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Improving Mathematical Critical Thinking Ability through Realistic Mathematics Learning in Junior High School Students

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ABSTRACT

Critical thinking is a structured way of thinking in making decisions and solving problems. Due to the presumption that the critical thinking ability in junior high school students was low, realistic mathematics learning is considered to be able to improve students' critical thinking ability. The purpose of the research in this article was to describe the improvement of mathematical critical thinking ability through realistic mathematics learning reviewed from indicators and the averages increase each cycle. This type of research was Class Action Research that was carried out in 2 cycles. The research subjects consisted of mathematics teachers and 16 students of class VIII private Islamic Junior High School in Surakarta. The data analysis technique in this study was qualitative descriptive to identify students and teachers during the mathematics learning process. The results of student work, data analysis were done by giving a score on each indicator. Score 1 if correct and score 0 if wrong. The results showed that the application of realistic mathematics learning improved the ability to think critically of mathematics. The average increase in mathematical critical thinking ability was 23.75% in pre-cycle, 71.25% in cycle I, and 85% in cycle II. It is concluded that mathematical critical thinking ability can improve through realistic mathematics learning.

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INTRODUCTION

Education has the most important position in increasing human resources. Education is a way of transferring knowledge from one person to another by establishing standards, thus, the process of techniques and style of teaching and learning are needed (Lamichhane, 2018; Siagian, 2006). In general, education is a real and structured effort to build learning situations and active learning processes. Education aims to extends the ability of students to believe in Almighty God, good manners, healthy, educated, skilled, imaginative, independent, democratic citizens, and responsibilities.

In national education, mathematics is used as one of the core subjects at all levels of education. Based on PERMENDIKNAS Number 22 of 2006, the goals of mathematics learning in school are 1) mastering mathematical design, describe the implications of inter-designs, and running designs or algorithms in an elegant, careful, practical, and correct way in solving problems; 2) utilizing logic in models and features, doing mathematical tricks in creating levelling, designing information, or describe mathematical ideas and explanations; 3) solving problems which encompass competence in mastering problems, compiling mathematical models, working on models, and describing the solutions obtained, 4) expressing ideas with symbols, tables, diagrams, or other instruments to describe problems, and 5)

having good behaviour respect the benefits of mathematics in life, namely having curiosity, interest, and interest in learning mathematics, as well as active and confident behaviour in solving problems.

Looking the purpose of PERMENDIKNAS Number 22 of 2006, mathematics learning mainly depends on thinking ability, especially mathematical critical thinking, in order to be able to overcome some of the abstract mathematics learning problems. For students of junior high school, abstract material is difficult to accept because students cannot just imagine it. Therefore, concrete objects are indispensable in the learning of mathematics. However, they are also need to be introduced to semi-concrete objects from junior high school age so that students' thinking is more open to abstract material.

A person is said to have experienced a learning process if there has been a change in himself, from not knowing to knowing, from not understanding to understanding, from not being able to be able, and so on (Leon & Schaap, 2020; Shemshack & Spector, 2020). The end of the learning process is the learning outcomes achieved by students. The results of learning mathematics are very important for every unit of education because it greatly affects the success of schooling at every level of the education unit. However, in Indonesia, the results of learning mathematics tend to be low at almost every level of education. The low results of learning mathematics show that the quality of education in Indonesia is still relatively low and unsatisfactory, thus the success of education has not been complete achieved.

The factors that affect the low learning outcomes of mathematics in students is the mathematical critical thinking ability which has not been fully mastered by students. The mathematical critical thinking ability in students from the past until now has not been accustomed to schools. The teacher has not been optimal in guiding students to think critically about a problem. In solving mathematical problems, students only think superficially, so that in answering a problem they do not pay attention to mathematical processes and concepts. This mathematical critical thinking ability must be improved so that students find it easier to solve problems when they understand the concept.

