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CRITICAL THINKING ABILITY OF JUNIOR HIGH SCHOOL STUDENTS IN SOLVING MATHEMATICS QUESTIONS OF THE NATIONAL SCIENCE COMPETITION

Ari Malinda [1*], Yenita Roza [2], Maimunah [3]

[1,2,3] Mathematics Education Study Program, FKIP, Universitas Riau
Kampus Bina Widya KM. 12,5, Simpang Baru, Kota Pekanbaru, Riau 28293, Indonesia

e-mail: [1] arimalinda87@gmail.com

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*corresponding author**

Abstract

Critical thinking ability is the ability to identify problems, evaluate and develop arguments and solve problems appropriately. Critical thinking must be mastered as a fundamental ability that students must possess. One strategy that can develop students' critical thinking skills is giving problem-solving tasks, such as KSN questions. The KSN questions have more complex problems and a very high difficulty level. This study aimed to measure students' critical thinking in solving the problems of the National Science Competition (KSN) in the field of Mathematics. This research is qualitative descriptive research. The research subjects were three 8th-grade students who were members of the competition team of Public Junior high School 3 Siak Kecil. The data collection technique was in the form of a written test to measure students' critical thinking skills. The results showed that students had good mathematical critical thinking skills. Overall, students can investigate the context of the problem (interpretation), model or formulate mathematical problems (analysis), develop answer concepts by applying appropriate strategies (evaluation), and write conclusions (inference). The results of the data analysis concluded that of the three students who took the test, S-1 had excellent critical thinking skills.

Keywords: critical thinking, national science competition, question

1. Introduction

Mathematics learning is a teaching and learning process designed and planned by teachers to help students develop their creative thinking skills in constructing knowledge in order to better understand mathematical material (Susanto, 2013). To understand mathematical concepts correctly, one must be able to think critically. Critical thinking is the procedure of studying or creating a report of a problem by using logical reasoning in making judgments (Fristadi & Bharata, 2015).

According to Johnson (2010), Critical thinking is a method for solving problems, making decisions, influencing others, checking assumptions, and conducting scientific studies that are directed and clear. Critical thinking is also defined as the ability to say something confidently according to our beliefs.

The ability to think critically is fundamental to students because it allows them to reason in solving their challenges. Furthermore, students critical thinking ability is essential because it is 1) Primary or intellectual capital (knowledge). 2) Vital aspects of human development and 3) As a scientific discipline to prepare students to succeed in life (Utami, 2017). Because there are so many advantages to thinking critically, it is hoped that students will be able to compete with the development of world science and technology and overcome the difficulties that arise due to the critical thinking process.

Choy & Cheah (2009) define critical thinking as a complex process that requires a high level of cognitive processing of information. Masrukan & Sulistiani (2016) state that the development of critical thinking skills and abilities enables students to get used to facing challenges and solving problems by analyzing their own thinking to decide on a choice and draw conclusions, so that quality graduates are printed. So it can be said that critical thinking is a very important thing, because it is closely related to quality graduates.

However, it is tough for students to improve their critical thinking skills. Learning mathematics is difficult for students, causing mathematics lessons to be less desirable. Only several students can study mathematics as a science that can hone critical thinking skills.

In fact, in the field, it was found that there were differences that students had in class. One of them is the difference in intelligence. The intelligence of each student is different. Most students still rely on the material delivered by the teacher in class. Students also prefer to ask directly to the teacher before understanding the questions.

In addition, most students do not apply strategies in completing arithmetic operations, so in the end, many students' answers are not appropriate when working on questions—coupled with their lack of initiative and interest in studying the material at home. The statement above shows the students' lack of response and critical thinking in learning mathematics.

In contrast, to students who have above-average intelligence. They are more motivated to solve challenging problems and require higher-order thinking skills. They can understand and find concepts and apply the most effective problem-solving methods. They also always practice solving problems. Therefore, they are used to solving problems that have a very high level of difficulty.

Supporting facts are research reports conducted by Sianturi et al. (2018) and Arif et al. (2020) that state several reasons for the lack of responsiveness and critical thinking in mathematics learning. One of them is that students prefer to memorize material and formulas rather than find concepts. Thus, it causes students to find it challenging to improve their thinking skills to solve problem-solving that requires analysis, manipulation, and strategies. Meanwhile, Sari et al. (2020) research shows that students' critical thinking skills lead to an inability to apply appropriate techniques to specific problems.

