



Students' Thinking Processes in Solving Higher Order Thinking Skills (HOTS) Problems Based on Metacognitive Levels

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ABSTRACT

This study aims to describe students' thinking processes in solving Higher Order Thinking Skills (HOTS) problems in terms of metacognitive levels among students of class XII MIPA 4 at SMA Negeri 2 Banjarsari. This research employed a qualitative descriptive approach. The subjects were 27 students classified into three metacognitive levels (high, moderate, and low) based on a metacognitive questionnaire. Five students were selected as research subjects: one with high metacognition, two with moderate, and two with low. Data were collected through HOTS written tests, a metacognitive questionnaire, and unstructured interviews, and analyzed through data reduction, data display, and conclusion drawing. The results showed that students with high metacognitive levels performed systematic higher-order thinking through planning, monitoring, and evaluation stages. Students with moderate levels were able to solve problems procedurally but showed limited monitoring and evaluation. Students with low levels experienced difficulties in planning, monitoring, and evaluating their problem-solving processes. In conclusion, metacognitive level influences the quality of students' thinking processes in solving HOTS problems and highlights the importance of developing metacognitive skills in mathematics learning.

Keywords: *thinking process, hots problems, metacognitive level*

INTRODUCTION

Students' thinking processes constitute a fundamental aspect of learning activities, as through these processes students not only receive information but also process, understand, and connect it with their prior knowledge and experiences. An active thinking process enables students to construct meaningful understanding rather than merely memorizing information mechanically. Anderson and Krathwohl [1] emphasize that effective thinking processes can foster deeper conceptual understanding. Without active engagement in thinking, learning tends to be short-term and easily forgotten, as it is not integrated into the learners' existing knowledge structures.

The distinction between memorization and understanding has become a crucial emphasis in modern education. Memorization may help students answer simple questions, but it does not guarantee their ability to apply concepts in real-life situations. In contrast, conceptual understanding makes knowledge more flexible, durable, and transferable across various learning contexts. This aligns with Ausubel's (1968) theory of meaningful learning and is supported by findings [2], which state that new information becomes meaningful when it is connected to students' existing cognitive structures. Furthermore, [3] indicate that learning based on conceptual understanding is more

effective than memorization-based approaches, particularly in helping students deal with novel problems. Therefore, active thinking processes serve as an essential bridge from merely remembering information to developing the ability to analyze, evaluate, and create.

The revised taxonomy model proposed by Anderson and Krathwohl [4] explains that cognitive processes consist of six levels: remembering, understanding, applying, analyzing, evaluating, and creating. These stages indicate that thinking is a dynamic, complex, and developmental activity. In mathematics learning, thinking processes involve not only cognitive activities but also emotional and social dimensions that influence conceptual understanding [5]. Thinking itself can be described as a series of interactions among cognitive functions in the brain, encompassing reasoning, analysis, evaluation, and creativity [6]. Furthermore, [7] add that thinking processes may take the form of associative (creative) thinking or directed (convergent) thinking, both of which are strongly influenced by students' cognitive readiness and the level of difficulty of the problems they encounter.

In the context of 21st-century learning, Higher Order Thinking Skills (HOTS) have become one of the essential competencies. HOTS encompass the ability to

connect, manipulate, interpret, and transform knowledge, enabling students to solve new problems creatively and critically [8]. Solving HOTS-oriented problems requires not only the ability to analyze and evaluate but also the capacity to create and develop innovative solutions.

However, students' HOTS cannot be separated from their metacognitive abilities, namely the awareness of and ability to regulate their own thinking processes. [9] explain that metacognition includes three main components: planning, monitoring, and evaluating. These components are interconnected in helping students manage their learning processes in a more strategic. [10] previous studies on Higher Order Thinking Skills (HOTS) in mathematics learning have generally focused on measuring students' achievement outcomes or identifying procedural errors, rather than examining the underlying thinking processes that occur during problem solving. Although metacognition has been widely acknowledged as an important factor influencing higher-order thinking, limited research has explored how different levels of metacognitive ability shape students' planning, monitoring, and evaluation processes when solving HOTS problems, particularly in the topic of measures of central tendency (mean, median, and mode). Preliminary findings at SMAN 2 Banjarsari indicate that while some students are able to reach the analysis level, fewer progress to evaluation and creation levels, suggesting a gap between expected HOTS competencies and students' actual cognitive performance. Furthermore, students' difficulties are not only computational but also conceptual, as they struggle to connect statistical results with logical interpretations in contextual problems. Therefore, this study offers novelty by providing an in-depth qualitative analysis of students' thinking processes based on metacognitive levels (high, moderate, and low) in solving HOTS problems on measures of central tendency. By integrating HOTS, metacognitive stages, and statistical concepts within a single analytical framework, this research contributes a more comprehensive understanding of how metacognitive levels influence the quality of higher-order thinking in mathematics learning.

Study [11] indicates that students' difficulties in solving HOTS problems on the topic of measures of data dispersion are caused by weak conceptual understanding, limited practice with higher-level problems, and low levels of critical and reflective thinking skills. These conditions highlight the crucial role of metacognition in assisting students to monitor, regulate, and evaluate the problem-solving strategies they employ.

Based on this background, the present study focuses on students' thinking processes in solving Higher Order Thinking Skills (HOTS) problems viewed from their levels of metacognition, particularly on the topic of measures of central tendency. This focus was chosen to obtain a deeper understanding of the relationship between students' metacognitive abilities and their success in solving HOTS problems. The novelty

of this study lies in the direct analysis of the relationship between metacognitive levels ranging from tacit use, aware use, strategic use, to reflective use and students' abilities to understand, apply, and interpret statistical concepts. Students with low levels of metacognition tend to perform calculations mechanically, whereas those with high levels of metacognition are able to develop effective solution strategies, connect concepts to contextual situations, and evaluate their solutions critically and reflectively. Therefore, the purpose of this study is to describe and analyze students' thinking processes in solving HOTS problems based on their metacognitive levels and to examine how these levels influence the quality of their higher-order thinking in mathematics learning.