Based on observations and interviews with Mathematics teachers in eighth grade at private Islamic Junior High School in Surakarta, it was concluded that students mathematical critical thinking ability were low. Critical thinking is reasoning about beliefs or reasonable actions, centered on establishing what is believed or done (Ennis, 1996). Critical thinking is a process of coming to conclusions that can be learned and applied in different contexts (Dwyer, 2017; Lamont, 2020). Critical thinking is a structured way of thinking in making decisions and solving problems. The low ability to think critically can be seen from the indicator. According to Ennis (1996), critical thinking indicators are as follows: 1) Can formulate the points of the problem (31,25%); 2) can clarify the facts that are needed to solve the problem (31,25%); 3) can select logical, relevant and accurate opinions (18,75%); 4) can recognize answers based on different perspectives (18,75%); 5) can judge the outcome of statements made as decisions (18,75%).

At this junior high school level, students' mathematical critical thinking ability towards a mathematical problem can be started and directed little by little. To be able to improve the mathematical critical thinking ability, the learning process can utilize learning models that appeal to students. However, based on the information obtained, many teachers do not know the models of mathematics learning. Learning model is an abstract framework that describes structured learning steps to process student learning knowledge so that certain learning objectives are expected to be met (Suprihatiningrum, 2013, p.145). In general, the learning model is the entire arrangement of exposure to learning materials consisting of all aspects both before, during, and after the teacher's learning, as well as all related facilities that are used directly or indirectly in the teaching and learning process.

Mathematics itself has many learning models such as problem-based learning models, discovery learning, project-based learning, inquiry learning, constructivism learning, and others. In this case, realistic mathematics learning is considered to improve mathematical critical thinking ability in students (Dolapcioglu & Doğanay, 2022; Dolapcioglu et al., 2015; Nasrulloh & Amin, 2022). The ability to think critically will encourage students to their curiosity and be able to arrange the truth in desperate conditions so that it will improve the students' mathematical ability.

Realistic mathematics learning is a learning based on every day (contextual) problems as a source of ideas in the formation and application of mathematical concepts. Realistic mathematics learning is real activities carried out in everyday life based on the application of mathematics (Pratiwi & Widjajanti, 2020). The steps of realistic mathematics learning are four: 1) Understand contextual

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issues; 2) solve contextual issues; 3) compare and discuss answers; and 4) conclusions (Fitrah, 2016, p.97).

Applications of realistic mathematics learning, students are required to be able to explain the concepts used and give reasons correctly, find concepts and show supporting evidence for generalizations correctly, choose important information and choose the correct strategy in solving it and doing calculations, and correcting errors by correct and explain properly. In realistic mathematics learning, students are expected to be able to improve students' thinking ability optimally, especially mathematical critical thinking ability (Cahyaningsih & Nahdi, 2021; Dhayanti et al., 2018; Dolapcioglu & Doğanay, 2022; Laurens et al., 2017; Soedjana, 1986).

The research results of Lisa (2018) concluded that students who used realistic mathematics learning had better critical thinking ability than those who used conventional learning. Learning approaches and early mathematical ability to improve critical thinking ability had no interaction. The research results of Delina et al., (2018) concluded that students who used realistic mathematics learning had better critical thinking ability and self confidence than those who used conventional learning. The research results of Sholihah & Rejeki (2020) concluded that the critical thinking ability in each indicators increased in cycle I and cycle II, and that learning outcomes that met the minimum completion criteria increased in cycle I and cycle II. Therefore, realistic mathematics learning approach can improve students' critical thinking ability and learning outcomes in mathematics.

The research results of Asiyah et al., (2021) concluded that the results of the validity of enhanced learning devices and critical thinking skills in categories were valid. The effectiveness of learning devices met effective standards with a minimum learning completion criteria achievement with percentage of 86.1 %. Student activity and liveliness met established standards, and student response to learning devices was in the good category. Students from cycle I to cycle II improved their critical thinking skills by an average of 0.34 and the minimum completion standard for their studies improved by 17.35 %. The research results of Ulaimi et al., (2021) concluded that the mathematical critical thinking ability of Junior High School Dewantara 1 students on cube and beam materials taught with the Realistic Mathematics Education approach in the experimental class were better than students who were taught with conventional learning in control classes.

