

## Assessing Problem-Solving Proficiency in Mathematics: Insights from Seventh-Grade Students

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ABSTRAK	ABSTRACT
<p>Kemampuan pemecahan masalah matematis adalah kemampuan dalam melakukan prosedur matematika untuk memecahkan masalah. Penelitian ini bertujuan untuk menganalisis kemampuan pemecahan masalah matematis siswa SMP kelas VII pada materi persamaan linear satu variabel. Penelitian ini merupakan penelitian kualitatif jenis deskriptif dengan subjek penelitian tiga orang siswa kelas VII yang memiliki kemampuan matematika tinggi, sedang, dan rendah. Instrumen yang digunakan adalah soal tes tulis, wawancara, dan observasi. Hasil penelitian menunjukkan bahwa siswa dengan kemampuan matematika tinggi bisa memenuhi 3-4 indikator, siswa dengan kemampuan matematika sedang dapat memenuhi 2-3 indikator, dan siswa dengan kemampuan matematika rendah hanya bisa memenuhi 1-2 indikator saja.</p> <p><b>Kata Kunci:</b> Kemampuan pemecahan masalah matematis, persamaan linear satu variabel.</p>	<p>Mathematical problem-solving ability refers to the capacity to perform mathematical procedures to solve problems. This study aims to analyze the mathematical problem-solving abilities of seventh-grade junior high school students on the topic of linear equations with one variable. This research is a qualitative descriptive study involving three seventh-grade students with high, medium, and low mathematical abilities as the subjects. The instruments used in the study included written test questions, interviews, and observations. The results indicated that students with high mathematical abilities were able to meet 3 – 4 indicators, students with medium mathematical abilities met 2 – 3 indicators, and students with low mathematical abilities met only 1 – 2 indicators.</p> <p><b>Keywords:</b> Mathematical problem-solving skills, linear equations in one variable.</p>

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## 1. INTRODUCTION

Problem-solving ability in mathematics is an essential skill that everyone should possess (Nadila et al., 2023; Hasna, Sagita, & Utami, 2024). This ability is not only useful in school mathematics but also applicable to everyday life (Mukhibin et al., 2024). Problem-solving can be defined as the process of overcoming difficulties or obstacles to achieve a desired goal (Putri et al., 2019; Pitriyani & Afriansyah, 2023). Solving mathematical problems involves a series of complex cognitive processes, starting with understanding the essence of the problem, designing a solution strategy, executing the plan, and reevaluating the obtained solution (Awalia, 2023; Rahayu et al., 2024).

According to Fitriani (2020), the ability to solve mathematical problems is a skill that enables individuals to tackle various types of challenges, including mathematical problems and issues encountered in other fields or everyday life. Harahap and Surya (2017) describe mathematical problem-solving as a complex cognitive activity that requires the implementation of multiple strategies to address and resolve problems. Thus, problem-solving ability can be seen as the capacity to comprehend an issue, determine an appropriate strategy, and ultimately solve the problem.

One of the most critical aspects of problem-solving is its process (Utami & Puspitasari, 2022; Ramadoni & Admulya, 2023). Solving mathematical problems involves applying previously learned mathematical knowledge to new and unfamiliar situations (Rahmayanti & Maryati, 2021; Lisnani & Inharjanto, 2023). During this phase, students can utilize their existing knowledge to generate new ideas or methods for addressing the challenges they face. Mathematical problem-solving ability can be measured using specific indicators designed to assess this skill.

Problem-solving in mathematics is a structured process that can be broken down into measurable components (Minggi et al., 2022; Sanidah & Sumartini, 2022). According to Polya (Palapasari et al., 2019), the key indicators of problem-solving include: (1) understanding the problem, (2) devising a solution plan, (3) carrying out the plan, and (4) reviewing the solution obtained.