In line with that, the results of interviews with teachers in the research of Siti Aisyah et al. (2021) show that it is known that the majority of students are passive in the flow of mathematics learning activities. When asked about the information and questions presented, some students did not understand and became more silent. As a result, students are less able to convey ideas about the material being taught, and they have difficulty understanding questions in the form of descriptions. The statement above shows that students' critical thinking is very lacking.

Critical thinking helps a person to assess, make decisions, and draw appropriate conclusions from problems (Lambertus, 2009). Therefore, the ability to think critically must be mastered as a fundamental ability that students must have. Therefore, they can face the progress of world science and technology and overcome problems that arise in the future.

According to Soedjadi (in Subekti, 2012) problem solving is the goal of material in mathematics education which is related to training

the implementation of mathematics and skills in solving mathematical problems. One way to overcome good problem-solving is to compete. In Indonesia, one of the competitions in the field of mathematics that can improve students' critical thinking is called the National Science Competition (KSN). The National Science Competition (KSN) is an annual competition at the elementary, junior high, and high school levels. The aim is to develop the competitive ability of students to compete in a sporting manner in technology and science skills to develop their math and science skills.

KSN is a high-level competition where the participants are students who excel academically compared to other students. However, the KSN questions in mathematics are different from the questions tested at school. It is because the KSN questions have more complex problems and a very high difficulty level.

KSN questions usually require students to think more actively and recall information that has been received. Students who are accustomed to working on KSN questions can certainly be able to solve the problems given in class. Research conducted by Latifah et al. (2018) states that students who are accustomed to competing in math olympiads outperform others. Mathematics olympiad coaching is undoubtedly recognized as having good mathematical abilities.

Based on the problems above, the researchers analyzed the critical thinking ability of junior high school students in solving mathematics questions of the National Science Competition (KSN). The goal was to discover students' critical thinking processes in solving the National Science Competition (KSN) questions.

2. Method

This research was a qualitative descriptive study. The research subjects were 3 students participating in the math olympiad who were in class VIII of SMPN 3 Siak Kecil. This study aimed to measure students' critical thinking skills in solving the problems of the National Science Competition (KSN) in the field of mathematics. The results of students' written test answers were used as a data source.

The research instrument used test questions on the number material, as many as two questions adapted from KSN questions in the field of mathematics for junior high school students. Then, the student's test results on each item were analyzed in the form of scoring to collect information about students' ability to think critically and mathematically. The scoring used the rules that had been set. After the students completed the written test, the results of their answers were checked. Then, each indicator was assigned a minimum score of 0 and a maximum score of 4.

In this study, four critical thinking indicators were used to measure students' mathematical critical thinking skills: interpretation, analysis, evaluation, and inference. In addition, the descriptive analysis technique was used in data analysis. Finally, the data presented was used as a short description in the form of a narrative (qualitative) based on students' answers to the KSN questions.

Conclusions were drawn by describing students' written test results based on the achievement of indicators of critical thinking skills. Therefore, the criteria of students with critical thinking skills are based on their respective categories.

3. Result and Discussion

The written test was carried out at Public Junior High School 3 Siak for 8th-grade students. The questions used to consist of 2 questions with number material. The research subjects were three students who were members of the Public Junior High School 3 Siak Kecil competition team. The data analysis of the written test results of students' critical thinking skills is shown in Table 1 below:

Table 1. Students' Critical Thinking Ability

Subject Name	Indicators of critical thinking skills achieved
S-1	Meet all critical thinking indicators, namely interpretation, analysis, evaluation, and inference
S-2	Meets three critical thinking indicators, namely analysis, evaluation, and inference
S-3	Meets two critical thinking indicators, namely analysis, evaluation

Based on the results of the written test of critical thinking skills on the achievement of critical thinking ability indicators, the following results are obtained:

a. Meet all stages of critical thinking ability indicators

All indicators of critical thinking skills in S1 are fulfilled, namely interpretation, analysis, evaluation, and inference. The following is an illustration of student completion results:

