Mathematical Reflective Thinking of Junior High School Students in Solving Algebra Problems

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Mathematical Reflective Thinking of Junior High School Students in Solving Algebra Problems

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Article Info	ABSTRACT
	Mathematical reflective thinking is a key higher-order thinking skill in mathematics learning. However, these skills remain underdeveloped for some students, particularly when solving algebraic problems. This study aims to describe seventh-grade students' mathematical reflective thinking in algebraic problem solving. The participants were all students in Class VIIA at a junior high school in Karawang. Using purposive sampling based on a reflective thinking test, three students were selected to represent high, medium, and low ability categories. Data were collected through a test and follow-up interviews and analyzed qualitatively to capture patterns of reflective thinking across categories. The findings show clear variation among students. High-ability students reflected logically on both the problem-solving process and the correctness of results. Medium-ability students demonstrated partial and inconsistent reflection, often reflecting on steps but not fully evaluating their conclusions. Low-ability students experienced substantial difficulty in monitoring and evaluating their work. These results suggest that students' reflective thinking develops at different levels in algebraic problem solving, and future research should examine instructional and individual factors that shape these differences.

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Introduction

Mathematics must be studied from elementary school to high school because it influences the growth of other disciplines and is one of the most frequently used sciences in everyday life (Husain et al., 2024; Nurfadhillah et al., 2021). However, mathematics is often perceived as a frightening subject because students believe that mathematics is always related to numbers,

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formulas, and complicated calculations (Aprilia & Fitriana, 2022). In addition, the reflective thinking skills of students in Indonesia are currently still low, as evidenced by the majority of students' inability to integrate their understanding of the problems they face, evaluate the steps taken to solve them, and reflect on the results obtained (Kurniawati et al., 2024).

Reflective thinking skills are an important indicator in measuring the quality of students' thinking, which includes the ability to examine, analyze, and reflect on the process and results of solving a problem (Gurol dalam Sari et al., 2020). This skill is essential in solving math problems, where students should not only understand the concept, but also be able to evaluate the steps taken and consider alternative solutions (Shofary et al., 2025).

Mathematical reflective thinking is a rational decision-making mechanism for solving problems and evaluating decisions that have been made (Widiyasari et al., 2020). Mathematical reflective thinking ability is a person's skill in relating newly learned perceptions or strategies to those previously learned, which are still stored in memory, so that they are able to formulate steps to solve and find solutions to mathematical problems encountered (Suwartia et al., 2023). In line with this, mathematical reflective thinking skills include skills that involve linking new knowledge with existing knowledge to formulate solutions and draw logical conclusions (Fira et al., 2023; Sholihah, 2021). Based on the description of these various opinions, mathematical reflective thinking skills can be interpreted as cognitive abilities that require logical reasoning processes through the linking of new information or strategies with previously acquired knowledge. These skills enable individuals to develop strategies for solving mathematical problems, evaluate the choices made, and draw logical conclusions about the problems encountered.

Mathematical reflective thinking skills play an important role in solving various mathematical problems, including those in algebra (Andika, 2023). Algebraic material not only emphasizes the ability to manipulate symbols and procedures, but also requires a deep understanding of concepts. When solving algebraic problems, students must recall their prior knowledge, review the steps they have taken, and evaluate the strategies they have used to ensure that the solutions obtained are correct and accurate (Asmara, 2025). This process demonstrates the ability to think reflectively, which can optimize students' mastery and skills when solving mathematical problems.

Regarding this matter, the indicators of mathematical reflective thinking ability used in this study were adopted from Maulida et al., (2024) According to Surbeck, Han, Mayor (1991), they are as follows:

Table 1. Indicators of Mathematical Reflective Thinking Ability

Phase/Level	Indicator
Reacting	a. State what is being asked.
	b. State what is known.
	c. State the relationship between what is being asked and what is known.
	d. Be able to explain that what is known is sufficient to answer what is being asked.
Elaborating	a. Explain the answers to problems that have been encountered
	b. Relate the questions asked to problems that have been encountered
Contemplating	a. Determine the meaning of the problem
	b. Detect errors in the answer
	c. Correct and explain if there are errors in the answer
	d. Make the correct conclusion

Several researchers have conducted studies on students' mathematical reflective thinking skills. One such study was conducted by Ananda et al., (2021) at SMP Negeri 14 Satu Atap

