

The mathematical critical thinking ability of Mts Students reviewed from habits of mind

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Abstract

Critical thinking is a process that involves thoroughly evaluating information to make sound decisions. This skill enables students to systematically analyze problems, address challenges in an organized manner, formulate issues, and develop effective solutions. According to PISA results, the average mathematics score of Indonesian students remains below the international average. One significant aspect of mathematics learning, particularly in the affective domain, is the habit of mind, which supports the achievement of education goals. This study aims to assess students' critical thinking skills and describe the critical thinking processes of Islamic junior high school students in solving mathematical problems in relation to their habits of mind. A descriptive qualitative approach was employed. The subjects consisted of 48 eighth-grade students from an Islamic junior high school in Bandung, with the topic of relations and functions. Data were collected through critical thinking tests, habits of mind questionnaires, and interviews. The data were analyzed inductively to gain an in-depth understanding of students' critical thinking processes. The results showed that the average score of students' critical thinking ability was 66%, which falls into the moderate category. Moreover, the critical thinking process in solving mathematical problems varied based on students' levels of habits of mind. Students with high levels of habits of mind. Students with high levels tended to demonstrate stronger critical thinking skills.

Keywords: Critical Thinking, Descriptive Qualitative, Habits of Mind, PISA, Relation and Functions.

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INTRODUCTION

The advancement of science and technology is accelerating so that information can be easily accessed for various groups. This convenience needs to be followed by skills in processing and utilizing information. One of the skills needed is good thinking skills to help in decision-making techniques, contributing positively to the quality of critical thinking (Turan et al., 2019). The concept of independent learning education focuses on cognitive development, one of which is mathematical literacy where students are able to analyze well and can think critically (Yaniawati et al., 2023). In line with that, Mailisman et al. (2020) stated that Indonesian students must master skills that include critical thinking, creativity, communication and collaboration. Critical thinking is a thought process that involves cognitive processes (Zein et al., 2024) with the aim of making rational decisions about what to believe or do (Syafri et al., 2020). People with critical thinking skills will search, analyze and

evaluate information, make conclusions based on facts and then make decisions (Nurdina et al., 2024; Indrasiene et al., 2018).

The ability to think critically mathematically, can be seen through the student's thinking process which is constructed from observing behavior (Widodo, 2012). This is in line with the opinion of Syamsuddin (2019) that the thought process is closely related to mental activities used to understand, formulate, and solve problems and make decisions. So that critical thinking allows students to study systematic problems, face challenges in an organized way, formulate problems and design solutions (Azar et al., 2023). In school, students get mathematics learning which is one of the learning that aims to make students have the ability to collaborate, think logically, analytically, systematic, critically and creatively (Rachmantika & Wardono 2019).

One of the global references in looking at students' mathematical abilities is through the PISA assessment organized by the OECD. PISA is a comprehensive survey program that focuses more on students' practical knowledge in acting, one of which is assessing students' reasoning competence, including critical thinking skills (Rahayu, 2016). PISA assesses 15-year-old students' knowledge and skills in math, reading, and science. This test explores the extent to which students can solve complex problems, think critically, and communicate effectively (OECD, 2023). However, based on the OECD in PISA 2022, the average scores obtained by Indonesian students in mathematics are still below the international average. Indonesia's average score is 366 out of an international average score of 472 and is ranked 70th out of 81 countries. In line with that, previous studies have stated that students' critical thinking skills are still relatively low (Resti et al., 2018; Hidayanti et al., 2016) on the indicators identifying, evaluating and inference with an average value of 41.72 (Razak, 2017). So this shows that students' mathematical critical thinking skills need to be further developed.

Indonesian education that is oriented towards character education as explained by the Ministry of Education and Culture (2016) is not only the cognitive realm but also the effective realm that needs to be considered. The effective realm in learning is attitudes, values, feelings, emotions and the degree of acceptance or rejection of an object (Ariyana et al., 2018). Meanwhile, the cognitive realm is a student's skill when dealing with others and a skill in self-regulating (Hui & Mahmud, 2023). Sinaga and Arliani (2024) stated that cognitive styles and thinking habits significantly affect students' critical thinking skills. Cognitive activities and critical thinking habits are known as soft skills. The types of soft mathematical skills are mathematical disposition, learning independence, self-efficacy, self-esteem, self-concept, confidence and habits of mind (Hendriana et al., 2017).

