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ANALYSIS OF HIGH SCHOOL STUDENTS' MATHEMATICAL REFLECTIVE THINKING ABILITY IN SOLVING THREE-VARIABLE LINEAR EQUATION WORD PROBLEMS

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ABSTRACT

Mathematical reflective thinking is an essential ability that enables students to understand problems, connect prior knowledge, evaluate solution strategies, and justify their conclusions. This study aims to analyze high school students' mathematical reflective thinking ability in solving three-variable linear equation word problems. This research employed a descriptive method with a qualitative approach supported by quantitative descriptive analysis. The subjects were 33 eleventh-grade students from a senior high school in Karawang Regency. Data were collected through three essay questions designed based on three indicators of mathematical reflective thinking: reacting, comparing/elaborating, and contemplating. The results showed that students' mathematical reflective thinking ability was not yet fully developed. Based on the categorization, 9.1% of students were in the high category, 72.7% were in the medium category, and 18.2% were in the low category. The analysis of students' responses indicated that students were generally able to identify some information in the problems, but many still experienced difficulties in constructing mathematical models, selecting appropriate solution strategies, and verifying the correctness of their answers. These findings suggest that students need learning activities that encourage deeper reflection, systematic problem solving, and evaluation of mathematical reasoning.

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1. INTRODUCTION

Mathematics plays a fundamental role in developing students' logical, systematic, and critical thinking skills. In the context of 21st-century education, mathematics learning is not only oriented toward obtaining correct answers but also emphasizes the thinking processes used by students in solving problems. These processes include analyzing information, constructing mathematical models, evaluating strategies, and reflecting on obtained results. Therefore, mathematics learning is expected to foster higher-order thinking skills that enable students to face complex and contextual problems in both academic and real-life situations (Putra & Hakim, 2023). Among these higher-order thinking skills, mathematical reflective thinking is considered essential because it supports students in understanding concepts deeply and improving their problem-solving abilities.

Mathematical reflective thinking refers to an individual's ability to reconsider the problem-solving process by understanding the problem, connecting it with prior knowledge, evaluating solution strategies, and drawing appropriate conclusions. This ability encourages students not only to solve mathematical problems but also to analyze and justify each step taken during the solution process (Daniar & Ardiyanti, 2025). Reflective thinking is categorized as a higher-order thinking skill because it requires individuals to think carefully, evaluate their reasoning, and reconsider their decisions before reaching conclusions. Anwar and Sofiyan (2018) state that mathematical reflective thinking involves deep understanding, careful reasoning, and deliberate decision-making, which are necessary for solving complex mathematical problems. In addition, reflective thinking enables students to monitor their cognitive processes, identify mistakes, and revise incorrect reasoning, leading to more meaningful learning experiences.

The importance of mathematical reflective thinking has been widely discussed in mathematics education research. Students who possess strong reflective thinking skills tend to be more capable of evaluating strategies, correcting errors, and connecting mathematical concepts effectively. These abilities are essential in developing students' problem-solving competence and conceptual understanding. However, several studies have reported that students' mathematical reflective thinking skills remain low. Budiarti et al., (2024) found that 96.77% of 31 students involved in their study were categorized as having low mathematical reflective thinking ability. Similarly, Ramadhani et al., (2024) reported that 76% of 29 students in their research also demonstrated low reflective thinking skills. These findings indicate that most students still struggle to evaluate their problem-solving processes and reflect on their reasoning. Furthermore, international research also supports this issue. Kember et al., (2008) reported that students' reflective thinking tends to remain at a surface level, where learners are unable to conduct deep evaluation of their cognitive processes. These findings suggest that improving students' mathematical reflective thinking ability remains an important challenge in mathematics education.

One of the mathematical topics that requires strong reflective thinking ability is the System of Linear Equations in Three Variables (SLETV). This topic is considered complex because students are required not only to apply procedural steps but also to interpret contextual problems, construct mathematical models, select appropriate solution strategies, and verify the accuracy of the obtained results. These activities correspond to the stages of reflective thinking, namely reacting, comparing or elaborating, and contemplating (Husain et al., 2022). In the reacting stage, students identify relevant information and understand the problem. In the comparing or elaborating stage, students connect the problem with prior knowledge and determine appropriate solution strategies. Finally, in the contemplating stage, students evaluate the results and reconsider the correctness of their reasoning. Therefore,

SLETV material provides a suitable context for analyzing students' mathematical reflective thinking ability.

