

Open-Ended Question Solving Ability Based on Mathematical Creative Thinking Disposition

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ABSTRACT

The purpose of this study is to determine the level of mathematical thinking and find out the problem solving skills on open questions based on the differences in mathematical creative thinking dispositions. This study used descriptive qualitative analysis to obtain a clear insight of the facts and phenomena studied. The students of class XI IPA MAN 1 Cirebon as subjects of the study. The researcher found that problem solving skill divided three level: 9% of students have a high level of mathematical problem solving skill, 82% of students have middle level of mathematical problem solving skill, and 9% of students have a low level of mathematical problem solving skill. Students with high level of mathematical creative thinking disposition understood the problem well, makes and carrying a settlement plan, and re-examining the process and results. A middle level of mathematical creative thinking understood the problem well, but mostly they are less able to make and implement a complete plan, and do not fully examining the process and results. Students with the low disposition level of mathematical creative thinking, mostly they understood the problem. Whereas they cannot make and carried out the plan correctly, and they do not re-examining the process and results.

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1. INTRODUCTION

In the educational process, mathematics is an important subject, as well as being a source of other knowledge. There are a number of sciences whose discoveries and developments originate from mathematics (Akbar & et al, 2018). Based on Minister of Education and Culture Regulation No. 59 of 2014, it is explained that one of the objectives of learning mathematics in schools is so that students are able to understand mathematical concepts, namely explaining the relationships between concepts

and using concepts and algorithms, flexibly, accurately, efficiently and precisely in solving problems. This shows that mathematics learning does not only aim at improving student learning outcomes, but also aims at improving problem solving abilities. Thus, mathematics lessons can develop thinking abilities.

In the mathematics learning process, students can develop their mathematical creative thinking abilities, namely when students solve mathematical problems creatively. Creativity arises because of strong motivation within the individual. This shows that apart from cognitive factors that influence creative growth, affective factors are also ones that influence the growth of creativity. These affective factors are referred to as mathematical creative thinking dispositions. The disposition to think creatively in mathematics is the awareness, desire, tendency and strong contribution for students to think and act creatively in a positive way (Herlina, 2013).

Lack of affective aspects, in this case the disposition to think creatively in mathematics, can hinder the problem solving process related to mathematics and other fields (Dania & et al, 2019). Therefore, students who have the disposition to think creatively mathematically will have a positive attitude during the learning process. The attitude of students who have a creative mathematical thinking disposition will be seen from several aspects, namely fluency, original thinking skills, flexible thinking skills, elaboration skills, evaluating skills, curiosity, feeling challenged. by diversity, respect, imagination, the ability to dare to take risks (Herlina, 2013).

Basically, the ability to think creatively is an essential ability that students need to have and develop when studying mathematics, because it is a supporting factor in the ability to think creatively in mathematics (Sumarmo, 2013). However, the fact is that in secondary schools it appears that the disposition to think creatively in mathematics is still low (Nurhalimah, 2016). This can be seen from students' lack of interest in solving mathematical problems, such as low curiosity, lack of imagination, not daring to take risks to be more creative when solving mathematical problems, especially if the questions given are different in form from those exemplified by the teacher. With the disposition to think creatively mathematically, students are able to persist when facing problems, take responsibility and do good work in learning mathematics.

In the 21st century, problem solving ability is one of the important competencies that students have, not only in mathematics but also in other fields or in everyday life. Problem solving abilities can develop thinking abilities. This is because students will think creatively and have an attitude of never giving up in finding the best solution to the problems they face. Problem solving ability is an intellectual activity to find solutions to the problems faced which involves knowledge and experience (Maemunah & et al, 2016).

The results of a survey conducted by PISA in 2018 showed that Indonesian students' problem-solving abilities were still low. Indonesia is ranked 73rd out of 78 countries with an average score of 379. In fact, in the educational process students' abilities are sharpened through the problem solving process, so that students can improve the various skills they have. These skills are related to the skills of obtaining appropriate information, analyzing information, and realizing how important it is to re-check the results that have been obtained (Cahyani & Setyawati, 2016).