To evaluate students' problem-solving abilities, teachers are encouraged to provide exercises that enhance mathematical problem-solving skills (Pradiarti & Subanji, 2022). One of the topics that can support this development is linear equations with one variable. This material not only aids in improving problem-solving skills but also has practical applications in everyday life, where students are presented with real-world problems requiring solutions. To find these solutions, students must comprehend the problem, plan the solution by formulating mathematical statements (in the form of linear equations with one variable), determine the resolution, and review the results.

Based on these considerations, this study was conducted to analyze the mathematical problem-solving abilities of seventh-grade junior high school students, particularly concerning the topic of linear equations with one variable.

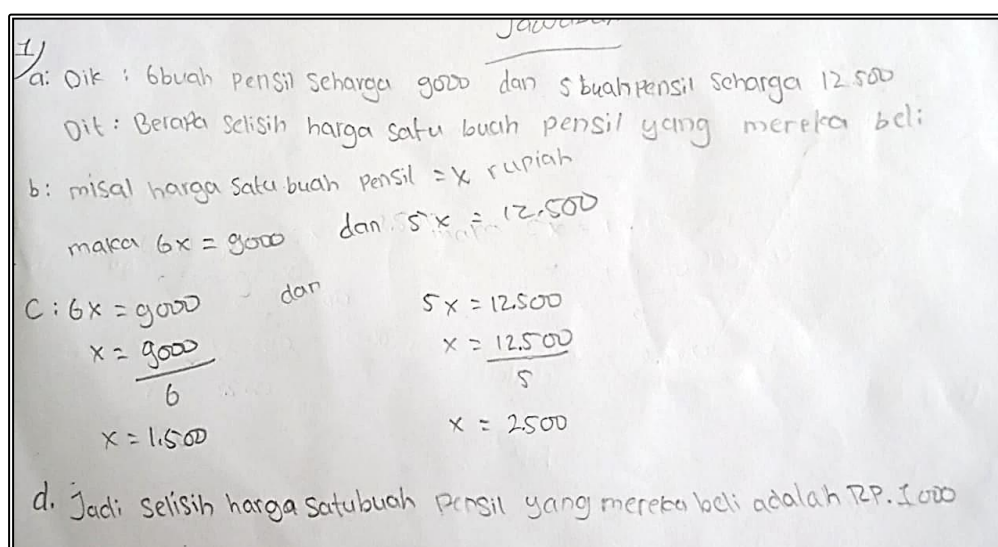
## 2. METHOD

This study employs a qualitative approach with a descriptive methodology, wherein the findings are presented systematically in descriptive narratives. Conducted in November 2023, the research involved three seventh-grade students from the 2023/2024 academic year at SMP Negeri 8 Garut as the sample. The instruments utilized in this study included written test sheets, interviews, and observation guidelines. The written test comprised open-ended questions designed based on Polya's problem-solving indicators. The interviews consisted of questions related to students' problem-solving abilities as demonstrated in their responses to the test questions. Meanwhile, the observation sheet contained statements guiding the observer in describing the students' mathematical problem-solving skills. The data were collected through written tests, interviews, and observations, with the test results serving as the basis for conducting the interviews and observations. The data from interviews and observations were then analyzed to provide a detailed description of the students' mathematical problem-solving abilities in the context of linear equations with one variable.

## 3. RESULT AND DISCUSSION

### a. Result

The following paragraphs provide an analysis of the mathematical problem-solving abilities of the participants based on the results of both written tests and interviews.



Handwritten solution for a problem involving the price of pencils. The text is written in Indonesian and shows the steps to find the difference in price between two types of pencils.

1/

a: Dik : 6 buah Pensil seharga 9000 dan 5 buah pensil seharga 12.500  
Dit : Berapa selisih harga satu buah pensil yang mereka beli

b: misal harga satu buah pensil = x rupiah  
maka  $6x = 9000$  dan  $5x = 12.500$

c:  $6x = 9000$  dan  $5x = 12.500$   
 $x = \frac{9000}{6}$  dan  $x = \frac{12.500}{5}$   
 $x = 1.500$  dan  $x = 2.500$

d. Jadi selisih harga satu buah pensil yang mereka beli adalah Rp. 1.000

Figure 1. Response of Participant S1 to Problem 1

As shown in Figure 1, Participant S1 successfully solved the mathematical problem by addressing all the problem-solving indicators, including understanding the problem, planning the solution, executing the solution plan, and verifying the results obtained.