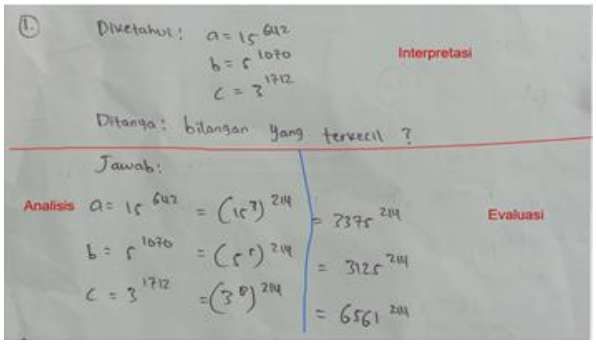

Figure 1. Results of Completion of S-1 Question No.1

Figure 1 shows that the interpretation indicator correctly wrote 'what is known and 'what is asked' and understood important information from the question. In the analysis indicator, students are correct in writing the mathematical model on the problem by changing different powers to the same power on the numbers a, b, and c. In the evaluation indicators, the subject does the calculations correctly by making the right strategy. Finally, at the inference stage, students write the conclusions of the existing problems by writing the smallest number of the given questions. As stated by Arif & Hayudiani (2017) that conclusions can be drawn from the answers that have been completed at the evaluation stage. This shows that students with high mathematical abilities can fulfill the inference indicators.

In the next stage, students worked on question no. 2, where students answered very carefully and in detail so that the achievement of the four critical thinking indicators was met. The results of the settlement can be seen in Figure 2 below:

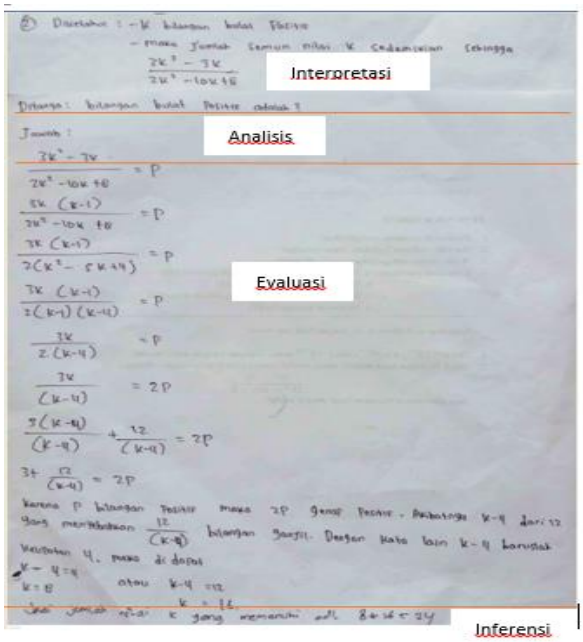

Figure 2. Results of Completion of S-1 Problem No. 2

Figure 2 shows that all indicators of critical thinking skills are met in solving problems. In the interpretation indicator stage, S-1 can identify problems well by making 'what is known and 'what is asked' correctly and completely. Sumarmo (Febianti, 2012) argues that the identification of mathematical problems includes elements 'what is known, 'what is asked,' and the suitability of the required elements. Then, students work on the questions by connecting what is known and asked in the question so that students can choose the proper method to solve the problem.

In the analysis indicators, S-1 has modeled the problem into numbers and made a relationship between the conditions and the problems presented. In the evaluation indicators, S-1 used the right strategy in its execution and was correct in carrying out calculations. In detail, S-1 explains determining the results in the final answer. Furthermore, at the final stage, inference, S-1 has written appropriate conclusions from the questions presented. Therefore, it can be said that the S-1 mathematical critical thinking ability is excellent.

b. Fulfills three stages of critical thinking indicators, namely analysis, evaluation, and inference

Based on the results of the completion of the written test, it was found that the S-2 fulfilled three critical thinking indicators, namely analysis, evaluation, and inference. The result of solving the problem is shown in Figure 3 below:

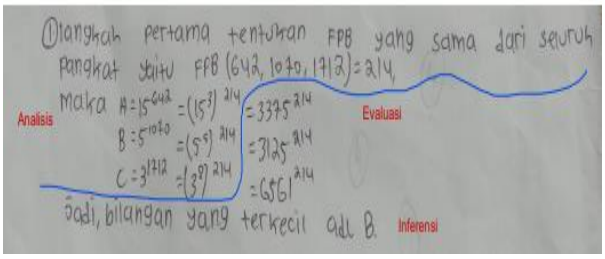

Figure 3. Results of Completion of S-2 Problem No.1

Figure 3 shows that S-2 did not make what is known and what is asked in the question. However, students know the meaning of the problem by formulating a mathematical model of the problem and, in detail, an explanation by first determining the LCM of the known numbers. Therefore, students have met the analysis stage.