The low ability to solve mathematical problems is caused by students not being used to solving challenging non-routine problems and honing creative thinking skills. Apart from that, according to Mariam & et al (2019), the mathematics learning process tends to be based on one textbook with conventional learning stages, so that when students are faced with they will have difficulty solving different problems (Mariam, 2019). Most students can only solve problems if the questions given are similar to the examples explained by the teacher. This is because they rely on formulas, not concepts, one of which is in the circle equation material, students are confused about understanding the meaning of the question and determining the formula to use. Students are only experts at remembering and doing basic things so that students' thinking abilities are less developed, while students' thinking abilities can develop through challenging situations and problems.

Another thing that influences the process of solving mathematical problems is the type of questions used. Providing closed types of questions is considered not optimal for developing students' mathematical creative thinking abilities. Nisa & et al (2019) in their research explain that open ended questions are considered capable of having an influence on students' problem solving abilities, students will express original knowledge from the results of thinking based on what they know and understand in solving the questions.

If there are problems that are solved directly using formulas and tend to use procedural concepts, many students do not use their own methods, as a result problem solving only emphasizes the results, not the students' creative thinking processes (Priyono, 2017). Therefore, it is also necessary to provide open ended question types. The open ended question type is a question that can be solved using several methods or solving strategies. Using open ended questions gives students the opportunity to solve problems using various strategies through their thinking abilities, in this case the problem solving process can help students to develop their creative thinking abilities.

Based on the problems above, it is necessary to carry out further studies to find out how problem solving abilities are based on differences in students' mathematical creative thinking dispositions (MCTD) who focus on circle equation material with open ended question types. Thus, the aim of this research is to determine the MCTD level of MAN 1 Cirebon City students and to determine the description of the mathematical problem solving abilities of MAN 1 Cirebon City students on open ended questions based on differences in MCTD.

2. METHOD

This research uses a qualitative approach, as for the method used is descriptive. According to Nawawi (2015) the descriptive method is a way of solving problems that are investigated by describing the current condition of the subject or object of research (society, person, institution) as it is or based on visible facts. In descriptive research, it does not provide treatment and regulation of external variables. In this study, researchers carried out an analysis in the form of a description of problem-solving abilities on open-ended questions with a focus on circular equations based on differences in creative mathematical thinking dispositions in class XI students. The description carried out is to provide an overview of problem solving abilities based on the Polya stages which are reviewed based on differences in students' creative thinking dispositions.

The research was conducted at MAN 1 Cirebon City and carried out in even semesters. The population in this study was all classes XI Science, while the sample in this study was XI Science 1 MAN Kota 1 Cirebon, sampling was based on purposive sampling. The research stages are as follows: 1) distribution of the MCTD questionnaire; 2) giving a problem solving ability test on open ended questions; 3) interview; 4) qualitative data analysis; 5) drawing conclusions. The instruments used in the research are questionnaire sheets, test sheets and interview guides which have been tested and validated by experts.

In this research, the data collection techniques used were test and non-test. The test technique is the implementation of an assessment by asking a number of questions that need to be answered correctly by the respondent. This test method aims to determine students' problem solving abilities. The results of these answers will be analyzed based on the problem solving stages based on Polya (Argarini, 2018), with the stages as follows as shown in table 1.

Table 1. Stages of Problem Solving According to Polya

Stages of problem solving	Indicators
Understand The Problem	Subjects can understand what is known and what is asked in the questions given
Devise a plan	Subjects can choose the method/formula that can be used to solve the problem given
Carry out the plan	Subjects are able to use strategies/methods that have been planned to solve the questions given
Looking back	The subject checks again to ensure the accuracy of the answers they have obtained when solving the questions

Non-test techniques in the form of questionnaires and interviews. A questionnaire is a data collection technique by providing written questions which are answered in writing by respondents (Hardani, et al., 2020). This questionnaire/questioner is used to determine differences in students' mathematical creative thinking dispositions. The questionnaire is structured based on questions that contain indicators of the disposition to think creatively in mathematics. Meanwhile, an interview is a question and answer activity between two people to exchange information and ideas, so that the

meaning of a particular object can be found (Sugiyono, 2012). The guidelines for questions during interviews in this research are questions regarding problem solving in mathematics and students' mathematical creative thinking dispositions.