The results of previous research tended not to be able to answer the problem of mathematical critical thinking ability in junior high school students in the eighth grade optimally. Related to the analysis described, the alternative solution offered is to improve mathematical critical thinking ability through realistic mathematics learning for eighth grade Junior High School students. Based on that, the purpose of the research in this article is to describe the improvement of mathematical critical thinking ability through realistic mathematics learning reviewed from indicators of critical thinking and averages increase in pre-cycle, cycle I, and cycle II.

METHOD

Research type and design

The type of research was Action Research and the research design was a Class Action Research (CAR). This Class Action Research was carried out in 2 cycles. Each cycle consisted of 2 meetings with four stages, namely: planning, action, observation, and reflection.

Research location and time

The research was conducted on students of class VIII semester 1 of a private Islamic Junior High School in Surakarta in the academic year 2021. The research was conducted in approximately 6 months for preparation, data collection, writing article, and reports. The target of this research was the ability to think critically in mathematics which was increased through realistic mathematics learning.

Research subject and object

The research subjects consisted of Mathematics teachers and 16 students of class VIII private Islamic Junior High School in Surakarta, consisting of 10 female students and 6 male students. The objects of this research were the students mathematical critical thinking ability and realistic mathematics learning models. Indicators of critical thinking ability were formulated to the points of the problem; clarified the facts needed to solve the problem; selected logical, relevant and accurate opinions;

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recognized answers based on different perspectives; and judged the outcome of statements made as decisions.

Data and data sources

The types of data in this study were the process of learning mathematics, mathematical critical thinking ability, and data on the work of the eighth grade. The data source was obtained from teachers, students, and answer sheets containing the results of the math description test results of students of class VIII private Islamic Junior High School in Surakarta.

Data collections

The data collection techniques in this study were interviews, documentation, and tests. The interview was conducted with the teacher of Mathematics subject in class VIII private Islamic Junior High School in Surakarta to find out the students' mathematical critical thinking ability. Documentation was recorded during classroom activity. The test was done in written form in the form of a description to measured mathematical critical thinking ability.

Research instrument

The research instrument was used to make it easier to collect data. The instrument used in this study were observation sheets, field note sheets, and written tests. The observation sheets consisted of the implementation of realistic mathematics learning which contained about whether or not each aspect of learning was included in realistic mathematics learning. The field note sheets were used to record important information about the act of teaching and learning during the learning process. The observation sheets and field notes sheets were used for two cycles. The written tests consisted of written test cycle I and cycle II. This written test consisted of 1 description question which was used to determine students mathematical critical thinking ability. The test must be completed by following the indicators of mathematical critical thinking ability, namely 1) Can formulate the points of the problem; 2) can clarify the facts that were needed to solve the problem; 3) can select logical, relevant and accurate opinions; 4) can recognize answers based on different perspectives; 5) Can judge the outcome of statements made as decisions.

The validity and reliability in this study used sources and methods. Source of the study was the data that was taken from 2 contra sources, which were teacher and students. Method was the data that was taken from 2 methods, namely interviews and observation. Based on the data obtained, the research instruments were said to be reliable and valid.

Research procedure

Cycle I of research procedures at the planning stage were compiled as Learning Implementation Plan and mathematics learning materials, observation sheets, field note sheets, written tests, and assessment guidelines. The action stage, doing mathematics learning according to realistic mathematics learning steps, namely understood contextual issues; solved contextual issues; compared and discussed answers; and stated conclusions. The observation stage, noting whether or not each aspect of the implementation of realistic mathematic learning was achieved in accordance with the observation sheets, and the process of recording important things about the act of teaching and learning on the field note sheets then gave written test for students were very much included. The reflection stage consisted of evaluating based on observation sheets, field note sheets, and written tests. Then, the final stage was maximized realistic mathematic learning in cycle II.