One of the effective domains in mathematics is the habit of mind which is a supporting factor in the achievement of national education goals and mathematics learning goals in the affective aspect. Some of the goals related to learning mathematics include having an attitude of appreciating the usefulness of mathematics in life, an attitude of curiosity, attention, interest in learning mathematics, tenacity and confidence, therefore a strong disposition and intelligent behavior are needed. In research, Altan et al. (2019) explained that what is meant by a strong and intelligent disposition is habits of mind. This is supported by Berenhaus and Cupchik (2020) who stated that habits of mind are important in learning because thinking is the core of all lessons in school.

Habits of mind are not a natural talent or innate factor but a habit of positive behavior that is learned

deliberately and consciously repeated over and over again. Based on the context of mathematics, mathematical habits of mind are a special attitude in approaching mathematical problems and thinking about mathematical concepts as done by mathematicians (Dzulfikar, 2018). These thinking habits that must be developed by students include the habit of observing patterns, the habit of experimenting, the habit of describing, the habit of exploring, the habit of being a thinker, the habit of being an inventor, the habit of visualizing, the habit of compiling conjectures and the habit of guessing. Habits of mind can also be used as a response to questions and answers to a problem that is not immediately known, so that teachers can observe how students produce knowledge rather than just remembering knowledge.

Research on Habits of Mind was conducted by Kose and Tanisli (2014), namely identifying geometric thinking habits of prospective elementary school teachers. The results of this study are that prospective elementary school teachers do not have a different way of thinking about the components that show geometric thinking habits, and they cannot analyze the given problem. So that the elementary school teacher has a language of thinking that is not at the desired level. Furthermore, Safitri (2017) stated that the average category of students' habits of mind in mathematics learning is moderate and of the 16 indicators given, the highest indicator score is the indicator of the student willing to continue learning and the lowest indicator score is the indicator of the student being able to check accuracy. Based on the description above, the study of critical thinking, based from the habits of mind needs to be carried out. Therefore, the researcher will conduct an analysis of the level of students' mathematical critical ability is, how the process of mathematical critical thinking of students is reviewed from the habits of mind.

METHOD

This study employed a descriptive method research with a qualitative approach. The qualitative descriptive method was used to explore and understand the critical thinking processes of Madrasah Tsanawiyah (MTs) students in solving mathematical problems in relation to their habits of mind (Yaniawati & Indrawan, 2024). The aim of this approach was to describe and analyze students critical thinking processes based on qualitative data collected at a specific point in time. The participants consisted of 48 eighth-grade students from an MTs located in Bandung during the 2021/2022 academic year. The learning topic focused on relations and functions. Data collection was carried out in the natural setting where the research took place. The primary instrument in this study was the researcher, supported by test and non-test instruments, including a mathematical problem-solving test to assess critical thinking, a habits of mind questionnaire, and interviews.

The research procedure began with students completing a 16-item habits of mind questionnaire. Based on their responses, students were categorized into three groups: High Habits of Mind (HOMH), Medium Habits of Mind (HOMM), and Low Habits of Mind (HOML). Following this, a mathematical critical thinking test was administered, focusing on relation/function problems aligned with critical thinking indicators. These indicators included classification, analysis, inference, and strategy execution. The purpose of this test was to gather information regarding the student's thinking processes at each of critical thinking. To ensure the quality of the instrument, the critical thinking test was first piloted on students outside the sample. The results were then reviewed by experts and analyzed for validity and reliability.

After the test, interviews were conducted with selected students from each habits of mind category to

confirm and deepen the data obtained from the test. These interviews provided qualitative insights into the students reasoning and thought processes. The data collected were analyzed inductively to gain a comprehensive understanding of the students mathematical critical thinking levels and to describe their thinking processes based on their habits of mind.