The following is a summary of the interview results with S1 regarding Problem 1.

Researcher (P) : "What do you think about Problem 1? Did you encounter any difficulties?"

Student (S1) : "Alhamdulillah, no difficulties, ma'am. I was able to solve it."

Researcher (P) : "How did you check your answer to make sure it was correct?"

Student (S1) : "I tried to assume that Ahmad's pencil costs Rp1,500 and then multiplied it by 6, which gives the correct total of Rp9,000 as stated in the problem. I did the same for Roni's pencil price."

The interview with S1 regarding Problem 1 revealed that S1 found the problem easy. The researcher primarily explored how S1 rechecked their solution before drawing a final conclusion. Therefore, it can be concluded that S1 demonstrates a high level of problem-solving ability, having fulfilled all the necessary indicators.

Handwritten mathematical work for Problem 2:

2.)  
 a. Dik : usia adik 6 tahun lebih muda dari usia kakak dan jumlah usia mereka 28 tahun  
 Dit : Berapakah usia mereka masing-masing

B. misal usia kakak =  $x$   
 maka  $2x - 6 = 28$  dan  $2x + 6 = 28$

C:

$\begin{aligned} 2x - 6 &= 28 \\ 2x &= 28 + 6 \\ 2x &= 34 \\ x &= \frac{34}{2} \\ x &= 17 \end{aligned}$ <p>usia kakak = 17 tahun</p>	$\begin{aligned} 2x + 6 &= 28 \\ 2x &= 28 - 6 \\ 2x &= 22 \\ x &= \frac{22}{2} \\ x &= 11 \end{aligned}$ <p>usia adik = 11 tahun</p>
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d:

$\begin{aligned} 2x - 6 &= 28 \\ 2(17) - 6 &= 28 \\ 34 - 6 &= 28 \end{aligned}$	$\begin{aligned} 2x + 6 &= 28 \\ 2(11) + 6 &= 28 \\ 22 + 6 &= 28 \end{aligned}$
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Figure 2. Response of Participant S1 to Problem 2

In Figure 2, S1 correctly addressed the first two indicators of mathematical problem-solving: understanding the problem and planning the solution. However, S1 made a conceptual error that affected the execution and verification stages, which are the third and fourth indicators.

The following is a summary of the interview results with S1 regarding Problem 2.

Researcher (P) : "How did you solve Problem 2?"

Student (S1) : "I first assumed the age of the older sibling as  $x$ . Then, since the younger sibling is 6 years younger, I added their ages together, so I got  $2x - 6 = 28$ ."

Researcher (P) : "Why is there another equation,  $2x + 6 = 28$ , written next to it?"

Student (S1) : "Yes, ma'am. I was confused because the age of the older sibling can be determined by that equation, which is 28 plus 6, then divided by 2. I thought the age of the younger

sibling would be the same, but instead of adding 6, I subtracted it from 28, then divided by 2."

Researcher (P) : "I see. Are you confident your answer is correct?"

Student (S1) : "After thinking about it again, I realized I made a mistake, ma'am. It was clear that the younger sibling is 6 years younger, so after finding the older sibling's age, I should have just subtracted 6. I was in a rush and worried I wouldn't finish in time."

Researcher (P) : "It's okay, don't worry. Just make sure to be more careful with the next problem."

The interview with S1 revealed that S1 acknowledged making a mistake in the planning stage, where a lack of attention led to errors in the subsequent steps.

