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Exploring secondary students' reflective thinking skills in statistics based on mathematical ability

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ABSTRACT
Reflective thinking plays a vital role in mathematics learning, particularly in solving complex problems. Understanding students' reflective thinking abilities across its aspects—technique, monitoring, insight, and conceptualization—is essential for selecting appropriate instructional methods. This study aims to describe junior high school students' reflective thinking abilities in learning statistics based on their initial mathematical ability. A qualitative approach with a case study design was used to explore reflective thinking skills in the four aspects: technique, monitoring, insight, and conceptualization. The research participants consisted of 30 seventh-grade students from a junior high school in Boyolali, Indonesia, who were grouped into three categories based on their mathematical ability: high, medium, and low. Data were collected through reflective thinking tests, observations, and interviews, and analyzed using the constant comparative analysis method. The results reveal a hierarchical relationship between mathematical ability and reflective thinking. Students with high mathematical ability demonstrated complete reflective thinking, fulfilling all indicators across the four aspects. Students with moderate ability exhibited partial reflective thinking, meeting some indicators but not fully optimizing others. Students with low mathematical ability showed the weakest reflective thinking skills, meeting indicators only partially in technique, monitoring, and insight, while failing to achieve the conceptualization indicators optimally. These findings confirm that foundational mathematical knowledge is a critical determinant of students' capacity for deep reflective problem solving in statistics and provide important implications for the development of targeted instructional methods.

KEYWORDS
Mathematical ability; reflective thinking; statistics

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INTRODUCTION

Reflective thinking plays an important role in mathematics learning because it encourages students to solve problems, understand processes, evaluate strategies, and draw meaningful conclusions (Morkoyunlu & Altun, 2022). Reflective thinking refers to the process of rationalizing problems, building relationships among ideas, experiences, knowledge, perceptions, and reasoning, and selecting appropriate strategies to solve problems (Akpur, 2020). It helps students determine effective strategies for reaching logical solutions (Setiyani et al., 2022). In mathematics, reflective thinking supports the development of strong conceptual understanding, enabling students not only to memorize formulas but also to apply knowledge in various situations (Toraman et al., 2020). Through reflective thinking, students can identify errors, improve understanding, and develop metacognitive skills that support long-term learning.

Reflective thinking consists of four main aspects: technique, monitoring, insight, and conceptualization (Kholid et al., 2021). The technique aspect refers to the selection of appropriate methods for solving problems. In problem solving, choosing suitable strategies influences accuracy and effectiveness (Coppersmith & Star, 2022; Zahara et al., 2020). The monitoring aspect involves continuous evaluation of the problem-solving process. Evaluation is essential for assessing the effectiveness of strategies and considering alternative approaches (Angkotasan et al., 2024; Karaoglan Yilmaz et al., 2023). Without proper evaluation, individuals may fail to solve problems effectively (Kholid et al., 2020). The insight aspect refers to moments of sudden understanding of the underlying relationships in a problem, often described as enlightenment (Mukti & Permatasari, 2023). Meanwhile, conceptualization refers to the ability to abstract problem-solving experiences into general principles that can be applied in new situations (Aldahmash et al., 2021). Thus, these four aspects are essential components of reflective thinking that should be developed in mathematics learning involving complex problem solving.

However, previous research shows that students' reflective thinking skills remain low. Studies by Khotimah et al. (2023) and Kurnia et al. (2024) reveal that many students struggle to critically analyze statistical data, such as identifying patterns or evaluating the validity of information, with only a few able to provide meaningful interpretations. Students tend to focus on basic calculations without reflecting on the meaning of the data, as shown in Ratnaningsih and Hidayat (2020) where participants stopped at the computational stage without proceeding to critical analysis. This situation is exacerbated by instruction that is still oriented toward procedural learning rather than deep understanding, where classroom activities are dominated by technical exercises such as drawing graphs and calculating means without conceptual discussion (Alfauziyya & Masduki, 2023; Koga, 2022). This condition is particularly concerning because, according to PISA 2022 data, only 1 in 5 Indonesian students reached the minimum competency level in data literacy (OECD, 2022).

Statistics learning has strong potential to develop reflective thinking because it involves collecting, organizing, analyzing, and interpreting data (Zerdali & Eğmir, 2025). This subject requires students to construct graphs, compute averages, question data representations, identify biases, and make informed decisions (Ratnaningsih & Hidayat, 2020). A study by Casanellas et al. (2020) shows that when students engage in the full statistical process—from question formulation and data collection to interpretation—their critical and reflective thinking skills improve significantly, particularly in recognizing data limitations and considering alternative interpretations (Yan et al., 2025). However, this potential is often not fully realized because instruction tends to emphasize technical procedures rather than the development of statistical reasoning (Kurnia et al., 2024).

Unfortunately, statistics learning in schools is often limited to technical activities, such as creating tables or diagrams, without engaging students in deeper reflective processes (Howley & Roberts, 2020). Students are rarely encouraged to critically analyze data or relate it to real-life contexts, even though research by Junaedi and Wahyudin (2020) shows that engagement in authentic statistical projects can improve reflective thinking and conceptual understanding. As a result, although students may be able to solve problems procedurally, many fail to develop reflective thinking skills essential for understanding statistics holistically.

Students' low reflective thinking ability in statistics becomes more complex when associated with differences in initial mathematical ability. Initial mathematical ability is significantly correlated with readiness to develop reflective thinking, where students with strong foundational knowledge tend to more easily analyze data critically and connect concepts (Ugur & Çakiroglu, 2024). However, Saracoglu (2022) found that even students with high initial ability still require appropriate scaffolding to transform procedural knowledge into conceptual understanding. This aspect is often overlooked in conventional statistics instruction. More concerningly, students with low initial ability are further disadvantaged, as procedure-focused instruction widens the gap in understanding. Kvasz (2019) notes that a purely procedural approach without reflection makes it difficult for these students to see the relevance of statistics in real life.

Research on reflective thinking in mathematics education has been widely conducted. For example, Deringöl (2019) examined the relationship between reflective thinking skills and academic achievement in mathematics; Setiyani et al. (2022) studied reflective thinking processes of prospective elementary teachers in solving arithmetic problems in relation to mathematical disposition; Erdogan (2019) investigated the effect of cooperative learning supported by reflective thinking activities on students' critical thinking skills; Kholid et al. (2024) explored students' reflective thinking processes in solving mathematical problems. However, no study has specifically examined reflective thinking in relation to students' initial mathematical ability in statistics. Therefore, in-depth research is needed to explore how students' initial ability influences their reflective thinking processes. This study is important for understanding how initial ability shapes students' reflective thinking characteristics and for informing the development of more effective mathematics instruction.

Based on this description, this study aims to describe how students' mathematical ability influences their reflective thinking processes in learning statistics at the junior high school level.

METHODS

This research uses a qualitative approach. Qualitative research explores and interprets meanings constructed by individuals or groups in relation to social phenomena (Cresswell, 2014). Furthermore, qualitative research is a naturalistic inquiry process that seeks to understand social phenomena in their natural settings (Hendryadi, Tricahyadinata, & Zannati, 2019). In this study, qualitative research is used to explore social phenomena and processes through fieldwork without manipulation.