Next, the data was analyzed using data analysis techniques according to Miles and Huberman (Lestari, 2020). The data analysis technique is carried out in three stages, namely data collection, data reduction and drawing conclusions.

3. RESULT AND DISCUSSION

Data on students' mathematical creative thinking disposition was obtained from filling out a questionnaire totaling 30 items that were suitable for use based on expert validation results. Based on the scores obtained, students are then grouped according to their level of creative thinking disposition. The grouping of students' mathematical creative thinking dispositions can be seen in Figure 1.

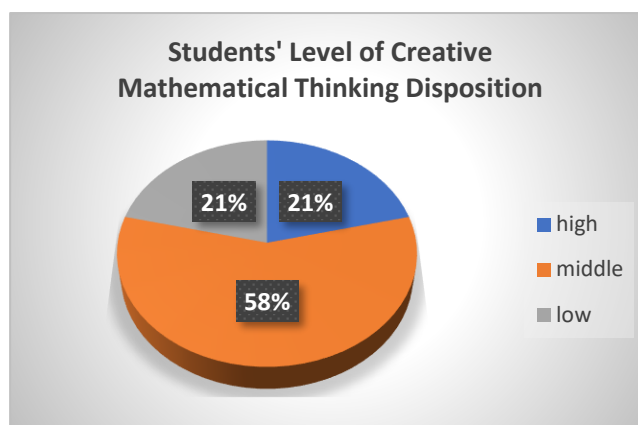


Figure 1. Students' Level of Creative Mathematical Thinking Disposition

Based on Figure 1 above, it is explained that students in class having a low level of mathematical creative thinking disposition amounted to 7 students or 21%. Thus, it can be seen that students in class XI IPA 1 MAN Cirebon City are dominated by students who have a moderate level of mathematical creative thinking disposition.

The problem solving abilities in the high category open ended questions amounted to 3 students or 9%. There were 27 students who had problem solving abilities in the moderate category of open ended questions or 82%. There were 3 students who had problem solving abilities in the low category of open ended questions or 9%.

Students who fall into the high, low and medium Creative Mathematical Thinking Disposition (CMTD) categories are analyzed for their mathematical problem solving abilities. The selection of research subjects from each category is as follows.

Table 2. Research Subjects Based on Purposive Sampling

No.	Creative Mathematical Thinking Disposition		
	High	Medium	Low
1	S6	S12	S10
2	S11	S27	S25
3	S22	S2	S3

Problem solving abilities in open ended questions based on the disposition to think creatively in mathematics are presented in table 3.

Table 3. Recap of Problem Solving Abilities in Each Student CMTD Category

CMTD Categories	Student Code	Question Number				
		1	2	3	4	5
High	S6	Less	Capable	Capable	Capable	Capable
	S11	Capable	Capable	Capable	Capable	Capable
	S22	Capable	Capable	Capable	Less	Less
Moderate	S12	Capable	Less	Capable	Incapable	Less
	S27	Capable	Less	Capable	Incapable	Less
	S2	Less	Capable	Capable	Incapable	Incapable
Low	S10	Less	Less	Capable	Incapable	Incapable
	S25	Incapable	Incapable	Incapable	Incapable	Incapable
	S3	Less	Incapable	Capable	Incapable	Incapable

Based on Table. 3, Mathematical problem solving ability in the high mathematical creative thinking disposition category is 80% capable and the remaining 20% less capable. Meanwhile, the ability to solve mathematical problems in the moderate mathematical creative thinking disposition category is 40% capable, 33% less capable and the remaining 27% incapable. Meanwhile, the ability to solve mathematical problems in the low mathematical creative thinking disposition category is 13% capable, 20% less capable and the remaining 67% incapable.