Tanjungpinang showed that out of 12 students, only about 25% had high potential for mathematical reflective thinking, while 50% were in the moderate category and the rest were low, especially in difficulty connecting concepts and concluding answers. Saiful et al., (2024) Conducted research at a junior high school in Aceh Besar found that of the 21 students who took the test, the majority (66.66%) had moderate reflective thinking skills, with the most difficulty in the comparing and contemplating indicators. In line with this, the results of the study Fira et al., (2023) at SMP Negeri 1 Siding, Bengkayang Regency, also showed that no more than half of the students were able to achieve the minimum passing grade in solving mathematical reflective thinking problems. The findings from these three studies indicate that further research is needed to thoroughly examine students' mathematical reflective thinking skills.

Based on previous studies, junior high school students' mathematical reflective thinking skills are still in the moderate to low category and are generally only assessed in general terms. The novelty of this study lies in the analysis of junior high school students' mathematical reflective thinking skills in solving problems in algebra. This study aims to describe the mathematical reflective thinking skills of seventh-grade students at a junior high school in Karawang Regency in the 2024/2025 academic year in solving algebra problems.

Method

Type of Research

This study takes a qualitative approach and descriptive method. A qualitative approach is a type of research that uses natural language to describe certain phenomena (Abdussamad, 2021). According to Rusandi & Rusli (2021) Descriptive research is research that characterizes and understands a phenomenon, such as current conditions, status, relationships, developing perspectives, or effects.

Research Subject

The research subjects were all students in class VIIA at a junior high school in Karawang Regency in the 2024/2025 academic year who were selected because they had studied algebra. All students took a test of mathematical reflective thinking skills. The subjects were selected using purposive sampling, which is the determination of subjects based on specific considerations (Sugiyono 2023). Based on the criteria of the mathematical reflective thinking test results, three students were selected as interview subjects in the high, medium, and low categories.

Instrumen

The instruments used in this study applied a test of mathematical reflective thinking skills consisting of two questions referring to a thesis consistent with this study, which had been validated (Andika, 2023). In addition, this study also used a semi-structured interview instrument that had been validated, which encouraged students to explain how they solved the tests given. Both were compiled based on the same indicators of mathematical reflective thinking skills. The tests contained mathematical problems presented in the form of algebraic story problems. The tests given to the subjects in this study are included in Figure 1 below.

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Figure 1. Mathematical Reflective Thinking Ability Test

Data Collection

Data collection techniques in this study were conducted through written tests and interviews. Written tests were given to all students in class VII A with the aim of collecting data on mathematical reflective thinking skills, which were obtained through analysis of students' answers to the questions given. Semi-structured interviews were conducted with three students selected from the test results to obtain supporting data in the form of students' explanations regarding the thinking process and mathematical problem-solving strategies used.

Data Analysis

Data sourced from test results and interviews were analyzed using Miles and Huberman's qualitative data analysis model (Tristanti et al., 2022) which consists of four main steps. In the data collection stage, information is obtained through written tests and interviews with students. Next, in the data reduction stage, the test and interview results are sorted, simplified, and focused on information related to indicators of mathematical reflective thinking skills. In the data presentation stage, the reduced data is compiled and presented in the form of a descriptive narrative to illustrate the students' mathematical reflective thinking skills. Finally, conclusions are drawn by formulating the main findings of the study based on the overall results of the data analysis.

To determine the value of students' mathematical reflective thinking test results, the calculation formula $P = \frac{F}{N} \times 100\%$, is used, where P is the percentage, F is the score obtained, and N is the maximum score. After that, the researcher divided the scores into three categories based on the categorization formula according to Azwar in 2008 (Sausan & Wibowo, 2024) as presented in Table 2 below.

Table 2. Student Categorization

No	Value Interval	Category
1.	$x > (M_i + SD_i)$	High
2.	$(M_i - SD_i) < x \le (M_i + SD_i)$	Medium
3.	$x \le (M_i - SD_i)$	Low

Explanation:
x = Student score
M_i = Average student score
SD_i = Standard deviation

Research Results

Based on the test results given to 34 students in class VII A from a junior high school in Karawang Regency, the researcher selected three students to be interviewed. The selection was based on ability level categories, namely one student from each of the high, medium, and low categories. Student S-27 represented the high category with a high score in mathematical reflective thinking ability. Student S-10 was selected for the medium category, while student S-3 represented the low category. Each category represented students whose work would be analyzed and interviewed further. Complete details regarding the results of the mathematical reflective thinking ability test are shown in Table 3 below.

