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Analysis of Students' Mathematical Creative Thinking Abilities on Relation and Function Material

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Abstract

The ability to think creatively, especially in mathematics, is highly needed today for the development of science in the 21st century. However, many Indonesian students still find it difficult to develop creativity in solving problems related to relations and functions. This research aims to identify the level of creative thinking ability of eighth-grade students at SMPN 5 Kendari in the material of relations and functions. The methodology used is qualitative. The instrument used is 4 essay questions on mathematical creative thinking ability in the material of relations and functions. These questions include indicators of fluency, flexibility, originality, and elaboration. The results of the study show that most of the eighth-grade A students have good fluency skills, but their flexibility skills still need to be improved. Originality and elaboration skills are also still very low. Meanwhile, the level of mathematical creative thinking ability of eighth-grade A students at SMP Negeri 5 Kendari is in the medium category with 21 students (70%). Based on the results of the above descriptions, it shows that students' mathematical creative thinking abilities based on the distribution of questions are not fully owned and need to be improved.

Keywords: creative thinking; mathematics learning; thinking ability.

INTRODUCTION

Mathematics is an important part of science that must be mastered by students so that they can contribute to the development of science in the 21st century (Li & Schoenfeld, 2019). According to the National Education Association, students need to have six essential abilities in the 21st century: critical thinking, collaboration, communication, creativity, Culture and connectivity called 6C (Anugerahwati, 2019). Creative thinking is one of the important abilities that students must have. However, some students still find mathematics difficult, so it becomes a challenge in learning mathematics (Aprilia & Fitriani, 2020). In previous research (Wahyudi et al., 2019) In in-depth interviews with 6 selected subjects, it has been proven that most of them have a significant disinterest in the subject of mathematics. As a result, students have difficulties and make mistakes in handling problems related to mathematics. The most common problem and that often arises in the difficulty of mathematics is the low creativity of students in learning mathematics (Werdiningsih, 2019).

The ability to think creatively mathematically is one of the important factors needed to achieve educational goals, especially in the dimension of creating. Educational objectives according to Bloom are a framework for classifying learning outcomes expected to be achieved by students, which was later revised by Anderson and Krathwohl with new dimensions such as remember, understand, apply, analyze, evaluate, and create (Anderson & Krathwohl, 2001). The ability to think creatively mathematically is the ability to generate new, original, and innovative solutions that can be used to solve problems (Susanti & Novtiar, 2018). Mathematics as an exact science requires more creative thinking than rote memorization (Aripin & Purwasih, 2017). Because to learn mathematics is not enough just to memorize and read, but also requires

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the ability to think, especially creative thinking (Siviani et al., 2018). The ability to think creatively is needed to solve various problems, both mathematical problems and real problems in life (Rasnawati et al., 2019). The ability to think creatively mathematically as the ability to think to create new ideas that are original, different and uncommon, so as to bring precise and accurate results (Abidin et al., 2018).

The results of the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) survey in 2018 show that the study of Indonesian junior high school students shows that there is not much change in each participation, TIMSS shows that the creative thinking ability of Indonesian students is still low, with only 2% of students who can solve high-level questions that require creative thinking skills. The results of PISA 2022 show that Indonesian students have quite good creative thinking skills. 32% of Indonesian students can solve high-level problems that require creative thinking skills. This means that there has been a significant improvement compared to the results of PISA 2018, where only 2% of Indonesian students were able to solve these questions. However, there are still some aspects that need to be improved, namely their ability to generate new original and innovative ideas, their ability to explore their ideas deeply and thoroughly, their ability to communicate their ideas clearly and effectively (OECD, 2023).

In previous research (Laksono & Effendi, 2021) shows that students' mathematical creative thinking ability still needs to be improved. In the study, out of a total of 37 students who participated, as many as 31 students fell into the category of less creative. This is due to the low understanding of students of the material taught, which results in many students' answers that are less qualified and some even do not answer. This shows that students' ability to think creatively mathematically still needs to be improved. The ability to think creatively mathematically that is still low today is a drawback, even though this ability has an important value. Creative thinking is an important ability that facilitates various views from various parties and helps in overcoming various problems. With the increase in creative thinking skills, there will be many ideas and suggestions that come from various points of view and imagination that develops (Mardhiyana & Sejati, 2016). Creative thinking also increases sensitivity to problems and allows to generate fresh ideas and unconventional thinking (Darwanto, 2019).

In research (Ramdani & Apriansyah, 2018) found that the lack of students thinking creatively was due to more focused learning by the teacher and the lack of student involvement in problem solving given by the teacher. This results in reduced student interest in solving math problems that require various strategies. Therefore, it is important to improve the creative abilities of students at school. On research (Nasir et al., 2022) which examines the application of learning models Team Assisted Individualization For the ability to think creatively in mathematics, the results show the implementation of learning using a learning model Team Assisted Individualization in junior high school students are categorized as good and excellent. (Damanik & Syahputra, 2018) research on the use of models Discovery Learning In improving students' mathematical creative thinking skills, the results show that it succeeds in increasing students' mathematical creative thinking. These studies can be concluded that students' mathematical creativity abilities can be developed and improved by applying appropriate learning models in the learning process.

The ability to think creatively will grow well if students learn on their initiative, are given the trust to think and dare to come up with new ideas. Opinions about the ability to think creatively show that the ability to think creatively can be developed through a lesson designed by the teacher so that it can train students to explore all the abilities that exist in themselves. Students are generally familiar with simple and routine problems that can be solved in one or a certain way. This makes them often confused when faced with more complex or non-routine problems because it is difficult to connect mathematical concepts that have been learned before (Safaria & Sangila, 2018).