RESULTS AND DISCUSSION

Habits of Mind Students

The calculation of the results of the questionnaire obtained data with an ideal average of 99.50 and an ideal standard deviation of 6.83. The classification of high habits of mind (HHOM) with a score greater than or equal to 106.33, moderate habits of mind (MHOM) with a score greater than or equal to 92.67 and a more difficult score of 106.33, and low habits of mind (LHOM) with a score less than 92.67. The following are the results of the habits of mind questionnaire with the number of subjects for each category in Table 1 as follows.

Table 1. Results of the Habits Of Mind Category Questionnaire

No	Category	N	Percentage
1	Tall	8	16,67 %
2	Keep	23	47,92%
3	Low	17	35,41%
	Sum	48	100%

Based on Table 1. that each category of habits of mind has a different number of students. The smaller number of HHOM compared to other categories illustrates that there are still many students who are not used to thinking critically in mathematics learning (Nurdiansyah et al., 2021; Nurmeidina et al., 2022). For students in the MHOM and LHOM categories, it is necessary to get treatment as an effort to improve critical thinking skills. If the quality of students improves, it will affect the student's mindset and eventually improve their mathematical skills (Dong et al., 2023). Mathematical creative thinking skills are associated with habits of mind towards creativity where students who have positive habits of mind towards creativity tend to have good mathematical creative thinking skills. And vice versa (Mahmudi & Sumarmo, 2015; Nurmeidina et al., 2022). Teachers need to provide an approach to mathematics learning that is able to improve students' habits of mind (Sumartini, 2022) so that they are used to thinking and practicing in dealing with mathematical problems. Efforts that can be made to improve students' habits of mind include: (1) evaluating student learning outcomes; (2) pay more attention to the student's learning environment; and (3) adding a supportive student experience to each mathematical activity he or she does (Ibrahim et al., 2023). In addition, student learning techniques need to be considered such as making a study schedule, making concise and well-organized notes (Yadav, 2024).

Critical Thinking Skills of MTs Students

A person's thought process can be identified through four stages, namely classification, assessment, inference and strategy (Baidawi et al., 2023). The results of students' critical thinking processes certainly have implications for the acquisition of scores obtained when given a critical thinking ability test. The

problems given refer to the indicators of critical thinking stages and scoring for each stage each has an ideal score of 4. A score of 0 - 2 indicates that the student has not gone through the critical thinking stage well and a score of 3 - 4 indicates that the student can go through the critical thinking stage well. The average score for each critical thinking stage indicator is presented in Table 2. as follows.

Table 2. Average Mathematical Critical Thinking Score

Indicators of the stages of critical thinking	Ideal Score	Correspondence	Percentage (%)	Category
Clarification	4	3,49	87,37	Tall
Assessment	4	2,98	74,48	Keep
Inference	4	2,55	63,67	Keep
Strategy	4	1,64	40,89	Very Low
Average		2,66	66,60	Keep

In Table 2. Showing the ability of students at each stage of the critical thinking ability indicator has different scores. However, for the overall results of the indicators, an average critical thinking score was obtained in the medium category. This proves the results of an OECD study (2023) in PISA 2022 that the average score of Indonesian students in mathematics is still below the international average, which shows that students' critical thinking skills need to be developed again (Suryawan et al., 2023). In addition, based on research by Aji et al. (2024) it is stated that only one in five schools in South Sumatra is an indicator of students' thinking skills by showing a high category. One of the factors that causes a lack of mathematical critical thinking skills is a lack of understanding in mathematics and habits of mind (Sumartini, 2022).

The score on the student's critical ability test based on the categories of high, medium and low habits of mind had different results. Students with the category of high habits of mind (HHOM) which totals eight students can go through the stages of critical thinking, clarification, assessment, inference and strategy. This is in line with what Nahak et al. (2022) stated, that HHOM students can solve problems by meeting the critical thinking indicators correctly and correctly. Furthermore, 23 students with moderate habits of mind (MHOM) category have different stages of critical thinking, namely six students who can go through the four stages of critical thinking, namely the stages of clarification, assessment, inference and strategy, 13 students can go through three stages of critical thinking, namely the stages of clarification, assessment and inference, three students can go through two stages of critical thinking, namely clarification and assessment and one student can only go through one The critical thinking stage is the clarification stage. Therefore, MHOM students have not been able to carry out the stages of critical thinking thoroughly (Amalia et al., 2020). Furthermore, for students with low habits of mind (LHOM) category, there is one student who can go through the four stages of critical thinking, namely the stages of clarification, assessment, inference and strategy, three students can go through three stages of critical thinking, namely the stages of clarification, assessment, and inference, six students can go through two stages of critical thinking, namely the classification and assessment stages, five students can go through one stage of critical thinking, namely the classification stage and two Students cannot go through any stage of critical thinking. Students in the low category do not

understand the problem and there are still inappropriate solution steps (Satriani, 2020). So that dominating LHOM students cannot make the right conclusions (Zaki et al., 2021).