For examples of answers given for each CMTD category are shown as follows.

1. Persamaan lingkaran yang berpusat di $O(0,0)$ dinyatakan dengan $y = \sqrt{n-x^2}$. Nilai n adalah jari-jari dan merupakan salah satu akar persamaan $x^2 - 8x - 9 = 0$. Tentukan jari-jari lingkaran tersebut!

Jawab: $y = \sqrt{n-x^2}$
 $y^2 = n - x^2$
 $y^2 + x^2 = n$
 $x^2 + y^2 = r^2 \quad r^2 = n$

Dik: Pusat di $O(0,0)$
 $y = \sqrt{n-x^2}$
 Persamaan $x^2 - 8x - 9 = 0$
 Dit: Jari-jari?

$x^2 - 8x - 9 = 0$
 $(x-9)(x+1) = 0$
 $x = 9 \quad x = -1$
 $r^2 = 9 \quad r^2 = -1 \rightarrow$ tidak termaruk
 $r = \pm 3$ Jadi jari-jari lingkaran tersebut adalah 3

Figure 2. Answers of Students in the High CMTD Category

Based on Figure 2, can be explained by analysis of students' answers based on the High CMTD Category at stage (1) Understanding the Problem, the research subject wrote down what was known, namely the circle equation and quadratic equation, then also wrote down what was asked in the question, namely the radius of the circle. In this case, it can be predicted that the research subjects understand the questions well. (2) Making a plan, students restore the circle equation $y = \sqrt{n-x^2}$ to $x^2 + y^2 = n$, then factor the quadratic equation to find the value of n . In this case, it appears that students plan well. (3) Carrying out the plan, students square the right side and left side of the known circular equation, then factor the quadratic equation contained in the problem to find the value of n . After finding a satisfactory value of n , he calculated the radius of the circle. In this case, it appears that the students carried out the plan well. (4) Looking or Checking Again, students write back the final results of the calculations carried out, namely that the radius of the circle is 3. In this case, it is predicted that students will check the process and results again.

<input type="checkbox"/>	Dik : Pusat $(0,0)$ n : Jari-jari dan akar persamaan
<input type="checkbox"/>	$y = \sqrt{n-x^2}$ $x^2 - 8x - 9 = 0$
<input type="checkbox"/>	Dit : Jari-jari lingkaran ?
<input type="checkbox"/>	Jawab :
<input type="checkbox"/>	Persamaan kuadrat persamaan lingkaran
<input type="checkbox"/>	$x^2 - 8x - 9 = 0$ $y = \sqrt{n-x^2}$ $n = r^2$
<input type="checkbox"/>	$(x+1)(x-9) = 0$ $y^2 = n-x^2$ $n = 9$
<input type="checkbox"/>	$x = 1$ $x = 9$ (m) $x^2 + y^2 = n$ $r = \sqrt{9} = 3$
<input type="checkbox"/>	Jadi r adalah 3.

Figure 3. Answers of Students in the Moderate CMTD Category

Based on Figure 3, the analysis of students' answers in the moderate CMTD category, it shows that at stage (1) Understanding the Problem, Students wrote down completely what was known in the problem, namely the equation of the central circle $(0,0)$, $y = \sqrt{n-x^2}$ and the roots of the equation $x^2 - 8x - 9 = 0$, and n is the radius. Then he can write down what is asked in the question, namely the radius of the circle. In this case, students are predicted to be able to understand the problem well. (2) Making a Plan, students factor the quadratic equation to find the radius of the circle, then return the circle equation to its general form, after finding the value of n , they find the radius. In this case, it appears that students are able to make a complete and correct solution plan. (3) Carrying out the plan, students factor the quadratic equation $x^2 - 8x - 9 = 0$ and obtain a value of n that satisfies 9, then they calculate the radius of the circle by rooting n . In this case, it can be seen that students are able to carry out the solution plan correctly. (4) Viewing or Rechecking, students rewrite the results obtained after carrying out calculations. In this case, it appears that students are able to re-examine the process and results.