To develop students' mathematical creative thinking skills, a place is needed to provide opportunities for students to express and share their ideas according to their respective creativity (Surya et al., 2018). According to (Chin & Fu, 2021) argues that education should seek solutions to support all students and ensure that they have equal opportunities in maths learning. Therefore, we need to find various solutions to improve students' mathematical creative thinking skills. However, before examining how solutions improve students' mathematical creative thinking skills, this study aims to determine students' mathematical creative thinking skills on relation and function materials. Developing the ability to think creatively mathematically in students is very important to train them to use creativity from an early age (Ali et al., 2021). Mathematics that continues to be considered difficult will affect students' creative thinking ability and cause them to often make mistakes when solving math problems. In fact, in mathematics education, creative thinking is an important part of the teaching and learning process, including the interaction between students and teachers (Qadri et al., 2019).

According to (Fajriah & Asiskawati, 2015) stated that at the Junior High School (SMP) level, the child's thinking phase is generally in the transition phase from concrete operations to formal operations because junior high school students can already think abstractly such as doing analysis, using reasoning, etc. but should depart from real situations first. In this phase, children are encouraged to actively solve problems and develop new ideas through creative thinking. The ability to think creatively in the mathematics learning outcomes of students is still relatively low at the junior high school (SMP) level (Ginting et al., 2019), this is a motivation for researchers to further explore the creative thinking of junior high school students, especially on relation and function materials.

Relationship and function material is one of the materials taught at the junior high school (SMP) level. Relationships and functions are very important to teach to students because relations and functions become prerequisite materials that provide students with understanding concepts to move to the next material. Relation and function material is one of the materials that is classified as difficult for junior high school students because relation and function material not only requires students' understanding of the concept of relations and functions themselves, but also requires students to understand other prerequisite materials, namely sets, to connect different mathematical concepts, such as sets, relationships, and functions. This requires them to think creatively to find ways to incorporate these concepts into problem solving (Ihsan & Pradipta, 2015). A person's creative thinking ability can be measured based on indicators of creative thinking ability. This study focuses more on measuring students' mathematical creative thinking ability through indicators according to (Susanto, 2016) which states that a person's creative thinking ability is based on four indicators, namely fluency of thinking (fluency) related to the ability to generate many ideas, flexibility of thinking (flexibility) the ability to see problems from various points of view, the authenticity of thinking (originality) viewed based on the originality of the idea or ideas produced and elaboration (elaboration) is a supporter of the three indicators, namely the ability to detail ideas.

Based on the results of the researcher's interview with a grade VIII mathematics teacher of SMP Negeri 5 Kendari, information was obtained that most students have limitations in thinking creatively mathematically on relation and function materials. This can be seen from the way students solve problems, students are only able to solve problems in the way they have been taught, which is in accordance with the example given by the teacher. Students tend to only memorize routine problem solving and do not try to find different solutions when facing non-routine problems. This is due to a lack of understanding of the concepts of relations and functions, as well as a lack of exploration of new ideas. Events like the above certainly hinder the creative thinking process of students, where students have not been able to do open-ended problems, they only rely on the examples given by the teacher, do not try to find different

solutions or ideas when facing problems that are not routine or different from the examples given. This, if allowed to eat the development of students' creative thinking abilities is not good, resulting in students only mastering the techniques taught before and not having the opportunity to increase creativity thinking (Kamsinah, 2022).

There have been numerous studies on the analysis of mathematical creative thinking ability, such as the research conducted by Media (Alkariim & Aini, 2023), which concluded that students categorized as having low creative thinking are still hindered by mathematical rules, resulting in less accurate solutions. Researcher by (Kadir et al., 2022) concluded that students' mathematical creative thinking abilities are categorized as moderate or not yet optimal. The research by (Laksono & Effendi, 2021) concluded that students' mathematical abilities are still less creative, and students have not been able to master the four indicators of mathematical creative thinking ability. Furthermore, (Kamalia & Ruli, 2022) concluded that the mathematical creative thinking ability of junior high school students in Karawang Regency on the topic of plane figures is still categorized as low. The difference in this research is that this research focuses on the analysis of students' mathematical creative thinking abilities on the topic of Relations and Functions using the indicators of fluency, flexibility, originality, and elaboration.

Based on the description that has been described, there is a problem that is quite interesting to be studied, namely the low mathematical creative thinking ability of junior high school students on relation and function material. This is due to several factors, including lack of understanding of mathematical concepts, lack of student involvement in problem solving, and lack of exploration of new ideas. Therefore, this study was conducted with the aim of measuring students' mathematical creative thinking ability on relation and function material.

METHODS

This study employed a qualitative research design. The participants were 30 students from class VIII A of SMP Negeri 5 Kendari. Purposive sampling was used to select participants based on specific criteria (Sugiyono, 2017), namely students who had studied relations and functions and demonstrated a good understanding of mathematics. The research instrument was a written essay test consisting of 4 questions on the topic of relations and functions. Data was collected through written tests and in-depth interviews. Data analysis was conducted qualitatively, focusing on in-depth interpretation of students' responses to the questions. This analysis aimed to deeply understand how students think and construct their understanding of the concepts of relations and functions, as well as how they express their creative thinking abilities. The indicators of fluency, flexibility, originality, and elaboration were used as a framework for analyzing students' responses, but a broader interpretation was also conducted to understand the nuances and depth of students' mathematical creative thinking. Before being used, the test instrument was validated and tested for reliability by a panel of experts.

After conducting an analysis of students' mathematical creative thinking skills according to the scoring guidelines for mathematical creative thinking skills developed by (Rahmawati, 2016), then interviews were conducted on selected subjects. To obtain students' mathematical creative thinking ability test scores, scoring guidelines for mathematical creative thinking ability tests can be presented in the following table 1.