In the evaluation indicators, students make strategies correctly and precisely in completing calculations. For example, students multiply the number by the power to get the smallest number. Then, students also complete the answers by writing the conclusion correctly. Thus, students have met the inference indicators.

In the next stage, students do the completion for question no. 2 with the results of the answers as follows:

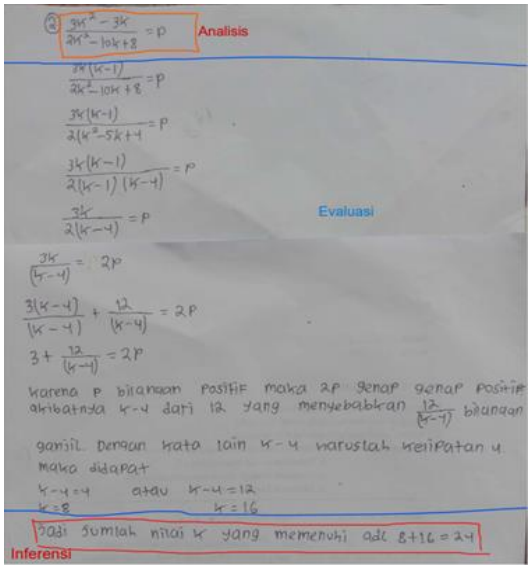

Figure 4. Results of Completion of S-2 for Question No. 2

Figure 4 shows that in the interpretation indicator, S-2 does not make what is known and asked by the question. Students work on the analysis indicator stage to turn the problem into numbers, model and present problems in numerical form.

In the evaluation indicator, the problem has been written as an equation and solved so that it gets an unknown number. In this case, students were said to have been able to use the right strategy despite errors in the calculations. In the inference indicator, S-2 has concluded correctly and precisely. From the results of the settlement, it can be said that S-2 has good mathematical critical thinking skills.

c. Meets two critical thinking indicators, namely analysis and evaluation

Based on the results of the completion of the written test of mathematical critical thinking skills, it was found that S-3 met two critical thinking indicators. The results of solving question no.1 in S-3 can be seen as follows:

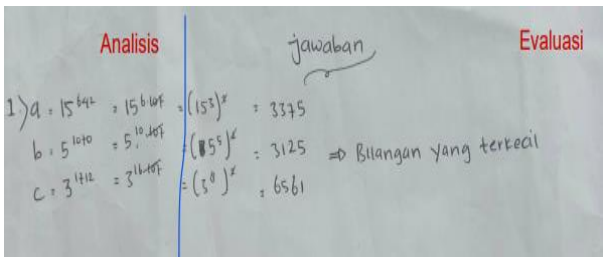

Figure 5. The Results of Completion of S-3 for Question No.1

Figure 5 shows that in the interpretation indicator, S-3 did not make what is known and asked by the question. Students worked on the stage of making mathematical models even though they were not quite correct (analysis indicators), and students made strategies that were less precise in doing calculations (evaluation). However, the student correctly explained that the smallest number is in b. In the inference indicator, students did not make conclusions.

In the next stage, students completed question no.2 with the following results:

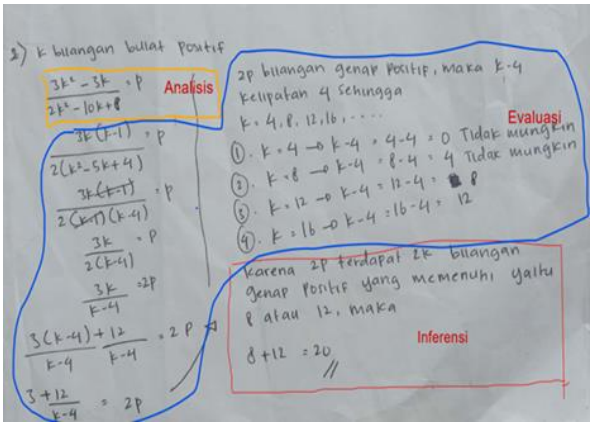

Figure 6. The Results of Completion of S-3 for Question No.2

Based on Figure 6, the interpretation indicator is not met. However, S-3 can make a mathematical model in the form of numbers, explaining the relationship between a condition and a given problem. Thus, the analysis indicators are met.