RESEARCH METHODS

This study employed a descriptive qualitative method to describe students' metacognitive activities in solving Higher Order Thinking Skills (HOTS) problems. The research was conducted at SMAN 2 Banjarsari in the first semester of the 2025/2026 academic year, involving all 27 students of class XII MIPA 4 as the research population. The sampling technique used was purposive sampling based on the results of a metacognitive questionnaire, resulting in five students representing high, moderate, and low metacognitive levels for in-depth analysis.

The research data consisted of metacognitive questionnaire results, essay-type HOTS test responses, think-aloud protocols, and interviews. Data analysis was carried out through the stages of data reduction, data display, and conclusion drawing. The validity of the data was ensured through technique and source triangulation as well as member checking. Through these procedures, the study provided a clear description of students' metacognitive levels in solving HOTS problems.

RESULT AND DISCUSSION

This study aims to describe students' thinking processes in solving HOTS problems viewed from their levels of metacognition, namely high, medium, and low. Prior to data collection, the metacognitive questionnaire was first validated through expert judgment to ensure its content validity and clarity of items. A pilot test was then conducted to examine the reliability and consistency of the instrument. After the questionnaire was declared valid and reliable, it was administered to all 27 students of class XII MIPA 4.

Based on the results of the questionnaire, students were classified into three categories of metacognitive level: high, medium, and low. The classification was determined using the established scoring criteria. From these categories, research subjects were selected using purposive sampling to represent each metacognitive level. One student representing the high metacognitive level (S4), two students representing the medium level (S21 and S17), and two students representing the low level (S1 and S11) were chosen for in-depth analysis.

After the subjects were selected, data were collected through written HOTS tests, unstructured interviews, think-aloud protocols during problem solving, and document analysis of students' written work. These multiple data sources were used to obtain a

comprehensive understanding of students' thinking processes at each metacognitive level.

Based on the results of the metacognitive questionnaire, the data obtained are presented in Table 1 below.

Table 1. Results of Students' Metacognitive Questionnaire.

No	Name	Planning (Score/18)	Monitoring (Score/18)	Evaluation (Score/16)	Total Score	Average (Total Score/52)	Category
1	S1	53	53	50	155	2,98	Low
2	S2	59	54	51	164	3,15	Medium
3	S3	58	56	49	163	3,13	Medium
4	S4	73	76	67	216	4,15	High
5	S5	61	60	47	168	3,23	Medium
6	S6	47	45	45	137	2,63	Low
7	S7	52	55	48	155	2,98	Low
8	S8	60	57	47	164	3,15	Medium
9	S9	49	55	46	150	2,88	Low
10	S10	48	48	46	142	2,73	Low
11	S11	55	35	43	133	2,56	Low
12	S12	56	53	44	153	2,94	Low
13	S13	45	73	44	162	3,12	Medium
14	S14	63	59	45	167	3,22	Medium
15	S15	60	54	47	161	3,09	Medium
16	S16	52	49	41	142	2,73	Low
17	S17	63	55	47	165	3,17	Medium
18	S18	49	65	49	163	3,13	Medium
19	S19	56	63	50	169	3,25	Medium
20	S20	57	49	47	153	2,94	Low
21	S21	71	69	55	195	3,75	Medium
22	S22	58	62	48	168	3,23	Medium
23	S23	56	59	54	169	3,25	Medium
24	S24	46	45	33	124	2,38	Low
25	S25	57	59	40	156	3,00	Low
26	S26	53	55	46	154	2,96	Low
27	S27	56	53	50	159	3,06	Medium

Based on Table 1, out of 27 students, 1 student (3.7%) was categorized as having high metacognition, 15 students (55.6%) were in the moderate category, and 11 students (40.7%) were in the low category. These data indicate that the majority of students were at a moderate level of metacognition, while the number of students with high metacognition was very limited. In general, students' metacognitive abilities were not evenly distributed and were still dominated by the moderate and low categories. This finding is consistent with the study conducted by [12], which reported that most students tend to fall into the moderate and low metacognitive levels, with only a small proportion reaching the high category.

In terms of the planning, monitoring, and evaluation aspects, students in the high category demonstrated relatively balanced and consistent scores across all three components. Students in the moderate category showed fairly good performance, although their scores were not stable across each aspect. Meanwhile, students in the low category exhibited noticeable imbalances, particularly in the evaluation aspect, which tended to be lower. This suggests that many students have not yet optimally reflected on and evaluated their thinking processes. Overall, these data indicate the need to develop students' metacognitive skills, particularly at the evaluation stage, in order to

enable them to solve HOTS problems more systematically, reflectively, and effectively. This finding is consistent with the study by [13], which demonstrated that improving metacognitive regulation, especially in the evaluation aspect, significantly contributes to students' success in solving higher-order thinking problems.

The results of this study further indicate that students' metacognitive levels significantly influence the quality of their thinking processes in solving HOTS problems. This finding is consistent with Flavell's (1979) theory of metacognition, which emphasizes that awareness and regulation of one's own thinking processes play a crucial role in successful problem solving. Students with high metacognitive levels demonstrated systematic and reflective thinking patterns through planning, monitoring, and evaluation stages, as also confirmed by [14], who reported that metacognitive regulation contributes to improved academic performance. In contrast, students with low metacognitive levels tended to work mechanically without deep reflection. This supports the findings of [15], who stated that higher-order thinking skills require strong self-regulation and reflective control.

The main findings also reveal that most students were categorized at the moderate metacognitive level, with only a small percentage reaching the high level.

