

ANALYSIS OF MATHEMATICAL CRITICAL THINKING SKILLS USING PROBLEM-BASED LEARNING MODELS IN JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

The ability to think critically is currently one of the abilities that students need to have because with the ability to think critically in students can improve the quality of education in Indonesia, with this statement this research was conducted with the aim of describing the critical thinking skills of junior high school students using a problem-based learning model on quadratic equation material. This type of research is in the form of descriptive research with qualitative methods. This research was located at SMPN 3 Cimahi with 9 subjects who had high, medium and low abilities in critical thinking covering 3 classes. The data collection technique was carried out by providing 4 description questions and interviews to the subjects. Data analysis techniques in research refer to qualitative data analysis according to Miles and Huberman. The results of the study were measured based on indicators of critical thinking skills according to Facion (2015) where, 67% of students were able to interpret, 58% of students were able to analyze, 72% of students were able to evaluate, and 69% of students were able to infer so that it could be concluded that there was a significant influence of the problem-based learning model on critical thinking skills.

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INTRODUCTION

Education is one aspect in the country that can determine the progress and development of the country, it is because developed countries will have a superior quality of education compared to developing countries so that the more knowledge it will strengthen a nation in increasing human resources, one of which is the science of mathematics Nurlaeli in (Sitompul, 2021). As for according to Septian & Rizkiandi (2017) explained that education is an event to develop technological knowledge, it is because in the world of education there are stages to improve the quality of children so that education is crucial in advancing a nation.

In the world of education, mathematics subjects are very important to be taught in schools, this is because mathematics can be applied in everyday life and also many certain subjects that do require basic mathematical skills that are appropriate Hendriana in (Simarmata et al., 2018). Mathematics also makes it easier for someone to have the ability to think rationally, innovatively, intellectually and carefully in dealing with changes that occur in the world Sugiharti, Supriadi & Andriani in (Purwasih et al., 2020). According to Sulistiani and Masrukan in (Pratama & Mardiani, 2022) states that "Mathematics has a very important role in developing students' critical thinking skills, which will encourage students to be able to solve problems with more critical thinking. This opinion is in line with Hutajulu (2017) which explains that the ability to think critically has an important role at every level of education. Critical thinking itself can trigger a person to think divergently, able to analyze a problem, able to think systematically and able to think independently.

According to Asriningtyas in (Saputri & Rahayu, 2021) also argues that the ability to think critically is a person's high-order thinking ability to solve a problem where here students will be able to consider the answers or decisions to be taken. According to Tanjung in (Rosmalinda et al., 2021) also states that critical thinking is a person's ability to logically examine existing information and then evaluate it critically in order to make the right decision. Meanwhile, according to Facione (2015) in (Safitri & Miatun, 2021) revealed that the critical thinking ability indicator has four interpretations, analysis, evaluation and inference in which the four aspects students are encouraged to be able to think rationally, precisely, logically, and critically.

However, based on observations in class IX at SMP Negeri 3 Cimahi, it shows that students' critical thinking skills are still low. This happens because students are not used to using critical thinking skills in solving problems. This problem is supported by facts on the ground carried out by Bulak in (Dewi et al., 2019) that students' critical thinking skills look still relatively low, this is shown when students are in dealing with existing problem situations, where it seems that students are poorly trained in testing a problem, questioning a problem, connecting a problem, or evaluating a problem. The results of research conducted by Andini & Warni (2019) concluded that data analysis and student responses to the description questions regarding mathematical critical thinking skills showed that public junior high school students in Karawang Regency had a less level of mathematical critical thinking skills, with an average percentage of students reaching 41.54%.

In addition, it is also supported by research conducted Fitri et al., (2023) which shows that the results of the assessment of the critical thinking skills of grade IX students show that the majority of students have a very low level of critical thinking skills. Some common mistakes include incompleteness in writing down known and questions on the problem, lack of precise mathematical models and examples made by some students, and the tendency to write answers immediately without doing calculations first. In addition, some students are able to do calculations correctly, but do not include proper explanations, and not all students include conclusions from the answers they give. These results indicate that students are not used to doing non-routine problems, so training is needed to improve their critical thinking skills.

