



Journal of Education and Learning Mathematics Research (JELMaR)

Online ISSN : 2715-9787

Print ISSN : 2715-8535

Journal Homepage : <http://jelmar.wisnuwardhana.ac.id/index.php/jelmar/index>

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To cite this article: Ndahawali, H., Hariyani, S., & Farida, N. (2020). Analysis of Students' Critical Thinking Skills in Solving Mathematics Problems on Pythagoras. *Journal of Education and Learning Mathematics Research (JELMaR)*, 1(2), 1-7.
<https://doi.org/10.37303/jelmar.v1i2.19>

To link this article : <https://doi.org/10.37303/jelmar.v1i2.19>



Publisher

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Faculty of Teacher Training and Education,
Universitas Wisnuwardhana Malang

Analysis of Students ' Critical Thinking Skills in Solving Math Problems on Pythagoras

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Abstract: *This study aims to describe the critical thinking skills in solving math problems. The approach used in this research is qualitative research with descriptive research type. The research subjects were 32 students. The six interview subjects were divided into three levels of critical thinking, namely 2 high categories, 2 medium categories and 2 low categories. Data collection procedures are tests of critical thinking skills and interviews. Research data analysis refers to indicators of critical thinking, namely: interpreting, analyzing, evaluating and inferring. Student achievement on each indicator includes: 1) Percentage of students' ability to interpret the completion of the test questions by 65.5%; 2) The percentage of students' ability to analyze the completion of the test questions by 39.1%; 3) The percentage of students' ability to evaluate is 66.6%; and 4) Percentage of students' ability to infer by 40%. The ability of students to interpret a problem solving is good. Students have been able to write out what is known and asked in the problem correctly, but there are students who are less thorough and incomplete in writing the unit of distance. The ability of students to analyze problem solving is quite low. Students do not provide information on drawing illustrations. The ability of students in evaluating problem solving is good. Students are able to do the calculations correctly in accordance with the rubric of assessment. The ability of students to reference problem solving is low. Students are not used to writing the final conclusions of the answers obtained.*

Keyword: Critical Thinking, Mathematics Questions, Pythagoras

INTRODUCTION

Mathematics is one of the study taught at every level of education. Mathematics plays a very important role to educate learners by developing critical, analytical and logical thinking skills through problem Solving (Sunardingsih, 2019). It can be interpreted, that mathematics makes one accustomed to thinking systematically, scientifically, using logic, critical, careful, effective, and efficient and can increase creativity, so students have the ability to acquire, analyze, conclude and utilize information to survive in the ever-changing circumstances.

Thinking skills are an indispensable ability to overcome life's challenges. Kalelioglu and Gulbahar (2014) suggest that thinking skills include critical thinking skills, creative thinking, and problem-solving skills. The ability of critical thinking is a very necessary ability to be face various problems in public and personal life. Facione (2011) states that critical thinking is self-regulatory in deciding on something that produces interpretation, analysis, evaluation, and inference, or exposure using an evidence, concept, methodology, criterion, or contextual consideration as the basis for the decision.

Prihatini (2018) defines critical thinking as the ability to interpret, analyse, and evaluate ideas and arguments. Nowadays, the ability of critical thinking is considered as the basic ability that must be mastered such as reading and writing skills. Critical thinking is important for a person to solve problems ranging from simple to complex in everyday life (Gueldenzoph and Snyder, 2008). Based on such definitions, it can be concluded that critical thinking is the ability to interpret, analyse, evaluate an idea, observation result,

information, or argument. Critical thinking abilities are also useful for making decisions based on evidence.

Based on the results of a student post test at SMP N 6 Singosari, examples of students' answers as shown Picture 1.

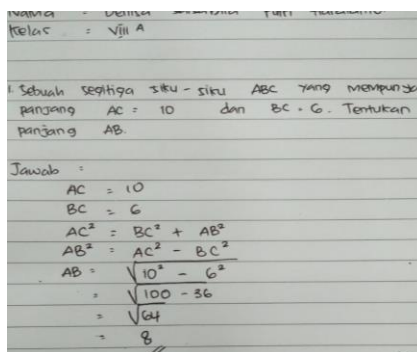


Figure 1. The Completion Student's Work at the Time of Observation

Students answer questions correctly such as Figure 1, i.e. the value of $AB = 8$, the procedures that have been undertaken do not meet critical thinking indicators. Students have not solved the right things. Students do not write what is known and asked, students do not create illustration images and students do not conclude the answer.