This study employs a case study design. A case study is an in-depth examination of an individual, group, institution, social phenomenon, or event. Case studies focus on understanding phenomena within specific boundaries or defined units of analysis (Merriam & Tisdell, 2015). This research specifically explores a class of students who have experienced mathematics learning, particularly statistics, with further analysis of three groups of students based on high, medium, and low ability levels.

A total of 30 seventh-grade students from a junior high school in Boyolali, Indonesia participated in this study. The sampling strategy used was purposive sampling, in which participants were deliberately selected based on criteria relevant to the research objectives. The students were chosen because they had participated in statistics learning in class, ensuring that they possessed sufficient knowledge and experience to provide relevant data. Participation was voluntary, and students expressed their willingness to take part without coercion. Accessibility and availability were also considered in the sampling process.

For in-depth analysis, three students were selected as representative cases, one from each mathematical ability category (high, medium, and low), to explore their reflective thinking skills more comprehensively through interviews and document analysis. The decision to focus on three students rather than all 30 participants was a deliberate methodological choice aligned with the qualitative case study design. This approach prioritizes depth over breadth, allowing for a rich, detailed, and nuanced exploration of reflective thinking processes. By focusing on one representative case per ability group (S-T for high, S-S for medium, and S-R for low), the study provides a holistic and contextualized understanding of how reflective thinking manifests within each category, illustrating the phenomenon in a way that a broader but more superficial analysis could not achieve. Such in-depth case analysis is a key feature of case study research, as it enables the researcher to uncover complex patterns and meanings embedded in students' problem-solving behaviors (Merriam & Tisdell, 2015).

This study used two types of instruments: primary and supporting. The primary instrument is the researcher, who plans and conducts data collection and analysis, draws conclusions, and prepares the research report. The supporting instrument includes an interview guide. The interview instrument was developed based on the research objectives, problem formulation, and language appropriateness (Yorulmaz et al., 2021).

Data collection was conducted through documentation and interviews. Researchers documented the results of the initial assessment and students' reflective thinking test results. The initial assessment was used to categorize students' mathematical ability into three levels: high, medium, and low. Meanwhile, the reflective thinking test results were used to explore students' reflective thinking abilities across the aspects of technique, monitoring, insight, and conceptualization within each ability category. The reflective thinking test instrument was carefully developed to ensure content validity, readability, and expert judgment, thereby ensuring that it accurately measures students' reflective thinking abilities.

First, content validity was established by grounding the instrument in a strong theoretical framework, specifically by adapting reflective thinking indicators from Kholid et al. (2022), which include the four main aspects: technique, monitoring, insight, and conceptualization. Second, expert judgment was conducted. Two senior lecturers in mathematics education, each with more than ten years of experience in educational assessment and mathematics instruction, served as expert validators. They were given the draft test items, scoring rubric, and theoretical framework and asked to evaluate the alignment of items with constructs, clarity of language, and suitability for seventh-grade students. Based on their feedback, revisions were made to improve clarity and eliminate ambiguity, ensuring that the non-routine problems (see Figure 1) effectively elicited the targeted reflective thinking processes.

Third, a readability test was conducted with three seventh-grade students from a similar population but outside the research sample. This pilot test ensured that the language and context of the problems were understandable and age-appropriate. Students were asked to read the questions and paraphrase them in their own words to confirm comprehension, resulting in minor revisions for clarity. Through this multi-stage process—combining

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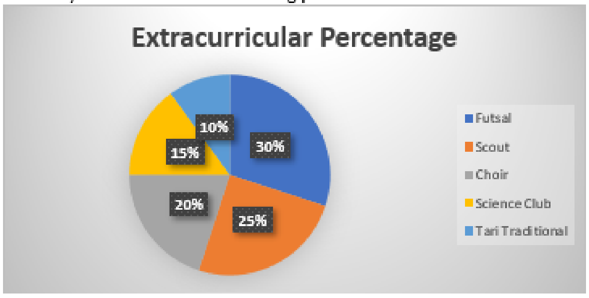
theoretical grounding, expert validation, and empirical readability testing—the instrument's content validity was strengthened, ensuring that it accurately measures the intended reflective thinking abilities.

REFLECTIVE THINKING ABILITY TEST QUESTIONS ON STATISTICS MATERIAL

Question Instrument

1) A survey was conducted among 100 students to find out the most **popular extracurricular activities**. The results of the survey are shown in the following **pie chart**:



   a. **Describe the conclusions** that can be drawn regarding students' extracurricular preferences.
   b. If the school wants to increase students' interest in **Traditional Dance, what strategies can be implemented** based on the data patterns presented?

2) A teacher records the **math test** scores of 10 students: **75, 80, 85, 90, 95, 100, 85, 80, 90, 85.**
   a. Calculate the **mean (average), median (middle value)**, and **mode (most frequent value)** of the data.
   b. From the results, **what can be concluded about the academic performance of the students in the class**?
   c. Compare the three measures of data centering and explain in what situations each measure is more useful.

3) A survey was conducted to find out **students' study time at home in one week**. Here are the data:

Day	Study Time (Hours)
Monday	2
Tuesday	3
Wednesday	2
Thursday	4
Friday	3
Saturday	5
Sunday	4

   a. Draw a **line chart** to show the pattern of students' study time.
   b. From the diagram, what conclusions can be drawn about the students' study patterns? Are there any particular trends that can be observed?

Figure 1. Non-routine Mathematics Problems

In addition, researchers conducted interviews with students to obtain detailed data related to their reflective thinking skills. Through these rigorous validation procedures—content validation based on established theoretical indicators, readability testing through careful language consideration, and expert judgment involving specialist reviews—the reflective thinking test instrument was confirmed to be a valid, reliable, and effective tool for measuring the intended construct. The reflective thinking test items were designed in the form of non-routine mathematics problems, as shown in Figure 1. Such problems can be used to reveal students' reflective thinking abilities.

The data obtained from students' responses to the reflective thinking test were then analyzed using the rubric presented in Table 1.

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Table 1. Rubric for Assessing Students' Reflective Thinking Ability

Score	Techniques	Monitoring	Insight	Conceptualization
1	Students have difficulty understanding the information, do not fully comprehend the question, and select ineffective strategies for solving the problem.	Students do not monitor solution steps effectively, do not evaluate their answers, and do not carefully consider their decisions.	Students do not show enthusiasm in solving problems, do not correct mistakes, and have difficulty identifying strategies to overcome obstacles.	Students do not show sufficient understanding of alternative solutions, are less able to describe relevant problems, and fail to connect concepts with other contextual applications.
2	Students have a basic understanding of the information and provide general responses, but the strategies chosen are less optimal.	Students show limited monitoring of solution steps and errors and lack consideration of appropriate decisions.	Students have sufficient motivation to solve problems but lack initiative in correcting their answers or finding better strategies.	Students have a basic understanding of alternative solutions but struggle to relate the concepts to real situations.
3	Students comprehend the information well, answer questions in sufficient detail, and select effective strategies, although these are not yet fully efficient.	Students monitor the solution process fairly well but still lack the ability to consistently identify errors or make optimal decisions.	Students show enthusiasm in solving problems and are willing to correct incorrect answers, but they still need reinforcement in identifying appropriate strategies.	Students understand some alternative solutions and can explain relevant problems but still lack strong conceptual connections between ideas.