To deal with problems and facts that occur in mathematics learning at school, the right solution is needed so that students are able to think critically when solving problems that occur in mathematics lessons, namely by using the right approach, method, or model in order to support students to have critical thinking skills. One of the learning models that can support students to think critically is the problem-based learning model, because this learning model begins with the step of giving a real problem, so that students will be trained to think critically when solving the problem. The problem-based learning model can develop critical thinking skills and make students active in learning because the material discussed revolves

around everyday problems (Prasetyo & Kristin, 2020). In line with the explanation Fristadi & Bharata (2015) which says that the use of problem-based learning models causes students to play a more active and motivated role to apply and develop their critical thinking skills. So, through this learning method, students are expected to have a better opportunity to hone their critical thinking skills when facing various kinds of problems. In addition, problem-based learning has characteristics as a learning method where learners use problems as a basis for learning. This method encourages students' ability to think critically, solve problems, and apply knowledge in real life (Octavianis & Subroto, 2022). Based on this statement, it encourages researchers to conduct a study entitled Analysis of critical thinking skills using problem-based learning models in junior high school students.

METHOD

This research is a descriptive research using qualitative methods. According to Moleong in (Dores ,S.Pd., M.Pd et al., 2020) stated that "qualitative research is research that begins with observation, while after observation we will describe a data in narrative form using natural methods". Data analysis in this study refers to qualitative data analysis according to Miles and Huberman in research (Benyamin et al., 2021), namely: stage 1) data reduction (data retrieval process). At this stage researchers conducted a study located at SMP Negeri 3 Cimahi in class IX. Researchers take research subjects based on the high, medium and low critical thinking skills of students on quadratic equation material, then from 3 classes that have been taught using the Problem Based Learning model, researchers chose 9 people based on the category of critical thinking skills. Further after selecting a subject for research, the researcher gave 5 description test questions to the subjects then conducted interviews related to the questions that had been done by the subjects. Stage 2) Presentation of data, At this stage, researchers first assess interviews and test questions that have been done by subjects based on four indicators of students' ability to think critically according to Facion (2015), namely interpretation, analysis, evaluation, and inference. The data that has been obtained from the subject is then presented in the form of graphs to illustrate the results of the research that has been done. Stage 3) data inference, At this stage, researchers conclude the results of assessments that have been carried out related to students' critical thinking skills in solving quadratic equation problems.

Table 1. Mathematical Critical Thinking Ability Indicators

Mathematical Critical Thinking Aspects	Indicators
Interpretation	Students are able to understand the problems given so that in answering the questions students write down what is known, asked, then students answer the questions correctly.
Analysis	Students are able to identify the questions in the question correctly, so as to be able to choose the right way to solve the problem.
Evaluation	Students are able to complete the calculation of questions correctly and precisely.
Inference	Students are able to make conclusions correctly and precisely, according to the context of the problem.

This research procedure, namely: 1) Research subjects are selected based on the medium height and low of students in critical thinking, 2) the results of the completed test instrument are collected, 3) conduct interviews related to the test instruments that have been filled, 4)

The processed data is then inferred based on predetermined indicators. The data collection instrument consists of: 1) critical thinking ability test questions, aimed at analyzing and identifying students' critical thinking skills, (2) interviews, aimed at finding out the reasons students provide answers to the test questions given.

The benchmark in measuring students' critical thinking skills refers to the indicators proposed by (Facione 2013), where these indicators include interpretation, analysis, evaluation, and inference based on the scoring rubric that has been made. determining the category of the level of mathematical critical thinking ability refers to Arikunto in (Rahayu et al., 2018).

$$\text{Percentage Value} = \frac{\sum n}{\sum N} \times 100\%$$

Information:

n : Number of marks earned by students

N : Maximum number of values

The criteria for determining students' mathematical critical thinking ability are presented in Table 2.

Table 2. Students' level of mathematical critical thinking ability

Category	Percentage (%)
Very Good	81-100
Good	61-80
Enough	41-60
Not Good	21-40
Very Not Good	0-20

RESULTS AND DISCUSSION

Results

Based on research that has been carried out at SMP 3 Cimahi. The data produced in this study is in the form of student learning results obtained by providing test instruments in the form of 4 question descriptions. The results of this study were obtained from the results of data processing that had been analyzed based on reference to scoring guidelines for mathematical critical thinking skills. The results of scoring mathematical critical thinking skills on quadratic equation material are presented in table 3 below:

Table 3. Student Critical Thinking Ability Test Results Criteria

No	Mathematical Critical Thinking Indicators	Average (%)	Criterion
1	Interpretation	67%	High
2	Analysis	58%	Enough
3	Evaluation	72%	High
4	Inference	69%	High

Based on the data generated from the students' mathematical critical thinking skills test presented in table 1, it was obtained that for question number 1 with interpretation indicators it has a percentage of 67% which is included in the high category. It can be concluded that

there is a good influence when learning using problem-based learning models on mathematical critical thinking skills on interpretation indicators. In question number 2 with the Analysis indicator has a percentage of 58% which is included in the sufficient category. It can be concluded that there is a fairly good influence when learning using a problem-based learning model on mathematical critical thinking skills on analytical indicators. Question number 3 with evaluation indicators has a percentage of 72% which is in the high category. It can also be concluded that there is a good influence when learning using problem-based learning models on mathematical critical thinking skills on evaluation indicators, and for number 4 with inference indicators has a percentage of 69% which belongs to the high category. It can be concluded that there is a good influence when learning using problem-based learning models on mathematical critical thinking skills on inference indicators.

Diketahui: $x = -3$ salah satu akar persamaan
 $x^2 + (c+6)x + c - 5 = 0$
 Ditanya: Akar lainnya
 Jawab: $x^2 + (c+6)x + c - 5 = 0$
 $(-3)^2 + (c+6)(-3) + c - 5 = 0$
 $9 - 3c - 18 + c - 5 = 0$
 $-3c + c = -2c$
 $-2c = 18 - 9 + 5$
 $-2c = 14$
 $c = \frac{14}{-2} = -7$
 $x^2 + (-7+6)x + (-7) - 5 = 0$
 $x^2 - x - 12 = 0$
 $a = 1$
 $b = -1$
 $c = -12$

$a \times c$
1×-12
-12
$-1 \mid 12 \mid 11$
$-2 \mid 6 \mid 4$
$-3 \mid 4 \mid 1$
$-4 \mid 3 \mid -1$

 $(ax+q) \quad (ax+r)$
 $(x-4) \quad (x+3) = 0$
 $x = 4 \quad x = -3$
 HP $\{-3, 4\}$ akar lainnya 4

Figure 1. The result of the work of the 5th subject (S5)

Figure 1 is one of the students' answers to the question. If $x = -3$ is one of the roots of the equation $x^2 + (c+6)x + c - 5 = 0$ then the other roots are

Jika persamaan $x^2 + 1 = 2(x - 3)$ diubah menjadi bentuk umum
 $ax^2 + bx + c = 0$. Maka nilai $a + b + c$ sama dengan ...
 Jawab:
 $x^2 + 1 = 2(x - 3)$
 $x^2 + 1 = 2x - 6$
 $x^2 - 2x + b + 1 = 0$
 $x^2 - 2x + 7 = 0$
 $a = 1 \quad b = -2 \quad c = 7$
 $a + b + c$
 $1 + (-2) + 7 = 6$
 Maka nilai $a + b + c$ sama dengan 6.

Figure 2. The result of the work of the 1st subject (S1)

Based on figure 2 is one of the students' answers to the question. If the equation $x^2 + 1 = 2(x - 3)$ is converted into the general form $ax^2 + bx + c = 0$ then what is the value of $a + b + c$

Jawaban:
 $x^2 - 5x - 24 = 0$
 $\begin{array}{r} \times 6 \\ -24 \\ \hline -8 \quad 3 \end{array}$
 $(x-8) \quad x+3=0$
 $x=8 \quad x=-3$
 $x_1 > x_2$
 $x_1 = 8 \text{ dan } x_2 = -3$
 maka
 $2x_1 - 3x_2 = (2 \cdot 8) - 3(-3) = 16 + 9 = 25$

Figure 3. The result of the work of the 9th subject (S9)

Based on figure 3 is one of the students' answers to the question. It is known that X_1 and X_2 are the roots of the equations $x^2 - 5x - 24 = 0$ and $X_1 > X_2$. The value of $2x_1 - 3x_2$ is

Menurut saya persamaan kuadrat $x^2 + 7x + 3 = 0$ tidak mempunyai akar-akar real yang sama. Karena untuk menentukan persamaan tersebut memiliki akar kembar atau tidak, kita bisa mengetahuinya dengan cara menghitung diskriminannya. Jika diskriminannya 0, maka persamaan tsb memiliki akar real yang kembar. Sementara;
 $\boxed{x^2 + 7x + 3 = 0} \rightarrow D = b^2 - 4ac$
 $= 7^2 - 4(1)(3)$
 $= 49 - 12$
 $= 37 > 0 \text{ (BUKAN AKAR REAL KEMBAR)}$

Figure 4. The result of the work of the 6th subject (S6)

Based on figure 4 is one of the students' answers to the question. The quadratic equation $x^2 + 7x + 3 = 0$ has the same real roots. Prove the statement above then explain why.