In solving word problems related to SLETV, students are required to understand the information presented, translate the problem into mathematical equations, and determine appropriate solutions. However, in practice, many students experience difficulties in understanding contextual information, constructing mathematical models, and evaluating the obtained results. These difficulties indicate that students often rely on procedural approaches without reflecting on the problem-solving process (Adha & Rahaju, 2021) reported that students tend to struggle in interpreting story problems and verifying their answers, which reflects weak reflective thinking ability. As a result, students frequently make conceptual and procedural errors when solving SLETV problems. This condition highlights the need to analyze students' mathematical reflective thinking ability in solving contextual problems, particularly in SLETV material.

Previous studies have generally examined mathematical reflective thinking in various mathematical topics, but limited research has specifically focused on reflective thinking ability in solving SLETV word problems at the high school level. Most studies emphasize general problem-solving skills without deeply analyzing the stages of reflective thinking in the SLETV context. Therefore, further investigation is necessary to explore how students demonstrate reflective thinking when solving SLETV word problems. This study attempts to fill this gap by analyzing students' mathematical reflective thinking ability based on reflective thinking stages in solving contextual SLETV problems.

Based on the described background, this study aims to analyze the mathematical reflective thinking ability of high school students in solving word problems on the System of Linear Equations in Three Variables (SLETV) material. This analysis focuses on students' ability to understand problems, connect them with prior knowledge, evaluate solution strategies, and recheck the obtained results. The findings of this study are expected to provide a clearer description of students' mathematical reflective thinking ability and contribute to improving mathematics learning, particularly in developing higher-order thinking skills. In addition, the results of this research are expected to serve as a reference for teachers in designing learning activities that support the development of students' reflective thinking skills in mathematics learning.

2. METHOD

This study employed a descriptive research design with a qualitative approach. Descriptive qualitative research aims to describe and analyze phenomena systematically and accurately without testing hypotheses. This approach was used to obtain an in-depth description of students' mathematical reflective thinking ability in solving word problems on the System of Linear Equations in Three Variables (SLETV) material. This is in line with Sukmadinata (2017), who states that descriptive research is intended to describe existing conditions as they naturally occur. Therefore, this study focused on analyzing students' reflective thinking processes based on their responses to the given problems.

This research was conducted at a senior high school in Karawang Regency during the even semester of the 2025/2026 academic year. The subjects of this study were 33 students of class XI. The subjects were selected using purposive sampling technique, with the consideration that the students had studied the SLETV material. The selected subjects were expected to provide information related to students' mathematical reflective thinking ability in solving SLETV word problems.

The data in this study were collected using a test instrument designed to measure students' mathematical reflective thinking ability. The instrument consisted of three essay

questions related to SLETV word problems. The questions were developed based on indicators of mathematical reflective thinking ability. The indicators used in this study referred to Surbeck et al., (1991), which include: (1) reacting, (2) comparing, and (3) contemplating. The reacting indicator refers to students' ability to understand problems and identify relevant information. The comparing indicator refers to students' ability to connect problems with prior knowledge and determine appropriate strategies. The contemplating indicator refers to students' ability to evaluate solutions and recheck the obtained results.

Before being administered to students, the instrument was validated by two experts in mathematics education to ensure content validity. The validation process included assessing the suitability of questions with indicators, clarity of language, and appropriateness of the SLETV material. Based on expert suggestions, revisions were made to improve the quality of the instrument. After validation, the instrument was administered to students.

The data collection procedure began by administering the test to students. Students were asked to solve three SLETV word problems in written form. Their answers were then collected and scored using a scoring rubric based on mathematical reflective thinking indicators. Each indicator was assessed according to students' ability to demonstrate reflective thinking processes in their written responses.

