

CRITICAL THINKING PROFILE OF MATHEMATICS IN INTEGRAL MATERIALS

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Abstract

This study aims to determine the critical thinking skills of mathematics in one of the high schools in the city of Cimahi with indicators of mathematical critical thinking skills used are Analyzing and evaluating arguments and evidence, Arranging clarification, Arranging explanations based on relevant and irrelevant data, Identifying and evaluating assumptions. The method of this research is qualitative with descriptive research types. The research subjects were 76 students in one city of Cimahi. The data collection technique used in this study was a test of four items. Data analysis was carried out with 3 steps, namely data reduction, data presentation, and conclusion drawing. The results showed that the average achievement test of students' mathematical critical thinking skills as a whole is still relatively low in the percentage of each indicator, 34% for indicators compose clarification, 5% analyze and evaluate arguments and evidence, 10% Prepare explanations based on relevant data and those that do not relevant and 64% Identifying and evaluating assumptions.

Keywords: Critical thinking ability, Integral

Abstrak

Penelitian ini bertujuan untuk mengetahui kemampuan berpikir kritis matematis di salah satu SMA di kota Cimahi dengan indikator kemampuan berpikir kritis matematis yang digunakan adalah Menganalisis dan mengevaluasi argumen dan bukti, Menyusun klarifikasi, Menyusun penjelasan berdasarkan data yang relevan dan yang tidak relevan, Mengidentifikasi dan mengevaluasi asumsi. Metode penelitian ini adalah kualitatif dengan jenis penelitian deskriptif. Subjek penelitian yaitu 76 siswa di salah satu kota Cimahi. Teknik pengumpulan data yang digunakan dalam penelitian ini adalah tes uaian sebanyak 4 butir soal. Analisis data dilakukan dengan 3 langkah yaitu reduksi data, penyajian data dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa rata-rata pencapaian tes kemampuan berpikir kritis matematis siswa secara keseluruhan masih tergolong rendah presentase tiap indikator, 34% untuk indikator menyusun klarifikasi, 5% menganalisis dan mengevaluasi argumen dan bukti, 10% Menyusun penjelasan berdasarkan data yang relevan dan yang tidak relevan dan 64% Mengidentifikasi dan mengevaluasi asumsi.

Keywords: Kemampuan berpikir Kritis, Integral

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INTRODUCTION

Mathematics is a human activity carried out in everyday life both consciously and unconsciously. We often think that mathematics is a science related to calculations such as that carried out by a swordsman, accountant, surgeon and so on, whereas mathematics is not only as narrow as that mathematics is an activity of thinking, seeing patterns and looking for solutions that are expected. This is in line with the opinion of Lange (Sadiq, 2007) Mathematics can be seen as a language that describes patterns in both patterns in nature and patterns found by the human mind. These patterns can be real or imagined, visual or mental, static or dynamic, qualitative or quantitative, purely utilitarian or little more than recreational interests. They can emerge from the world around us, from the depths of space and time, or from the inner workings of the human mind.

Everyone does mathematical activities according to their capacity. For example, a warrior of mathematical activity is counting, farmers want to increase their production by observing changes and problems that exist, someone wants to arrive at a destination in a timely manner by choosing the right path, considering all the possibilities to get to the destination. Thinking activities whether calculating numbers or thinking about determining a decision by considering all the possibilities available is a part of mathematical thinking. Cocroft (Sadiq, 2007) reveals that it would be very difficult, impossible to live a normal life in very many parts of the world in the twentieth century without using the mathematics of some kind. Therefore mathematical abilities are very important benefits for human life.

One of the advantages of learning mathematics is that it can build critical thinking patterns both in mathematics and critically in solving life problems. Critical thinking ability is one of the types of mathematical abilities. Ennis (Novtiar & Aripin, 2017; Setiawan, 2015) means that critical thinking ability is the ability to think reflective that is reasonable and focused on what has been determined and trusted. Glaser (Sumarmo, et.all, 2012) reveals critical thinking skills in synergy with mathematical disposition skills that collaborate with reasoning knowledge, cognitive strategies to generalize, prove and analyze situations in a reflective manner.