Mathematical Critical Thinking Process of MTs Students

The First Problem

The results of data processing of mathematical critical thinking ability tests and habits of mind questionnaires will be described according to the critical thinking process in accordance with three categories of habits of mind, namely high habits of mind (HHOM), moderate habits of mind (MHOM) and low habits of mind (LHOM) (Putri et al., 2021; Nurmeidina et al., 2022). In Figure 1. The first problem is in the form of material about relationships/functions. This problem is carried out to find out the stage of critical thinking of students in carrying out the stages of clarification, assessment, inference and strategy. The following are the questions and details of the students' answers.

1. Four children named Budi, Tian, Parto and Sukma. Budi and Tian are tall, the other children are not. Tian and Parto are black, the other children are not. Budi and Sukma have curly hair, the others do not. So the child who is black but not tall is Parto. Is it true that a child who is black but not tall is Parto? Explain!

Figure 1. The First Problem

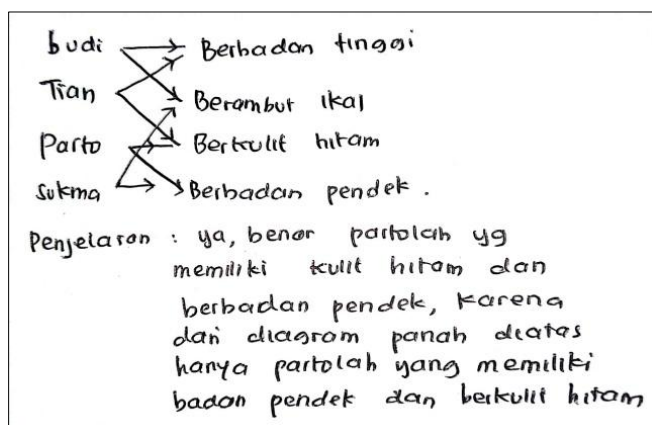


Figure 2. HHOM Category Students' Answers to the First Problem

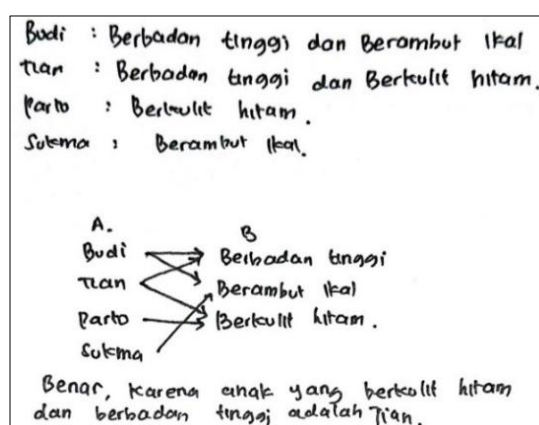


Figure 3. Student Answers in the MHOM Category to the First Problem

Based on research by Prasetyo and Firmansyah (2022), students with high critical thinking skills will be able to understand problems, plan strategies, solve problems, and evaluate decisions. Figure 2 and interviews show that students in the HHOM category can carry out the process of classification, assessment, inference and strategy stages (Nurmeidina et al., 2022). The initial process of solving problems is by identifying problems first. The student knows what problems are contained in the question so that students can determine important questions in the question based on the information needed. Then the student can use the information to be used and find the steps to solve the problem by making an arrow diagram from the

information data of the time of the visit. After making an arrow diagram, the student matches the statement on the question with the data collection results that have been obtained. So that the student with strong belief, can make a conclusion to the question in the question and after getting the answer the student double-checks the steps that have been taken to ensure the answer that has been made. Putri et al. (2024) stated that students in the HHOM category have habits of never giving up, thinking flexibly, applying past knowledge to new situations, and metacognition in solving mathematical problems. This is also in line with four indicators of students' thinking habits, namely perseverance, thinking about thinking, flexibility of thinking, and the ability to apply previous knowledge to new situations (Nauli et al., 2024).