The most prominent weakness was observed in the evaluation stage. This condition aligns with the findings of [16], who explained that evaluation is the most complex metacognitive stage because it requires critical self-reflection. Additionally, this result supports the study of [17], which found that many students do not spontaneously employ metacognitive strategies, particularly in the evaluation phase.

Several factors may explain these outcomes. First, instructional practices that remain procedurally oriented may hinder the development of metacognitive reflection [18]. Second, limited experience in solving HOTS problems that demand analysis, evaluation, and creation may contribute to low metacognitive regulation [19]. Third, the lack of explicit training in metacognitive strategies, such as self-questioning and monitoring comprehension, as suggested by [20], may also contribute to these findings.

This study has several strengths, as it provides an in-depth qualitative description of students' thinking

Table 2. Percentage Distribution of Students' Metacognitive Levels

No	Category Metacognitive	Number of Students (f)	Percentage (%)
1	High	1	3,70
2	Medium	14	51,85
3	Low	12	44,44
4	Total	27	100

Based on Table 2, the majority of students were categorized at the moderate level of metacognition, with 14 students or 51.85% out of a total of 27 students. This indicates that more than half of the students possess fairly adequate metacognitive skills, such as being able to plan and implement problem-solving steps; however, they are not yet fully consistent in monitoring and evaluating their thinking processes.

Furthermore, 12 students (44.44%) were categorized as having low metacognition. This percentage is relatively high, indicating that nearly half of the students still experience difficulties in controlling and reflecting on their thinking processes. Students in this category tend to solve problems procedurally without careful planning and demonstrate limited monitoring and evaluation of their answers. This finding is consistent with the study by [22] which stated that low metacognitive regulation leads students to rely more on mechanical procedures without adequate control and reflection in the problem-solving process.

Meanwhile, only one student (3.70%) was categorized as having high metacognition. This very small percentage indicates that only a limited number of students are able to optimally apply planning, monitoring, and evaluation strategies in the problem-solving process. Overall, this distribution suggests that students' metacognitive abilities are still dominated by the moderate and low levels. Therefore, more structured and systematic instructional efforts are needed to enhance students' metacognitive awareness and regulation, as emphasized by [23], who highlighted the importance of strengthening metacognitive strategies in improving students' thinking processes and problem-solving performance.

processes based on metacognitive levels and integrates HOTS, metacognition, and statistical concepts within a single analytical framework. However, it also has limitations, including the relatively small sample size and its focus on a single class, which may limit the generalizability of the findings.

When compared with previous studies, the results are consistent with findings indicating that metacognitive ability is positively correlated with higher-order thinking skills [21]. No significant contradictions were identified; rather, this study extends previous research by offering a more detailed explanation of how metacognitive levels (tacit use, aware use, strategic use, and reflective use) are manifested in the stages of planning, monitoring, and evaluation in solving HOTS problems on measures of central tendency.

The percentage distribution of students' metacognitive levels based on the data in Table 2 is presented below:

The findings of the study reveal that most students are at moderate and low levels of metacognition, with only one student reaching the high level. This condition can be explained through a logical cause-and-effect relationship. Learning practices that primarily emphasize procedural completion and obtaining correct answers have made students less accustomed to planning strategies, monitoring their thinking processes, and evaluating their work. As a result, when solving HOTS problems, students with low metacognitive levels tend to work mechanically without clear planning, while those at the moderate level can follow solution steps but are not yet optimal in monitoring and evaluation. In contrast, students with high metacognitive levels demonstrate more systematic and reflective thinking because they are aware of and able to control each stage of the problem-solving process [24]. Therefore, the higher the level of metacognition, the more structured and meaningful the students' thinking processes become.

The main findings indicate that the majority of students fall into the moderate metacognitive category (51.85%), followed by the low category (44.44%), and only 3.70% in the high category. The most prominent weakness was found in the evaluation stage, suggesting that students' reflective thinking skills are not yet optimally developed. These results may be influenced by several factors, including instructional approaches that focus more on procedural learning, limited exposure to HOTS-based problems, insufficient explicit training in metacognitive strategies such as self-questioning and monitoring understanding, and a learning culture that prioritizes final answers over thinking processes.

This study has several strengths, as it provides an in-depth description of students' thinking processes at each metacognitive level and employs multiple data collection techniques questionnaires, written tests, interviews, and document analysis thus ensuring comprehensive data. However, the study also has limitations, including the relatively small number of participants from a single class, which limits generalizability, and the potential subjectivity inherent in qualitative data analysis. When compared with

previous studies, the findings are consistent with research indicating that metacognition is positively related to higher-order thinking skills and problem-solving ability. No significant contradictions were identified; instead, this study reinforces previous findings by offering a more detailed explanation of how different metacognitive levels influence the stages of planning, monitoring, and evaluation in solving HOTS problems. Table 3 below presents the selected research subjects based on their metacognitive category.

Table 3. Classification of Metacognitive Questionnaire Results.

Subject Selection	Metacognitive Classification Criteria
S4	High
S2	Medium
S19	Medium
S1	Low
S10	Low

Based on Table 3 regarding subject selection, this study involved five students who were chosen to represent each level of metacognitive category. S4 represented the high category, S2 and S19 represented the moderate category, while S1 and S10 represented the low category. This selection indicates that each metacognitive level was proportionally represented to enable a comparative analysis of students' thinking processes across categories

Subjects S2 and S19 were selected to represent the medium metacognitive level. Both subjects showed fairly good planning and implementation skills; however, they still exhibited limitations in monitoring their understanding and conducting in-depth evaluation of their results. The selection of two subjects in the medium category aimed to illustrate the variation in thinking processes among students at the intermediate level.

Based on the results of the analyzed metacognitive questionnaire, the researcher selected five research subjects representing each level of metacognition: high, medium, and low. The selection of these subjects was intended to obtain a comprehensive description of the variations in students' thinking processes when solving mathematics problems in terms of their metacognitive levels.