Data analysis in this study was conducted using the constant comparative method (CCM), which includes data reduction, categorization, and synthesis (Moleong, 2007). he implementation of CCM begins with data reduction, which involves organizing raw data from the initial assessment answer sheets, reflective thinking tests, and student interviews. Furthermore, data from the initial assessment answer sheets were grouped into three categories: high, medium, and low. The category criteria used are presented in Table 2 determines the category criteria used (Glass & Hopkins, 1996).

Table 2. Rubric for Assessing Students' Reflective Thinking Ability

Category Determination Criteria	Category
Score ≥ 70	High
50 ≤ Score < 70	Medium
Score < 50	Low

Based on the reflective thinking test answer sheets and student interview results, the researchers analyzed reflective thinking in each ability category to determine students'

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reflective thinking abilities across the identified aspects. The indicators of reflective thinking ability used in this study include technique, monitoring, insight, and conceptualization, as shown in Table 3 (Kholid et al., 2022).

The coding process was carried out in three systematic stages. First, open coding was conducted by carefully reading all student answer sheets and interview transcripts, followed by identifying and marking specific segments of text that corresponded to the reflective thinking indicators presented in Table 3. For example, statements demonstrating understanding of information were coded as T1, understanding the question as T2, and selecting effective strategies as T3 for the technique aspect. Similarly, evidence of monitoring solution steps was coded as M1, checking answer correctness as M2, and considering decisions as M3. For insight, enthusiasm in solving problems was coded as I1, willingness to correct incorrect answers as I2, and identifying strategies to avoid difficulties as I3. For conceptualization, understanding alternative solutions was coded as C1, describing relevant problems as C2, and connecting related concepts as C3.

Table 3. Indicators of Reflective Thinking

Aspect	Indicators	Code
Techniques	1. Understand the information	T1
	2. Understand the question	T2
	3. Select effective and efficient strategies for solving the problem	T3
Monitoring	1. Monitoring Solution Steps	M1
	2. Monitoring whether the answer is correct or not	M2
	3. Considering making a decision	M3
Insight	1. Eager to solve problems	I1
	2. Prepared to correct wrong answers	I2
	3. Finding strategies to avoid difficulties	I3
Conceptualization	1. Understand alternative solutions	C1
	2. Recount relevant problems	C2
	3. Connecting relevant concepts	C3

Second, axial coding was employed to group related codes into broader categories based on the four main aspects of reflective thinking. All codes under technique (T1, T2, T3) were grouped into the “Techniques” category; monitoring codes (M1, M2, M3) into “Monitoring”; insight codes (I1, I2, I3) into “Insight”; and conceptualization codes (C1, C2, C3) into “Conceptualization.”

Third, selective coding was conducted to integrate and refine these categories by systematically comparing coded data across the three ability groups (high, medium, and low) to identify consistent patterns in how students demonstrated each reflective thinking indicator. Categorization was carried out by organizing the coded data according to reflective thinking indicators and students’ mathematical ability levels. Using the scoring rubric in Table 1, researchers classified students' responses as fully meeting, partially meeting, or not meeting each indicator. This process enabled systematic comparison of reflective thinking patterns across the high, medium, and low ability groups. Finally, conclusions were drawn by synthesizing the categorized data and interpreting how students in each ability group performed across all four reflective thinking aspects. Throughout this process, researchers continuously referred back to the original data to ensure that conclusions were firmly grounded in evidence, maintaining clear links between raw data and reflective thinking indicators.

The data validity technique used in this study was method and source triangulation. Method triangulation was used to compare student answer sheets and interview results, while source triangulation was used to compare data from different participants within the same ability category.

RESULT AND DISCUSSION

Based on data collection and analysis, the findings are presented according to three categories of students' reflective problem-solving thinking. The proportion of students in the high category (S-T) was 33% (10 students), the medium category (S-S) was 46% (14 students), and the low category (S-R) was 21% (6 students). Furthermore, students' reflective thinking abilities are analyzed based on these high, medium, and low categories. Figure 2 shows the percentage distribution of students in each mathematical ability category.

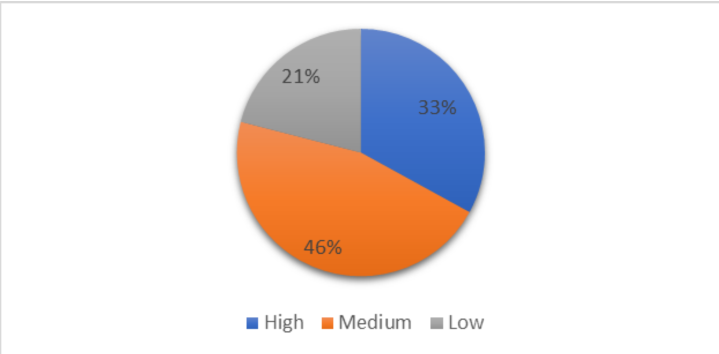

Figure 2. Percentage of Students in Each Category

Techniques

Students in the high reflective thinking ability category generally meet all indicators of reflective thinking. This can be seen from S-T's work, which demonstrates appropriate problem-solving steps and fulfills all indicators of the technique aspect. Figure 3 presents S-T's response to the problem.

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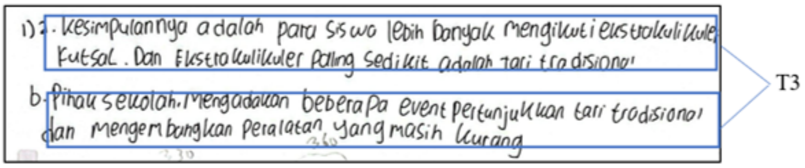
Original Version



Translate Version

1) a. The conclusion is that students mostly participate in futsal extracurriculars. And the least extracurricular is traditional dance.
b. The school, organize several traditional dance performance events and develop equipment that is still lacking.