Table 3. Mathematical Reflective Thinking Test Scores

No	Value Interval	Category	Many Students
1.	$x > 96$	High	5
2.	$52 < x \leq 96$	Medium	23
3.	$x \leq 52$	Low	6

Based on Table 3, the results of the analysis of students' answers show that the level of students' mathematical reflective thinking skills when solving mathematical reflective thinking ability tests varies. The following presents the results and discussion related to the completion of tests on students' mathematical reflective thinking skills, along with the results of interviews with each student selected as a representative of each skill category.

Students with High Mathematical Reflective Thinking Skills (Subject S-27)

Reacting Indicators

Figure 2. Subject S-27's responses to the reacting indicators for questions 1a and 2a.

Based on the results of the students' written tests in Figure 2, subject S-27 wrote down what was asked in the questions, namely how old the older and younger siblings are now for question number 1a and how much money the third child received for question number 2a. Subject S-27 wrote down what was known in question number 1a, namely that the younger sibling was younger than the older sibling and that the combined ages of the older and younger siblings would be 35 years five years later. Subject S-27 also wrote down complete information for question number 2a, namely the amount of money, that the second child had more money than the third child, and that the first child had more money than the second child. The interview results also reinforce Subject S-27's answers. The following is an excerpt from the interview with Subject S-27 to understand the question and find out how Subject S-27 thinks.

Researcher	:	*From the questions that have been worked on, please explain the information in the questions?*
Subject S-27	:	*For question number 1, we know that the younger sibling is 5 years younger than the older sibling and that five years ago, their combined ages were 5 years. The question asks how old the older and younger siblings are now. For question number 2, what is known is the amount of money Mr. Andre has, that the second*

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child has Rp25,000 more than the third child, and that the first child has more money than the second child. The question is, how much money does the third child have?

Researcher	:	So, what is the relationship between what is known and what is asked?
Subject S-27	:	The relationship between the known and the asked is for solving the problem in the question.
Researcher	:	Then is the information sufficient for solving the problem?
Subject S-27	:	It is sufficient.

Elaborating indicators

Figure 3. Subject S-27's responses to the elaborating indicators for questions 1b and 2b.

Based on the results of the students' written tests in Figure 3, Subject S-27 began solving the problem by assuming the information to create a mathematical model. For question 1b, Subject S-27 assumed that the younger sibling was a and the older sibling was k, then the mathematical model was $a = k - 5$. For question number 2b, Subject S-27 assumed that the money received by the third child was x, so the mathematical model for the second child's money was $25.000 + x$ and the mathematical model for the third child's money was $3(25.000 + x) = 75.000 + x$. The interview results also reinforce Subject S-27's answers. The following is an excerpt from the interview with Subject S-27 to understand the question and find out how Subject S-27 thinks.

Researcher	:	After reading this question, have you ever encountered a similar question before?
Subject S-27	:	Yes.
Researcher	:	What are the differences between this question and the one you encountered before?
Subject S-27	:	The questions are almost the same, only the numbers are different.
Researcher	:	Then, how did you solve the problems in the questions?
Subject S-27	:	By making assumptions first and then converting them into mathematical form.

Contemplating indicators

Figure 4. Subject S-27's responses to the contemplating indicators for questions 1c, 1d, 2c, and 2d.

Based on the results of the students' written tests in Figure 4, Subject S-27 began solving the problem by rewriting the mathematical model to create an equation, then adding the same terms in the equation and using the substitution method. In question number 1c, Subject S-27 obtained the values of variables $a = 10$ and $k = 15$, while in question number 2c, Subject S-27 obtained the value of variable $x = 100.000$. From these results, Subject S-27 was able to draw conclusions about the problems. For question 1d, the conclusion was that the older sibling was 15 years old and the younger sibling was 10 years old. For question 2, the conclusion was that the third child received Rp100.000. The interview results also reinforce Subject S-27's answers. The following is an excerpt from the interview with Subject S-27 to understand the questions and find out how Subject S-27 thinks.