Subjects S1 and S10 were selected to represent the low metacognitive level. Both subjects demonstrated limitations in understanding the problem, formulating solution strategies, and regulating as well as evaluating their thinking processes. Their problem-solving procedures tended to be unsystematic and often stopped before reaching an appropriate conclusion.

1. Research Findings of the High Metacognitive Subject (S4)

Subject S4 was chosen to represent the high metacognitive level because this student demonstrated very strong abilities in planning, monitoring, and evaluation. The subject was able to systematically plan problem-solving strategies, consistently monitor each step taken, and effectively evaluate and reflect on the results obtained.

S4 was selected as the student representing the high metacognitive category based on the results of the metacognitive questionnaire. The detailed results of S4's metacognitive questionnaire are presented in Table 4 below.

Table 4. Results of the Metacognitive Questionnaire for Subject S4

Metacognitive Component Indicators	Number of Correct Responses	Metacognitive Level	Metacognitive Level Classification Criteria
Planning	73	High	High
Monitoring	76	High	
Evaluating	67	High	

Based on Table 4, the three indicators of metacognitive components planning (73), monitoring (76), and evaluation (67) are categorized as high. This indicates that, in general, students possess good abilities in planning solution strategies, monitoring their thinking processes, and evaluating the results obtained. Although the evaluation score is slightly lower than planning and monitoring, the overall level of metacognition falls within the high classification.

problems. From a cause-effect perspective, S4's ability to plan, monitor, and evaluate did not emerge by chance, but rather as a result of well-developed metacognitive awareness. When students have strong cognitive control, they do not merely read the problem to find an answer; instead, they strive to understand the structure of the problem first. The awareness that percentage data must be converted into the number of participants before being analyzed reflects careful planning. Furthermore, the habit of organizing data into tables and rechecking calculation steps represents active monitoring that ensures procedural accuracy. At the final stage, the

The findings for subject S4 show that a high level of metacognition directly contributes to the quality of the thinking process in solving HOTS

ability to interpret measures of central tendency contextually demonstrates reflective evaluation. Thus, the higher an individual's metacognitive awareness and regulation, the more systematic, controlled, and meaningful their thinking process becomes.

The results of this study indicate that students with high metacognition are able to carry out the three stages of thinking regulation planning, monitoring, and evaluation completely and consistently. The subject not only follows mathematical procedures but also understands the rationale behind the chosen strategy and is able to relate the computational results to the problem context. This clearly distinguishes the thinking characteristics of students in the high category from those in the moderate and low categories.

Several factors may explain these findings, including well-developed reflective abilities, experience in dealing with problems requiring in-depth analysis, and possible study habits that encourage rechecking and critical thinking. In addition, internal factors such as motivation and a sense of responsibility for answer accuracy may further strengthen effective metacognitive regulation.

This study has strengths in its ability to describe in detail students' thinking processes at each metacognitive stage through data triangulation (tests, interviews, and document analysis). The qualitative approach enabled the researcher to capture cognitive dynamics that are not visible from written answers alone. However, this study also has limitations, including the limited number of subjects and its focus on a single content context, meaning that the findings cannot yet be widely generalized. Moreover, qualitative data interpretation inevitably carries a potential for subjectivity.

When compared with previous research as outlined in the *state of the art* section of the introduction, the findings of this study are consistent with those of [25], who emphasized that metacognition plays a crucial role in controlling cognitive processes, as well as the research of [26], which demonstrated that metacognitive regulation is positively correlated with problem-solving effectiveness. The results are also aligned with the revised Bloom's Taxonomy framework proposed by [27], which positions evaluation as a higher-order thinking level requiring metacognitive control. Furthermore, the findings are supported by recent research [28], which confirms that metacognitive regulation including planning, monitoring, and evaluation significantly contributes to successful problem solving. In line with this, [29] in *Thinking Skills and Creativity* reported a significant positive relationship between metacognitive regulation strategies and the enhancement of higher-order thinking skills. Additionally, [30] in *Contemporary Educational Psychology* revealed that monitoring and self-evaluation activities directly improve the quality

of complex problem solving. Therefore, no contradictions were found with previous studies; rather, this research further strengthens and clarifies how metacognitive regulation is concretely manifested at each stage of solving HOTS problems, particularly in the topic of measures of central tendency.

The results of the analysis of students' answers can be seen in Figure 1 below.

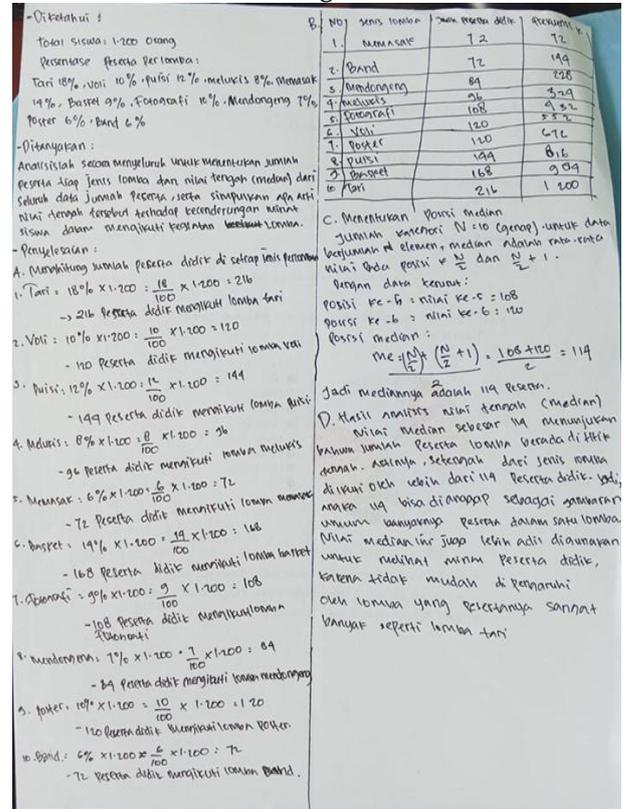


Figure 1. Analysis of Student S4's Response

Figure 1 shows that student S4 demonstrates a high level of metacognition. This is evident from the structured planning of the solution, accurate monitoring through systematic calculations and data organization, and reflective evaluation by rechecking results and interpreting them according to the problem context. The answer is not merely procedural but indicates clear awareness and control of the thinking process at each stage of problem solving

2. Research Findings of Medium Metacognitive Subjects (S2 and S19)

S2 was selected as a student representing the medium metacognitive level based on the results of the metacognitive questionnaire. The detailed results of S2's metacognitive questionnaire are presented in Table 5 below.