Figure 3. Results of S-T Answers on Technique Indicator

Figure 3 shows that, in the first problem, S-T was able to understand the information well, interpret the question correctly, and choose effective and efficient strategies to solve the problem. Overall, S-T solved the problem by fulfilling all indicators of the technique aspect of reflective thinking. Based on the interview, S-T was able to understand the information and what was being asked in the problem and did not experience difficulties in solving it. S-T also determined an appropriate problem-solving strategy based on the written answer and the interview, which related to data interpretation in the pie chart. The following interview excerpt supports S-T's response:

M : *"From the answer you wrote (pointing to the student's answer), what information did you immediately understand?"*
S-T : *"When I read the question, I immediately recognized the information and knew what was asked. I knew the names of the extracurricular activities and the percentages of participants." (T1)*
M : *"How do you know which extracurricular activities are more and less popular than the others?"*
S-T : *"From the highest and lowest percentages." (T2)*
M : *"Why can you answer like this?"*
S-T : *"Because the school activities allow students to recognize and choose extracurricular programs, such as traditional dance, and develop their interests." (T3)*

Thus, based on Figure 3 and the interview results, it can be seen that S-T understands the information related to data representation in pie charts, clearly understands what is being asked, and applies appropriate solution strategies by linking the given information correctly. Therefore, S-T fulfills all indicators of the technique aspect, namely T1, T2, and T3. This finding is consistent with Ardani (2021), who found that students with high mathematical ability tend to demonstrate strong reflective thinking skills and reach higher levels of reflection. Furthermore, high-ability students are able to fulfill all indicators of the technique aspect, including understanding key information, interpreting questions correctly, and determining appropriate solution strategies. This is also in line with Tisngati and Genarsih

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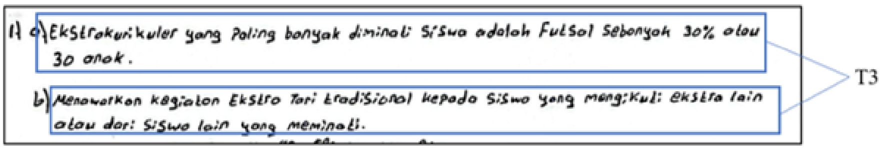
(2021), who state that students with high mathematical ability tend to demonstrate all indicators of reflective thinking when solving mathematical problems.

Students with moderate reflective thinking ability generally meet some, but not all, of the predetermined indicators. This can be seen from S-S's work, where only some indicators of reflective thinking ability are fulfilled. Figure 4 shows of S-S's response

Original Version



Translate Version

1) a. The extracurricular activity that attracts the most students is futsal as much as 30% or 30 children.
b. Offer traditional dance extra activities to students who take other extracurricular activities or from other students who are interested.

Figure 4. Results of S-S Answers on Technique Indicator

Figure 4 shows that S-S was able to solve the first problem, although she did not mention the extracurricular activities that students were least interested in and only referred to the most popular ones. In the second problem, S-S provided a solution by assigning traditional dance as the chosen extracurricular activity for each student. Overall, S-S's answers are similar to those given by S-T; therefore, S-S is considered able to solve the problems by fulfilling the indicators of the technique aspect of reflective thinking, but not optimally. The following interview excerpt supports S-S's response:

M : *"From the answer you wrote (pointing to the student's answer), what information did you immediately understand?"*
S-S : *"I read the question repeatedly because at first I was confused about its meaning. Then I understood the information and what was being asked. I know the percentage of students participating in extracurricular activities." (T1)*
M : *"How do you know which extracurricular activity is more popular and less popular than the others?"*
S-S : *"Because it has the highest percentage." (T2)*
M : *"Why can you answer like this?"*
S-S : *"Because by offering it, maybe the students want to join." (T3)*

Thus, based on Figure 4 and the interview results, it can be seen that S-S understands the data presented in the pie chart and what is asked in the problem, although she initially experienced confusion when solving it. She then applied a solution strategy by linking the information she understood. Therefore, S-S fulfills indicators T1 and T2, but indicator T3 is not yet optimal. This is in line with the views of Sumitro et al. (2019) and Kholid et al. (2020), who state that under certain conditions, students are unable to fully understand and

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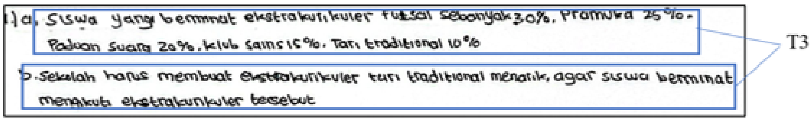
conclude all information contained in a problem. Therefore, students with moderate ability have not yet optimally fulfilled all indicators of reflective thinking in the technique aspect. This is also supported by Rahmadhani et al. (2020) who found that students with moderate mathematical ability are only able to fulfill some indicators of reflective thinking, not all of them.

Students in the low reflective thinking ability category are only able to achieve part of the predetermined indicators. This can be seen from S-R's work, which still shows difficulties in solving problems using appropriate steps due to limited understanding of contextual problems and relevant concepts. S-R's answer is presented in Figure 5.

Original Version



Translate Version

1) a. Students who are interested in extracurricular activities are futsal 30%, choir 20%, science club 15%, traditional dance 10%.
   b. Schools must make traditional dance extracurricular activities interesting, so that students are interested in participating in these extracurricular activities.

Figure 5. Results of S-R Answers on Technique Indicator

Figure 5 shows that S-R had difficulty solving the two problems given. In the first problem, S-R only wrote general information from the pie chart without explicitly mentioning the extracurricular activities students were most and least interested in. Meanwhile, in the second problem, S-R was unable to formulate a concrete strategy to increase interest in traditional dance; the answer was limited to the statement "make it more interesting" without further elaboration. Nevertheless, S-R still attempted to solve the problem. This can be seen from the answer given, where S-R wrote down the results of her analysis, even though it was not entirely in line with the question. The following interview excerpt supports this finding.

M : *"From the answer you wrote (pointing to the student's answer), what information did you immediately understand?"*
S-R : *"I read the problem repeatedly because it was difficult. I looked at the problem and wrote down what was listed in the pie chart" (T1)*
M : *"Why can you answer like this?"*
S-R : *"I do not know, maybe to make it more interesting" (T3)*

Thus, based on Figure 5 and the interview results, it can be seen that S-R was able to understand the information about data representation in pie charts by listing all the information, but did not fully understand what was asked in the problem due to difficulty in comprehension and limited ability to apply an appropriate solution strategy. Therefore, S-R only fulfilled one technical indicator, namely T1. The T2 indicator was not fulfilled because S-R did not understand what was asked, while the T3 indicator was only minimally demonstrated. This shows that students with low mathematical ability have the weakest reflective thinking skills. This is consistent with (Salido & Dasari, 2019), who stated that students with low ability generally demonstrate weak reflective thinking skills, often limited to routine actions.

Furthermore, Hajar et al. stated that factors influencing low reflective thinking ability include poor understanding of mathematical concepts, errors in applying concepts, and lack of experience with reflective thinking tasks (Lestari et al., 2023). This difficulty among low-ability students in understanding problem statements and formulating appropriate strategies aligns with international findings by Scheibe et al. (2023), who reported that students with low mathematical ability struggle to translate word problems into mathematical models and experience difficulties recalling prior knowledge, which hinders their reflective thinking in problem solving.

Monitoring

In the monitoring indicator, S-T was able to solve the problem effectively, starting by determining the steps of the solution. S-T then computed the mean, median, and mode using appropriate methods: calculating the mean by summing all mathematics test scores and dividing by the number of students; determining the median by first sorting the data and identifying the middle value (85); and identifying the mode by determining the most frequently occurring value (85). Figure 6 Figure 6 shows the results of S-T's solution, supported by the interview results below.