While on the evaluation indicators, the student used strategies with guidelines at the previous stage, but they were still not perfect, and there were still errors in their calculations. Students are not careful in doing the questions. The correct answer should be because k is a multiple of 4, so for k - 4 = 12, the result is k = 16, but it is different from what students are doing; k - 4 = 12 - 4 = 8. According to Budiyono, the third step was answered correctly, and students did not make a mistake in the second step. Similarly, if the student in the first step did not make a mistake, the second step was answered correctly (Budiyono, 2008).

In the inference indicator, S-3 makes a wrong conclusion because the student was still wrong in completing calculations at the stage of the evaluation of the questions. However, this shows that S-3 has written a conclusion from the context of the question, even though the answer's final result is wrong. Therefore, the critical thinking ability of S-3 is quite good.

The results of scoring on student answers in solving questions for each indicator are shown in the following graph:

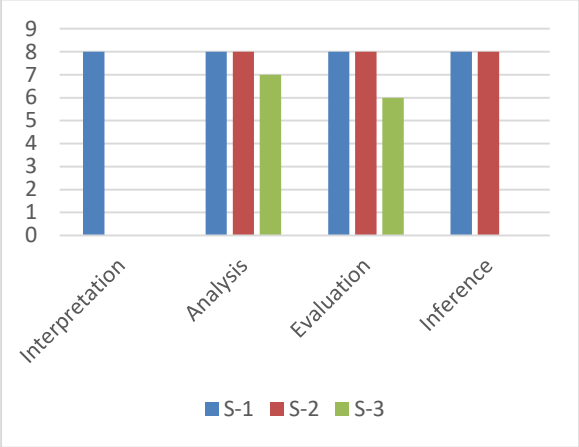

Figure 7. Scoring Diagram of the Student Completion Process

Figure 7 shows that each student has varying critical thinking skills in solving problems on the questions. In this case, S-1 has the highest score among other students. It can be seen from all aspects of the indicators of critical thinking skills being met. For example, in the interpretation indicator, only S-1 writes down what is known and asked in the questions.

All students correctly worked on the questions given in the overall analysis indicators. This truth is because students can recognize and understand the relationship between certain situations and problems. In the evaluation indicator, students work on the problem with a strategy even though there are still errors in the solution. The error is due to a lack of accuracy or errors in calculations. Meanwhile, on the inference indicators, most students make conclusions.

The previous research that supported this research, namely the Ovi Adiniyah Rochmah (2019), concluded that the results of the analysis of students' critical thinking were categorized as good. Each student has a varied character that affects the results of critical thinking. In general, it can be said that olympiad students can solve KSN questions even though each student has different styles and ways of solving problems.

4. Conclusion

Based on the results of the written test of the mathematical critical thinking ability of three students included in the mathematics competition team at Public Junior High School 3 Siak Kecil, it was found that the student's critical thinking ability in solving KSN questions was quite good. Overall, students can investigate the context of the problem (interpretation), model or formulate mathematical problems (analysis), develop answer concepts by applying appropriate strategies (evaluation), and write conclusions (inference). Each student has a varied style in answering the questions given. It depends on the mindset and logic of each student.

S-1 has fulfilled all stages of critical thinking indicators. S-1 makes what is known and asks about the problem, modeling or formulating problems, using appropriate strategies to solve and make conclusions. S-2 fulfills three stages of critical thinking indicators, namely modeling or formulating problems, using appropriate strategies, and ultimately making conclusions from the context of the problem. Meanwhile, S-3 fulfills two indicators, namely modeling or formulating problems and using strategies. Of the three students who took the test, S-1 has excellent critical thinking skills.

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