

CRITICAL THINKING SKILLS OF STUDENTS FROM THE ASPECT OF STRATEGY AND TACTICS IN SOLVING MATHEMATICS PROBLEMS

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Abstract

This study aimed to determine students' critical thinking skills from aspects of strategy and tactics in solving mathematics problems. This study used a qualitative approach with descriptive methods. The subjects of this study consisted of 5 graduate students in Malang. The instrument used was a test of critical thinking skills from aspects of strategy and tactics and interviews. The results of the description and interview analysis showed that students' critical thinking skills in solving problems were low. For each indicator revealed high-level problems. Indicators of critical thinking skills formulated alternative solutions, used arguments, and it was re-examined by having relatively low.

Keywords: Critical Thinking Skills, Strategy, and Tactics

Learning by aspects of critical thinking is very necessary for solving math problems. Critical thinking is needed in solving mathematics problems because critical thinking provides the right direction in thinking and working, and helps find the linkages of factors to one another accordingly. This is in accordance with the opinion of Gibby (2013: 150) states that the success of the problem-solving process requires critical thinking skills. Therefore, the ability to think critically is needed in learning. Facione (2015) says that critical thinking is an ability that will influence someone. This is because that someone will have the right thoughts in solving problems. Huitt (1992) also says that critical thinking is an important tool for success in the 21st century. The main purpose of education in the 21st century is to provide someone with the skills to think critically, to know what they are doing and justify it based on good decision making (Armstrong, 2009; Gardner, 1999; Zohar & Cohen, 2016; Gokhale, 2005). Therefore, critical thinking skills are needed by someone in learning.

Some researches are stating points about critical thinking. That means they point out the important things in critical thinking to solve the students' problem in mathematics. Critical thinking is the use of cognitive representations, processes, and strategies that are reflective, systematic, rational in making decisions (Cook, Johnson, Moore, Myers, Pauly, Pendavris, et al., in Palmer, 2007). Ennis (1996: 12) states that critical thinking is a thought process that aims to make rational decisions about what is believed or done. Thus, critical thinking considers and evaluates information, which ultimately allows one to make decisions actively. Walker & Finney (1999: 540) are stating that critical thinking is an intellectual process in making concepts, applying, analyzing, synthesizing, or evaluating as information obtained from the results of observation, experience, reflection, where the results of this process are used as the basis for taking action.

Furthermore, some revelations have done by research on critical thinking. They reveal critical thinking skills included: the research of Tee, Leong, and Rahim(2018) found that critical thinking ability was one of the things that greatly influence learners' performance in mathematics reasoning, but self-efficacy was stated to have no direct effect on the application of critical thinking skills. Duron, Limbach, and Waugh (2006) state that learners should be stressed to have critical thinking skills in learning in the hope that learners will have fun and meaningful learning experiences. In the research states that critical thinking is essential because if someone thinks critically, that person will be able to solve a simple problem. Snyder and Snyder's research (2008) state that critical thinking is essential because automatically thinking critically, someone will be able to solve simple and complex problems in everyday life. Svecova, Varelia, Rumanova, &Pavlovicova (2013) and Chukwuyenum (2013) state that in the learning process it should implement activities that train a person's critical thinking skills to provide opportunities to hone their critical thinking skills.

Facione (2015) classifies the core of critical thinking skills, including interpretation, analysis, inference, evaluation, explanation, and self-regulation. A person can fulfill the aspect of interpretation if he can group the received problems so that they have meaning and are meaningful. Analysis aspects fulfilled if someone can connect between information and concepts. Inference aspects are satisfied if one can conclude solving the problem. Evaluation aspects are fulfilled if someone can judge statements or opinions that are received from both him and others. The explanation aspect is fulfilled if someone can explain the statement or opinion that has been expressed to be a strong opinion. The self-regulation aspect of students can regulate their existence in the face of solving the problem.

According to Ennis in Costa (1985: 16), there are 12 indicators of critical thinking that are summarized in 5 groups of thinking skills, namely providing simple explanations (elementary clarification), building essential skills (basic support), concluding (interface), making further explanations (advance clarification), as well as strategy and tactics (strategy and tactics). Clarification aspects include focusing questions, analyzing arguments, asking questions, and answering questions. Essential support aspects involve considering whether the source can be trusted or not to consider the observation report. The aspect of the interface consists of deducing and considering the results of deduction, inducing, and considering result induction in making and determining the outcome of consideration. The aspect of advance clarification includes defining terms and considering definitions and identifying assumptions. Elements of strategy and tactics include learning activities and interacting with others, analyzing arguments, asking questions, and answering questions.

The researcher had conducted observations on graduate students by being given a critical thinking test. The observations found that among 13 students, there were only two correct students in making action from the solution to the given problem. This made the researchers suspect that 11 other students had weaknesses in making actions and seeking answers.