In Cycle II, the research procedure was the same as cycle I. The planning stage were compiled as Learning Implementation Plan and mathematics learning materials, observation sheets, field note sheets, written tests, and assessment guidelines. The action stage consisted of doing mathematics learning according to realistic mathematics learning steps, namely understood contextual issues; solved contextual issues; compared and discussed answers; and stated conclusions. The observation stage, noting whether or not each aspect of the implementation of realistic mathematic learning was achieved in accordance with the observation sheets, and the process of recording important things about the act of teaching and learning on the field note sheets then gave written test for students were very much included. The reflection stage consisted of evaluating based on observation sheets, field note sheets, and written tests. Then, compared the initial conditions or pre-cycle with the result of written tests in cycle I and cycle II, whether there was an increase or not.

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Data analysis

The data analysis technique in this study was qualitative descriptive to identify students and teachers during the mathematics learning process. The results of student work, data analysis were done by giving a score on each indicator. Score 1 if correct and score 0 if wrong. Percentage formula of each indicator is as follows:

Percentage of Critical Thinking Indicators $= \frac{Number\ of\ Correct\ Answers}{Total\ Number\ of\ Students}\ x\ 100\%$

RESULT AND DISCUSSION

The action research was carried out in two cycles, which began with interviews and observations with Mathematics teachers of class VIII private Islamic Junior High School in Surakarta. The goal was to find out the initial conditions about the mathematics learning process and the students mathematical critical thinking ability. The results of the interview and observation were: mathematical critical thinking ability of the students was low, and the mathematics learning process was accomplished via way of lectures and discussions together.

In cycle I of the classroom action research planning stage, researchers drew up about 1) Learning Implementation Plan (LIP) I, 2) learning materials of Linear Equation of Two Variables, System of Linear Equation of Two Variables, and Graph Solving Method, 3) written tests I, and 4) written test assessment guidelines I. The Learning Implementation Plan (LIP) I was prepared for one cycle consisted of two meetings. The instruments were field notes sheet I and observation guidelines sheet I. The action and observation phase of the first meeting cycle was held on Wednesday, November 17, 2021.

Action was given by applied Realistic Mathematics Learning to the learning of mathematical chapter of "Linear Equation of Two Variables", sub-chapter of Linear Equation of Two Variables, System of Linear Equation of Two Variables, and Graph Solving Method according to (Fitrah (2016, p.97). The first step was to understand contextual issues. Researchers provided contextual issues, then asked students to understand the issues. The second step was to solved contextual issues. The researcher explained the issues and the steps of its completion, then asked the student to resolve it individually. The third step was to compare and discuss the answers. Students were asked to compare and discuss work outcomes with other students. The fourth step was to conclude. Students were directed to draw conclusions related to such contextual issues. The written test was conducted on Thursday, November 18, 2021, at the second meeting.

Observations were made according to the observation guidelines sheet I and important things were recorded in the field notes sheet I. The reflection stage, based on the observations that take place that the realistic mathematics learning process had not been maximized. Test results obtained from written tests were not on target. The students' mathematical critical thinking ability had not increased optimally. Thus, the results in cycle I can be used as a guide to improve the learning process in cycle II

In cycle II, class action research was conducted just like a cycle I. The planning stage, researchers draw up 1) Learning Implementation Plan (LIP) II, 2) learning materials of Substitution Solving Method, Elimination Solving Method, and Mixed Solving Method (Elimination-Substitution), 3) written tests II, and 4) written test assessment of guidelines II. The Learning Implementation Plan (LIP) II was prepared for one cycle consisted of two meetings. The instruments used were field notes sheet II and observation guidelines sheet II. The action and observation phase of the first meeting cycle was held on Wednesday, November 24, 2021.