This research is important, so we familiarize students to solve the problem appropriately and critical thinking capability indicator fulfillment. The purpose of this research is to know the critical thinking ability of grade VIII students in SMP N 6 Singosari in solving mathematical problems on the material pythagoras.

Previous research on critical thinking is Ennis (2011) using five indicators of critical thinking ability, namely: Elementary clarification (giving a simple explanation), Basic Support (building basic skills), inference, advance clarification (making further clarification) and strategy and tactics. In this study, researchers used a critical thinking ability indicator by Facione (2011). Facione (2011) Classifying four indicators of critical thinking ability: interpret, analyse, evaluate and interpret.

METHOD

This research intends to analyse the students'critical thinking skills in solving the mathematics on Pythagoras material. The subject of research is students at SMP N 6 Singosari. The Data collected in this research is descriptive. The Data contains the students' critical thinking ability to solve problems Pythagoras material. The approach used in this research is a qualitative approach. This approach is applied to get descriptive information about the ability of critical thinking. Gumilang (2016) says that basically qualitative observation is a tradition in social sciences that relies on human observation. This means that all observation activities in this study require the five senses of human beings.

Data collection begins with determining the subject of research. Before starting the interview, researchers created a relationship of trust with the informant. Researchers introduced himself first. In collecting data, researchers do several things: 1) The test aims to obtain data about students'critical thinking skills in solving math problems. The test material of this critical thinking ability is Pythagoras, 2) Interviews on this study were intended to complement the test results, 3) field notes were used to record important events during the ongoing research process. Assessment of the test results adjusted to the modified assessment guidelines of the Facione (2011) such as Table 1.

Table 1. Guidelines for Mathematical Critical Thinking Ability

| No | Mathematical Critical Thinking indicators | Student Response | Score |
|----|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | Interpretation | Students do not write the known and asked | 0 |
| | | Students write information that is known and asked in question, but the answer is not correct | 1 |
| | | Students only write information that is known precisely or Students only write what is asked in the question correctly | 2 |
| | | Students write information that is known from the question appropriately but incomplete | 3 |
| | | Students write information that is known and what is asked of the matter appropriately and fully. | 4 |
| | | | |
| 2 | Analysis | Students do not make mathematical models of the problem given | 0 |
| | | Students create a mathematical model of the given question, but the answer is not correct | 1 |
| | | Students create a mathematical model of the given question appropriately, but he does not give illustrations. | 2 |
| | | Students create a mathematical model of the given question appropriately, but the illustrations made are wrong. | 3 |
| | | Students create a mathematical model of the given question precisely and he also provides true and complete illustrations. | 4 |
| | | | |
| 3 | Evaluation | Students do not apply the concept in problem solving | 0 |
| | | Students apply an improper concept in solving the problem | 1 |
| | | Students apply the right concept in solving the problem, but completion step is not systematic. | 2 |
| | | Students apply the right concept in solving the problem, but he made a mistake in the calculation technique. | 3 |
| | | Students apply the right concept in solving the problem, complete and correct in conducting the calculation. | 4 |
| | | | |
| 4 | Inference | Students do not write conclusions | 0 |
| | | Students write inappropriately conclusions | 1 |
| | | Students write conclusions, but there is part of conclusions that are less precise | 2 |
| | | Students make conclusions appropriately, but there are incorrect calculations | 3 |
| | | Students make conclusions appropriately and fully | 4 |
| | | | |

Data analysis techniques on this research include data reduction, data presentation and withdrawal of conclusions. Data reduction is done by correcting or analyzing the results of the student's work after they complete the Pythagoras matter. Once the data is reduced, the next step is presenting the data. The presented Data consist of test results and interviews to students. The data presentation phase includes: a) presenting the results of the student's critical thinking ability test; b) Presenting the results of interviews; and c) Withdrawal of conclusions or verification. Withdrawal of conclusions or verification is a series of intact activities to answer research questions. The withdrawal of conclusion is done by comparing the student test results with the interview results then the researcher draws conclusions about the students' critical thinking ability appropriately.

After the data is analyzed, the next step is checking the validity of data. The data validity checking technique is conducted using three ways, namely: (1) Observers'diligence check techniques, (2) peer checking, and (3) triangulation. This research uses method of triangulation. Triangulation method is done by comparing the information or data obtained with different data collection procedures. In this research, researchers use data collection procedures i.e. interviews, test questions and field records.