Table 1. Student Mathematical Creative Thinking Ability Score Assessment Guidelines

Ability Think	Reaction to a problem or problem	Score
Fluency	Did not answer the question.	0
	Provide ideas that are irrelevant to problem solving.	1
	Gives a relevant idea but the answer is wrong.	2

Ability Think	Reaction to a problem or problem	Score
	Provide more than one relevant idea but still have errors.	3
	Provide more than one relevant idea and the completion is correct and clear.	4
Flexibility	Did not answer the question	0
	Gave an answer one way but the results were still wrong.	1
	Give answers in one way but the results are correct.	2
	Giving more than one answer but the results are wrong because there are errors in the calculation process.	3
	Gives answers more than one way and the calculation process all results are correct.	4
Originality	Did not answer the question.	0
	Gives answers in its own way but is incomprehensible.	1
	Expressing opinions, but only modifying, the work process is already directed.	2
	Giving answers in its own way but there are errors in the calculation process so that the results are wrong.	3
	Give answers in their own way with a directed calculation process and the results are correct.	4
Elaboration	Did not answer.	0
	There is an error in the answer and it is not accompanied by details.	1
	There are errors in the answers but accompanied by detailed details.	2
	There are errors in the answers but they are accompanied by detailed details.	3
	Provide correct and detailed answers.	4

(Source: Rahmawati, 2016)

After the data on mathematical creative thinking skills is obtained, the research will then conduct an analysis to be subsequently collected in several categories, namely high, medium and low based on the categorization of (Kadir et al., 2022).

Table 2. Criteria for Categorizing Students' Mathematical Creative Thinking Abilities

Criterion	Value
Tall	Value $\geq \bar{x} + SD$
Keep	$\bar{x} - SD \leq$ Value $< \bar{x} + SD$
Low	Value $< \bar{x} + SD$
$\bar{x} =$ Rata-rata	$SD =$ Standard deviation

The data obtained is in the form of test results of mathematical creative thinking ability which is processed by calculating the percentage of scores obtained by students on each indicator of mathematical creative thinking ability with the following criteria:

Table 3. Interpretation of Students' Level of Mathematical Creative Thinking Ability

Presented	Interpretasi
81%-100%	Excellent
61%-80%	Good
41%-60%	Enough
21%-40%	Less
0%-20%	Very Lacking

(Source: Nufus, 2021)

The data analysis techniques used in this research include data reduction, data display, and conclusion drawing (Sugiyono, 2017). Data reduction involves summarizing, categorizing, and focusing on the key points, identifying themes and patterns, and discarding irrelevant information. In qualitative research, data can be displayed in various forms such as brief descriptions, diagrams, relationships between categories, and flowcharts. Meanwhile, conclusions are drawn as answers to the research questions that have been previously formulated. These conclusions are made based on the results obtained from the tests and interviews.

RESULTS AND DISCUSSION

This study was conducted to analyze the mathematical creative thinking ability of SMP Negeri 5 Kendari students in solving problems on relation and function material. This research data is in the form of qualitative data obtained through a mathematical creative thinking test on 30 grade VIII A students. To examine more deeply and be able to reveal things that are not visible in the students' answers, interviews were conducted with selected students, research interview participants were selected 1 student each based on obtaining the highest scores in each high, medium and low category and having good communication.

The ability to think creatively mathematically students whose data collection uses test questions in the form of essays/descriptions as many as 4 questions on relationship and function material. and interviews adjusted to indicators of mathematical creative thinking ability, namely fluency, flexibility, originality and elaboration. The results of the answers to the students' mathematical creative thinking ability test are used as research guidelines to determine the level of students' mathematical creative thinking ability and identify indicators of mathematical creative thinking ability that have been mastered by students. Students' mathematical creative thinking ability is divided into three categories, namely high, medium and low, the category criteria used are as follows: KBKM is high if: KBKM value $\geq 52{,}402$; Medium KBKM if: $13{,}432 \leq$ KBKM Value $< 52{,}402$; KBKM is low if: KBKM value $< 13{,}432$. The category of students' mathematical creative thinking ability is presented in figure 1.

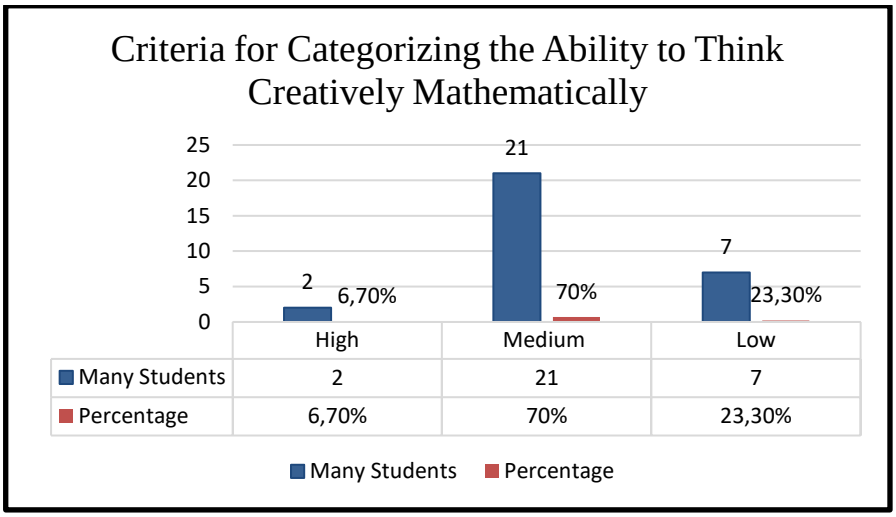


Figure 1. Criteria for Categorizing the Ability to Think Creatively Mathematically in Number and Percentage

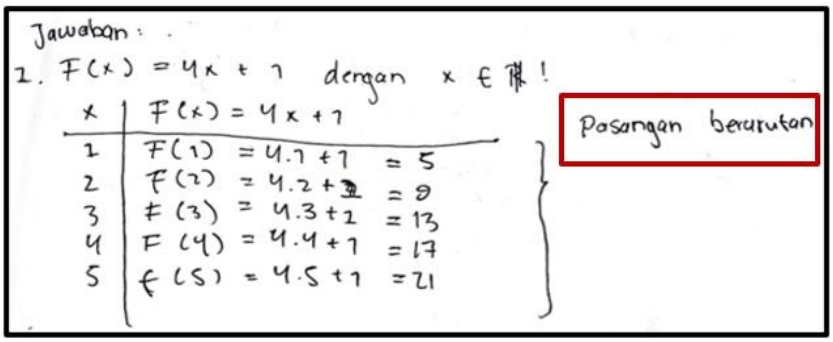
Based on Figure 1. the criteria for categorizing students' mathematical creative thinking abilities show that out of 30 students, only 2 students are in the high category with a percentage of 6,70%, 21 students are in the middle category with a percentage of 70%, and 7 students are in the low category with a percentage of 23,30%. If the results of the test of students' mathematical creative thinking abilities are viewed from the average score and percentage of each indicator of students' mathematical creative thinking abilities, the following results are obtained:

Table 4. Calculation Results of the Mathematical Creative Thinking Ability Test

Mathematical Creative Thinking Indicator	Rata-rata	Presented Indicators
Fluency	2,43	60,75%
Flexibility	1,90	47,50%
Originality	0,63	15,75%
Elaboration	0,30	7,5%

Based on table 4, it can be seen that there is a difference in the average value of each indicator of mathematical creative thinking ability. Each indicator of mathematical creative thinking is represented by 1 question item. Using the formula, the average fluency indicator is 2,43 (60,75%), in flexibility is 1,90 (47,50%), in originality is 0,63 (15,75%), and in elaboration is 0.30 (7,5%). Thus, it can be concluded that the average value of mathematical creative thinking ability is highest on the fluency indicator is 2,43 and for the lowest value on the elaboration indicator is 0,30. The following will present the questions, students' answers or solutions related to mathematical creative thinking ability, and the results of the interviews. The students' answers varied, but the ones that will be presented are those chosen from each category (high, medium, and low) based on the highest score and good communication skills.

❖ Students' Mathematical Creative Thinking Fluency



Description:

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Figure 2. Results of Answers and Interviews on Mathematical Creative Thinking Ability of High-Ability Students

P : Do you understand the problem asked in question number 1
MAG : Yes, I do.
P : If you understand, please explain how you found the answer?
MAG : I chose the values of x as 1, 2, 3, 4, and 5. Then, I made a table like the one in question number 4. I wrote down x, then paired it with $f(x) = 4x + 1$. I substituted the values of x into the formula, for example, when x is 1, $f(x) = 4 \cdot 1 + 1 = 5$, when x is 2, $f(x) = 4 \cdot 2 + 1 = 9$, and so on.
P : Do you think there's another way to solve this problem?
MAG : No, this is the only way I know.

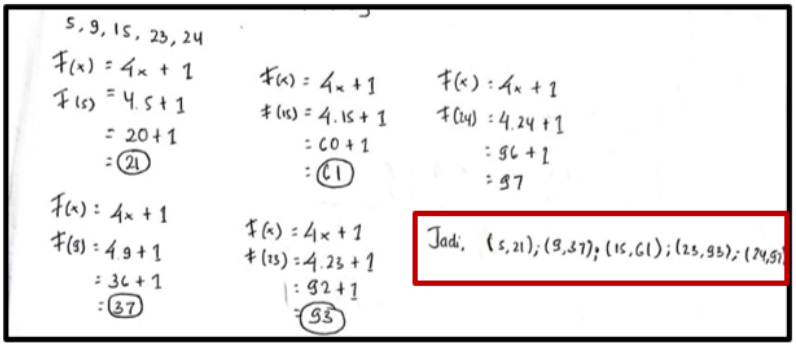

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Figure 3. Results of Answers and Interviews on Mathematical Creative Thinking Ability of Students with Moderate Ability

P : Do you understand the problem asked in question number 1
ANK : I understand.
P : If you understand, please explain how you found the answer?
ANK : I chose 5, 9, 15, 23, and 24. The first number is 5, and the given formula is $f(x) = 4x + 1$. If we substitute x with 5, we get $f(5) = 4 \times 5 + 1 = 21$, so the ordered pairs are (5, 21), (5, 21), (9, 37), (15, 61), (23, 93), (24, 91), and so on.
P : Do you think there's another way to solve this problem?
ANK : Maybe, it depends on how people understand it.

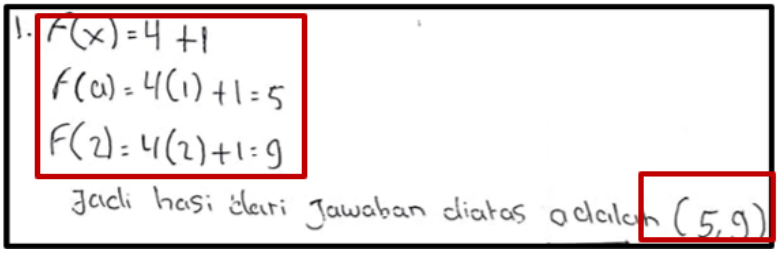

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Figure 4. Results of Answers and Interviews on Mathematical Creative Thinking Ability of Low-Ability Students

P : Do you understand the problem asked in question number 1
CS : I don't quite understand yet.
P : If you understand, please explain how you found the answer?
CS : I don't understand starting from x ∈ ℝ and what to do with f(x) = 4x + 1.
P : Do you think there's another way to solve this problem?
CS : There's nothing.

Based on the results of the tests and interviews, the students' mathematical creative thinking ability on the fluency indicator can be described as follows. For the fluency indicator in question number 1, students have mastered it well. Based on the results, students' mathematical creative thinking ability on the fluency indicator achieved an average score of 2.43 with a percentage of 60.75%. Some students were able to provide several good answers with clear problem-solving. According to(Noer, 2009), fluency is the ability to generate many ideas, answers, and problem solutions. There were also students who were able to provide more than one answer but were less accurate, and some even only provided one irrelevant answer and the problem-solving was unclear. Students have not yet understood the concept of relations and functions and have not understood the meaning of the question well.

High-criteria students can provide more than one answer, but students do not write their ordered pairs. Medium-criteria students can provide more than one answer, but the answers given in the ordered pairs do not write curly brackets as a set symbol. Low-criteria students only write one answer, but the answer given is wrong, students write the function formula incorrectly and the choice of real numbers, where students use the letter for the value of, while it should be, so the use of the letter is not appropriate because it is not a number. Where in the research (Suripah & Retnawati, 2019) states that students in the high criteria for the fluency indicator have been able to provide many ideas and solve problems, but for students in the low criteria many give ideas and try to answer the question but the answers given are still wrong due to lack of understanding.