Furthermore, based on the results of the researcher's interviews with students in the MHOM category, to confirm the answers that have been written as in Figure 3, information was obtained that they understood the problems contained in the questions given (Dzulfikar, 2018). MHOM students can analyze the information contained in the questions to check the correctness of the answers that have been contained in the questions. Furthermore, data collection is carried out based on the time of visit for each child. After collecting data, the student matched the statement on the question with the results of the existing data. And stated that the statement was in accordance with the data provided. Then at the end of the work, check the answers that have been obtained. So that students with the MHOM category are able to solve the first problem to meet all stages of critical thinking. Students with developed thinking habits are able to solve problems, provide arguments and develop mathematical problem-solving strategies (Mahmudi & Sumarmo, 2015; Habibi, 2020; Marzuki et al., 2024).

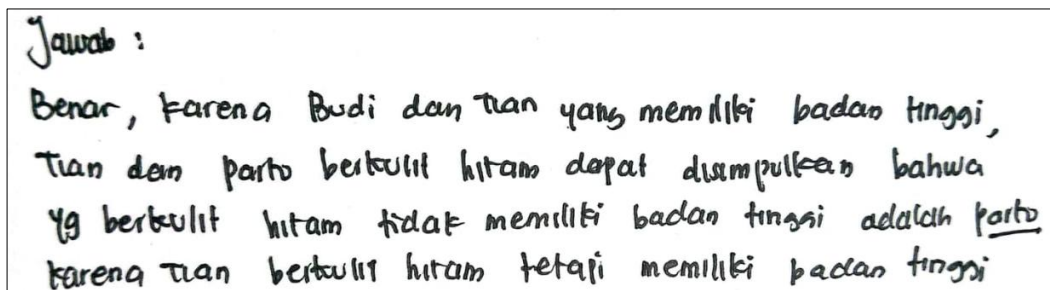


Figure 4. Students' Answers in the LHOM Category to the First Problem

Furthermore, based on the results of the researcher's interviews with students in the MHOM category, to confirm the answers that have been written as in Figure 4, information is obtained that they can understand well the problem referred to in the question. The student can detail the data contained in the problem, can make a solution strategy based on the information that has been detailed, and can find a solution. However, it did not re-check. Even though students with low critical thinking categories are able to solve problems. This is because students who often practice with the same type of questions tend to be able to solve them so that they can express and improve problem-solving skills (Walidainismawati et al., 2021; Uredi & Kosece, 2020).

Second Problem

The second problem is the problem of function. This question is to measure the ability of students'

mathematical critical thinking stages. The questions and details of the students' answer results represent the categories habits of mind in solving the following errors:

2. It is known that $f(x)$ is a function that fulfills $f(x + y) = x + f(y)$ and $f(0) = 2$. Determine the value of $f(2021)$?

Figure 5. Second Problem

- Karena dalam soal diketahui
 $f(0) = 2$, maka nilai $y = 0$
 $f(x + y) = x + f(y)$
 $f(x + 0) = x + f(0)$
 $f(x) = x + 2$
 maka nilai dari $f(2021)$
 $f(x) = x + 2$
 $f(2021) = 2021 + 2$
 $f(2021) = 2023$

Figure 6. Students' Answers to the HHOM Category on the Second Problem

$f(x + y) = x + f(y)$
 $f(0) = 2$
 $f(2021) = ?$
 Jawab :
 $f(0) = 2 \rightarrow f(0 + y) = 0 + f(y)$
 $f(y) = f(y)$
 $f(0) = 2$
 $x + y = 0$
 $x + f(y) = 2$