M : *"What steps did you use to solve the problem?"*

S-T : *"I calculate the mean first by adding all the math test scores and dividing by the number of students, then I determine the median. I sort the data first, then take the middle value, and for the mode I identify the most frequent value" (M1)*

M : *"Did you check your steps when working on the problem?"*

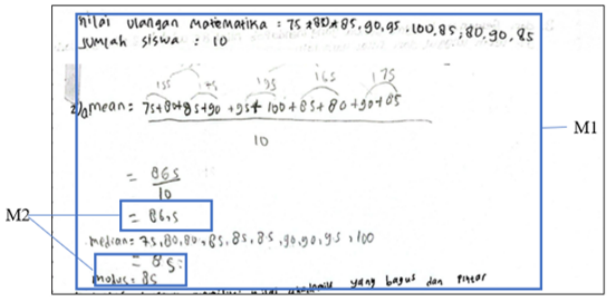
S-T : *"Yes, I rechecked the order of the data for the median and the repeated values for the mode, and after I calculated the mean, I tried to calculate it again"* (M2)

M : *"When solving the problem, did you ever find an answer that felt 'not quite right', and what decision did you make?"*

S-T : *"If I feel something is not right, I try to check from the beginning. If my answer is wrong, I correct it by recalculating" (M3)*

Based on Figure 6 and the interview results, it can be seen that S-T fulfills all monitoring indicators: monitoring solution steps correctly, checking the correctness of answers, and reconsidering decisions when errors are found. S-T re-evaluates and recalculates to obtain the correct result. Thus, S-T fulfills all monitoring indicators (M1, M2, and M3). This is in line with Setyaningsih and Ghufron (2024) whose research confirms a strong reflective thinking profile, as students also fulfill all monitoring indicators, including evaluating problem-solving steps, verifying answers, and applying appropriate strategies.

Original Version



Translate Version

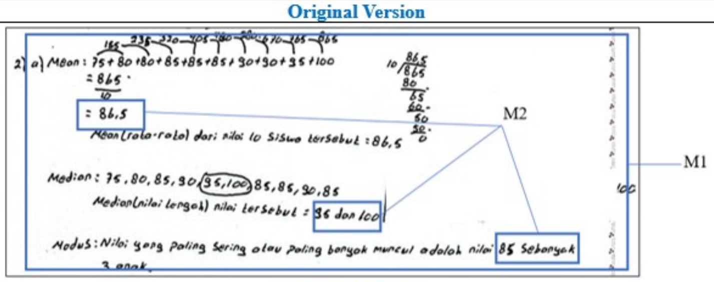
2) math test scores: 75, 80, 85, 90, 95, 100, 85, 80, 90, 85
student count: 10

a. mean = $\frac{75+80+85,+90+95+100+85+80+90+85}{10}$
$= \frac{865}{10}$
$= 86{,}5$
Median = 75, 80, 80, 85, 85, 90, 90, 95, 100
= 85
Mode = 85

Figure 6. Results of S-T Answers on the Monitoring Indicator

Students with moderate reflective thinking ability have fulfilled the monitoring indicators, but some indicators have not been fully achieved. This can be seen from the work of S-S, who solved the problems but only met some of the reflective thinking indicators. Figure 7 presents the results of S-S's answer.

Original Version



Translate Version

2) a.) mean = 75, 80, 85, 90, 95, 100, 85, 85, 90, 85
$= \frac{865}{10}$
$= 86{,}5$
Mean (rata-rata) dari nilai 10 siswa tersebut = 86,5

Median = 75, 80, 85, 90, 95, 100, 85, 85, 90, 85
Median (nilai tengah) nilai tersebut = 95 dan 100

Mode = Nilai yang paling sering atau paling banyak muncul adalah nilai 85 sebanyak 3 anak.

Figure 7. Results of S-S Answers on the Monitoring Indicator

Figure 7 shows that S-S can solve the problem by monitoring the steps correctly, namely determining the mean, median, and mode values. S-S was unable to fully monitor whether the answer was correct or incorrect because a calculation error occurred when determining the median value. The data were not sorted first, and the middle values were directly identified as 95 and 100. In the interview excerpt, S-S demonstrated some consideration of her solution, as shown by her attempt to recalculate the results obtained. Overall, S-S was able to solve the problem by fulfilling the monitoring indicators of reflective thinking ability, but not optimally. The following interview excerpt supports S-S's response.

M : *"What steps did you use to solve the problem?"*
S-S : *"I calculated the mean by adding all the scores and dividing by 10 students. Then the median is the middle score, and I calculated the mode as the most frequently occurring value" (M1)*
M : *"Did you check your steps when working on the problem?"*
S-S : *"I rechecked the answer and recalculated the results I obtained" (M2)*
M : *"When solving the problem, did you ever find an answer that felt 'not quite right', and what decision did you make?"*
S-S : *"I repeated it from the beginning. If there was a wrong answer, I corrected it" (M3)*

Thus, based on Figure 7 and the interview results, it can be seen that S-S was able to monitor the solution steps appropriately. However, she was unable to consistently monitor the correctness of her answers and fully justify her decisions. Thus, S-S fulfills all monitoring indicators (M1, M2, and M3), but the M2 indicator is not fully optimized. This partial achievement supports the findings of Ratnaningsih and Hidayat (2020) who stated that students with moderate mathematical ability may only fulfill some reflective thinking indicators, as the monitoring aspect is present but not yet optimal in evaluating the correctness of solutions.

Students in the low reflective thinking ability category could only achieve part of the monitoring indicators. This can be seen from the results of S-R's work, which still failed to solve the problem using appropriate steps because she experienced difficulty in working on the task. S-R's answer is presented in Figure 8.

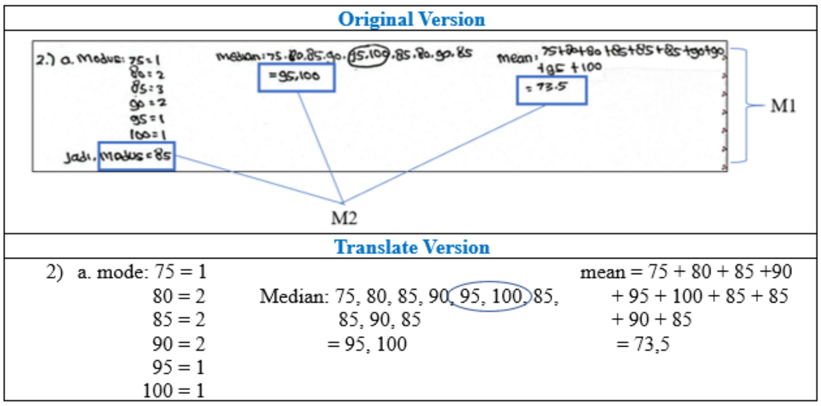


Figure 8. Results of S-R Answers on the Monitoring Indicator

Figure 8 shows that S-R was less able to solve the problem effectively by monitoring the steps, as indicated by an inappropriate sequence of procedures, where S-R determined the mode first, followed by the median, and then the mean. S-R was also less able to monitor whether her answers were correct because calculation errors occurred in determining the mean value (73.5), and in determining the median, where the data were not sorted first and the middle values were directly identified as 95 and 100. In the interview excerpt, S-R also showed limited ability to evaluate her decisions, as indicated by her failure to recalculate the results obtained, because she felt it was too difficult. Nevertheless, S-R still attempted to solve the problem. This can be seen from her answers, where she attempted all questions, although they were not entirely appropriate. The following interview excerpt supports this finding.