Based on the results of the researcher's interview with high-criteria students, they were able to explain the process of working on question number 1. For medium-criteria students, they can explain how to work and understand what is asked in question number 1. While for low-criteria students, they cannot explain how to solve it, and do not understand well what is asked in question number 1.

❖ Students' Mathematical Creative Thinking Ability on the Flexibility Indicator

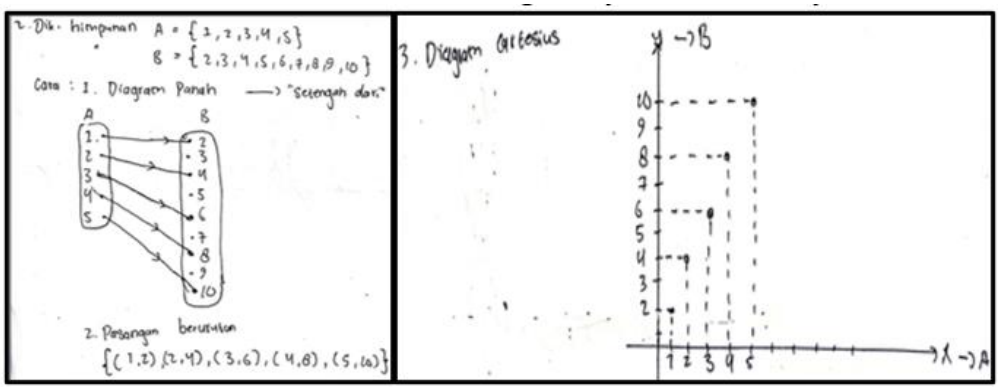

Figure 5. Results of Answers and Interviews on Mathematical Creative Thinking Ability of High-Ability Students

P : How many ways did you find to solve the problem?
MAG : Are there three ways.
P : Do you think there's another way to solve the problem?
MAG : No, I only understand three ways.
P : Can you explain the steps you took to find the answer?
MAG : The first way is using arrow diagrams. We create columns, A for set A and B for set B. Then, we find the relation "half of", so 1 is half of 2, and so on. Then we draw lines to connect the two numbers. For ordered pairs, we can use the arrow diagram we've made. We simply group them together, using curly brackets, then regular parentheses, like (1, 2), and so on, closing with a curly bracket. For Cartesian diagrams, the domain is on the bottom or x-axis, while the codomain is on the side or y-axis. We input the numbers, then draw lines one by one to connect the numbers from the domain to the codomain after obtaining the coordinates. Finally, we connect the points with a line.

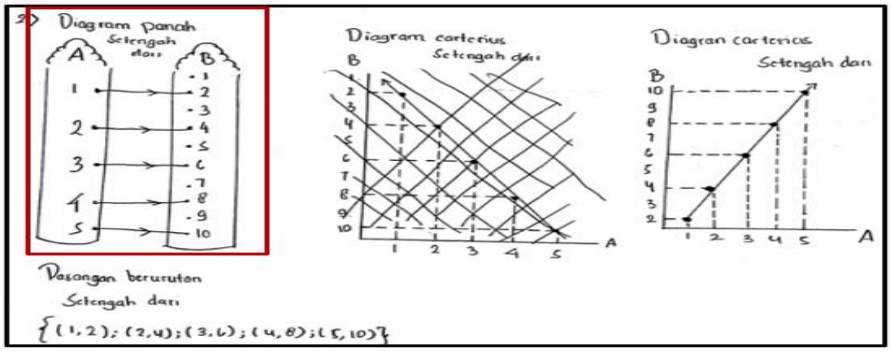

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Figure 6. Results of Answers and Interviews on Mathematical Creative Thinking Ability of Students with Moderate Ability

P : How many ways did you find to solve the problem?
ANK : I used 3 methods.
P : Do you think there's another way to solve the problem?
ANK : There's one more, right, which is a table diagram.
P : Can you explain the steps you took to find the answer?

ANK : The first one is using an arrow diagram, with the domain being 1, 2, 3, 4, 5, and the codomain being 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. 1 is paired with 2 because 1 is half of 2, and so on. The second method is a Cartesian diagram, with the domain below being 1, 2, 3, 4, 5 and the codomain above being 2, 3, 4, 5, 6, 7, 8, 9, 10. We just pair 1 with 2, and so on. Once that's done, we plot the points at their intersections. The third method is ordered pairs (1,2), (2,4), (3, 6), (4, 8), (5, 10).

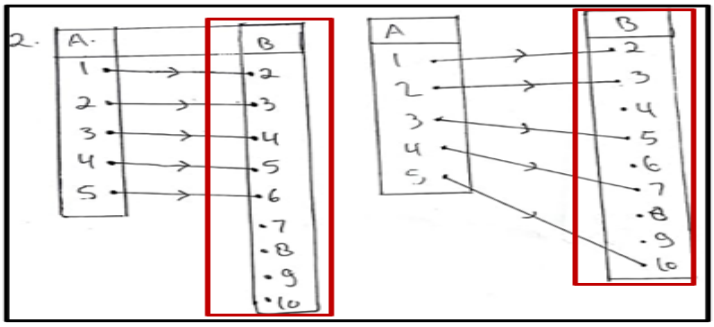

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Figure 7. Results of Answers and Interviews on Mathematical Creative Thinking Ability for Low-Ability Students

P : How many ways did you find to solve the problem?
CS : One way.
P : Do you think there's another way to solve the problem?
CS : Nothing.
P : Can you explain the steps you took to find the answer?
CS : I don't know

Based on the results of the tests and interviews, the students' mathematical creative thinking ability on the flexibility indicator can be described as follows. For the flexibility indicator in question number 2, students were able to solve the problem using more than one alternative answer. According to (Azhari & Somakim, 2014), flexibility is defined as providing uniform answers/ideas but with different thinking directions, being able to change methods/approaches and being able to see problems from various perspectives. Based on the research results, the average score of students' mathematical creative thinking ability on the flexibility indicator was 1.90 with a percentage of 47.50%. Although some students were able to provide more than one correct solution, other students still had difficulties in understanding the concept of relations and could only provide one incorrect answer.

