a percentage of 52.1% which is the order of achievement of indicator number two from the bottom [25]. The arrangement of arguments is influenced by inner emotions or is called emotional conditions related to critical thinking skills [26]. Therefore, compile and analyze arguments is closely related to emotional intelligence.

The third subject with high emotional intelligence can apply known information to formulas to solve problems. However, the third subject when finding the area of the triangle encountered an error because uses the length of the base of the triangle, which is 5 cm belonging to a right triangle. You should use the base of the isosceles triangle whose value is 10 cm. So, the area of the triangle obtained by the third subject is half of the calculation for the area of an isosceles triangle. Even so, the area of the kite calculated by the third subject is correct because using the diagonal one is ten centimeters and the diagonal two is twenty centimeters. Therefore, the third subject obtained different results from the area of the kite and two times the area of the triangles. Based on this, it is assumed that the third subject has a misunderstanding of the concept of the area of an isosceles and right triangle. The third subject assumed that determining the area of a triangle must be the same as determining the area of a right triangle. This is by other research which shows that the low ability of critical thinking is caused by students not being able to evaluate answers and identity/concepts/definitions [22]. Therefore, in understanding the various forms of triangles and their area formulas, it is necessary to improve understanding of the concept, so as not to experience the same error when working on more complicated problems. This is supported by other research which explains that educators must provide problem challenges for students to have more complex critical thinking skills related to concepts in the material being studied in the mathematics learning process [27]. Based on the explanation of the results of tests and interviews with the third subject, the third subject does not meet the indicators of analyzing the veracity of statements which causes the third subject to innovate and his adaptability to the concept of the triangle is not good, so that his emotional intelligence affects his critical thinking skills.

The fourth subject who has low emotional intelligence can understand the questions and what formulas should be used in solving the questions. However, the fourth subject experienced an error in applying the information to the formula he composed. Besides, the fourth subject did not understand the questions that he wanted, so the fourth subject did not answer the existing questions. The fourth subject also misunderstood the definition of the number of parallel sides of the trapezoid. The fourth subject adds up the parallel side and adds it again with the hypotenuse of the trapezoid and then divides by two then times the high asked is equal to the area of the trapezoid known. Here the fourth subject incorrectly added up the parallel side which was added again to the slant side of the trapezoid. It should be enough for the fourth subject to add up the parallel values of the trapezoid alone. Subject 4 in this way will not get the right answer, so the researchers suspect that the fourth subject does not understand the definition of the number of parallel sides, slanted sides, and height in a trapezoid. Subject 4 thus became wrong in deciding to complete the steps in the solution which resulted in an answer to conclude. Other studies explain that students have difficulty with modified questions because many students cannot complete the answers to the questions given [28]. In this case, students are not able to make conclusions correctly [29]. Following other studies that explain that critical thinking skills are very important for students to
make conclusions with alternative logical thinking [24]. Furthermore, the lack of self-confidence, self-control, and adaptability of students in emotional intelligence greatly affects the decision making to complete the steps to solve this problem. Therefore, the teacher must motivate and make students aware that critical thinking skills are needed to overcome various mathematical problems [30]. So, students’ critical thinking skills are influenced by emotional intelligence.

Based on the results of the discussion above, the researcher concluded that students experienced several errors when solving geometry problems that required students to think critically. This happens to students who have low, medium, and high emotional intelligence. The intended errors include students’ understanding of the problems that exist in the questions, using information that is known in the questions to identify information that is not yet known but is needed in solving problems, applying the information to formulas that are compiled, understanding definitions and concepts, and taking ideas/steps problem-solving. This error makes students difficult to solve contextual problems to measure students’ critical thinking skills. This happens because students’ emotional intelligence regarding adaptability, self-confidence, innovation, self-control, and self-awareness is lacking. Students’ critical thinking skills are influenced by students’ emotional intelligence. The higher the students’ mathematical critical thinking skills, the higher a person’s emotional intelligence [20]. Therefore, students need to be given non-routine questions and there needs to be the supervision of understanding definitions, concepts, and formulas for flat shape material, so that students have confidence in themselves in compiling information that will be substituted into formulas that have been compiled and students can have ideas/steps towards solving questions in a coherent, directed, and precise manner.

4. Conclusion and Suggestion
Based on the discussion of the results of written tests and interviews, the researcher concluded that students who had high emotional intelligence were 35.48%, 32.26% had medium emotional intelligence, and students who had low emotional intelligence were 32.26%. Problems with indicators identify existing biases and compile and analyze arguments that can be done by students who have high emotional intelligence, but they cannot work on problems with indicators to make conclusions and analyze the veracity of statements. This is due to errors in understanding the definition and concept of material in flat shapes. Problems with indicators that make conclusions and analyze the veracity of statements can be done by students who have medium emotional intelligence, but they cannot work on problems with indicators to identify existing biases and compile and analyze arguments. This is because students’ errors in understanding the information are known to identify the information that must be sought and needed to solve the problems in the questions. All indicators cannot be done correctly by students who have low emotional intelligence. This is due to students’ mistakes in understanding the questions, definitions, concepts, and mathematical formulas in the related material. Therefore, researchers suggest that educators provide a lot of practice questions that are varied as well as complex and educators need to provide monitoring of the definitions, formulas, and concepts of flat shape material so that students can use ideas, formulas, and concepts appropriately in solving geometric problems. non-routine and varied. The novelty in this research is that critical thinking skills are analyzed based on the level of students’ emotional intelligence.

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