Students’ mathematical critical thinking ability on cube and cuboid problems

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Abstract. The critical thinking ability becomes a prerequisite and purpose in learning Mathematics today. This study was aimed to analyze the mathematical critical thinking ability of students by using four indicators: identifying concept characteristics, selecting strategies for solving problems, providing complete and correct explanations, and evaluating the solution of problem. This was a descriptive research. Data collection was done by giving the test of mathematical thinking ability about cube and cuboid to 38 students in one of junior high schools in Lembang District. The results showed that the average ability of students in identifying the characteristics of the concept was about 43.7%, in choosing a strategy to solve the problem was about 17.9%, in providing a complete and correct explanation was about 26.8%, and in evaluating the solution of problem was about 21.1% from the ideal score. According to the result, it showed the student need to enhance in critical thinking ability.

1. Introduction

The development of information technology makes information flow growing very fast. For example, the presence of "search engines" such as "Google" provides an opportunity to obtain information in a variety of ways, places, times or sources. It cannot be denied, at this time, many students use "Google" as one source of getting information. Being informed or given knowledge only is not sufficient [1]. Students must have ability to think critically as a "filter" in managing the information received. Meanwhile, according to 21st Century Partnership Learning Framework [2], critical thinking is one of the competencies that must be owned by human resources in the 21st century in order to survive to face an increasingly dynamic world. In other words, the ability to think critically becomes a prerequisite as well as the goal of learning. Developing students' critical thinking is a major educational goal today [3] [4].

The importance of critical thinking ability requires further study, especially in education and learning. The ability to think critically in learning must have several indicators. A student who has the ability to think critically must meet these indicators. The achievement of these critical thinking indicators indicates the level of a student's critical thinking ability. In other words, each indicator will shape students' critical thinking ability.

In this study, the authors analyze the achievements of each indicator of critical thinking ability. The main problem in this research is how the achievement of each indicators of critical thinking ability of
junior high student on cube and cuboid subject. This study aims to determine and analyze the dominant indicators in shaping students' critical thinking ability.

Critical thinking is a reflective and sensible thinking activity that focuses on determining what to believe and what to do [5,6]. Furthermore, Ernest defines critical thinking as the ability to make conclusions based on the results of observation and information [7]. Critical thinking includes cognitive processes such as checking, analyzing the reasons why problems arise, and interpreting the results [8].

There are indicators of critical thinking ability according to some experts. According to Facione, the ability to think critically includes skills for interpretation, analysis, evaluation, inference, explanation and self-regulation [9]. Norris and Ennis identify five indicators of critical thinking ability, namely: (1) elementary clarification; (2) basic support; (3) inference; (4) advances clarification; and (5) using strategies and tactics to solve problems [10]. Sumarmo et.al proposes critical thinking ability consisting of (1) analyzing and evaluating arguments and evidence; (2) to clarify; (3) make valuable considerations; (4) make explanations based on relevant and irrelevant data; and (6) identify and evaluate assumptions [11].

Based on some of the above opinion, the researcher concludes the indicator of critical thinking ability consists of (1) identify the characteristics of concept; (2) choose a strategy to solve the problem; (3) provide a complete and correct explanation; and (4) recheck and clarify errors in problem solving process.

2. Method
This research was a quantitative descriptive research. Data collection was done by giving the test of mathematical thinking ability about cube and cuboid to 38 students in one of junior high schools in Lembang District. The test instrument that measures critical thinking ability consists of 4 questions each representing each indicator. Before the instrument is used, it is first validated by the experts.

Scores obtained by students on each question reflect the achievement of the indicator of critical thinking ability. The score was analyzed descriptive-quantitatively. The researchers calculated the achievement of each indicator of critical thinking ability based on the average score and frequencies.

3. Results and discussion
The critical thinking test instrument was given to 38 students who were the subject of the study. Question 1 is used to measure the first indicator that is the ability to identify the characteristics of the concept. Question 2 is used to measure the second indicator that is the ability to choose a strategy to solve the problem. Question 3 is used to measure the third indicator that is the ability to provide complete and correct explanation. Question 4 is used to measure the fourth indicator that is the ability to check back and clarify errors in problem solving. Table 1 shows the test results obtained by the students for each question.

| Question | Mean   | Standard Deviation | Variance |
|----------|--------|-------------------|----------|
| Question_1 | 4.368  | 1.731             | 2.996    |
| Question_2 | 1.789  | 1.727             | 2.982    |
| Question_3 | 2.684  | 2.195             | 4.817    |
| Question_4 | 2.105  | 2.024             | 4.097    |

From Table 1 it can be seen that the average score of question 1 has the highest value. Question 3 occupies the 2nd position sequentially followed by questions 4 and 2. This shows that in general the results obtained by students on question 1 are better than others. In other words, students' critical thinking ability are dominated by indicators of ability to identify the characteristics of concepts. The average score of 2 is the lowest compared to other problems, it can show that the indicator of the ability to choose a strategy for solving student problems is the lowest indicator achievement.
The first critical thinking indicator is the ability to identify the characteristics of the concept. This indicator is measured through question number 1. From the results of the above research found that this indicator is the most dominant indicator in shaping students’ critical thinking ability. This means that in general students have better ability in the first indicator than other indicators. Question 1 measures students’ ability to identify mathematical concepts related to cubes and natural numbers. Based on the test results, almost all students are able to identify the characteristics of concepts related to cubes and native numbers despite having different explanatory levels. From Table 2 it can be seen that 7.9% of students were able to identify the required concept characteristics with correct but incomplete explanations, 21.1% of the students identified the required concepts but were not accompanied by explanations, 55.3% of the students gave correct answers but did not show the process of identifying concept, 13.2% of students identified the concepts needed with the wrong final answer, 2.6% of the students did not provide relevant answers.