M : *"What steps did you use to solve the problem?"*
S-R : *"I calculated the mode, then the mean and median, but I am not sure" (M1)*
M : *"Did you check your steps when working on the problem?"*
S-R : *"I do not know how to check it" (M2)*
M : *"When solving the problem, did you ever find an answer that felt 'not quite right', and what decision did you make?"*
S-R : *"I tried to correct it" (M3)*

Thus, based on Figure 8 and the interview results, it can be seen that S-R was less able to monitor the solution steps appropriately, less able to verify the correctness of answers, and less able to evaluate her decisions. Therefore, S-R did not fully achieve the monitoring indicators. This reflects a broader pattern of weak reflective thinking skills among low-ability students. In the monitoring aspect, students have not been able to fulfill all reflective thinking indicators optimally. In line with Zerdali and Eğmir (2025), this is influenced by weak conceptual foundations and a lack of evaluative practices in the problem-solving process. This finding corroborates international research by Özbek and Cho (2022) , which emphasizes that metacognitive awareness and reflective thinking are strongly interconnected, and students who lack evaluative practices in problem-solving consistently demonstrate weaker monitoring skills across different educational contexts.

Insight

In the second problem, in addition to the monitoring indicator, S-T also fulfilled the insight indicator. S-T showed enthusiasm and persistence in solving the problem. He corrected his answers and identified strategies to overcome difficulties. The results of S-T's interview support this finding.

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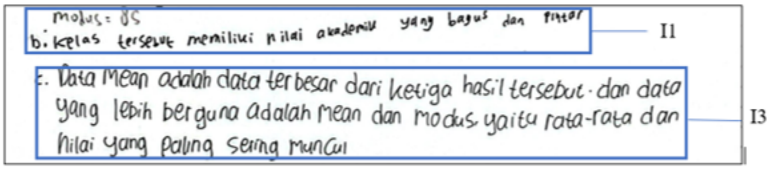
Translate Version
a. The class has good academic scores and is smart b. The mean is the largest of the three results and the more useful data are the mean and mode, which are the average and the most frequent value.

Figure 9. Results of S-T Answers on the Insight Indicator

Figure 9 shows that S-T solved the problem enthusiastically and did not give up, as indicated by his ability to generate innovative solutions based on analysis of values from the previous problem. S-T was able to correct her answers appropriately and find solutions when encountering difficulties. Overall, S-T's response indicates that she fulfilled the insight indicator of reflective thinking ability. The following interview excerpt supports S-T's response.

M : *"How did you feel when you solved this problem? What did you do to solve it?"*
S-T : *"I enjoyed it! The problem is challenging, so I can try several ways to solve it" (I1)*
M : *"What did you do when you realized your answer was wrong after you finished working?"*
S-T : *"I reworked it by checking again the values obtained, then related them to the question" (I2)*

Thus, based on Figure 9 and the interview results, it can be seen that S-T was eager to solve the problem, did not give up when facing difficulties, corrected her answers appropriately, and found suitable solutions. Therefore, S-T fulfilled all insight indicators, namely I1, I2, and I3. This positive disposition and self-regulation are characteristics of strong reflective thinkers. Consistent with Damastuti et al. (2023) high-ability students also meet all indicators of insight, including persistence in problem-solving, correcting incorrect answers, and identifying strategies to overcome difficulties.

Students with moderate reflective thinking ability have fulfilled the insight indicators, but some indicators have not been fully achieved. This can be seen from the work of S-S, who was able to solve the problem but only met some of the reflective thinking indicators. Figure 10 shows the results of S-S's answer.

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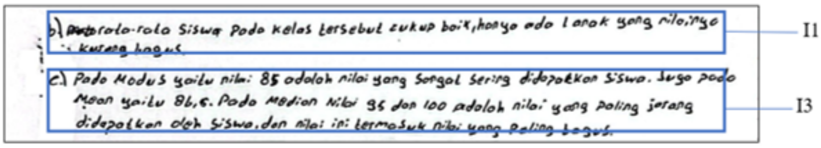

Translate Version

b. the average in the class is quite good, there is only 1 child whose score is not good enough
c. in the mode, the value of 85 is the value that students get very often, as well as the mean which is 86.5. In the median, the values of 95 and 100 are the values that are least often obtained by students, and these values are among the best values.

Figure 10. Results of S-S Answers on the Insight Indicator

Figure 10 shows that S-S was able to solve the problem enthusiastically and did not give up, as indicated by her persistence in continuing the work even though she experienced difficulties until she obtained an answer. However, S-S was unable to fully correct her answer due to a calculation error in the previous step. As a result, the analysis became less accurate, and S-S was unable to find an appropriate solution when facing difficulties. Overall, S-S's response indicates that she fulfilled the insight indicator of reflective thinking ability, but not optimally. The following interview excerpt supports S-S's response.

M : *"How did you feel when you solved this problem? What did you do to solve it?"*
S-S : *"I felt the question was a bit difficult, so I kept trying until I found the answer" (I1)*
M : *"What did you do when you realized your answer was wrong after you finished working?"*
S-S : *"I checked the values again and then I answered the question" (I2)*

Thus, based on Figure 10 and the interview results, it can be seen that S-S was eager to solve the problem, did not give up when experiencing difficulties, and attempted to correct her answer despite remaining calculation errors, and ultimately arrived at a solution. Therefore, S-S fulfilled all insight indicators (I1, I2, and I3), but indicators I2 and I3 were not fully optimized. In the insight aspect, students are not yet optimal in fulfilling the indicators of correcting answers and determining strategies when encountering difficulties. Students tend to assume that they are not experiencing significant difficulties in problem solving, so they do not feel the need to apply alternative strategies. This is in line with Setiyani et al. (2024), who state that in learning, students often only utilize their knowledge without evaluating or developing it further.

Students in the low reflective thinking ability category could only achieve part of the insight indicators. This can be seen from the results of S-R's work, which still failed to solve the problem using appropriate steps due to difficulties experienced during problem solving. S-R's answer is presented in Figure 11.

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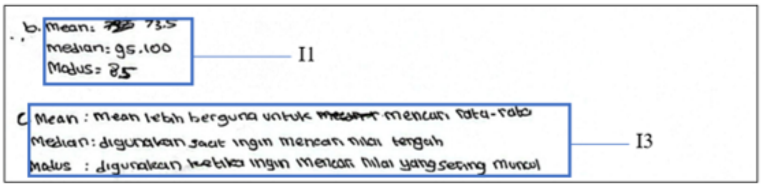

Translate Version

b. mean: 73,5
modus: 95, 100
mode: 85

c. mean: mean is useful for finding the average
median: used when you want to find the middle value
mode: used when you want to find a value that appears frequently

Figure 11. Results of S-R Answers on the Insight Indicator

Figure 11 shows that S-R was less able to solve the problem because she gave up immediately when attempting to solve it. S-R was also unable to correct her answer appropriately because, during the interview, she stated that she did not know how to make corrections and was unable to find solutions when encountering difficulties. Overall, S-R's response did not optimally fulfill the indicators of insight in reflective thinking ability. The following interview excerpt supports S-R's response.