Based on this consideration, the researcher chose one aspect of critical thinking related to the weakness of the student. In this case, the researcher chose aspects of strategy and tactics. The sub-

indicators in the element of strategy and tactics according to Ennis in Costa(1985: 17)namely to uncover problems, choose criteria to consider possible solutions, form alternative solutions, determine temporary actions, repeat them, observe their application, use arguments, use logic strategies, use rhetorical strategies, show positions, speeches, or writings. In this study, the indicators taken are focused on indicators, (1) revealing the problem, (2) formulating alternative solutions, and (3) using arguments, and (4) repeating.

METHOD

This study used a qualitative approach with descriptive methods. This study described, recorded, analyzed, and interpreted the conditions that occurred. The problem in this study was the skills to think critically from the aspect of strategy and tactics in solving mathematics problems. The subjects or participants of the research were students of postgraduate students in Malang. The students were taken by purposive sampling. This research was conducted by analyzing the results of tests of critical thinking skills from aspects of strategy and tactics in solving mathematic problems. Then, it was doing interviews. The subjects in the study were 5 postgraduate students in Malang who were taken based on certain answers. The instrument used was a critical thinking ability test sheet from the aspect of strategy and tactics and interview guidelines given to research subjects. The research procedures were preliminary research, organizing instrument as a test, and interview for critical thinking. Finally, it went to provide a conclusion at the end. Some steps of the procedure were pointed out as the following.

- 1) Transcribing collected data.
- 2) Comprehending collected data.
- 3) Describing collected data by elimination, specification, simplification, abstraction, and transformation
- 4) Analyzing the detail and deciding the unit and the coding
- 5) Describing students' critical thinking in solving the mathematics problem.
- 6) Analyzing students' critical thinking based on aspects of strategy and tactics.
- 7) Analyzing unique and interesting things to provide a conclusion

RESULT AND DISCUSSION

The test of students' critical thinking skills viewed from the aspect of strategy and tactics used in this study are as follows:

PQRSTU is hexagon with the size of the angles 120° , if $PQ = 1 \text{ cm}$, $QR = 4 \text{ cm}$, $RS = 5 \text{ cm}$, and $ST = 2 \text{ cm}$, Specify around PQRSTU, in cm!

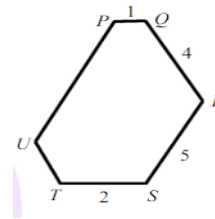


Figure 1. Test of Critical Thinking

The students' critical thinking skills from the aspect of strategy and tactics showed that the subject had differences in critical thinking skills. Critical thinking skills from aspects of strategy and tactics were analyzed into 4 indicators, namely (1) revealing the problem, (2) formulating alternative solutions and (3) using arguments and (4) repeating.

The test of students' critical thinking skills in terms of strategy and tactics aspects used one essay question. Test questions were given to graduate students. From the answers of students were taken with relevance to certain character traits which could be seen as follows:

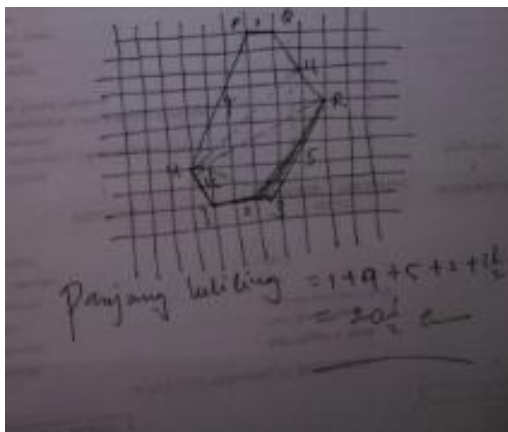


Figure 1. Answer of S1

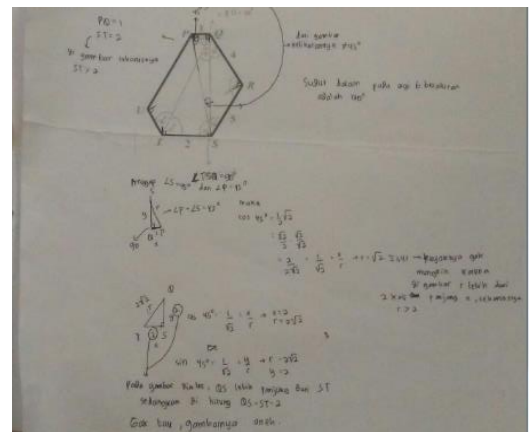


Figure 3. Answer of S3

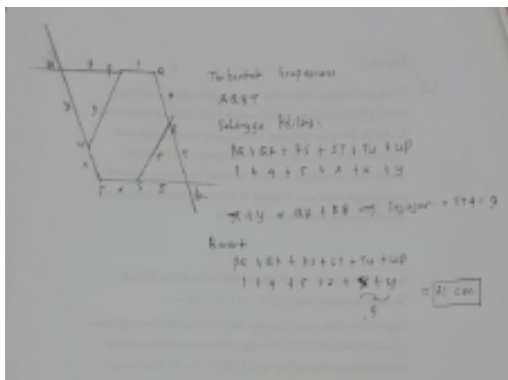


Figure 3. Answer of S2

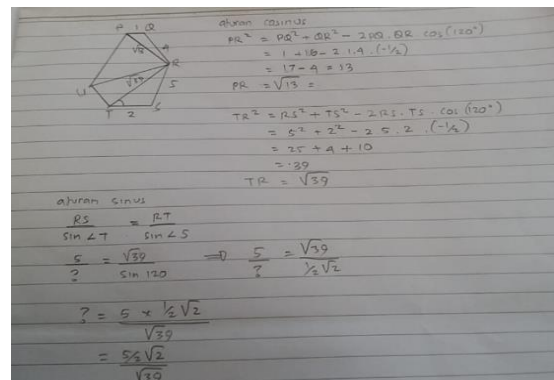


Figure 4. Answer of S4

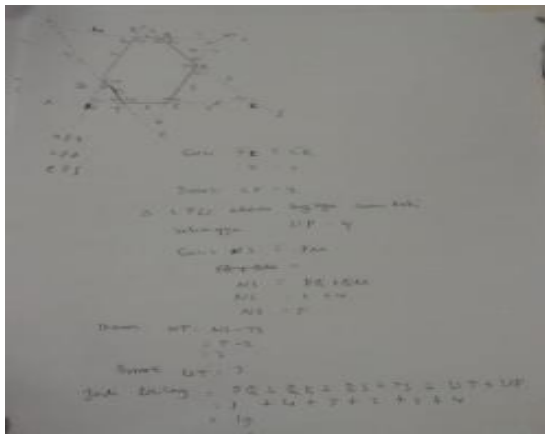


Figure 5. Answer of S5

Analysis of critical thinking skills from aspects of strategy and tactics were as follows:

1. Revealing the Problem

To measure the skills to think critically, students had seen the skills within understanding the problem, knowing what was being asked, and being able to reveal or showing any information that was on the given question. The answers of each student in the indicator revealed different problems. S1 answers were classified as low, where the student could only find out the problem. Not all the information on the question could be stated. After being interviewed, the students did not declare all information correctly based on the given questions. S2 answered the indicator and revealed that the problem was moderated because the postgraduate students could find out what the question meant, but not all the information on the question could be stated. After being interviewed, it turned out the S2 could understand the problem and could say all the information obtained from the problem. Indicator of uncovering S3 problems. Based on the answers to the subject, it could be concluded that among 5 subjects, only 4 subjects who could meet the indicator revealed the problem correctly. Therefore the critical thinking ability from the aspect of strategy and tactics on the indicator revealed the problem was high.

2. Formulating Alternative Solutions

To measure critical thinking skills in terms of strategy and tactics aspects on indicators formulated alternative solutions, it had been seen by the students' skill to get new information based on the information of the problem. This finding could apply existing information to design ideas that had been used in answering questions. The description had ideas or the right solution to solve the problem. S1 answers did not have new information based on the information in the question. S1 had ideas for answering question questions by estimating answers based on the results of the obtained images. But the idea was not right to solve the problem. After being interviewed, S1 said that the form was one way to find answers to questions. As with the S1, S2 had new information obtained from the problem. S2 considers that the image formed was like

showing a trapezoidal image. This made S2 had an idea to look for answers based on trapezoidal properties. Unlike the S1 and S2, S3 tried finding new information by measuring the angles and the images in the problem. S3 had the idea of answering questions using triangular comparison formulas based on the angles obtained. Unlike the previous students, S4 had information and ideas to answer the question by looking for diagonals using the rules sine and cosine. Whereas S5 got new information by searching for angles that related to the known angle and tried finding ideas by drawing lines that were parallel to the existing ones and using the congruent triangle. Based on the answers to the subject, it could be concluded that among the 5 subjects, only 2 subjects could meet the indicators formulating alternative solutions appropriately. Therefore, critical thinking skills from the aspect of strategy and tactics in indicators formulated alternative solutions that were relatively low.