Action was given by applied Realistic Mathematics Learning to the learning of mathematical chapter of "Linear Equation of Two Variables", sub-chapter of Substitution Solving Method, Elimination Solving Method, and Mixed Solving Method (Elimination-Substitution), and this is according to Fitrah (2016, p.97). The first step was to understand contextual issues. Researchers provided contextual issues, then asked students to understand the issues. The second step is to solve contextual issues. The researcher explained the issues and the steps of its completion, then asked the student to resolve it individually. The third step was to compare and discuss the answers. Students were asked to compare and discuss work outcomes with other students. The fourth step was to conclude. Students were directed to draw conclusions related to such contextual issues. The written test was conducted on Thursday, November 25, 2021, at the second meeting.

Observations were made according to the observation guidelines in sheet II and important things were recorded in the field notes of sheet II. In cycle II, researchers saw differences with cycle I, where

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in this cycle students were used to doing realistic mathematics learning. In cycle II of the reflection stage, based on observations, it appeared that the realistic mathematics learning process had been maximized. The test results obtained from the written test matched the target. The students' mathematical critical thinking ability in cycle II had increased optimally.

Based on the analysis of data from written tests that were given on cycle I and cycle II, it could be known that students' mathematical critical thinking ability had improved. The improvement of students' mathematical critical thinking ability can be seen in Figure 1:

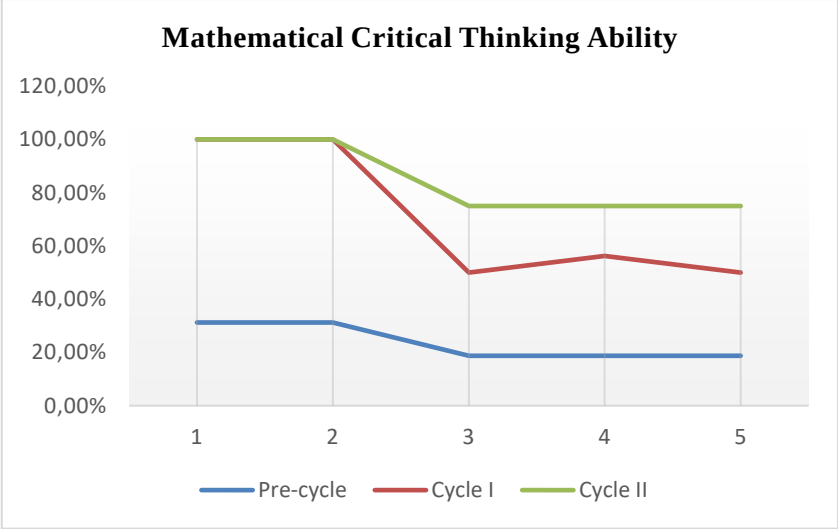

Figure 1. Improving Mathematical Critical Thinking Ability

Indicators of critical thinking ability by Ennis (1996) consisted of 1) Can formulate the points of the problem, 2) can clarify the facts that are needed to solve the problem, 3) can select logical, relevant and accurate opinions, 4) Can recognize answers based on different perspectives, 5) can judge the outcome of statements made as decisions. Based on these data, indicators of critical thinking ability descriptively are described as follows:

1) Formulate the problem point

This indicator is seen from the ability of students in formulating and writing what was known from a problem. Example of students' ability to formulate the problem points is shown in Figure 2.:

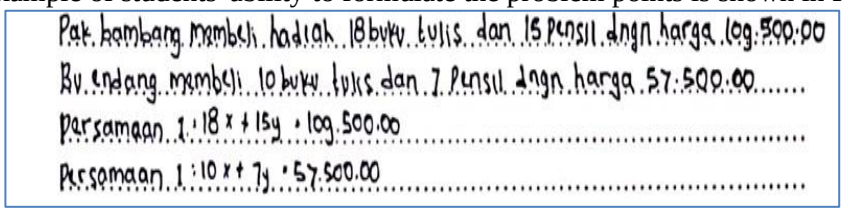

Figure 2. The Ability to Formulate the Points of the Problem

Translate:
Mr. Bambang bought a gift consisted of 18 notebooks and 15 pencils for Rp. 109.500.-
Mrs. Endang bought 10 notebooks and 7 pencils for Rp. 57.500.-
Equation 1: 18x + 15y = 109.500
Equation 2: 10x + 7y = 57.500