3).

a : Dik : Ibu membeli buah pir dan rambutan  
 ternyata harga 1 kg buah pir sama dengan tiga kali harga  
 satu kg buah rambutan dan ibu membeli buah pir 1 kg dan 2 kg  
 buah rambutan dan ibu membayar sebesar Rp 45.000.

b : misal 1 kg buah rambutan =  $x$   
 1 kg buah pir =  $3x$   
 maka :  $3x + 2x = 45.000$

c

$3x + 2x = 45.000$ $5x = 45.000$ $x = \frac{45.000}{5}$ $x = 9000$	$1 \text{ kg buah pir} = 3x$ $= 3 \times 9000$ $= 27.000$
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d. Jadi 1 kg buah rambutan adalah Rp. 9000  
 Jadi 1 kg buah pir adalah Rp. 27000

Figure 3. Response of Participant S1 to Problem 3

Figure 3 demonstrates that S1 was able to solve Problem 3 accurately and completed all indicators of problem-solving, from understanding the problem to verifying the solution.

The following is a summary of the interview results with S1 regarding Problem 3.

Researcher (P) : "How did you approach solving Problem 3? Did you encounter any difficulties?"

Student (S1) : "It was similar to the previous problem, Ma'am. The first step is to make an assumption, like using 'x,' and then create an equation. The difficult part, Ma'am, is making the linear equation from the problem; sometimes it takes me a while to figure it out. But once I have the equation, I can solve it, Insha'Allah."

Researcher (P) : "I see. So, the difficulty lies in formulating the equation, right? That's okay, with more practice, you'll get used to forming linear equations from math problems. As for solving the linear equation, Alhamdulillah, you can do that already."

Student (S1) : "Yes, Ma'am. Thank you, Ma'am."

The interview with S1 regarding Problem 3 confirmed that S1 did not face significant difficulties, though they occasionally experience challenges in formulating linear equations from the given problems.

1) a) Diketahui : 6 buah pensil seharga = 9000  
 5 buah pensil seharga = 12500  
 Ditanyakan = Berapa selisih harga 1 buah pensil yang mereka beli?  
 b) misal = 1 pensil seharga =  $x$   
 maka =  $6x + 9000 = 5x + 12500$   
 c)  $6x + 9000 = 5x + 12500$   
 $6x - 5x = 12500 - 9000$   
 $1x = 12500 - 9000$   
 $1x = 3500$   
 $x = 3500$

Figure 4. Response of Participant S2 to Problem 1

In Figure 4, it is evident that Participant S2 was able to complete the first indicator—understanding the problem—but could only partially plan the solution by making assumptions about the unknowns. The linear equation created, however, was incorrect, leading to errors in the subsequent problem-solving stages.

The following is a summary of the interview results with S2 regarding Problem 1.

Researcher (P) : "Could you explain why you created the equation like that?"

Student (S2) : "Yes, Ma'am, I'm still a bit confused, but I remembered the practice problem from the previous meeting, so I made the same equation."

Researcher (P) : "Do you understand the problem?"

Student (S2) : "Yes, Ma'am, I understand that the problem asks to find the price of the pencils given by Ahmad and Roni, but I had difficulty creating the linear equation."

Researcher (P) : "Alright, so you need to study more, and review the previous practice problems to better understand different problem-solving scenarios."

Student (S2) : "Okay, Ma'am."

In the interview, S2 admitted to struggling with creating the correct linear equation, which resulted in a failure to fully complete the remaining indicators of problem-solving.

2) a) Diketahui : jumlah usia mereka adalah = 28 tahun  
 Ditanyakan : Berapakah usia mereka masing-masing ?  
 b) Misal : Usia adik adalah =  $x$   
 Usia kakak + Usia adik = 28  
 maka :  
 $(x+6) + x = 28$       usia kakak  
 c)  $(x+6) + x = 28$        $(x+6) = 11 + 6$   
 $2x + 6 = 28$        $= 17$   
 $2x = 28 - 6$   
 $2x = 22$   
 $x = \frac{22}{2}$   
 usia adik =  $x = 11$   
 d)

Figure 5. Response of Participant S2 to Problem 2

As shown in Figure 5, S2 was able to address the first three indicators: understanding the problem, planning the solution, and executing the solution. However, S2 was unable to reach the final indicator—verifying the accuracy of the obtained solution.