Table 5. Results of the Metacognitive Questionnaire for Subject S2

Metacognitive Component Indicators	Number of Correct Responses	Metacognitive Level	Metacognitive Level Classification Criteria
Planning	59	Medium	Medium
Monitoring	54	Medium	
Evaluating	51	Medium	

The data in Table 5 show that the three indicators of metacognitive components planning (59), monitoring (54), and evaluation (51) are all categorized at a moderate level. This indicates that students have developed basic abilities to plan strategies, monitor their thinking processes, and evaluate outcomes; however, their implementation remains inconsistent and not yet optimal. The lowest score in the evaluation component suggests that reflection and rechecking of results still need improvement in order to make the thinking process more controlled and systematic.

The findings for subject S2 indicate that a moderate level of metacognition produces a fairly directed thinking process, yet it is not fully regulated. From a causal perspective, this condition can be explained by learning habits that emphasize procedural completion rather than deep reflection. S2 was able to identify basic information and the goal of the problem as an initial form of planning; however, the student still showed hesitation in ensuring the completeness of the data and frequently sought additional clarification. This finding is consistent with the study by [31], which suggests that learning environments focused primarily on procedural routines tend to limit the development of deeper metacognitive reflection. During the monitoring stage, S2 began to apply appropriate strategies, such as converting percentages into the number of participants and organizing data into a table. However, monitoring was not carried out consistently; several steps were not thoroughly reviewed, resulting in overlooked data even though they were considered sufficient. In the evaluation stage, S2 was able to complete the calculations and draw conclusions, yet the evaluation focused mainly on procedural accuracy rather than conceptual reflection on the reasons for selecting particular strategies. This suggests that the metacognitive control demonstrated was still operational rather than fully reflective.

These findings indicate that students with a moderate level of metacognition are capable of carrying out the three stages of thinking regulation

planning, monitoring, and evaluation but their implementation is neither consistent nor optimal. The regulation observed tends to be limited to following solution steps without deep cognitive supervision. Several factors may explain this condition, including instruction that is procedure-oriented, limited reflective practice, insufficient experience in solving HOTS problems, and internal factors such as hesitation and unstable self-confidence.

This study has the strength of providing a detailed description of students' thinking processes at each metacognitive stage through data triangulation, allowing cognitive dynamics that are not visible in written responses to be revealed through interviews, as emphasized by [32], who highlighted that triangulation enriches the depth and credibility of qualitative findings. However, this study also has limitations, including the limited number of participants and its focus on a single learning topic, which restricts the generalizability of the results. In addition, qualitative data interpretation inherently carries the potential for subjectivity, as noted by [33] who pointed out that researcher subjectivity is one of the inherent challenges in qualitative research.

When compared with previous studies as outlined in the state of the art in the introduction, the findings of this study are consistent with John H. Flavell (1979), who stated that metacognition plays an essential role in regulating thinking processes, as well as with Gregory Schraw and Rayne A. Dennison (1994), who found that metacognitive regulation correlates with problem-solving effectiveness. The findings are also in line with the view of Rupert [34], who explain that insufficiently developed metacognitive regulation tends to result in procedural rather than reflective control of thinking. Therefore, there is no contradiction with previous research; rather, this study clarifies how moderate metacognitive characteristics are concretely manifested in solving HOTS problems. Students' responses can be seen in Figure 2 below.

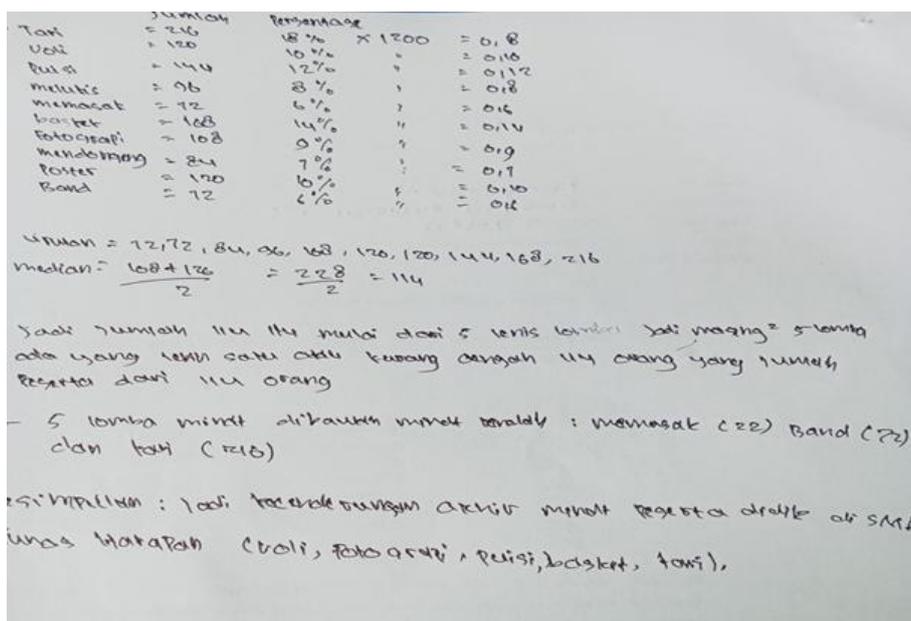


Figure 2. Student S2's Answer Sheet

Figure 2 shows that S2 demonstrates a moderate level of metacognition. The student is able to identify relevant information, apply appropriate procedures, and reach a correct conclusion. However, the solution process lacks consistent monitoring and deep evaluation, as some steps are not thoroughly reviewed and reflection remains procedural rather than conceptual.