Based on Figure 2. from the answer, it can be seen that students could formulate the problem points well. Students could write down information about the problems that was presented. On this indicator, all students could formulate and write down information that was known properly and correctly.

2) Clarify the facts that are needed

This indicator can be seen from the ability of students in determining the strategies to be used to solve problems. Example of students' ability to clarify the facts that were needed is shown in Figure 3.:

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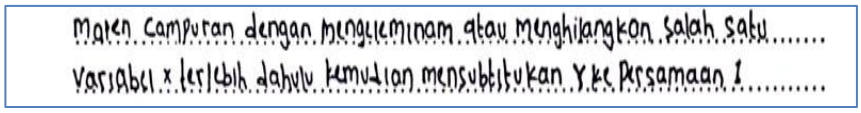

Figure 3. The Ability to Clarify the Facts that were Needed to Solve the Problem

Translate:
Mixed the material by eliminating one of the x variables first and then substituting y into equation 1

Based on Figure 3. from the answer, it shows that students could clarify the facts that were needed well. Students could determine the strategies that needed to be used to solve the problems that were presented. In this indicator, all students could determine the problem-solving strategy properly and correctly because it was the same as the example that had been given before.

3) Select logical, relevant, and accurate opinions

This indicator can be seen from the ability of students to solve problems using the strategies that had been determined in indicator two. Example of students' ability to select logical, relevant, and accurate opinions is shown in Figure 4.:

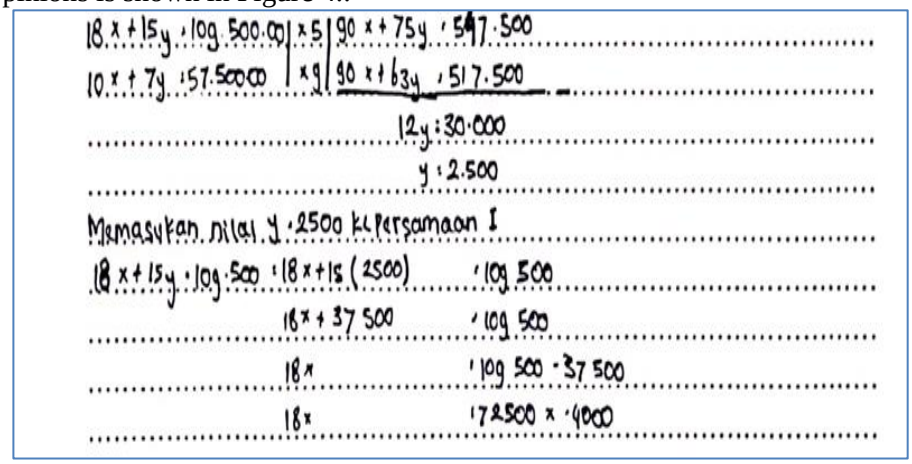

Figure 4. The Ability to Select Logical, Relevant, and Accurate Opinions

Translate :

18x + 15y = 109.500 | x 5 | 90x + 75y = 547.500
10x + 7y = 57.500 | x 9 | 90x + 63y = 517.500 -
12y = 30.000
y = 2.500

Substituting the value of y = 2.500 into equation 1

18x + 15y = 109.500
18x + 15(2.500) = 109.500
18x + 37.500 = 109.500
18x = 109.500 - 37.500
18x = 72.000
x = 4.000

Based on Figure 4. from the answers, it shows that students could select logical, relevant, and accurate opinions well. Students can solve the problems presented by the strategies that had been determined in indicator two. On this indicator, students' answers varied. Some students could get it done correctly, but some students finished wrong.