The following is a summary of the interview results with S2 regarding Problem 2.

Researcher (P) : "How did you solve Problem 2?"

Student (S2) : "First, I wrote down the information that was given and what was being asked. Then, I made some assumptions and created a linear equation and worked through it."

Researcher (P) : "Why didn't you check the answer you obtained?"

Student (S2) : "Yes, I forgot how to do the substitution."

Researcher (P) : "Alright, for the future, try to check your answer again."

Student (S2) : "Yes, I will."

The interview with S2 revealed that although the participant could progress through the first three stages, they struggled with the final step of confirming the correctness of their solution. Therefore, it can be concluded that S2 possesses a moderate level of mathematical problem-solving ability, successfully completing 2-3 indicators of the process.



3/ a) Diketahui: ibu membeli 1 kg buah pir dan 2 kg buah rambutan.  
Ibu membayar = 45.000  
Ditanyakan: Berapakah harga 1 kg buah masing-masing buah pir dan buah rambutan?

b) misal: Buah rambutan =  $x$   
Buah pir =  $3x$   
maka:  $3x + 2x = 45.000$

c)  $3x + 2x = 45.000$   
 $5x = 45.000$   
 $x = \frac{45.000}{5}$   
 $x = 9.000$

Buah pir =  $3x$   
 $= 3 \times 9.000$   
 $= 27.000$

Figure 6. Response of Participant S2 to Problem 3

Figure 6 shows that S2 managed to complete the problem-solving process up to the stage of executing the solution. However, S2 faced difficulties in the verification stage.

The following is a summary of the interview results with S2 regarding Problem 3.

Researcher (P) : "Did you experience any difficulties while working on Problem 3?"

Student (S2) : "Yes, I had some trouble formulating the linear equation, similar to when I worked on Problem 1. But for Problem 3, I eventually managed to solve it."

Researcher (P) : "Why didn't you finish it? Why didn't you reach the conclusion for this problem?"

Student (S2) : "Yes, sometimes I'm unsure how to check my answer, but I feel that my solution is correct; I just haven't reached the conclusion yet."

Researcher (P) : "To review your answer, try revisiting the steps you've already completed. Once you're confident, don't forget to write the conclusion. It's important to clarify what the price of Rp9,000 refers to, and so on."

Student (S2) : "Okay, I will do that, thank you."

In the interview, S2 explained that they were unsure how to check the correctness of their solution. Additionally, S2 sometimes had trouble formulating the linear equation due to the problem's divergence from familiar examples.

Jawab:

1. a) Diketahui: Ahmad membeli 6 buah pensil seharga Rp 90.000 dan Rani 5 buah pensil seharga 12.500  
Dit: Berapakah selisih harga satu buah pensil?

b) misal: harga satu pensil =  $x$   
maka:  $9x - 5 = 6x + 12.500$

c)  $9x - 5 = 6x + 12.500$   
 $9x = 6x + 12.500 + 5$   
 $9x = 6x + 17.500$   
 $9x - 6x = 17.500$   
 $3x = 17.500$   
 $x = \frac{17.500}{3}$   
 $x = 5.833$

d) Jadi harga Pensil Ahmad dan Rani adalah Rm 1390 dan Ahmad 1.500

Rani:  $12x - 6 = 5x + 9.000$   
 $12x = 5x + 9.000 + 6$   
 $12x = 5x + 9.006$   
 $12x - 5x = 9.006$   
 $7x = 9.006$   
 $x = \frac{9.006}{7}$   
 $x = 1.286$

Figure 7. Response of Participant S3 to Problem 1



In Figure 7, it is apparent that S3 could only address the first indicator—understanding the problem. The participant struggled with planning the solution, merely assuming the unknowns without correctly formulating the linear equation. Furthermore, the calculation process was flawed, leading to an incorrect conclusion.

The following is a summary of the interview results with S3 regarding Problem 1.