Discussions

Based on the results of mathematical critical thinking ability tests that have been carried out to students in solving quadratic equation problems, it can be seen that students have different critical thinking skills, the following are some samples of student solving results when solving quadratic equation problems:

a. Interpretation

One of the students' work is shown in figure 1. The student's answer after analysis illustrates that the use of problem-based learning models in learning affects students' mathematical critical thinking skills, especially in solving problems in problems. In doing the questions, students have shown progress in mastering the steps of answering the questions. This is in line with research conducted by Kurniawati et al (2020) which proves that the use of problem-based learning models on mathematical critical thinking skills in learning activities is effective to use. Please note that this research has differences with previous research, one of which is differences in research methods.

b. Analysis

One of the results of the student's work is seen in figure 2 above. The student's answer after the analysis illustrates that the use of problem-based learning models in learning is

quite influential on students' mathematical critical thinking skills. After using the problem-based learning model in learning activities, students are quite able to identify the questions in the question correctly and choose the right way to solve the problem. For example, in the results of S1 work, students successfully multiply the number 2 by the variables and numbers in parentheses, then move the number from the right segment to the left segment (move segments) to convert the equation into a general form of quadratic equation. Once it becomes a general form, students can easily add up grades a, b, and c. From this it can be concluded that S1 is able to analyze the problem carefully and choose the right way to solve it. This is in line with research conducted by Wahyuni et al (2017) which revealed that the problem-based learning model has an influence on students' mathematical critical thinking skills. Please note that this research has differences with previous research, one of which is a difference in research methods.

c. Evaluation

In figure 3, you can see the work of one of the students which shows a significant influence on students' mathematical critical thinking skills in solving problems after participating in learning using the problem-based learning model. This can be analyzed from the results of student answers, where S9 successfully completed the calculation of questions correctly and precisely using factoring. In addition, the S9 is also meticulous in its work so that the calculation results are correct. This is also in line with research Ulfah (2014) which shows that the application of problem-based learning models in mathematics learning has provided significant positive changes in students' critical and logical thinking skills, as seen from the striking percentage increase in students' critical thinking skills before and after applying problem-based learning. Please note that this research has differences with previous research, one of which is in the use of the type of research conducted.

d. Inference

Figure 4 shows one of the results of student work after participating in learning using a problem-based learning model. In doing the questions, students are able to make conclusions correctly and precisely according to the context of the problem. This is evident from the results of S6's work on question number 4, where S6 uses the discriminant formula ($b^2 - 4ac$) to determine the workmanship solution. S6 substitutes the values a, b, and c of the quadratic equation and gets a discriminant (D) of 37. With full understanding, S6 concludes that the quadratic equation has different real roots, not twin real roots, because $37 > 0$. The answer shows that S6 is able to conclude the results correctly and precisely, even carefully in understanding the question commands. The results of this analysis prove that the use of problem-based learning models can encourage students to improve critical thinking skills. This is in line with research conducted by Prihono & Khasanah (2020) which revealed that the problem-based learning model has a very significant influence in improving students' critical thinking skills. Please note that this research has differences with previous research, one of which is in the use of the type of research conducted.

CONCLUSION

Based on the results of research that has been carried out, it can be concluded that the mathematical critical thinking skills of students at SMPN 3 Cimahi have improved significantly during learning activities. Before applying learning with a problem-based learning model, students' mathematical critical thinking skills in solving math problems showed a low level. However, after applying the problem-based learning model, students are able to think critically mathematically in solving mathematical problems correctly and

precisely. In addition, students are more careful in understanding information from the questions given and are able to apply mathematical concepts better. This can provide a clear picture of improving students' mathematical critical thinking skills after using problem-based learning models in learning activities.

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