The third critical thinking indicator is the ability to provide a complete and correct explanation. This indicator is measured by using question number 3. From the research results it is found that this indicator is the second most dominant indicator after the first indicator. Question number 3 measures students' ability to explain the relation of cuboid relation to cubes based on area and volume. Based on test results, it generally indicates there is an understanding of the problem, providing an acceptable but incomplete explanation. From Table 3 it can be seen that 2.6% of students are able to provide correct problem solving but not complete, 13.2% of students give problem solving explanations with some errors, 31.6% shows an understanding of the problem, 26.3% of students do not provide relevant answers.

The fourth critical thinking indicator is the ability to apply the concept in problem-solving. This indicator is measured by using question number 4. From the research results it is found that this indicator is the third most dominant indicator. Question number 4 measures students' ability to apply the concept in problem-solving. Based on test results, it shows that 36.8% of students are able to solve problems but not completely, 94.7% of students can solve problems, but there are some errors, 2.6% of students are able to provide relevant answers but do not solve problems, 2.6% of students do not provide relevant answers.

Table 2. Frequency table of question 1.

| Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|---------|---------------|--------------------|
| Valid .00 | 1       | 2.6           | 2.6                |
| 2.00      | 5       | 13.2          | 15.8               |
| 4.00      | 21      | 55.3          | 71.1               |
| 6.00      | 8       | 21.1          | 92.1               |
| 8.00      | 3       | 7.9           | 100.0              |
| Total     | 38      | 100.0         | 100.0              |

Table 3. Frequency table of question 3.

| Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|---------|---------------|--------------------|
| Valid .00 | 10      | 26.3          | 26.3               |
| 2.00      | 12      | 31.6          | 57.9               |
| 4.00      | 10      | 26.3          | 84.2               |
| 6.00      | 5       | 13.2          | 97.4               |
| 8.00      | 1       | 2.6           | 100.0              |
| Total     | 38      | 100.0         | 100.0              |

Table 4. Frequency table of question 4.

| Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|---------|---------------|--------------------|
| Valid .00 | 14      | 36.8          | 36.8               |
| 2.00      | 11      | 28.9          | 65.8               |
| 4.00      | 11      | 28.9          | 94.7               |
| 6.00      | 1       | 2.6           | 97.4               |
| 8.00      | 1       | 2.6           | 100.0              |
| Total     | 38      | 100.0         | 100.0              |
The fourth critical thinking indicator is the ability to recheck and clarify the errors of a problem solving. From the results of the research, it is found that this indicator is not sufficiently dominant in shaping students' critical thinking ability. Question number 4 measures students' ability to check and clarify the completion of a mathematical problem related to the volume of the cuboid. The test results show that generally the students are only able to examine and provide acceptable explanations but are unable to find any errors in solving the problem. From Table 4 it can be seen that 2.6% of students found a mistake in solving the problem then give improvement and explanation but not complete, 2.6% students were able to check and find errors in problem solving but did not provide correct improvement, 28.9% of the students checked and gave acceptable explanation but no errors in problem solving, 28.9% of students provide explanations indicating an understanding of the problem, and 36.8% of students do not provide relevant answers.

Table 5. Frequency table of question 2.

|   | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|-----------|---------|---------------|--------------------|
| 0.00 | 15 | 39.5 | 39.5 | 39.5 |
| 2.00 | 13 | 34.2 | 34.2 | 73.7 |
| 4.00 | 9 | 23.7 | 23.7 | 97.4 |
| 6.00 | 1 | 2.6 | 2.6 | 100.0 |
| Total | 38 | 100.0 | 100.0 |                   |

The second critical thinking indicator is the ability to choose a strategy to solve the problem. From the research result, it is found that this indicator has the lowest contribution in forming students' critical thinking ability. Question number 2 measures students' ability to choose strategies for solving open problems related to cubes and cuboids. The test results show that the students are only able to show the understanding of the problem, problem solving strategy and problem solving but less precise. From Table 4 it can be seen that 2.6% of students solve the problem in a short way but the final answer is incorrect, 23.7% of students indicate a problem solving strategy but not complete, 34.2% of students indicate an understanding of the problem but do not show problem solving strategy, 39.5% of students do not provide relevant answers.

4. Conclusion

Based on the description above, it can be concluded that the ability to identify the characteristics of the concept is an indicator that dominates students' critical thinking ability on the subject of cubes and cuboids. The ability of students to choose problem-solving strategies and the ability to find and clarify errors in a problem-solving are the indicators that have the lowest contribution in forming students' mathematical thinking skills. Therefore, serious attention and action are needed to improve the students' ability to choose a problem-solving strategy and the ability to find or clarify the error of a mathematical problem solving.

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