Figure 7. MHOM Category Students' Answers to the Second Problem

Furthermore, based on the results of the researcher's interviews with students in the HHOM category, to confirm the answers that have been written as in Figure 6, information was obtained that HHOM students can go through the clarification stage. Then the student can go through the assessment stage. This can be seen from the student being able to identify and determine a problem-solving strategy by utilizing the information contained in the question. In line with Safitri (2017) stated that students understand an order before solving the given problem. Furthermore, the student is able to go through the inference stage, namely the student can determine the conclusions obtained from the calculation results, namely $f(x) = x + 2$ and determine the value $f(2021) = 2021 + 2 = 2023$. At the strategy stage, the student evaluates the problem-solving steps that have been taken. HHOM students are able to pass the critical thinking stage well (Marlita & Nari, 2024; Muniro et al., 2024; Nurmaliza et al., 2022). This proves that learning with high mathematical thinking habits (HHOM) will provide good mathematical critical thinking skills (Asria, 2019; Nurdiansyah et al., 2021).

Next, the researcher conducted interviews with students in the MHOM category to confirm the answers that had been written as in Figure 7. Information was obtained that they could go through the clarification stage well. The student can understand the problem and record the information contained in the question. At the assessment stage, the student cannot identify and cannot determine the completion strategy to be carried out, so the student cannot do the next stage, namely inference and strategy. This is because students with critical thinking skills are able to understand concepts but may not be able to solve problems correctly (Kholid et al., 2021). In line with that, previous research explained that students with moderate abilities in the critical thinking process are only able to understand problems but are less able to make the right strategies in solving problems (Muniro et al., 2024; Shafira et al., 2023; Nurmaliza et al., 2022).

$$\begin{aligned}
 f(x+y) &= x + f(y) \\
 f(0) &= 2 \\
 f(2021) &= \dots ? \\
 x+y &= 0 \\
 f(2021) &= 2000
 \end{aligned}$$

Figure 8. Students' Answers in the LHOM Category to the Second Problem

Furthermore, the researcher conducted interviews with students in the LHOM category to confirm the answers that had been written as in Figure 8. Information was obtained that they could go through the clarification stage well. The student is able to understand the problem and detail the data contained in the problem. However, the student cannot go through the next stage, namely assessment, inference and strategy. This is because LHOM students are not familiar with the question so it is difficult to answer the question (Muniro et al., 2024; Nurmaliza et al., 2022; Ulfiana, 2019). In line with Walidainismawati et al. (2021), students who lack critical thinking skills in solving math problems because they only focus on thinking that the problem is difficult rather than analyzing and solving problems with the right strategy.

Third Problem

The third problem is the problem of function. This question is to measure the ability of students' mathematical critical thinking stages. The questions and details of the students' answer results represent the categories of habits of mind in solving problems as follows.

3. If the first four members of the relation of the set of numbers are: (0,2), (1,4), (2,6), (3,8), then the following members are (4,10). Is the above conclusion true? Give the reason! Now write the next three members for the relation of the set of numbers below: (1,2), (2,5), (3,8), (...), (...), (...)
Explain how to get it!

Figure 9. Third Problem

Benar karena (0,2) dan (1,4)

$$\begin{aligned}
 \frac{x-x_1}{x_2-x_1} &= \frac{y-y_1}{y_2-y_1} & 2x &= y-2 \\
 & & 2x+2 &= y \\
 \frac{x-0}{1-0} &= \frac{y-2}{4-2} & \text{Kata pilih } x=4 \Rightarrow y &= 2(4)+2 \\
 & & &= 8+2 \\
 & & &= 10 \\
 \frac{x}{1} &= \frac{y-2}{2} & \text{Benar } x=4 \text{ maka } y &= 10
 \end{aligned}$$

(1,2), (2,5), (3,8), (4,11), (5,14), (6,17)

Benar, karena membentuk notasi bilangan cacah, yaitu dengan menambahkan 1,3 setelah urutan bilangan cacah dan 1,2.