High-criteria students were able to provide answers using three methods: arrow diagrams, ordered pairs, and Cartesian diagrams. Medium-criteria students provided answers using three methods: arrow diagrams, Cartesian diagrams, and ordered pairs, but there were errors in the arrow diagrams. Low-criteria students could only provide one method with an incorrect process. In their answers, students used arrow diagrams, but the placement of pairs from set A to set B was incorrect. In the research (Alkariim & Aini, 2023) students who were categorized as low criteria already understood how to present a set, but still did not understand mathematical rules such as determining the "half of" relation.

Based on the interview results, high-criteria students were able to explain the process of their written work and understood question number 2 well. Medium-criteria students understood the concept of the question and were able to explain their answers. While low-criteria students were only able to read their written answers but could not explain the process,

did not understand question number 2 well, and it seemed that the students connected the members of set A to set B incorrectly according to the relation determined in the question.

❖ Students' Mathematical Creative Thinking Ability on the Originality Indicator

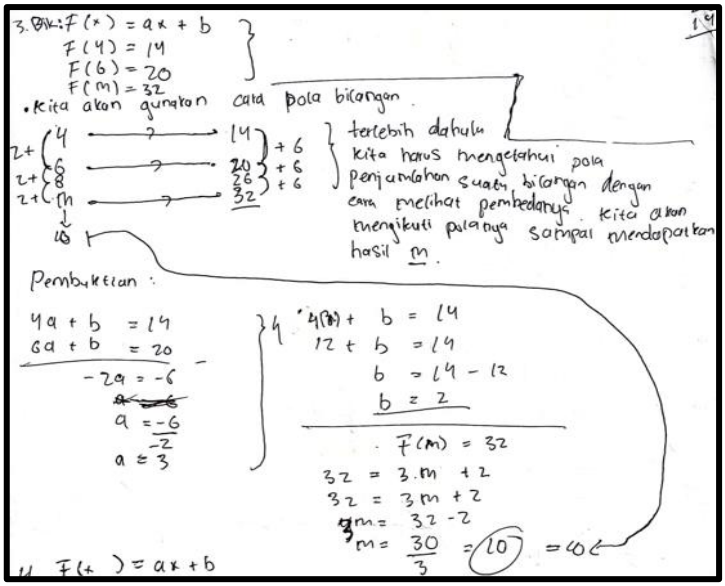

Figure 8. Results of Answers and Interviews on Mathematical Creative Thinking Ability of High-Ability Students

P : How did you come up with an answer like this?
MAG : If I just try using the number pattern method. Here, I will find the number pattern to find the value of m.
P : Can you explain the steps you took to solve this problem?
MAG : I'll start by creating a number addition pattern, here from 4 to 6 the difference is $+2$ then $4 + 2$ is 6, then in part B, $20 + 6 = 26$, then in part A add 2 continuously until the number 10, and in part B add 6 continuously until exactly the number 32, because it matches, this number pattern is the same, to be more sure. So, to prove it, I'll use the usual method, which is substitution and elimination, and I get the value of m, and after I prove it, the result is the same, m is 10.

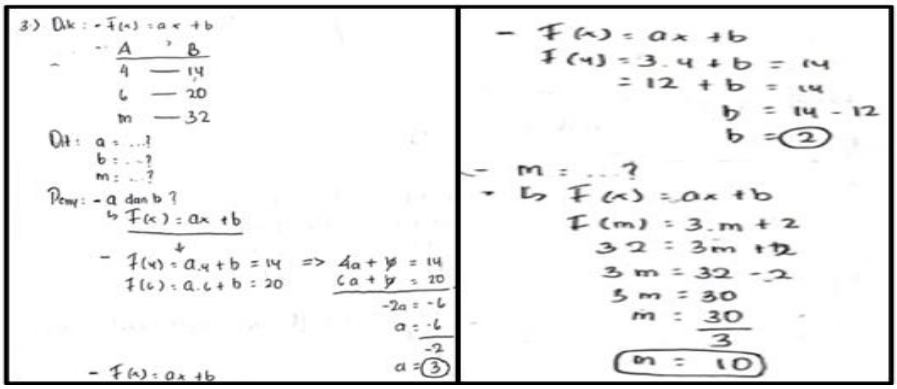

Figure 9. Results of Answers and Interviews on Mathematical Creative Thinking Ability for Students with Moderate Abilities

P : How did you come up with an answer like this?

ANK : Because we've been given practice problems similar to that one before, and I used the same method as I did on that problem, and it's the only way I can do it or understand it.
P : Can you explain the steps you took to solve this problem?
ANK : Here, the domain is 4, 6, and m, while the codomain is 14, 20, 32. $f(x) = ax + b$ is the function formula. Substitute $f(4) = 14$ and $f(6) = 20$ into the function formula. So, using the elimination method, we get $a = 3$. To find the value of b, we substitute the value of a into $f(4) = 14$ and get $b = 2$. Now, to find the value of m, we input the function formula $f(x) = ax + b$. $f(m) = 3m + 2$. $m = 10$.

Figure 10. Results of Answers and Interviews on Mathematical Creative Thinking Ability of Low-Ability Students

P : Can you explain why you didn't answer that question?
CS : Because I didn't understand the question, and I didn't know the right formula to answer it.
P : Can you explain what you didn't understand about the question?
CS : I don't understand how to determine the function's formula from the problem.