The data analysis technique in this study used descriptive qualitative analysis supported by quantitative data. The analysis steps included: (1) scoring students' answers based on reflective thinking indicators, (2) calculating students' total scores, (3) determining the mean and standard deviation, (4) categorizing students' mathematical reflective thinking ability into high, medium, and low categories, and (5) describing students' reflective thinking characteristics in each category. This analysis technique aimed to provide a comprehensive description of students' mathematical reflective thinking ability.

Students' mathematical reflective thinking ability levels were categorized based on the mean score and standard deviation. The categorization referred to Arikunto (Larasati & Effendi, 2022) as follows:

Table 1. Mathematical Reflective Thinking Ability Category

Category	Value Limit
High	$X \geq \bar{x} + SD$
Medium	$\bar{x} - SD < X < \bar{x} + SD$
Low	$X \leq \bar{x} - SD$

Information:
X = students' score
$\bar{x}$ = mean score
SD = standard deviation

After categorizing students' abilities, further qualitative analysis was conducted by describing students' answers in each category. The analysis focused on identifying students' reflective thinking characteristics based on reacting, comparing, and contemplating indicators. The results of this analysis were then used to draw conclusions regarding students' mathematical reflective thinking ability in solving SLETV word problems.

3. RESULTS AND DISCUSSION

3.1 RESULTS

The results of this study describe students' mathematical reflective thinking ability in solving SLETV word problems. The data were obtained from students' answers to three

essay questions developed based on the indicators of mathematical reflective thinking ability, namely reacting, comparing/elaborating, and contemplating.
The descriptive statistical results of students' mathematical reflective thinking ability are presented in table 2.

Table 2. Students' Mathematical Reflective Thinking Ability Test Results

Number of Students	Maximum Score	Minimum Score	Mean	Standard Deviation
33	80	33.3	56.4	13.9

Table 2 shows that the highest score obtained by students was 80, while the lowest score was 33.3. The mean score of students' mathematical reflective thinking ability was 56.4 with a standard deviation of 13.9. These results indicate that students' mathematical reflective thinking ability tends to be moderate.

Students' mathematical reflective thinking ability was further categorized into three levels, namely high, medium, and low, based on the mean and standard deviation. The categorization results are presented in Table 3.

Table 3. Category of Students' Mathematical Reflective Thinking Ability

Category	Number of Students	Percentage
High	3	9.1%
Medium	24	72.7%
Low	6	18.2%
Total	33	100%

Table 3 shows that most students were in the medium category, with 24 students (72.7%). Meanwhile, 6 students (18.2%) were categorized as low, and only 3 students (9.1%) were categorized as high. These results indicate that students' mathematical reflective thinking ability has not been optimally developed.
Students' mathematical reflective thinking ability was further analyzed based on each indicator, namely reacting, comparing/elaborating, and contemplating.

Reacting Indicator

The reacting indicator assesses students' ability to understand problems, identify known and asked information, and construct mathematical models. In question 1a, students were asked to determine known information and formulate SLETV equations.

Some students were able to identify all known information and construct complete mathematical models. These students correctly defined variables and formed three linear equations based on the problem. Their answers showed that they understood the contextual information and translated it into mathematical form.

However, several students experienced difficulties in identifying complete information. Some students only wrote part of the known data and failed to construct three equations. Other students did not state what was asked in the problem. This indicates that students still had difficulty understanding contextual problems and constructing mathematical models.

Comparing/Elaborating Indicator

The comparing/elaborating indicator measures students' ability to determine appropriate solution strategies and solve SLETV models. In question 1b, students were asked to solve the system of equations formed in the previous stage.

Some students demonstrated correct and systematic solution steps. These students used substitution or elimination methods appropriately and solved the equations sequentially until obtaining the values of each variable. Their answers showed that they were able to connect prior knowledge with the given problem.

On the other hand, several students showed incomplete solution steps. Some students selected incorrect equations for substitution, while others performed calculation errors. There were also students who obtained correct final answers but did not show logical and systematic steps. This indicates that students had not fully developed the ability to apply solution strategies appropriately.