RESULTS AND DISCUSSION

Student test results are corrected after students have performed the test. The test is a writing test, then researchers selected six students to be interviewed are two students high category, two students medium category and two students low category. Students'work is then measured using critical thinking ability indicators such as Table 2.

Table 2 Students at Levels of Critical Thinking Ability

| Critical Thinking Aspect score | Category Level of Critical Thinking | Student Code | Many participants |
|--------------------------------|-------------------------------------|----------------------------------------------------------|-------------------|
| $75 < CTAV \leq 100$ | Tinggi | A, B, C, D, E | 5 |
| $60 < CTAV \leq 75$ | Sedang | F, G, H, I, J, K, L | 7 |
| $0 < CTAV \leq 60$ | Rendah | M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AA, AB, AC, AD | 18 |

(CTAV : Critical Thinking Ability Value)

Based on table 2 that most students enter a low level of critical thinking ability of as many as 18 students. While students are included in critical thinking levels are as much as 7 students and 5 students enter into high critical thinking levels. In this section, researchers present data analysis results about students'critical thinking skills such as Table 3.

Table 3 Percentage of Students'Critical Thinking Ability for Each Indicator

| Indicator of Critical thinking ability | Average score of Indicator | The ideal score indicator | The percentage of each indicator |
|----------------------------------------|----------------------------|---------------------------|----------------------------------|
| Interpretation | 7,8 | 12 | 65,5% |
| Analysis | 4,7 | 12 | 39,1% |
| Evaluation | 8 | 12 | 66,6% |
| Inference | 4,8 | 12 | 40% |

| | |
|----------------------|--------|
| Total Average | 52,8 % |
|----------------------|--------|

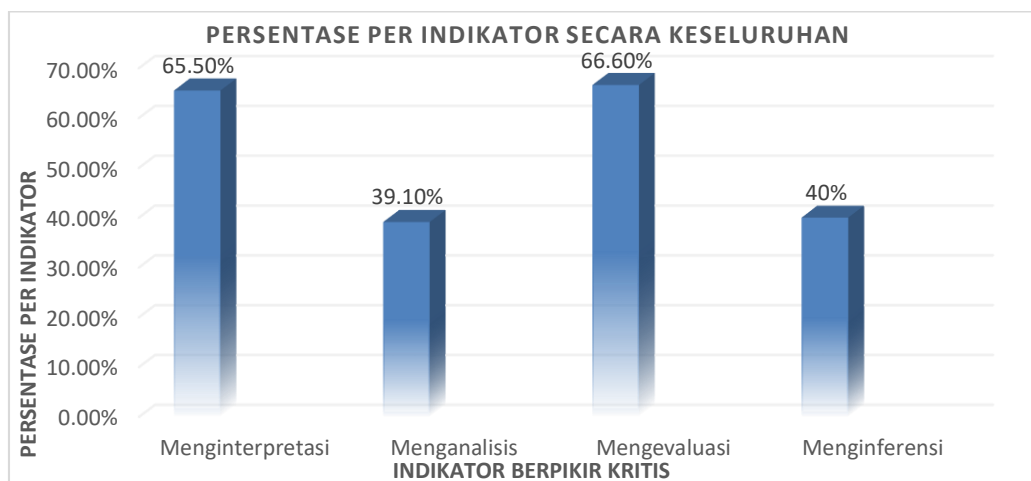


Figure 2 Percentage of Each Indicator

Table 2 and Figure 2 show a percentage of student's critical thinking ability are 52.8%. The percentage result of the Evaluation indicator as the first highest indicator for students of grade VIII F is 66.6%. The second highest indicator of the Interpretation indicator is 65.5%. The third highest indicator of the Inference indicator is 40%. The fourth highest indicator of the Analysis indicator is 39.1%.

Based on the results of the interview on six research subjects as follows: 1) Students are able to interpret the Pythagoras matter, but students cannot write the known information and the things they are asked appropriately. Students who can not interpret the question are students M and students N. This is because the students did not check back the answer, the students immediately worked on the calculations. Students emulate the completion of the teacher in the model (Hariyani, 2018). Students are not able to reason before determining the completion strategy; 2) Students are able to analyse the problem by creating mathematical models, but students do not write captions for drawn lines. Students who do not write symbols for the length of the line are students G and C. Students are not able to recognize various mathematical symbols. Students cannot translate questions into daily life; 3) Students are able to evaluate questions precisely and correctly. This can be demonstrated by students who can do mathematical calculations correctly, but some students do a mathematical miscalculation, including students F. The students are not thorough and rushed to work on the problem; 4) at the stage of inference, students are able to write down the conclusion of the final outcome, but some students cannot write down the conclusion of the final outcome. Students who do not write the conclusion of the final result are students M and students N. Students are not accustomed to writing conclusions from the final outcome of answers. Students assume when the final answer is obtained, the work is completed.