Critical thinking ability is one of the high-level thinking skills or often referred to as the Higher order Thinking Skill (HOTS) ability. The ability to think critically can be mastered if someone has knowledge of material and understands it. Suppose students do not master these prerequisites the critical power will not be developed because someone must consider, assess and decide on a problem that requires good knowledge and understanding of the material. Besides, students who are trained in critical thinking skills will have a positive attitude between self-confidence, self-confidence, and firmness in various existing problem situations so that they can adapt to their various environments. This is shared by Tresnawati, Hidayat, & Rohaeti (2017) developing mathematical abilities, especially critical thinking skills, a student must have a confident attitude and believe in their abilities so that they avoid anxiety and doubt.

Johnson (Hidayat, 2012) suggests that critical and creative thinking allows students to study problems systematically, face millions of challenges in an organized way, formulate innovative questions, and design problems that are seen as relatively new. This shows that critical thinking skills need to be developed and can be improved in learning so students can think critically in facing each problem. Students will always study the problem systematically, organized and consider and be able to take an accurate decision in solving the problem. This

is emphasized by Hassoubah (Hidayat, 2012) stating that by thinking critically and creatively the community can develop themselves in making decisions, judgments, and solving problems.

The ability of critical thinking in mathematics to be difficult to develop because student learning habits are only fixated on existing formulas and already feel sufficient if they can already use the formula. This is in line with the opinion of Hendriana (Hidayat, 2012) saying that students only imitate and record how to solve problems that have been done by the teacher. If they are given different questions with practice questions, they are confused because they do not know where to start working.

Critical thinking ability in this study measures the integral material. This material is a branch of calculus that is widely studied by students even though it is not a mathematics department because this material is needed by various other disciplines such as engineering, economics, Mathematics and Natural Sciences, etc. Interactive material is also one of the materials that is considered difficult by most students.

Based on the above explanation, it is necessary to examine students' high-level thinking skills, namely the ability to think critically mathematically in teaching and learning activities at school. Therefore researchers are interested in researching the title "Profile of Mathematical Critical Thinking Ability on Integral Material" with the indicators taken are analyzing and evaluating arguments and evidence, Arranging clarification, Arranging explanations based on relevant and irrelevant data, Identifying and evaluating assumptions. This study aims to determine the mathematical thinking ability of high school students.

METHOD

This study uses qualitative methods with descriptive research types. This study aims to describe high school students' critical thinking skills in integral material. The research subjects were 76 students in one city of Cimahi. The data collection technique used in this study was a test of four items. Then the question has been validated first and revised according to the suggestions of the validators. There are questions as follows:

Problem No. 1

Note the completion of the following questions !

$$\begin{aligned} \int \frac{x^3+2x-1}{x^2} dx &= \frac{\frac{1}{4}x^4 - \frac{2x^2}{2} - x}{\frac{1}{3}x^3} + c \\ &= \frac{\frac{1}{4}x^4 - x^2 - x}{\frac{1}{3}x^3} \times \frac{12}{12} + c \\ &= \frac{3x^4 - 12x^2 - 12x}{4x^3} + C \end{aligned}$$

Look at what part of the error solving the problem above! explain with relevant arguments!

Problem No.2

Prove the indeterminate form of integration below!

$$\int x^3 \sqrt[5]{\sqrt[7]{x^5 \sqrt[3]{x^2 \sqrt{x}}}} dx = \frac{42}{178} x^4 \sqrt[5]{\sqrt[7]{x^5 \sqrt[3]{x^2 \sqrt{x}}}} + C$$

Problem No.3

Marginal cost y' as a function of the unit of goods produced x , determined by the formula $y' = 1,064 - 0,005x$. Explain how to find the total cost of the function if the initial cost 16,3!