<input type="checkbox"/>	$y^2 = \sqrt{2-x^2}$
<input type="checkbox"/>	$x^2 - 8x - 9 = 0$
<input type="checkbox"/>	Maka Rumus Jari-jari $r^2 = ?$
<input type="checkbox"/>	$y^2 = \sqrt{a-x^2}$, $a = 9$
<input type="checkbox"/>	$y^2 = \sqrt{1-x^2}$
<input type="checkbox"/>	$J^2 = 2x - x^2$
<input type="checkbox"/>	$x^2 + y^2 = 2$

Figure 4. Answers of students in the Low CMTD category

Meanwhile, based on Figure 4, the analysis of students' answers in the Low CMTD category at stage (1) Understanding the Problem, students did not write clearly and completely what was known and asked in the question. This can be predicted that students will not be able to understand the questions well. (2) Making plans, students do not plan solutions correctly and completely. In this case, students cannot plan the solution well. (3) Carrying out the plan, students cannot do it clearly, the calculations they make are not correct. Based on the explanation presented, students were unable to carry out the solution plan well. (4) Looking or Checking Again, students do not conclude the calculation results obtained. It can be predicted that students will not be able to see or recheck the results of the calculations carried out.

The average mathematical problem solving ability in the high mathematical creative thinking disposition category is better than in the medium and low mathematical creative thinking disposition categories. Meanwhile, mathematical problem solving abilities in the moderate mathematical creative thinking disposition category are better than those in the low mathematical creative thinking disposition category. The problem solving abilities of each category are described as follows.

3.1. Problem Solving Abilities in Open Ended Questions Based on A High Mathematical Creative Thinking Disposition

1) Understanding the Problem

S22, S11, and S6 are able to understand the problem well. At this stage, the three subjects were able to write and mention the known elements in the questions completely and correctly. Then the three subjects were able to name the elements asked in the question correctly. This shows that S22, S11 and S6 have fulfilled the 1st indicator in solving the problem proposed by Polya.

2) Making Plans

S22 and S11 are able to make good resolution plans. At this stage both subjects are able to determine the method/formula completely and precisely. Both subjects were also able to explain the method/formula used to solve the problem in detail. However, for S6, there are still problems whose solution plans are incomplete. This generally shows that subjects in the high mathematical creative thinking disposition category have fulfilled the second indicator in problem solving proposed by Polya.

3) Implementing Plans

S22 and S11 are able to implement the completion plan well. At this stage both subjects are able to use the methods/formulas that have been planned and operate them correctly. Both subjects were also able to explain the method/formula used to solve the problem in detail. However, for S6 there are still questions that are solved with incomplete solution steps, so the results do not match the problems contained in the questions. This generally shows that subjects in the high mathematical creative thinking disposition category have fulfilled the 3rd indicator in problem solving proposed by Polya.

4) Viewing or Rechecking

S22 and S11 are able to view or recheck the process and results obtained. At this stage both subjects are able to make conclusions based on the answers they have obtained. Meanwhile, S6 only re-examined 3 questions, for the other 2 questions it did not re-examine related to the process and results obtained. This generally shows that research subjects in the high mathematical creative thinking disposition category have fulfilled the 4th indicator in problem solving proposed by Polya, while S3P has not met this indicator.

3.2. Problem Solving Ability In Open Ended Questions In The Category Of Moderate Mathematical Creative Thinking Disposition

1) Understanding the Problem

S12, S2, and S26 are able to understand the problem well. At this stage, the three subjects were able to write and mention the known elements in the question completely and correctly. Then the three subjects were able to name the elements asked in the question correctly. This shows that S12, S2, and S26 have fulfilled the 1st stage indicators in problem solving proposed by Polya.