3. Using Arguments

To measure critical thinking skills in terms of aspects of strategy and tactics on indicators using arguments, students had been able to see their ability to provide reasons and explain why they used ideas/concepts to solve problems. Students' abilities had also been seen whether they were able to solve the problem correctly. From the student answers, it could be seen that the ability to think critically from the aspect of strategy and tactics the indicators formulating alternative solutions were still classified as moderate. After being interviewed, S1 selected the idea that was done because it was related to distance. One way to find distance was by making partitions on the image according to the measurements in the question. From the partitions that were created later, the sizes are searched so that they could solve the problem. S2 could give a reason saying that the image in the question forms an irregular trapezoid because it had the same angle. This made the S2 to make the decision that the trapezoid made 3 equal side pairs. So, the unknown sides had been answered, and finally, the trapezoidal circumference could be searched. Another case with S3 was to find an unknown line length, and one way was to find a right triangle so that the triangle comparison formula was used. But S3 looked for right triangles only by manually estimating and measuring. Unlike S4, which said that the problem contained information, there were known angles and lines so that to find another line, and it should use the rules sine and cosine. The rules for sine and cosine were used by first looking for diagonals in the image so that the lines that were searched for had been answered. Whereas S5 said that to find known lines, it was used with trial and error steps. Subject 5 said that the first step used was the sine and cosine rule, but because the process was too long, the S5 tried another way, namely by using the concept of parallel lines and congruent angles. Based on the answers to the subject, it could be concluded that among 5 subjects, only 2 subjects could meet the indicators using arguments. Therefore, critical thinking skills from aspects of strategy and tactics on indicators use relatively low arguments.

4. Repeat

To measure critical thinking skills in terms of strategy and tactics aspects, students' skills were examined. S1 and S2 said the same thing that the results obtained had been rechecked, but the answers were not too convincing because the solution offered is still full of doubts. S3 also said different things, where S3 did not solve the problem because according to him, the picture on the question was not clear. S3 had repeatedly checked the questions and solutions provided, but S3 still did not solve the problem until it was complete. It was different from S4 who had reviewed by a clear and trusted solution. S4 did not solve the problem thoroughly because time was over. It was almost the same as with S5, which said that solutions and answers had been examined and were confident with the given answers. Based on the answers to the subject, it can be concluded that among the 5 subjects, no subject could fulfill the indicator using the exact check again. Therefore, critical thinking skills from aspects of strategy and tactics on indicators using re-checking were very low.

This data analysis describes:

Table 1. Result Analysis for Critical Thinking Skills by Aspects of Strategy and Tactics

Subjects	Aspects of Strategy and tactics			
	Revealing the Problem	Formulating Alternative Solutions	Using Argument	Repeat
S1	√	-	-	-
S2	√	-	-	-
S3	√	-	-	-
S4	√	√	√	-
S5	√	√	√	-

The table above illustrates that critical thinking skills from aspects of strategy and tactics were low. For indicator 1, students' critical thinking skills were high because all subjects fulfilled these indicators. In this indicator, students understood the problem, found out what was asked and revealed or showed what information was on the given problem. For indicator 2, critical thinking skills were classified as low because only 2 subjects formed alternative solutions. It obtained new information based on information on the problem. It applied existing information to design ideas that were used in answering questions and having ideas or the right solution to solve the problem. For indicator 3, students' critical thinking skills were low because there were only 2 subjects who gave reasons and explain why they used ideas/concepts to solve problems. For indicator 4, students' critical thinking ability was very low because no subject checked the results of the solving problem.

Ennis in Costa (1985: 16) says that one aspect of critical thinking was strategy and tactics (strategy and tactics). Aspects of strategy and tactics included, among others, uncovering the problem, formulating alternative solutions, providing the argument, and examining the results. The given questions to students were with the category of higher-order thinking because the matter could develop

critical thinking skills (King & Goodson, 2010; Syarifah, Usodo, & Riyadi, 2018). This is in accordance with the answers of students that students do not remember the characteristics of the angle and the congruent of the triangle. In solving mathematics problems, students ought to remember the basic concepts to support the development of critical thinking skills. So, students could find ideas and provide reasons for correct answers (D.S & Doerr, 2008; Innabi, 2003; Sumarmo, 2000).

This research clarifies that the low skill to think critically is also influenced by the lack of exercise in solving the problem (Facione, 2015; Kalelioglu & Gilbahar, 2013; Snyder & Snyder, 2008; Van, Thompson, Jacobson, & Reimann, 2012). The students who did not solve the questions correctly showed that students had low critical thinking skills. Students' low critical thinking skills is also in accordance with the research (As'ari, Mahmudi, & Nuerlaelah, 2017; Safrida, Ambarwati, & Adawiyah, 2018). This is also in accordance with the opinion of Ennis (2001), which says that someone who has high critical thinking skills then automatically someone can survive in solving problems.

CONCLUSION

The following conclusions can be drawn: (1) critical thinking skills from the aspect of strategy and tactics to indicators reveal a high problem; (2) the ability to think critically in formulating alternative solutions are classified low; (3) critical thinking skills from by using arguments are classified low and; (4) critical thinking skills by using re-checking are very low. Thus, further research needs other aspects to complete the student's critical thinking skills. This means, the next study hopefully will describe how students can solve the mathematics problems completely.

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