4) Recognize answers based on different perspective

This indicator is seen from the ability of students to solve problems with different strategies so that the same results were obtained. Example of students' ability to recognize answers based on different perspectives is shown in Figure 5.:

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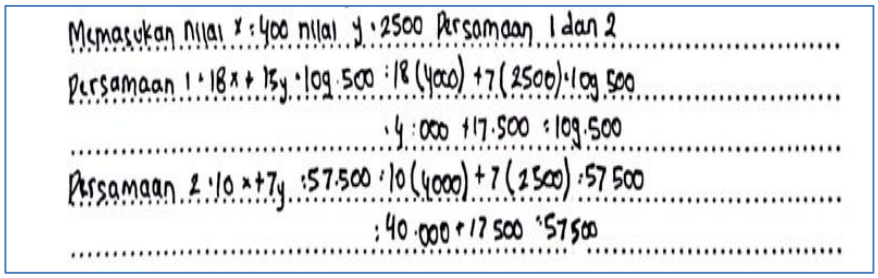

Figure 5. The Ability to Recognize Answers based on Different Perspective

Translate :
Substituting the value of x = 4.000 and y = 2.500 into equation 1 and 2
Equation 1 : 18x + 15y = 109.500 => 18(4.000) + 15(2.500) = 109.500
72.000 + 57.500 = 109.500 (Correct)
Equation 2 : 10x + 7y = 109.500 => 10(4.000) + 7(2.500) = 57.500
40.000 + 17.500 = 57.500 (Correct)

Based on Figure 5. from the answer, it shows that students could recognize answers based on different perspective well. Students could solve problems with different strategies, namely substitution, and got the same results as indicator three. On this indicator, students' answers varied. Some students could get it done correctly, but some students finished wrong.

5) Judge the outcome of statements made as decisions

This indicator can be from the ability of students to judge the outcome of statements made as decisions. Example of a students' ability to judge the outcome of statements made as decisions is shown in Figure 6.:

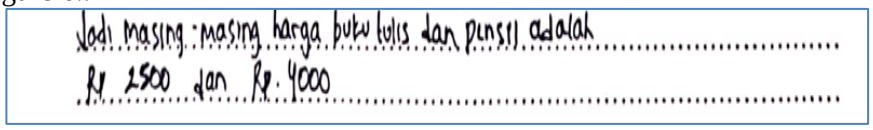

Figure 6. The Ability to Judge the Outcome of Statements Made as Decisions

Translate:
So, the price of notebooks and pencils are Rp 4.000,00 and Rp 2.500

Based on Figure 6. from the answer, it shows that students could determine the outcome of the statement taken as a decision well. Students could make decisions or conclusions from the problems presented. On this indicator, students' answers varied. Some students could get it done correctly, but some students finished wrong. Students answered incorrectly because indicators three and four of the students' answers were not correct.

After the realistic mathematics learning was applied and the description test was given to students of class VIII private Islamic Junior High School in Surakarta, the ability to think critically mathematically had improved. Improving mathematical critical thinking ability is presented in Table 1.

Table 1. Improving Mathematical Critical Thinking Ability

Indicator	Pre-cycle	Cycle I	Cycle II
Formulate the points of the problem	31.25 %	100 %	100 %
Clarify the facts needed to solved the problem	31.25 %	100 %	100 %
Select logical, relevant, and accurated opinions	18.75 %	50 %	75 %
Recognize answers based on different perspectives	18.75 %	56.25 %	75 %
Judge the outcome of statements made as decisions	18.75 %	50 %	75 %
Average	**23.75 %**	**71.25 %**	**85 %**

The results of this classroom action research , the realistic mathematics learning process was in a accoradance with the learning steps. The first step was to understand contextual issues. Researchers

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provided contextual issues, then asked students to understand the issues. The second step was to solve contextual issues. The researcher explained the issues and the steps of its completion, then asked the students to resolve it individually. The third step was to compare and discuss the answers. Students were asked to compare and discuss work outcomes with other students. The fourth step was to conclusion. Students were directed to draw conclusions relating to such contextual issues.