Students' ability to interpret the percentage of 65.5%. Students who are able to interpret about number 1 are students A and C, whereas students who are able to interpret question number 2 are students A, C and F, and students who are able to interpret question number 3 are students A and C. Students are not able to meet the indicators of interpretation, because students do not check the answer. The ability of interpretation in mathematics is important for a person, so he can think of solving the problem correctly. Karim (2015), it is important for students to have the ability to interpret because students can understand and

express a wide range of experiences, situations, data, events, and assessment of the problems found.

The student's ability in the analysis resulted in a percentage of 39.1%. At the analysis stage, students can identify the relationship between problem statements and mathematical concepts by creating image illustrations and providing explanations correctly. Students who are able to analyze questions number 1 and 2 correctly is subject A, and students who are able to analyze the question number 3 correctly is student C. Students do not write the caption on the drawn line. Students who do not write symbols for the length of the line are students G and C. This is because students do not recognize the mathematical symbols appropriately and the students are confused in understanding the story related to daily life. In this case it takes an attitude to think deeply so that students can solve the problem of the story. Glazer (2001) stated that critical thinking in analysis needed an attitude of thinking deeply about problems and things that were within reach.

The ability of the student in the evaluation of test completion is 66.6%. This indicator is the indicator with the highest value compared to the other indicators. Students who are able to evaluate questions number 1 and 2 correctly are all students, while students who are able to evaluate questions number 3 are students A, C, G, M and N. In this study, the student who made a calculation mistake on question number 3 is the student F. Students are less thorough and rushed to work on the question. Accuracy of students in solving problems is very important. There are some students who can understand the mathematical concept, but can still be wrong just because it is less thorough and rushed. Carson (2007) stated that although the students understood the mathematical concept given, the students could not solve the problem.

The student's ability in inference resulted in a percentage number of 40%. Students who can do inference on questions number 1 and 3 are students A, C, F and G. Students who can do inference in question number 2 are students A, F and G. The ability of inference in critical thinking processes is indispensable for directing students in making correct conclusions. In line with Facione (2011) that the aspect of inference is indispensable for students to identify and use the necessary elements to form the allegation and consider the relevant information in order to draw the correct conclusions.

CONCLUSION

Researchers concluded research results to answer the focus of research.

1. Analysis of the critical thinking skills of class VIII students at SMP N 6 Singosari in solving math problems on Pythagoras material amounted to 52.8% ;
2. The student's ability to interpret a question in this study was 65.5%. Students have been able to write the known information and determine what is asked in question, but there are some students who are not very thorough and incomplete in writing the unit of distance;
3. The students' ability to analyse a question in this study amounted to 39.1%. The result of the analysis of students' answers suggests that the student is already able to create an image illustration correctly. Students have made mistakes in analyzing the problem that they have not given a caption to the image illustration.
4. The ability of students to evaluate a question is 66.6%. Students are capable of calculating correctly according to the assessment rubric. At this stage, there are some students who are still unthorough in his work, students make mistakes in changing the unit of distance. Accuracy in this stage is very important, although students already understand the concept of mathematical correctly, but students can still make mistakes due to inaccuracy and rush.

5. The student's ability in inference in this study was 40%. Students who answer questions correctly are students. They have been able to make conclusions according to questions. Students make conclusions to strengthen answers to be logical and acceptable.
6. Students' critical thinking skills are categorized into three levels, which is a high level of critical thinking, which is as many as 5 students, a moderate level of critical thinking ability of 7 students and a low level of critical thinking ability of as many as 18 students. Some factors that determine the score of critical thinking skills are knowledge of the previous material, completion procedures meet the correct concept, accuracy of students in performing calculations and the appropriate duration of time in solving the problem.

ACKNOWLEDGEMENT

Acknowledgements are conveyed to a thesis instructor who has provided constructive feedback, direction and criticism during the period of the thesis arrangement, including guidance on drafting a thesis article.

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