In the next moderate metacognition category, S19 was selected as the student representing the moderate metacognitive level. This selection was based on the results of the student's responses to the metacognitive questionnaire. The detailed results of S19's metacognitive questionnaire are presented in Table 6 below.

Table 6. Results of the Metacognitive Questionnaire for Subject S19

Metacognitive Component Indicators	Number of Correct Responses	Metacognitive Level	Metacognitive Level Classification Criteria
Planning	56	Medium	Medium
Monitoring	63	Medium	
Evaluating	50	Medium	

The data in Table 6 indicate that the three metacognitive indicators planning (56), monitoring (63), and evaluation (50) are all categorized at a moderate level. Monitoring obtained the highest score, suggesting that students are relatively capable of supervising their thinking processes. However, the lowest score in evaluation indicates that students' ability to reflect on and recheck their results still needs improvement in order to make their thinking processes more controlled and systematic.

Subject S19, who falls into the moderate metacognitive category, demonstrates fairly adequate thinking regulation skills, yet these are not fully consistent or reflective. From a cause-effect perspective, this condition can be explained by learning patterns that emphasize procedural accuracy rather than conceptual understanding. As a result, S19 was able to identify key information and the objectives of the problem at the planning stage but remained uncertain about the completeness of the data, requiring additional clarification. During the monitoring stage, S19 applied appropriate strategies, such as converting percentages into the number of participants and organizing data into a

table. Nevertheless, monitoring was not carried out continuously, and several steps were not thoroughly reviewed. At the evaluation stage, S19 successfully completed the calculations and formulated a conclusion; however, the evaluation focused more on procedural correctness than on conceptual reflection regarding the choice of strategy. This indicates that the metacognitive control demonstrated remains at an operational level.

The findings of this study indicate that students with moderate metacognition are able to implement the three components of thinking regulation planning, monitoring, and evaluation yet their implementation remains suboptimal. The regulation demonstrated tends to follow procedural steps without deep cognitive supervision or reflective control. This finding is consistent with the study by [35], which reported that students at a moderate level of metacognition generally exhibit regulatory thinking processes, but these processes are not yet consistent or fully reflective in controlling problem-solving activities.

Several factors may have contributed to this condition, including procedure-oriented instruction,

limited reflective practice, insufficient experience in solving HOTS problems, and internal factors such as hesitation and unstable self-confidence. The strength of this study lies in its detailed description of students' thinking processes through data triangulation, enabling a more comprehensive analysis of metacognitive dynamics. However, the study is limited by the small number of subjects and its focus on a single learning topic, which restricts the generalizability of the findings, as well as the potential subjectivity inherent in qualitative data interpretation.

When compared with previous studies outlined in the state of the art in the introduction, the findings of this research are consistent with John

H. Flavell (1979), who emphasized the role of metacognition in regulating thinking processes, as well as with Gregory Schraw and Rayne A. Dennison (1994), who found that metacognitive regulation correlates with problem-solving effectiveness. These results are also in line with the findings of [36], who reported that students with low metacognitive regulation tend to solve mathematical problems procedurally without adequate planning and monitoring, resulting in mechanical thinking control. Therefore, this study does not contradict previous research; rather, it strengthens the concrete manifestation of moderate-to-low metacognition in solving HOTS problems. Students' responses can be seen in Figure 3 below.

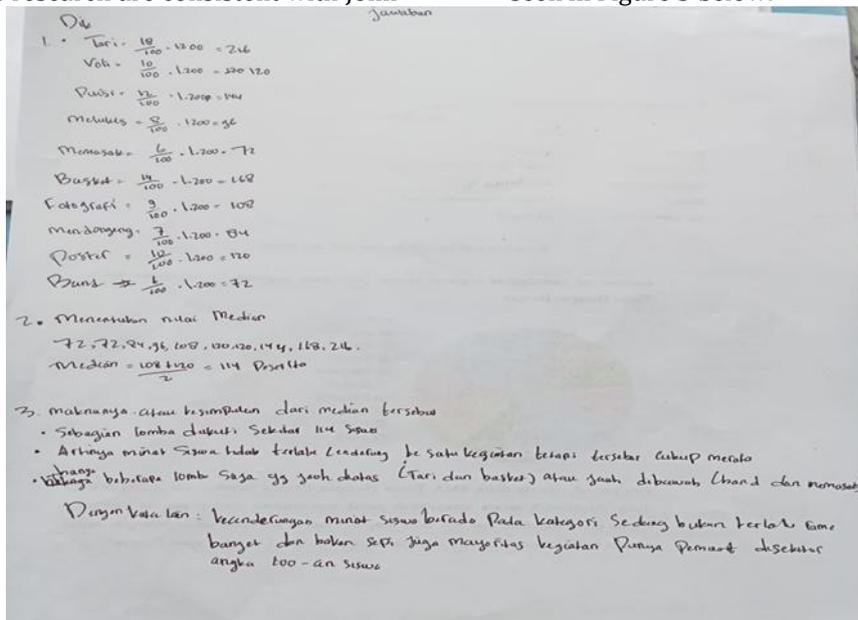


Figure 3. Student S19's Answer Sheet

Figure 3 illustrates that S19 demonstrates a moderate level of metacognitive ability. The student is able to apply appropriate strategies and reach a conclusion; however, the monitoring and evaluation processes are not yet consistent or deeply reflective, indicating that thinking control remains largely procedural.