Based on the results of the tests and interviews, the students' mathematical creative thinking ability on the originality indicator can be described as follows. For the originality indicator in question number 3, students were very poor at solving it using a method different from what was taught in class, where students used a different or original method. According to theory (Susanto, 2016), originality is when students can provide their own answers, students can develop original ideas or concepts. Based on the research results, students' mathematical creative thinking ability on the originality indicator achieved an average score of 0.63 with a percentage of 15.75%. The test results showed that almost all students were unable to answer questions other than those that had been taught by the teacher. This is because students are not accustomed to working on non-routine problems. So for students it is something new in solving problems. This causes students to be confused and have difficulty when working on the given problems because they do not know the various methods that will be used to solve the problem.

High-criteria students gave answers using a different method than what was taught in class, namely students solved it using a number pattern, and proved it using the method taught in class and the results were correct. Medium-criteria students gave correct answers and accurate calculations but used the method taught in class. Low-criteria students did not provide answers because they did not understand the question well. Based on interviews, high-criteria students were able to explain the process of working to get the results, while students with medium criteria could explain the steps in their work using the method taught in class and low-criteria students explained their reasons for not answering the question because they did not understand question number 3 well, so they were unable to work on it.

❖ Students' Mathematical Creative Thinking Ability on the Elaboration Indicator

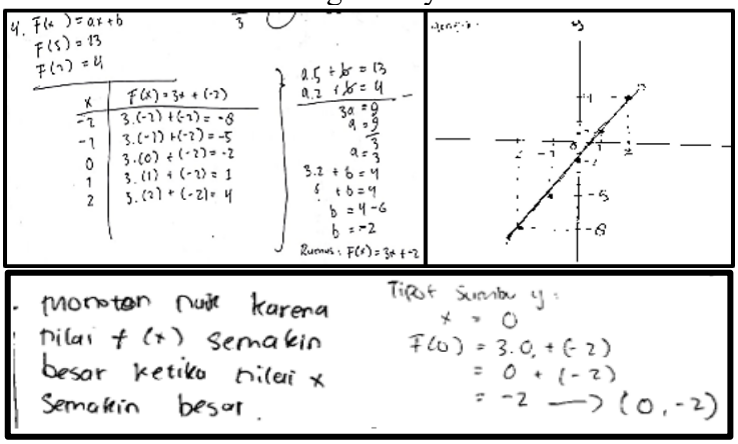

Figure 11. Results of Answers and Interviews on Mathematical Creative Thinking Ability of High-Ability Students

P : Can you explain how you analyzed this problem??
MAG : First, I found the values of a and b. We know that the general formula for a linear function is $f(x) = ax + b$. So, I wanted to find the values of a and b first to determine the graph's shape.
P : Can you explain the steps you took to solve this problem?
MAG : The problem gave us $f(5) = 13$ and $f(2) = 4$. I substituted these values into the formula and solved the system of equations to get $a = 3$. Then, I substituted $a = 3$ into the equation $f(2) = 4$ to find $b = -2$. So, the function is $f(x) = 3x - 2$. I created a table of values for x and f(x). I substituted different values of x into f(x) to find corresponding values of f(x) and plotted these points on a graph. The graph is increasing because as x increases, f(x) also increases. The x-intercept is at $(\frac{2}{3}, 0)$ and the y-intercept is at $(0, -2)$.

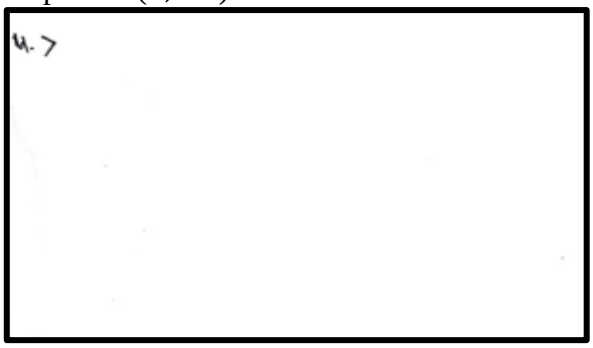

Figure 12. Students' Answers and Interview Results on Mathematical Creative Thinking Ability for Average Students

P : Can you explain why you didn't answer that question?
ANK : Because I don't quite understand it.
P : What part of the question don't you understand?
ANK : I don't understand the part about $f(5) = 13$ and $f(2) = 4$. I don't know what to do with it. I thought maybe I should find the x and y intercepts, but I'm confused about how to do that to get the graph.

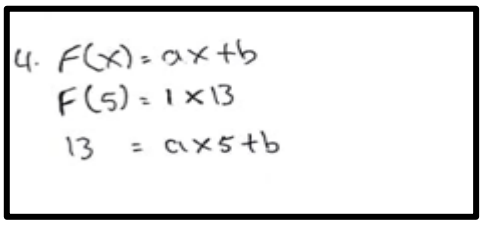

Figure 13. Results of Answers and Interviews on Mathematical Creative Thinking Ability of Low-Ability Students

P : Can you explain why you didn't answer that question?
CS : Because I don't understand the question.
P : What part of the question don't you understand?
CS : Everything. I don't understand how to create a graph from $f(5) = 13$ and $f(2) = 4$ given in the problem. I don't know how to process the problem to get the answer.

Based on the results of the tests and interviews, the students' mathematical creative thinking ability on the elaboration indicator can be described as follows. For the elaboration indicator on question number 4, this aspect was the weakest among students. Based on the research results, students' mathematical creative thinking ability on the elaboration indicator achieved an average score of 0.63 with a percentage of 15.75%. The test results showed that most students still struggled to provide detailed and structured answers, even though they were able to provide correct answers. According to (Kamalia & Ruli, 2022), elaboration means that students are able to think in detail. This is supported by the interview results, which showed that students still had difficulty understanding the problem concepts and developing answers in detail.

High-criteria students could provide correct answers but their steps were less detailed, with some steps omitted. Medium-criteria students did not provide answers, leaving their answer sheets blank, due to not understanding the problem concept and being confused about how to process the given information. Low-criteria students did not write their answers on the answer sheet because they did not know how to process the given information to get the answer and could not determine the steps that needed to be taken to solve the problem. Based on the interviews, high-criteria students were able to explain the steps and calculations in finding their answers. Medium and low-criteria students only explained their reasons for not answering question number 4 because they were confused about processing the problem to get the answer and were confused about where to start. This is in line with research Jati (2014) which found that students were still confused about where to start when working on a problem, and they were confused about linking the given information to what was being asked in the problem.