Problem No .4

Ani said to complete the form,

$$\int 8x(2x - 1)^5 dx$$

With substitution techniques. Whereas rani completes it using partial techniques. Do you think Rani and Ani's answers will be the same? If the answer is different, who is right? Explain!

To calculate the percentage of achievement of critical thinking skills in the score of questioning according to Susilawati (Herdiman, Nurismadanti, Rengganis, & Maryani, 2018) the following formula can be used:

$$P = \frac{T}{S \times N} \times 100 \%$$

Information :

P = Percentage of scores for each stage of each item

T = Total score of each indicator for each item about all subjects

S = Maximum score for each indicator for each item N = many subjects

Next to be able to classify and interpret the scores of each item according to Ridwan (Zakiyah, Imania, Rahayu, & Hidayat, 2018) can be used with Table 1 which is presented as follows:

Table 1. Classification Percentage Criteria used in Research

Criteria (%)	Clarification
$0 \leq N \leq 20$	Very Low
$20 < N \leq 40$	Low
$40 < N \leq 60$	Enough
$60 < N \leq 80$	Good
$80 < N \leq 100$	Very Good

Data analysis was carried out with 3 steps, namely data reduction, data presentation and conclusion drawing.

RESULTS AND DISCUSSION

Results

This research was conducted in one of the high schools in the city of Cimahi by conducting test tests on integral material in class XI IPA. The question consists of 4 questions to measure

critical thinking skills. Each question is given a score of 4 and the maximum score for the five questions is 20. The answers described referring to the indicators compiling clarification, analyzing and evaluating arguments and evidence, compiling explanations based on relevant and irrelevant data, identifying and evaluating assumptions. There are results of tests of critical thinking skills presented in the following table:

Table 2. Description of the Results of the Critical Thinking Ability Test

Critical thinking ability	Problem 1	Problem 2	Problem 3	Problem 4
\bar{x}	1,35	0,18	0,38	2,5
s	0,60	0,53	0,58	1,48
achievement	34%	5%	10%	64%

Based on Table 2, it can be described that the achievement of the items in question 34% for the indicators composes clarification, 5% analyzes and evaluates arguments and evidence, 10% Makes explanations based on relevant data and irrelevant and 64% Identifies and evaluates assumptions. The results of achievement of mathematical thinking skills in questions number 2 and 3 are interpreted very low, questions number 1 are low and questions number 4 are in good category.

Discussion

The results of the achievement of each item about mathematical critical thinking skills in the integral material as a whole are still low except the question number 4, which means that the problem of critical thinking skills is still considered difficult by most students. Syahbana (Novtiar & Aripin, 2017) says that there is still a low average mathematical thinking ability of middle school students. The average value of mathematical critical thinking skills of junior high school students is only 68 on a scale of 0-100. Both junior and senior high school level questions about students' mathematical critical thinking skills are still unsatisfactory.

The question of critical thinking is not easy to solve because critical thinking skills belong to the category of high-level thinking problems commonly known as the Higher order Thinking Skill (HOTS). Critical thinking is not a problem that requires a lot of calculations but requires a thought process to find a solution that is expected. It can be concluded that to be able to solve critical thinking questions the main prerequisite is that students must understand the basic concepts first or students must have good understanding skills. According to Suwarti (Aripin, 2015) there are still difficulties in solving the problem of mathematical understanding which results in the achievement of students' mathematical understanding abilities that are still relatively low.

The first step to being able to improve critical thinking skills must master the basic concepts or have mathematical understanding skills first. In being able to improve the ability to understand the need for increased learning in the classroom and design learning that can build or construct concepts so that students have broad insight not only can apply formulas but also can understand the essential meaning of the concept (Aripin, 2015; Hidayat & Aripin, 2019; Setiawan & Sari, 2018).

When the students' understanding ability in a material is good, the ability to solve critical thinking questions will be more optimal, because students already have the prerequisites in completing the problem, then students must be able to link the existing problems with the

concepts that have been understood. But if students do not have a basic understanding of material it will be difficult to solve the problem of critical thinking skills.