3. Results of the Low Metacognitive Subject (S1 and S10)

S1 was selected as a student representing the low metacognitive level based on the results of the metacognitive questionnaire. The detailed results of S1's metacognitive questionnaire are presented in Table 7 below.

Table 7. Results of the Metacognitive Questionnaire for Subject S1

Metacognitive Component Indicators	Number of Correct Responses	Metacognitive Level	Metacognitive Level Classification Criteria
Planning	53	Low	Low
Monitoring	53	Low	
Evaluating	50	Low	

The data in Table 7 indicate that the three metacognitive indicators planning (53), monitoring (53), and evaluation (50) are categorized as low. This suggests that students' abilities to plan strategies, monitor their thinking processes, and evaluate results are still limited. The low score in the evaluation component indicates that reflection and rechecking of answers have not been carried out optimally, resulting in weak and less systematic thinking control.

Subject S1, who falls into the low metacognitive category, demonstrates limitations in thinking regulation across all stages of problem solving. From a cause effect perspective, this condition can be explained by learning habits that do not emphasize deep understanding and self-reflection. Consequently, at the planning stage, S1 merely read the problem without constructing a comprehensive understanding, leading to incomplete and unstructured information recording.

Since no clear initial strategy was designed, the subsequent process became unfocused. During the monitoring stage, S1 performed calculations sporadically without supervising whether the steps aligned with the problem’s objectives. This lack of regulation caused the thinking process to stall and develop unsystematically. At the evaluation stage, the absence of reviewing habits prevented S1 from recognizing errors or inconsistencies between the results and the problem context. This sequence shows that weak planning led to ineffective monitoring and ultimately to unsuccessful evaluation, resulting in overall low metacognitive regulation.

The findings of this study indicate that students with low metacognition are not yet able to functionally implement the three components of thinking regulation planning, monitoring, and evaluation. Their thinking processes tend to be mechanical, unfocused, and lacking adequate self-control. This condition confirms that without effective metacognitive regulation, the resolution of HOTS problems becomes less effective, as stated by [37], who argued that weaknesses in managing metacognitive strategies directly affect the effectiveness of problem solving.

Several factors contribute to this condition, including instruction that focuses more on final results than on the learning process, limited opportunities for reflection and self-monitoring practice, insufficient experience in solving problems requiring deep analysis, and internal factors such as

low self-confidence and learning motivation. The combination of these external and internal factors contributes to weak thinking control.

This study has the strength of providing a detailed description of students’ thinking processes through the analysis of written responses and interviews, enabling comprehensive identification of metacognitive weaknesses. However, it is limited by the small number of subjects and its focus on a single learning topic, which restricts the generalizability of the findings. In addition, the qualitative approach allows for potential subjectivity in data interpretation.

When compared with previous studies outlined in the state of the art, the findings of this research are consistent with John H. Flavell (1979), who emphasized the crucial role of metacognition in regulating thinking processes. The results are also in line with Gregory Schraw and Rayne A. Dennison (1994), who found that low metacognitive regulation is associated with less effective problem solving. Furthermore, these findings support the study by [38], which reported that students with low metacognitive regulate

on tend to solve problems procedurally without adequate planning and monitoring. Therefore, this study does not contradict previous research; rather, it reinforces empirical evidence regarding the characteristics of low metacognition in solving HOTS problems. Students’ responses can be seen in Figure 4 below.

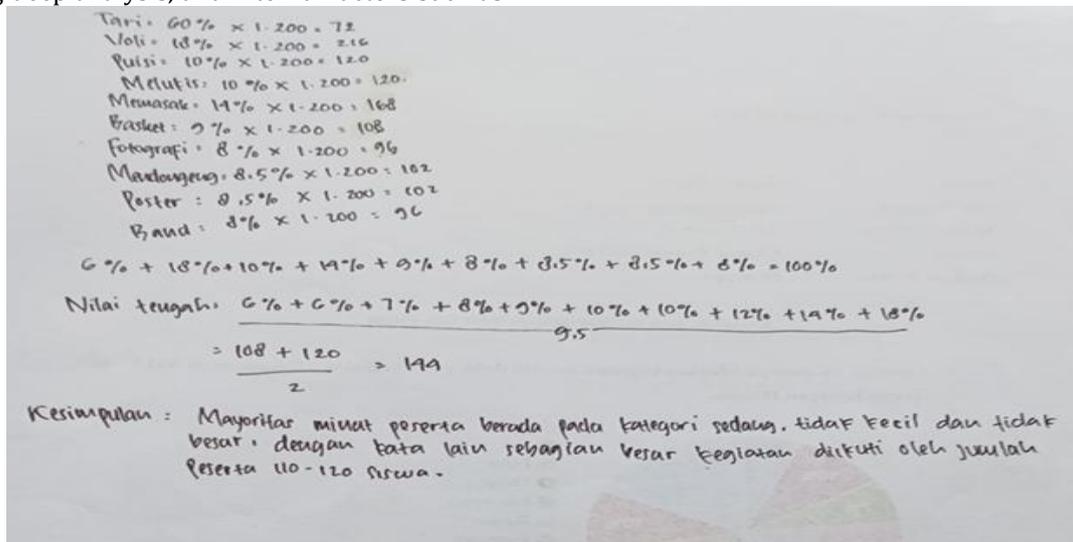


Figure 4. Analysis of Student S1’s Response

Figure 4 shows that S1 demonstrates a low level of metacognitive ability. The student is unable to plan strategies effectively, monitor the solution process consistently, or evaluate the results accurately, resulting in an unfocused and less systematic problem-solving process.

The next selected subject was S10, who was categorized as having low metacognitive ability. This selection was based on the results of the student’s responses to the metacognitive questionnaire. The

detailed results of S10’s metacognitive questionnaire are presented in Table 8 below.