Figure 10. HHOM Category Students' Answers to the Third Problem

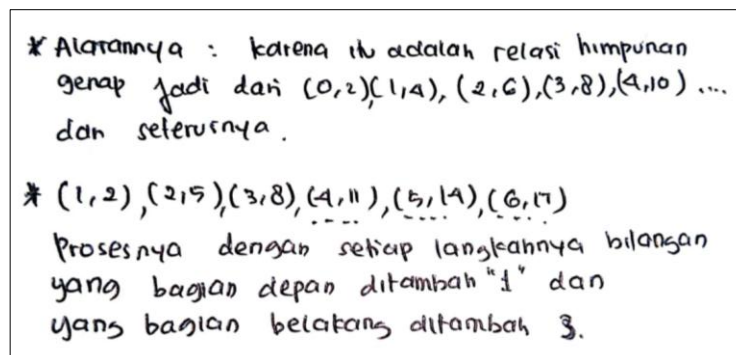


Figure 11. MHOM Category Students' Answers to the Third Problem

Furthermore, the researcher conducted interviews with students in the HHOM category to confirm the answers that had been written as in Figure 10. Information was obtained that they could go through the clarification stage well. The student can understand the problem of the problem well and can detail the data contained in the question, can determine the domain and range of the given question. at the assessment stage, HHOM students can go through this stage well. The student can identify the information and determine the settlement strategy to be made (Muniro et al., 2024). From the data obtained, HHOM students first looked for a function formula that met the condition of the problem. Then at the stage of inference the student can go through it well. The student can make a conclusion based on the available information so that the student can determine that the conclusion contained in the question is correct. Furthermore, HHOM students can go through the strategy stage well. This can be seen from the results of the interview, the student evaluated the problem-solving steps carried out and was able to solve the same problem with different alternative solutions. HHOM students have a high critical thinking way so that they are able to solve good mathematical problems. Students with high critical thinking skills (HHOM) are able to show the ability of all indicators, including classification, assessment, strategy, and inference (Lestari et al., 2024; Nurmaliza et al., 2022). In line with Nugroho (2020) that strong mathematical thinking habits can increase students' critical and creative thinking.

Furthermore, the researcher conducted interviews with students in the MHOM category to confirm the answers that had been written as in Figure 11. Information was obtained that they could go through the clarification stage well. The student can understand the problem and record the information contained in the question. At the assessment stage, the student can identify and can determine the settlement strategy to be carried out. At the inference stage, the student can draw conclusions from the results of the pattern experiment on Cartesian coordinates. At the strategy stage, the students did not evaluate the problem-solving steps that had been taken (Muniro et al., 2024; Nurmaliza et al., 2022). MHOM students can solve these problems because they are able to understand problems, formulate plans and implement plans (Yustiana et al., 2021). This is in line with Putri et al. (2024) that the Habits of Mind that students have are in the medium category, namely perseverance, thinking about thinking, flexibility in thinking, and the ability to apply past knowledge to new situations.

0-2	1-2
1-4	2-6
2-6	3-8
3-8	4-11
4-10	5-14
	6-17

Figure 12. LHOM Category Students' Answers to the Third Problem

Furthermore, the researcher conducted interviews with students in the LHOM category to confirm the answers that had been written as in [Figure 12](#). Information was obtained that they could go through the clarification stage well. The student is able to understand the problem and detail the data contained in the problem. However, the student cannot go through the next stage, namely assessment, inference and strategy. This is because the low critical thinking ability in solving mathematical problems by analysis, evaluation, and inference is the weakest sub-ability mastered by students (Basri, [2019](#)). Cartesian coordinate types are prone to difficulties and errors, especially in analyzing and evaluating (Anastia et al., [2024](#)). Ulfiana ([2019](#)) that low mathematical critical thinking skills are caused by students not being familiar with this type of problem. Therefore, it is necessary to have a balanced teaching approach that combines direct teaching and independent learning (Liu et al., [2024](#)).

CONCLUSION

A person's thought process is seen in four stages, namely classification, assessment, inference and strategy. The average score of thinking ability obtained by students of 66% is classified as moderate. Based on the results of filling out questionnaires, tests and interviews that have been carried out, it can be concluded that students' critical thinking processes in solving mathematical problems have different achievements according to the level of students' mathematical critical thinking skills reviewed from the habits of mind. The level of critical thinking ability of students in the high category is still very low compared to the medium and low categories. Students with high habits of mind have high critical thinking skills. Students with moderate habits of mind (MHOM) are able to solve problems. However, it is difficult to remember the concept of the formula used to solve the problem. As for students with low habits of mind (LHOM), they are only able to understand the problem and tend to have difficulty in determining a solution strategy and cannot solve the problem.

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