Contemplating Indicator

The contemplating indicator measures students' ability to verify solutions and draw conclusions. In question 1c, students were asked to check their answers by substituting values into the original equations and write final conclusions.

Some students demonstrated the verification process by substituting the obtained values into the equations. These students also wrote conclusions clearly and correctly. This shows that they were able to evaluate the correctness of their solutions.

However, many students did not perform verification. Some students directly wrote final answers without checking their correctness. Others wrote conclusions without explanation. This indicates that students' ability to evaluate and reflect on their solutions is still low.

Overall, the results show that students performed better in the comparing indicator than in reacting and contemplating indicators. Most students experienced difficulties in identifying known information and verifying solutions.

3.2 DISCUSSION

The results of this study indicate that students' mathematical reflective thinking ability is still at a moderate level. Most students were categorized in the medium level, while only a small number of students were categorized as high. This finding indicates that students have not fully developed reflective thinking skills when solving SLETV word problems. Students tend to focus on procedural calculations rather than reflecting on their problem-solving processes.

Based on the reacting indicator, students experienced difficulties in identifying known and asked information and constructing mathematical models. Some students failed to translate contextual problems into SLETV equations. This finding indicates that students still have limited ability in understanding contextual problems. Reflective thinking at the reacting stage requires students to analyze problem situations and identify relevant information. When students are unable to identify the information correctly, they cannot proceed to the next stages of reflective thinking. This result is consistent with Surbeck, Han, and Moyer (1991), who state that reacting is the initial stage of reflective thinking that involves recognizing and understanding problems.

In the comparing/elaborating stage, students demonstrated better performance. Several students were able to determine appropriate strategies and solve the SLETV equations systematically. These students were able to connect previously learned concepts with the given problems. However, some students still showed incomplete solution steps and calculation errors. This indicates that students' ability to compare strategies and apply appropriate methods is still developing. This finding supports the statement that reflective thinking requires students to relate new problems to prior knowledge and evaluate solution strategies (Daniar & Ardiyanti, 2025).

The contemplating stage showed that many students did not verify their solutions. Students tended to write final answers without checking the correctness of their results. This indicates that students have not developed the habit of evaluating their problem-solving processes. Reflective thinking at the contemplating stage requires students to reconsider their reasoning and verify results. When students skip this stage, they may produce incorrect conclusions. This finding is consistent with previous studies indicating that students often focus on obtaining answers rather than evaluating their solutions.

Overall, students' reflective thinking ability was weakest in the reacting and contemplating stages. Students had difficulty understanding contextual problems and verifying solutions. Meanwhile, students performed relatively better in applying solution procedures. This indicates that students are more familiar with procedural learning than reflective thinking processes.

These findings suggest that mathematics learning should emphasize reflective thinking activities. Teachers should encourage students to identify known information, explain solution steps, and verify their answers. Learning strategies such as problem-based learning and reflective questioning can help improve students' mathematical reflective thinking ability. By integrating reflective thinking activities into mathematics learning, students can develop deeper conceptual understanding and improve problem-solving skills.

4. CONCLUSION

The results of this study indicate that students' mathematical reflective thinking ability in solving SLETV word problems is still at a moderate level. Most students were categorized in the medium category, while only a small number of students reached the high category. This finding shows that students have not fully developed reflective thinking skills in solving contextual mathematical problems.

Based on the reflective thinking indicators, students demonstrated varying abilities in each stage. Students performed relatively better in the comparing indicator, where they were able to apply solution strategies to solve SLETV problems. However, difficulties were still found in the reacting and contemplating indicators. In the reacting stage, students had difficulty identifying complete information and constructing mathematical models. In the contemplating stage, many students did not verify their solutions and were unable to draw appropriate conclusions.

These findings indicate that students' reflective thinking processes are not yet optimal, particularly in understanding problems and evaluating solution results. Therefore, mathematics learning should emphasize the development of reflective thinking skills by encouraging students to identify known information, explain solution strategies, and verify their answers. By integrating reflective thinking activities into mathematics learning, students are expected to develop deeper conceptual understanding and improve their problem-solving abilities.

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