The result of this classroom action research by applying realistic mathematics learning was the increase in mathematical critical thinking ability in class VIII of private Islamic Junior High School in Surakarta was very significant. The increase in mathematical critical thinking ability from before the action until the action was taken can be seen based on the indicators of mathematical critical thinking ability as follow :

1) Can formulate the points of the problem

   The ability of students in formulating the point of the problem had increased, from before being given action 31.25 % after being given the action in cycle I 100 % and cycle II 100 %. This can be seen from the ability of students in formulating and writing what was known from a problem.

   This is accordance with research conducted by (Liberna et al., 2015) which stated that everyone must be active in understanding and formulating all available information.

2) Can clarify the facts needs to solve the problem

   The ability of students in clarifying the facts that were needed to solve the problem had increased from before being given action 31.25 % after being given the action in cycle I 100 % and cycle II 100%. This can be seen from the ability of students in determining the strategies to be used to solve problems.

   This is accordance with research conducted by (Liberna et al., 2015) which stated that everyone has problem to solves, so they have to think of strategies or steps to solves the problem.

3) Can select logical, relevant and accurate opinions

   The ability of students in selecting logical, relevant and accurate opinions had increased from before being given action 18.75 % after being given the action in cycle I 50 % and cycle II 75 %. This can be seen from the ability of students to solve problems using the strategies that have been determine in indicator two.

   This is accordance with research conducted by (Setiawan, 2015) which stated that in solving problems one must look for relevant reasons in a systematic and orderly manner.

4) Can recognize answers based on different perspectives

   The ability of students in recognizing answers based on different perspectives had increased from before being given action 18.75 % after being given the action in cycle I 56.25 % and cycle II 75 %. This can be seen from the ability of students to solve problems with different strategies so that the same results are obtains.

   This is accordance with research conducted by (Setiawan, 2015) which stated that in solving problems one must look for other alternatives as much as possible to solve the problems.

5) Can judge the outcome of statements made as decisions

   The ability of students in judging the outcome of statements made as decisions had increased from before being given action 18.75 % after being given the action in cycle I 50 % and cycle II 75 %. This can seen from the ability of students to judge the outcome of statements made as decisions.

   This is accordance with research conducted by (Delina et al., 2018) which stated that receiving a statement from the process that underlies the problem.

CONCLUSION

The result of research on students of class VIII private Islamic Junior High School in Surakarta was: by applying realistic mathematics learning, students' mathematical critical thinking ability was improved. Actions were given according to realistic mathematics learning steps which were consisted of understanding contextual issues, solving contextual issues, comparing and discuss answers, and stating conclusion.

Based on the analysis of data, each indicator of mathematical critical thinking ability obtained the result that the ability to formulate the points of the problem increased from 31.25% (5 students) to 100% (16 students) in cycle I and 100% (16 students) in cycle II. The ability to clarify the facts that were needed to solve the problem had increased from 31.25% (5 students) to 100% (16 students) in cycle I

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

and 100% (16 students) in cycle II. The ability to select logical, relevant, and accurate discussions increased from 18.75% (3 students) to 50% (8 students) in cycle I and 75% (12 students) in cycle II. The ability to recognize answers based on different perspectives increased from 18.75% (3 students) to 56.25% (9 students) in cycle I and 75% (12 students) in cycle II. The ability to judge the outcome of statements that made as decision increased from 18.75% (3 students) to 50% (8 students) in cycle I and 75% (12 students) in cycle II. The average increase in mathematical critical thinking was 23.75% in pre-cycle, 71.25% in cycle I, and 85% in cycle II.

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