Researcher	:	*Please explain in your own words how you solved this problem.*
Subject S-27	:	*I solved this problem by looking at the mathematical model that was created and from what we know in the question, we can make an equation. After that, the same terms are added together, but in question number 1c, I used the substitution method. After that, I got the solution to the problem.*
Researcher	:	*Please review your answer again. Have you double-checked the answer you obtained?*
Subject S-27	:	*Yes*
Researcher	:	*Are you confident in the conclusion you drew from this problem?*
Subject S-27	:	*Yes, I am confident.*

Students with Moderate Mathematical Reflective Thinking Skills (Subject S-10)
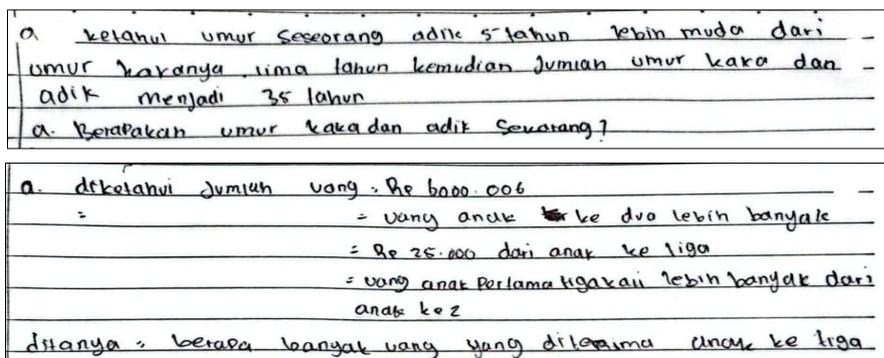
Reacting Indicators

Figure 5. Subject S-10's responses to the reacting indicators for questions 1a and 2a.

Based on Figure 5, which shows the results of the students' written tests, Subject S-10 answered question 1a by writing that his younger sibling is five years younger than his older sibling and that when added together, their ages are 35 years older. Subject S-10 also answered question 1a by writing his older sibling's current age. In question number 2a, Subject S-10 filled in the information in the question, namely the amount of money Mr. Andre had, the amount of money the second child had, which was greater than the amount of money the third child had, and the amount of money the first child had, which was greater than the amount of money the second child had. All of this was written in question number 2a by Subject S-10. In addition, Subject S-10 wrote down the answer to the question, namely the amount of money received by the third child. The interview results also reinforce Subject S-10's answer. The following is an excerpt from the interview with Subject S-10 to understand the question and find out how Subject S-10 thinks.

Researcher	:	*What information did you get from the two questions?*

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Subject S-10	:	*For question number 1, the information given is that a younger sibling is 5 years younger than their older sibling, and five years later, their combined age is 35 years old. For question number 2, Mr. Andre has Rp600,000 and has 3 children, where the second child has more money than the third child, and the first child has more money than the second child.*
Researcher	:	*Is there any other information besides that?*
Subject S-10	:	*Oh yes, the information about the problem is how old the older sibling and younger sibling are now in question number 1, and in question number 2, how much money the third child has.*
Researcher	:	*So what is the known and unknown relationship based on the information you mentioned?*
Subject S-10	:	*To find the solution to the problem.*
Researcher	:	*Then, is the information you have obtained sufficient to solve the problem?*
Subject S-10	:	*Yes, it is sufficient.*

Elaborating Indicators

Figure 6. Subject S-10's responses to the elaborating indicators for questions 1b and 2b.

Based on the results of the students' written tests in Figure 6, Subject S-10 in question number 1b made an assumption about the information obtained, namely by assuming that the younger sibling was a and the older sibling was i. In question number 1b, Subject S-10 assumed that the money received by the third child was x, so that the equation for the second child's money was $25.000 + x$ and the first child's money was $3(25.000 + x) = 75.000 + 3x$. The interview results also reinforce Subject S-10's answer. The following is an excerpt from the interview with Subject S-10 in understanding the question to find out how Subject S-10's thought process works.

Researcher	:	*Have you encountered this type of problem before?*
Subject S-10	:	*I think so.*
Researcher	:	*Then how do you solve it?*
Subject S-10	:	*From the information provided, I first make an analogy, so I set the younger sibling = a and the older sibling = i. Then, for the amount of money Mr. Andre has, I set it as x and convert the information into an equation.*

Contemplating indicators

Figure 7. Subject S-10's responses to the contemplating indicators for questions 1c, 1d, 2c, and 2d.