2) Making a Plans

S12, S2 and S26 are able to make a settlement plan but are not complete. At this stage the three subjects were less able to determine the complete method/formula. Most of the questions worked on by these three subjects were not solved based on complete solution steps. The three subjects were also less able to explain the method/formula used to solve the problem in detail. This shows that in general the research subjects in the category of creative mathematical thinking disposition do not meet the indicators for stage 2 in problem solving proposed by Polya.

3) Implementing Plans

S12, S2 and S26 implementing incomplete resolution plans. Then on several questions, these three subjects did not do the calculations correctly. The three subjects were also less able to explain the method/formula used to solve the problem in detail. This shows that in general research subjects in the category of creative mathematical thinking disposition do not meet the indicators for stage 2 in problem solving proposed by Polya.

4) Viewing or Rechecking

S12, S2 and S26 only rechecking the process and results for a few questions. This shows that the three subjects did not meet the indicators for re-examining problem solving proposed by Polya.

3.3. Problem Solving Ability In Open Ended Questions In The Category Of Low Mathematical Creative Thinking Disposition

1) Understanding the Problem

S10 and S25 are able to understand the problem well. At this stage, both subjects wrote and mentioned the elements that were known and were asked about in the questions completely and correctly, but the two subjects only wrote down the elements that were known in a few questions. However, S3 is unable to write down and state what is known and what is asked. This shows that in general subjects in the low mathematical creative thinking disposition category fulfill the 1st indicator in problem solving proposed by Polya.

2) Making Plans

S10 and S25 were only able to make a correct solution plan for 1 question while they were unable to make a solution plan for several other questions, while S3 was not able to make a correct solution plan for all questions. At this stage the three subjects were unable to determine the method/formula completely and precisely. The three subjects were also unable to explain the method/formula used to solve the problem in detail. This shows that in general subjects in the low mathematical creative thinking disposition category do not meet the 2nd indicator in problem solving proposed by Polya.

3) Implementing the Plan

S10 and S25 are only able to implement the solution plan correctly for 1 question number. Meanwhile, S3 was unable to implement a proper solution plan for all questions. In general, these three subjects did not perform calculations correctly. The three subjects were also unable to explain the method/formula used to solve the problem in detail. This shows that in general subjects in the low mathematical creative thinking disposition category do not fulfill the 3rd indicator in problem solving proposed by Polya.

4) Viewing or Rechecking

S10, S3 and S25 do not view or recheck the process and results obtained. This shows that in general the subject does not meet the indicators for re-examining problems proposed by Polya.

4. CONCLUSION

Based on the research results and discussions that have been explained, the problem solving abilities of MAN 1 Cirebon City students on open ended questions are categorized into 3 levels, namely high, medium and low. Students who have problem solving abilities on open ended questions in the high category are 3 students or as much as 9%, students who have problem solving abilities on open ended questions in the medium category are 27 students or as much as 82%, while students who

have problem solving abilities on open ended questions are in the medium category. Open ended low category amounted to 3 students or 9%.

The mathematical problem solving abilities of MAN 1 Cirebon City students on open ended questions based on differences in mathematical creative thinking positions are grouped into three categories. For a high level of mathematical creative thinking disposition, it shows that the majority of subjects have fulfilled the four indicators of problem solving according to Polya because they are able to understand the problem well, make plans correctly and completely, carry out the plan correctly, and review the process and results. The ability to solve problems in open ended questions in the mathematical creative thinking disposition category shows that the subjects are able to understand the problem well, but most of the subjects are less able to make plans and carry out plans completely, and do not fully examine the process and results. Meanwhile, problem solving ability in the low mathematical creative thinking disposition category shows that the majority of subjects are able to understand the problem, but cannot make appropriate plans, do not carry out plans appropriately, and do not review the process and results.

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