M : *"How did you feel when you solved this problem? What did you do to solve it?"*
S-R : *"The problem was complicated; I could not solve it" (I1)*
M : *"Did you correct your answer after you finished working?"*
S-R : *"I do not know how to correct it" (I2)*

Thus, based on Figure 11 and the interview results, it can be seen that S-R was not enthusiastic about solving the problem; she immediately gave up when experiencing difficulties, could not correct her answers, and was unable to find a solution. Therefore, S-R did not optimally fulfill all insight indicators (I1, I2, and I3). In terms of insight, students are not yet able to optimally fulfill all reflective thinking indicators. This lack of perseverance and initiative in problem solving significantly hinders their ability to engage in reflective thinking and overcome challenges, which is characteristic of weak reflective thinking skills, as noted by Saracoglu (2022). This pattern, in which low-ability students quickly give up when facing difficulties, aligns with international research by Broza et al. (2021), which found that students with weak metacognitive skills tend to abandon problem-solving efforts prematurely rather than persist in finding alternative strategies.

In the insight aspect, high-ability students were able to persist when facing difficulties, correct their mistakes, and find alternative strategies because they possess strong metacognitive awareness and a solid conceptual foundation. Medium-ability students showed initial enthusiasm and persistence but lacked sufficient metacognitive depth to fully evaluate

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their errors or develop effective alternative strategies. Low-ability students tended to give up quickly and were unable to correct their answers due to weak conceptual understanding and limited problem-solving experience.

Conceptualization

In the conceptualization indicator, S-T was able to solve the problem effectively, beginning with a clear understanding of alternative solutions. S-T then explained responses that were relevant to the given data and successfully connected them to the underlying concept. Figure 12 shows the results of S-T's answer to the problem.

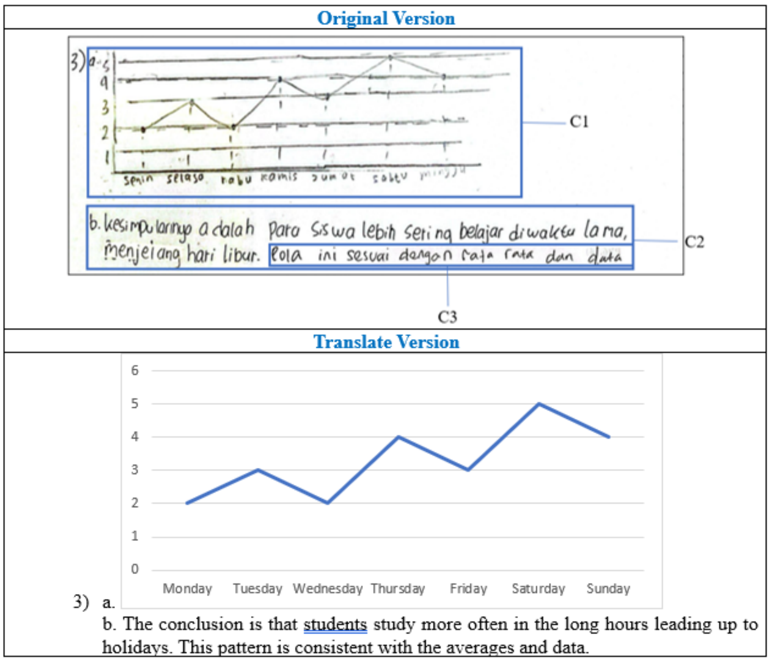

Figure 12. Results of S-T Answers on Conceptualization Indicator

Figure 12 shows that S-T was able to understand the alternative solution by correctly constructing a line diagram. S-T was also able to interpret the problem by stating that students study longer before the holiday period, as reflected in the line diagram that had been constructed. In addition, S-T was able to connect the solution with the concepts of mean and data interpretation appropriately. Overall, S-T's response fulfilled the conceptualization indicator of reflective thinking ability. The following interview excerpt supports S-T's response.

M : *"How do you present the study time data?"*

S-T : *"I made a line diagram by setting the horizontal axis as days and the vertical axis as study duration, then determining the values based on the data" (C1)*

M : *"Why do you think students often study during holidays?"*

S-T : *"Because maybe they have more free time during the holidays, ma'am, and from Monday to Friday they are tired" (C2)*

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Thus, based on Figure 12 and the interview results, S-T was able to understand alternative solutions, interpret the problem, and connect it with relevant concepts. Therefore, S-T fulfilled all conceptualization indicators (C1, C2, and C3). This demonstrates the ability to think abstractly and relate mathematical concepts to contextual situations. High-ability students also meet all conceptualization indicators, including the ability to understand alternative solutions, interpret problems, and connect relevant concepts (Erdoğan, 2020).

Students with moderate reflective thinking ability have fulfilled the conceptualization indicators, but some indicators have not been fully achieved. This can be seen from the work of S-S, who was able to solve the problem but only met some of the reflective thinking indicators. Figure 13 shows the results of S-S's answer.

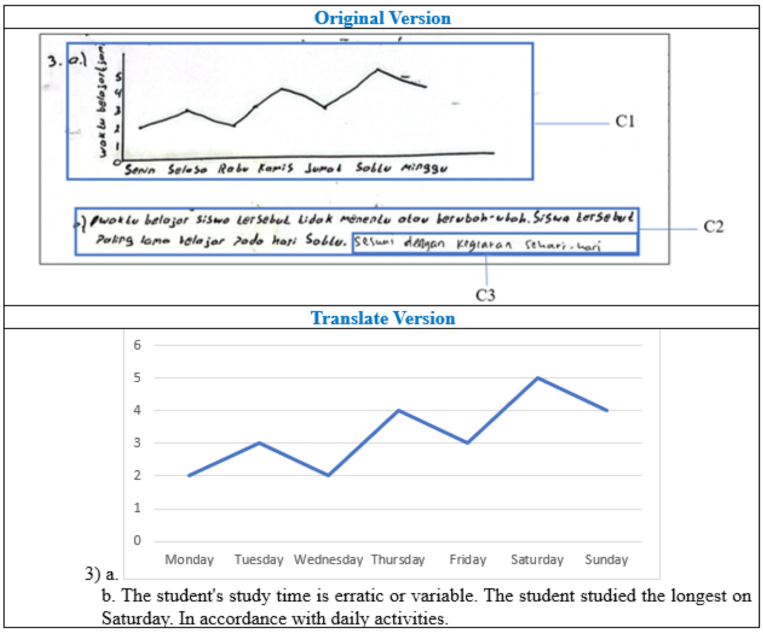

Figure 13. Results of S-S Answers on Conceptualization Indicator

Figure 13 shows that S-S was able to understand the alternative solution by appropriately constructing a line diagram based on the given data. However, S-S was less able to interpret the relevant problem and only wrote a general conclusion from the line diagram. On the other hand, S-S was able to connect the concept with everyday situations. Overall, S-S's response fulfilled the conceptualization indicator of reflective thinking ability, but not optimally. The following interview excerpt supports S-S's response.