In the number one problem, the achievement of students is still low, which is 34%. This question measures students' ability to clarify statements or the process of resolution whether right or wrong. The results of student answers are as follows:

I. Perhatikan penyelesaian soal berikut

$$\int \frac{x^3 + 2x - 1}{x^3} dx = \frac{\frac{1}{4}x^4 - \frac{3x^2}{2} - x}{\frac{1}{4}x^4} + c$$

$$= \frac{\frac{1}{4}x^4 - x^2 - x}{\frac{1}{4}x^4} \times \frac{12}{12} + c$$

$$= \frac{3x^4 - 12x^2 - 12x}{3x^4} + C$$

salah, karena menurut saya yang dibulatkan sama saya yg awalnya + jadi -

2

Figure 1. Results of Question No.1

It can be seen that one of the students' answers is considered to represent the answers of all students. Most can clarify only the calculation algorithm. Even though the mathematical concept of the integration process on the problem is wrong. Because for multiplication or division operations can not be directly integrated but must be simplified first to form $f(x) \pm g(x)$ according to the integral nature of course $\int \{f(x) \pm g(x)\} dx = \int f(x) dx \pm \int g(x) dx$ if it cannot be simplified to form $f(x) \pm g(x)$ it must use integration techniques.

The answer to question number 1 shows a lack of understanding of students in understanding the integral nature. In the above, answers shows that understanding concepts is very important and a prerequisite for being able to solve critical thinking problems. This is in line with the opinion of Purwasih, Aripin & Fitrianna (2018) that the ability of Higher order mathematical Thinking (HOMT) can be mastered well by students who have a conceptual understanding. Not enough just to understand but must be able to use concepts that are understood to be able to solve problems.

In question number 2 student achievement is very low at 5%. This question measures students' ability to analyze and evaluate arguments and evidence. The results of student answers are as follows:

2) Buktikan $\int x^3 \sqrt[5]{\sqrt[7]{x^5 \sqrt{x^2 \sqrt{x}}}} dx = \frac{42}{175} x^4 \sqrt[5]{\sqrt[7]{x^5 \sqrt[3]{x^2 \sqrt{x}}}} + C$

$$\int x^3 \sqrt[5]{\sqrt[7]{x^5 \sqrt{x^2 \cdot x^{\frac{1}{2}}}}} dx$$

$$\int x^3 \sqrt[5]{\sqrt[7]{x^5 \cdot \sqrt{x^{\frac{5}{2}}}}} dx$$

$$\int x^3 \sqrt[5]{\sqrt[7]{x^5 \cdot x^{\frac{5}{4}}}} dx$$

Figure 2. Results of Question No.2

From Figure 2 it can be concluded that most students cannot answer the question and only a few students can describe using exponent properties but stop in the middle of the road and are not resolved. This happens because students feel that the problem is the most complicated among the others even though it is only necessary to describe the process on the right and describe the left side of the results. Besides, it can also use the concept of integral reasoning, namely the rank added to one and divided by the rank that has been added to one.

The answer to question number 2 shows the lack of fighting the power of students to analyze existing problems with a simple concept and that on average students understand it but because the form of the question seems complicated many students do not write answers. Lack of student fighting power or often referred to as mathematical disposition. The results of the research by Kurniati, Pujiastuti & Kurniasih (2017) critical thinking skills will be able to increase when students have disposition skills and there are still many students who lack confidence, lack of curiosity, have not been diligent in learning which results in mathematical critical thinking being low.

In question number 3 student achievement is very low at 10%. This question measures students' ability to compile explanations based on relevant and irrelevant data. The results of student answers are as follows:

③ $y' = x$ $y' = 1,064 - 0,005 (16,3)$
 $x = 16,3$ $= 1,064 - 0,0815$
 $= 0,9825$

Figure 3. Results of Question No.3

Figure 3 shows the lack of students in understanding what is being asked and looking for appropriate concepts to solve problems. Besides, most students have not been able to provide an explanation based on relevant data and which are not relevant to be used in solving problems. Students answer this question by directly substituting the value of x to the equation

in the question, even though the problem is explained that y' is the marginal cost while the question is the total cost of the function.