Based on the results of the students' written tests in Figure 7, Subject S-10 began solving question number 1c by creating an equation from the assumption he made, namely $a = i - 5$. then Subject S-10 also created an equation from the information that Subject S-10 obtained regarding the current ages of the older and younger siblings, namely $(a + 5) + (i + 5) = 35$, but the solution that Subject S-10 worked on was incomplete and the result was inaccurate, so Subject S-10 could not draw a conclusion from the problem. In question number 2c, Subject S-10 began by substituting the amount of money Mr. Andre had from the equation that Subject S-10 created, which was by adding the first child's money + the second child's money + the third child's money = 600,000. Subject S-10 then performed the substitution, so that the equation became $(75.000 + x) + (25.000 + x) + x = 600.000$. However, Subject S-10 did not solve the equation and therefore did not answer question number 2d. The interview results also reinforce Subject S-10's answer. The following is an excerpt from the interview with Subject S-10 regarding their understanding of the question in order to understand how Subject S-10 thinks.

Researcher	:	*Please explain in your own words how you solved the problem.*
Subject S-10	:	*For question number 1, I first created an equation from the assumption that a=i-5, then I created another equation from the information obtained to find the values of a and i. For question number 2, I added up all the assumptions I had made.*
Researcher	:	*Then why wasn't it solved?*
Subject S-10	:	*I was confused about how to proceed after that.*

Students with Low Mathematical Reflective Thinking Skills (Subject S-3)

Reacting Indicators

Figure 8. Subject S-3's responses to the reacting indicators for questions 1a and 2a.

Based on Figure 8, which shows the results of the students' written tests. In question 1a, Subject S-3 wrote down what he knew from the question, namely that his younger sibling was five years younger than his older sibling, and that both of them would be thirty-five years old in five years. Question 1a, which asked how old the older and younger siblings were currently, was also noted by Subject S-3. Subject S-3 answered question number 2a by writing down what was known from the question, namely that the amount of money was Rp600,000, the second child had Rp25,000 more than the third child, and the first child had three times as much money as the second child. However, Subject S-3 did not fill in the information requested in the question. The interview results also reinforce Subject S-3's answers. The following is an excerpt from the interview with Subject S-3 to understand the question and find out how Subject S-3 thinks.

Researcher	:	*From questions 1 and 2, what information did you obtain?*

Subject S-3	:	The information in question number 1 is that the younger sibling is 5 years younger than the older sibling and five years later the sum of their ages is 35 years. The information in question number 2 is that Mr. Andre has a total of Rp600,000 for his three children, the second child has Rp25,000 more than the third child, and the first child has three times more money than the second child. So, how much money does the third child have?
Researcher	:	Is there any other information besides that?
Subject S-3	:	Oh yes, the question in number 1 asks how old the younger sibling and older sibling are now.
Researcher	:	Then why wasn't it written in the solution?
Subject S-3	:	I forgot.
Researcher	:	So what is the relationship between what is known and what is being asked based on the information you mentioned?
Subject S-3	:	To solve the problem.
Researcher	:	Then, is the information you obtained sufficient to solve the problem?
Subject S-3	:	Yes, it is sufficient.

Elaborating indicators

Figure 9. Subject S-3's responses to the elaborating indicators for questions 1b and 2b.

Based on the results of the students' written tests in Figure 9, Subject S-3 in question number 1b began by assuming that the younger sibling was a and the older sibling was i, and wrote the equation $a = i - 5$. In question number 1b, Subject S-3 assumed that the money received by the third child was x, so that the second child's money was $25.000 + x$ and the third child's money was $75.000 + x$. The interview results also reinforce Subject S-3's answers. The following is an excerpt from the interview with Subject S-3 to understand the question and find out how Subject S-3 thinks.

Researcher	:	Have you ever encountered a question like this before?
Subject S-3	:	I don't know, I forgot.
Researcher	:	Then how did you answer the question?
Subject S-3	:	I just tried to make an analogy. For question number 1, let's say younger sibling = a and older sibling = i, then a = i - 5. For question number 2, let's say the money received by the third child = x, then the money received by the second child = 25.000 + x.
Researcher	:	Then what does money = 75,000 + x mean?
Subject S-3	:	I don't know, I forgot.

Contemplating indicators

Figure 10. Subject S-10's responses to the contemplating indicators for questions 1c, 1d, 2c, and 2d.