Table 8. Results of the Metacognitive Questionnaire for Subject S10

Metacognitive Component Indicators	Number of Correct Responses	Metacognitive Level	Metacognitive Level Classification Criteria
Planning	48	Low	Low
Monitoring	48	Low	
Evaluating	46	Low	

The data in Table 8 show that all three metacognitive indicators planning (48), monitoring (48), and evaluation (46) fall into the low category. This indicates that students' ability to plan, monitor, and evaluate their thinking processes remains very limited. The lowest score in the evaluation component suggests that reflection and rechecking of answers were rarely carried out, resulting in weak and unfocused cognitive control.

Subject S10, who was categorized as having low metacognitive ability, demonstrated weaknesses in cognitive regulation that appeared sequentially from the initial stage of problem solving. In terms of cause and effect, this condition can be explained by learning habits that emphasize completing tasks quickly without careful planning and without reflection after obtaining an answer. As a result, at the planning stage S10 merely read the problem without constructing a comprehensive understanding, leading to incomplete and poorly organized information. When the initial strategy was not clearly designed, the subsequent process became unfocused.

At the monitoring stage, S10 attempted to perform calculations; however, the steps taken were sporadic and inconsistent because there was no control over whether the procedures aligned with the problem's objectives. This condition caused the problem-solving process to stall and prevented it from developing systematically. At the evaluation stage, the absence of a habit of rechecking answers meant that S10 did not recognize errors or inconsistencies between the results and the problem context. This sequence indicates that weak planning led to ineffective monitoring and ultimately resulted in failure to evaluate, causing overall metacognitive regulation to be very low.

Several factors contribute to these findings, including instructional practices that emphasize final outcomes rather than thinking processes, the lack of habituation to reflection and self-monitoring in learning, limited experience in dealing with higher-order analytical problems, as well as internal factors such as low motivation and self-confidence.

Collectively, these factors influence the weakness of students' thinking control and metacognitive regulation, as emphasized by [39], who stated that learning environments, cognitive experiences, and affective factors play significant roles in the development of students' metacognitive regulation.

Several factors contributed to these results, including instructional practices that focus more on final answers than on thinking processes, limited habituation of reflection and self-monitoring in learning, minimal experience with higher-order analytical problems, and internal factors such as low motivation and self-confidence. Collectively, these factors influence the weakness of students' cognitive control.

This study has strengths in its ability to reveal students' thinking processes in depth through analysis of written responses and interviews, allowing metacognitive regulation to be described comprehensively. However, the study also has limitations, including a limited number of subjects and a focus on a single learning topic, which restricts the generalizability of the findings. In addition, the qualitative approach allows for potential subjectivity in data interpretation.

When compared with previous studies outlined in the state of the art, the findings of this study are consistent with the work of John H. Flavell (1979), who emphasized the important role of metacognition in controlling and regulating thinking processes. The findings are also in line with research by Gregory Schraw and Rayne A. Dennison (1994), which demonstrated that low metacognitive regulation correlates with less effective problem solving. Furthermore, the findings of this study are consistent with the results of [40], who reported that students with low metacognitive regulation tend to solve problems procedurally without adequate planning and monitoring. Thus, there is no contradiction with previous research; rather, this study strengthens empirical evidence regarding the characteristics of low metacognition in solving HOTS problems. Students' answer results can be seen in Figure 4 below.

Jenis Lomba	Persentase	Jumlah Peserta	Jumlah Peserta (orang)
Banda	6%	6% x 1.200	72
Taksi	18%	18% x 1.200	216
Voli	10%	10% x 1.200	120
Puisi	12%	12% x 1.200	144
Wawancara	8%	8% x 1.200	96
M. Prambada	6%	6% x 1.200	72
Basket	14%	14% x 1.200	168
Fotografi	9%	9% x 1.200	108
Poster	10%	10% x 1.200	120
Mendongeng	7%	7% x 1.200	84

modus = 18% = 216 peserta (taksi)
 modus minor = 6% = 72 peserta (m. prambada, banda)
 median = $\frac{108 + 120}{2} = 114$

Figure 5. Analysis of Student S10's Response

Figure 5 presents S10's responses, which reflect low metacognitive ability, as seen in the lack of structured planning, inconsistent monitoring, and absence of answer evaluation during the problem-solving process.

CONCLUSION

This study aimed to describe students' thinking processes in solving HOTS problems based on their levels of metacognition (high, moderate, and low). The findings indicate that metacognitive level significantly influences the quality of students' thinking processes. The higher the level of metacognition, the more systematic, controlled, and reflective the problem-solving process becomes.

Most students were categorized at the moderate level of metacognition (51.85%), followed by the low category (44.44%), while only 3.70% reached the high category. These results suggest that students' metacognitive abilities are not yet evenly developed and are still predominantly at moderate and low levels. The most prominent weakness was found in the evaluation stage, indicating that students' reflective ability to review and assess their solutions remains limited. This finding is consistent with previous studies [39] and [40], which emphasize that metacognitive regulation, particularly monitoring and evaluation, significantly contributes to effective problem-solving and higher-order thinking performance.

Students with high metacognitive levels demonstrated complete and consistent implementation of planning, monitoring, and evaluation stages. They were able to design systematic strategies, control each step of the solution process, and reflect on results contextually. In contrast, students with moderate metacognition showed emerging regulatory skills but were not yet consistent and tended to rely on procedural approaches. Meanwhile, students with low metacognition solved problems mechanically, without clear planning, adequate monitoring, or proper evaluation of their answers. This condition aligns with findings from studies [41] and dan [42], which state that low metacognitive awareness leads to less structured and less effective thinking processes when solving complex problems.

In conclusion, metacognitive level directly affects the quality of students' thinking processes in solving HOTS problems. Therefore, instructional strategies

should place greater emphasis on developing metacognitive awareness and regulation, particularly in the evaluation stage, to foster more reflective, structured, and effective higher-order thinking skills.

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