In question number 3, most students do not know the concept of anti-derivative, which in this case is the application form. Besides, students cannot explain the relevant data on the question. To be able to solve this problem students must understand the concept of the situation or problem that exists then look for the right concept then make an explanation with relevant arguments following the relevant concepts. This is in line with the results of Kurniati's research, Pujiastuti & Kurniasih (2017) revealing the development of critical thinking skills when students can make decisions to develop problem-solving plans and do calculations to solve problems with coherence even though there are still a few mistakes.

In question number 4 the achievement of students is good with a percentage of 64%. This question measures students' ability to identify and evaluate assumptions. The results of student answers are as follows:

$$\textcircled{4} \int 8x(2x-1)^5 dx$$

$$u = 2x - 1$$

$$du = 2$$

$$dx = \frac{1}{2} du$$

$$\Rightarrow \int 8x u^5 \cdot \frac{1}{2} du$$

$$= 4x \cdot \frac{1}{6} u^6 + C$$

$$= \frac{4x(2x-1)^6}{6} + C$$

$$\int 8x(2x-1)^5 dx$$

$$dv = (2x-1)^5$$

$$v = \int (2x-1)^5$$

$$= \frac{1}{6} \cdot \frac{1}{2} (2x-1)^6$$

$$v = \frac{1}{12} (2x-1)^6$$

$$\Rightarrow \int 8x(2x-1)^5 dx$$

$$+ 8x \cdot \frac{1}{2} \cdot \frac{1}{6} (2x-1)^6 = \frac{4x(2x-1)^6}{6}$$

$$- \frac{8}{12} \cdot \frac{1}{2} \cdot \frac{1}{7} (2x-1)^7 = \frac{8}{168} (2x-1)^7 + C$$

$$= \frac{1}{21} (2x-1)^7$$

$$= \frac{4}{6} x (2x-1)^6 - \frac{1}{21} (2x-1)^7 + C$$

Kedua teknik jawabannya sama dan benar.
yaitu $\frac{4}{6} x (2x-1)^6 + C$

Figure 4. Results of Question No.4

Figure 4 above shows that in general students can answer that question only in the process of identifying problems there are still errors, namely the process of completion with substitution techniques is still wrong because there are still previous variables, namely variable x should substitute it must replace all variables. At the initial step $u = 2x - 1$ followed by searching $x = \frac{u+1}{2}$ change the value of x in front $(2x - 1)$. Furthermore, if the method is continued the results of integrating the substitution will appear to be different from the partial. This is where students must be able to criticize the problem of whether it is the same or different. Of course, in evaluating someone should not be too quick to make decisions but must be thoughtful. The results of Wisesa (2011) research in making decisions will involve thinking reasoning processes in which collaborating moral awareness and metacognitive abilities that will be realized in the auction process as an implementation in taking decisions..

If students simplify one method either substitution or partial method, the results of the two integrations will be the same. In this question students must identify clearly and thoroughly because they will make a mistake in conclusions, then besides evaluating the results of the answers also require critical thinking in making conclusions. Sumakim (Novtiar & Aripin, 2017) emphasizes the ability to think critically mathematically is very important for students because with this skill students can be rational in choosing a variety of alternative ways the best that must be done to make decisions. Then teaching students the ability to think critically mathematically needs to be done so that they can look at problems and find the best solutions in everyday life.

CONCLUSION

Based on the results of the results of the research and discussion above the researchers concluded that the average achievement test of students' mathematical critical thinking skills as a whole is still relatively low in the percentage of each indicator, 34% for indicators compiling clarification, 5% analyzing and evaluating arguments and evidence, 10% based on relevant data and irrelevant and 64% identifying and evaluating assumptions. Besides, it is important to continue to multiply and develop mathematical critical thinking skills so that people can always be critical and able to solve their life problems.

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