M : *"How did you present the study time data?"*
S-S : *"I made a line diagram by adjusting what is known in the data provided" (C1)*
M : *"Why do you think students often study on Saturday?""Why do you think students often study on Saturday?"*
S-S : *"Because Saturday leads to a holiday, Mom" (C2)*

Thus, based on Figure 13 and the interview results, it can be seen that S-S was able to

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understand alternative solutions but was less able to identify the core problem, although she was able to connect the concept with relevant contexts. Therefore, S-S fulfilled all conceptualization indicators (C1, C2, and C3), but indicator C2 was not fully optimized. While the conceptualization aspect was generally achieved, the ability to interpret and articulate the core problem was still limited. This indicates difficulty in interpreting and expressing the main idea from the represented data, which is a key aspect of conceptual understanding among medium-ability students (Sumitro et al., 2019).

Students with low reflective thinking skills fulfilled only some conceptualization indicators and did not achieve them optimally. This can be seen from the work of S-R, who was able to attempt the problem but only met some indicators of reflective thinking ability. Figure 14 shows the results of S-R's answer.

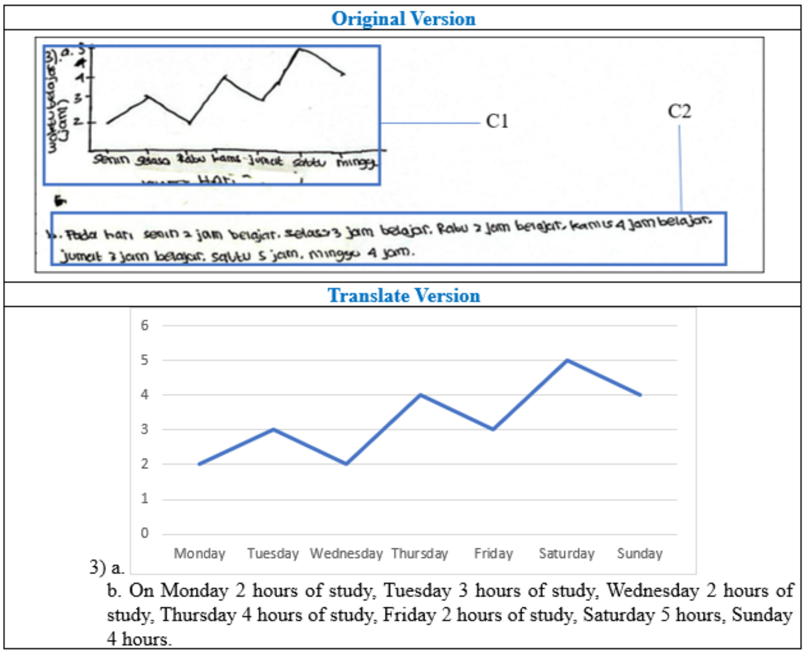

Figure 14. Results of S-R Answers on Conceptualization Indicator

Figure 14 shows that S-R could understand the alternative solution by appropriately making a line diagram according to the data presented. However, S-R could not identify the relevant problem and only rewrote the given data, and S-R could not connect the relevant concepts. Overall, S-R's answer fulfilled several indicators of conceptualization in reflective thinking skills but was less than optimal. The following interview excerpt supports S-R's answer.

M : *"How do you present the study time data?"*
S-R : *"I made a line diagram by entering the data in the question, then adjusted the day with the time" (C1)*
M : *"Tell me, what do you think this line diagram means?"*

S-R : *"This diagram is the students' study time" (C2)*
M : *"Can you relate it to relevant concepts?"*
S-R : *"Hmm… maybe the students only studied for a short time."*

Thus, based on Figure 14 and the interview results, it can be seen that S-R could understand alternative solutions but was less able to identify the problem and could not connect relevant concepts. Thus, S-R was only able to meet the conceptualization indicator C1. In the conceptualization aspect, students are expected to meet all three indicators: understanding alternative solutions, identifying the problem, and connecting relevant concepts. This shows a significant weakness in higher-order thinking skills, such as problem identification and conceptual connection, which are essential for deep reflective learning and are consistent with the profile of low-ability students having the weakest reflective thinking skills (Kuncoro et al., 2025). This difficulty in connecting mathematical concepts to real-world contexts among low-ability students supports international findings by Aldahmash et al. (2021), who reported that students with weak conceptual understanding struggle to abstract general principles from problem-solving experiences and apply them to new situations across different educational contexts.

In the conceptualization aspect, high-ability students demonstrated the capacity for abstract thinking, understood alternative solutions, articulated problems in their own words, and connected mathematical concepts to real-world contexts. Medium-ability students could understand alternative solutions but struggled to articulate problems and make meaningful conceptual connections. Low-ability students were only able to replicate procedures without understanding the underlying meaning, reflecting a fundamental gap in their conceptual development.

While this study provides in-depth insights into students' reflective thinking abilities, several limitations should be acknowledged. The research was conducted at a single junior high school with only 30 participants, and the qualitative analysis focused on three representative students, which limits the generalizability of the findings. Additionally, this study captured reflective thinking at one point in time, offering a snapshot rather than observing how these skills develop longitudinally.

Future research should consider conducting longitudinal studies to track the development of students' reflective thinking skills over an extended period. Comparative studies across multiple schools or regions are also recommended to explore how different educational contexts influence reflective thinking abilities. Furthermore, intervention-based research could investigate the effectiveness of specific instructional strategies, such as reflective journals or project-based learning, in enhancing students' reflective thinking skills across all mathematical ability levels.

CONCLUSION

Reflective thinking ability in the aspects of technique, monitoring, insight, and conceptualization among students in statistics learning at one junior high school shows variation. Students with high mathematical ability demonstrate excellent reflective thinking skills in all aspects, indicated by the achievement of all indicators. Students with moderate mathematical ability show fairly good reflective thinking ability, indicated by the achievement of some indicators in all aspects. Students with low mathematical ability demonstrate the weakest reflective thinking ability, indicated by achievement only in the technique, monitoring, and insight aspects, while conceptualization indicators are not optimally achieved.

The findings suggest a clear hierarchical relationship: students' initial mathematical ability significantly influences the quality of their reflective thinking across all four aspects: techniques, monitoring, insight, and conceptualization. Students with high mathematical ability demonstrate complete reflective thinking, fulfilling all indicators in every aspect. Students with moderate ability exhibit partial reflective thinking, achieving some indicators but not optimizing others. Students with low mathematical ability possess the weakest reflective thinking skills, partially meeting indicators in the technique, monitoring, and insight aspects, and failing to achieve conceptualization indicators optimally. These results confirm that foundational mathematical knowledge is a critical determinant of students' capacity to engage in deep, reflective problem-solving in statistics.

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