The ability to think creatively mathematically is categorized into three levels, namely high, medium, and low. Here are the characteristics of each category based on mathematical creative thinking indicators:

❖ Low Category

Based on data analysis from the results of the study, that overall out of 30 students there were 7 students who were in the low category. Low category students showed some weaknesses in solving the problem. Based on the results of tests and interviews, students only give one answer that does not match the question, using one method without variation, and the answer is not correct. In addition, students are also not able to provide solutions in unusual ways / unique ideas, or develop ideas / ideas. This is because they do not understand the meaning of the question well and consider the question difficult. In this case, students who are in the low category have not been able to master 4 indicators of mathematical creative thinking ability. This is in line with research conducted by (Kamalia & Ruli, 2022) that in the low category these

students have not met 4 indicators of mathematical creative thinking, namely fluency, flexibility, originality and elaboration.

❖ Medium Category

Based on data analysis from the results of the study, that overall out of 30 students there were 21 students who were in the medium category. Students have been able to provide various answers in solving a problem and other different alternatives. Where at number 1 is the indicator fluency Students have given various answers, at number 2, namely indicators flexibility Students are already able to complete in more than one way with the correct completion. This is in line with research conducted by (Kadir et al., 2022) Students who are in the medium category are able to meet 2 indicators of mathematical creative thinking.

❖ High Category

Based on data analysis from the results of the study, that overall out of 30 students there were only 2 students who were in the high category. Students with the ability to think creatively mathematically in high criteria are able to solve problems, students are not only fixated on one answer, able to provide solutions with different alternatives and provide original ideas. However, for students who give answers to question number 4, it is an indicator elaboration Students are only able to provide answers with correct results but have not been able to detail the solutions given, so they have not met the indicators elaboration. This is in line with research conducted by (Zarina et al., 2022) Students with high categories are able to master three indicators of mathematical creative thinking.

Based on the discussion presented above, the mathematical creative thinking ability of eighth-grade A students in solving tests on relations and functions is categorized as moderate with a score percentage of 70%. Most students have not been able to meet all four indicators of mathematical creative thinking. Research supporting the author's statement is (Kadir et al., 2022) who concluded that the creative thinking ability of eighth-grade students at SMP Negeri 1 Dungaliyo was at a moderate or maximum level with a score percentage of 59.26%. In this study, when solving problems, most students were unable to meet all the indicators of creative thinking ability in the material on triangles. Another supporting study was conducted by (Az Zahra & Roesdiana, 2023). The results showed that the mathematical creative thinking ability on algebraic function derivatives was moderate or less than optimal. This can be seen from the overall level of students' mathematical creative thinking ability of 64.62%, meaning that most students can solve mathematical creative thinking problems, although the results are not yet ideal.

In (Adawiah et al., 2019) study, it was concluded that the mathematical creative thinking ability of seventh-grade students at SMP Darul Falah Cihampelas, in the material of triangles and quadrilaterals, is categorized as moderate. In this study, when solving problems, students were less able to combine problem-solving methods with new elements to create new solutions and were less able to elaborate on the answers they provided. (Kasmawati et al., 2021) with research results on the mathematical creative thinking ability of eighth-grade students on the material of cubes and rectangular prisms based on levels, it was dominated by students in the moderate category with a percentage of 54.41%. Where the moderate group showed that all students did not meet all the measured indicators, from the results of tests and interviews, it showed that students only had fluency and flexibility aspects, as well as few ideas.

Students' mathematical creative thinking skills are still not at their maximum potential, as evidenced by their lack of understanding of the concepts of relations and functions. This is evident in students' difficulties in properly presenting relations, writing arrow diagrams, Cartesian diagrams, and ordered pairs, as well as using inaccurate mathematical notation to express relations. Misunderstandings in arrow diagrams, such as domain, codomain, and range, as well as inabilities in mathematical rules such as determining the "half of" relation, further hinder their understanding. The lack of understanding of the concept of functions, the

relationship between variable x and the function value f(x), and the relationship between elements in the domain and codomain sets connected by arrow diagrams, leads to difficulties in constructing the correct function formula, understanding the representation of functions with formulas and graphs, and analyzing function graphs to determine their properties such as x- and y-intercepts, increasing/decreasing functions

From the explanation above, although grade VIII A students of SMP Negeri 5 Kendari show sufficient ability in fluency and flexibility, their ability in originality and elaboration is still very lacking. Some of the factors that influence this are the lack of habit in solving open-ended math problems, which leads to confusion and difficulty in finding alternative solutions. It also results in students being lazy to try new ways or making new discoveries, and not confident in their own answers. In addition, students tend to do math problems by memorizing existing solutions and following the steps that have been taught, so they do not develop answers or expand ideas, and their answers become less detailed. The ability to think creatively mathematically plays an important role in learning mathematics. Therefore, efforts need to be made to develop and improve this capability, especially in the indicators of originality and elaboration. Its development requires continuous practice and full attention. This can be done through the habit of asking questions, building linkages between things, connecting ideas freely, students can explore their ideas without limitations and apply imagination to come up with new/different solutions.

CONCLUSION

Based on the research results and previous discussions, it can be concluded that the level of mathematical creative thinking ability of students in class VIII A of SMP Negeri 5 Kendari is categorized as moderate. Of the 30 students, 21 students (70%) are in the medium category, 7 students (23,30%) are in the low category, and only 2 students (6,70%) are in the high category. In solving problems related to the material of relations and functions, students' mathematical creative thinking ability shows good interpretation on the fluency indicator with an average score of 2,43 and a percentage of 60,75%. The flexibility indicator shows a fairly good interpretation with an average score of 1,90 and a percentage of 47,50%. While the originality and elaboration indicators show very poor interpretation with an average score of 0,63 and a percentage of 15,75% and an average score of 0,30 and a percentage of 7,5%, respectively.

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