Based on the results of the students' written tests in Figure 10, Subject S-3 solved question number 1c by creating an equation from the assumption that $a = i - 5$. Subject S-3 also created an equation from the information that Subject S-10 obtained regarding the current ages of the older and younger siblings, namely $(a + 5)(i + 5) = 35$. Subject S-3's solution was incomplete and the result was incorrect, which meant that Subject S-3 was unable to draw a conclusion and detect the error that had been made. Subject S-10 did not answer question 2c; there were only traces of Subject S-3 working on question 2c. The interview results also reinforced Subject S-3's answer. The following is an excerpt from the interview with Subject S-3 to understand the question and find out how Subject S-3 thought.

Researcher	:	*Please explain in your own words how you solved the problem.*
Subject S-3	:	*I don't know, I'm confused. For question number 1, I made an equation first and then solved it. For question number 2, I don't know, I don't understand.*

Discussion

On the reacting indicator, students with high mathematical reflective thinking skills demonstrate good understanding, as reflected in their ability to recognize known information, determine what is being asked, and link the two appropriately. In addition, students in this category are able to select relevant information to use in problem solving. On the elaborating indicator, students with high abilities are able to relate the problem at hand to similar experiences or problems that have been solved before. This ability supports the consideration process in problem solving and allows students to evaluate the steps used in solving the problem. Furthermore, on the contemplating indicator, students with high mathematical reflective thinking abilities are able to reflect on the process and results of problem solving so that they can draw appropriate conclusions. These findings are in line with the results of Widayat (2021) research, which revealed that students with high levels of mathematical reflective thinking abilities showed three main indicators, namely reacting, elaborating, and contemplating.

Meanwhile, students with mathematical reflective thinking skills showed fairly good performance on the reacting indicator, namely the ability to understand the elements of a problem and explain the relationship between known and unknown information. On the elaborating indicator, students in this category were able to recognize the differences between the problem at hand and problems they had encountered previously. However, students are not yet able to solve problems completely, so they are unable to evaluate the solution process or draw conclusions based on reflection on their answers. This condition shows that the contemplating indicator has not been met. This statement is reinforced by the findings of Ramadhani & Aini (2019), who stated that students with moderate mathematical reflective thinking skills only achieved two indicators, namely reacting and elaborating.

Students with low mathematical reflective thinking skills only demonstrate competence in the reacting indicator, which is the ability to state what is known and what is asked in a problem and explain the information needed to answer the question. However, students in this category are not yet able to relate the problem at hand to their previous experiences, so the elaborating indicator has not been met. In addition, students are also unable to evaluate the solution process or draw conclusions based on reflection on their answers, which indicates that the contemplating indicator has not been met either. This is in line with the results of research by Fira et al., (2023), which shows that students with low mathematical reflective thinking skills only demonstrate one sign of this ability, namely reacting.

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The results show that differences in students' mathematical reflective thinking abilities are reflected in the achievement of indicators. Students in the high category meet the indicators of reacting, elaborating, and contemplating, students in the medium category achieve the indicators of reacting and elaborating, while students in the low category only achieve the indicator of reacting. These findings confirm that the indicator of contemplating is the main differentiator of students' mathematical reflective thinking abilities.

Conclusion

Based on the results of the study, the mathematical reflective thinking skills of seventh grade students in solving algebraic problems vary greatly. This variation shows that mathematical reflective thinking skills are not only determined by initial understanding of the problem, but also by the ability to relate previous experiences and reflect on the process and results of the solution. The ability to reflect and draw conclusions is an important aspect in describing the depth of students' mathematical reflective thinking. This study has limitations in terms of the number of interview subjects and the scope of material, which only focuses on algebra, so the findings cannot be generalized. Therefore, further research needs to examine other factors that influence students' mathematical reflective thinking skills, such as learning styles and teachers' learning approaches.

Conflict of Interest

The author declares no conflict of interest.

Authors' Contributions

D.R.N. understood the presented research idea and collected the data. D.F. actively contributed to the development of the theory and methodology, data organization and analysis, the discussion of the results, and approval of the final version of the work. All authors declare that they have read and approved the final version of this manuscript. The total contribution percentages to the conceptualization, drafting, and revision of this manuscript are as follows: D.R.N.: 60% and D.F.: 40%.

Data Availability Statement

The authors declare that the data supporting the findings of this study will be made available by the corresponding author, [D.R.N.], upon reasonable request.

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