- Researcher (P) : "How did you solve Problem 1?"  
Student (S3) : "First, I wrote down what is given and what is being asked, Ma'am."  
Researcher (P) : "And then what did you do?"  
Student (S3) : "I made an assumption and wrote the equation, Ma'am."  
Researcher (P) : "Why did you write the equation this way? Can you explain?"  
Student (S3) : "It's hard, Ma'am. I don't understand."  
Researcher (P) : "So, you had difficulty creating the linear equation?"  
Student (S3) : "Yes, Ma'am."  
Researcher (P) : "I noticed that your calculations are not quite accurate. Do you understand how to calculate it?"  
Student (S3) : "No, Ma'am."

The interview with S3 confirmed that they did not fully understand the problem, only noting the given and sought information. Their attempts to plan the solution were incomplete, and their calculation methods were incorrect, resulting in errors in the subsequent indicators.

a. diket: usia adik dan kakak 5  
dit: berapa usia kakak masSinga?  
b. misal: usia kakak adalah = 5  
kakak = 5 + 5 = 20  
c.  $6 \times x = 20$   
 $6x = 20 + 6$   
 $6x = 34$   
 $x = \frac{34}{6}$   
 $x = 4$   
d. Jadi usia adik dan kakak adalah 5 tahun dan kakak 9 tahun

Figure 8. Response of Participant S3 to Problem 2

As shown in Figure 8, S3 was able to complete the first indicator—understanding the problem—by identifying the known and unknown information. However, the participant was unable to correctly plan the solution, leading to errors in the subsequent steps.

The following is a summary of the interview results with S3 regarding Problem 2.

- Researcher (P) : "Did you have difficulty solving Problem 2?"  
Student (S3) : "Yes, I couldn't create the linear equation from the problem."  
Researcher (P) : "What caused that?"  
Student (S3) : "I don't know, ma'am."

Researcher (P) : "I see here that you calculated 34 divided by 6 and got 4. Are you sure your answer is correct?"

Student (S3) : "Hehe, yes ma'am, I was wrong."

In the interview, S3 admitted to not knowing how to create the correct linear equation and acknowledged mistakes in their calculation process.

3. a) Dik: ibu membeli buah Pis dan buah Rambutan.  
 Dit: Berapa 1kg buah Pis dan 1kg buah Rambutan  
 b) misal : buah Pis dan Rambutan adalah  $x$  dan  $F$   
 maka:  $x + F = 15.000$   
 c)  $x + F = 15.000$   
 $1F = 15.000 - x$   
 $1F = 15.000 - x$   
 $F = \frac{15.000 - x}{1}$   
 d) Jadi, harga buah Pis dan buah Rambutan adalah  $\frac{15.000 - x}{1}$

Figure 9. Response of Participant S3 to Problem 3

In Figure 9, it is clear that S3 only managed to complete the first indicator—understanding the problem. The participant struggled with planning the solution, providing only assumptions, and failed to create an accurate linear equation or perform the correct calculations.

The following is a summary of the interview results with S3 regarding Problem 3.

Researcher (P) : "Can you explain your answer to Problem 3?"

Student (S3) : "Hmm. I don't understand, Miss."

Researcher (P) : "But you were able to complete parts a to d."

Student (S3) : "Yes, Miss, I can do part a, but for part b, I only know how to make an assumption. As for the equation, I don't understand it. So, I just filled it in randomly until I finished."

The interview with S3 revealed that the participant experienced significant difficulties when attempting to formulate the linear equation for all three problems, completing only the first indicator and failing to progress further. The lack of a proper solution plan and calculation errors demonstrate that S3 has a low level of mathematical problem-solving ability, making it difficult for them to solve the given problems.

In taking-conclusion stage, the findings suggest varying levels of problem-solving ability among the participants. Participant S1 demonstrated high competence, completing all indicators accurately, while S2 showed moderate ability, addressing several steps but struggling with

verification. In contrast, S3 exhibited challenges across almost all indicators, indicating a need for further support in developing problem-solving skills.

#### **b. Discussion**

This study focuses on analyzing problem-solving abilities, which were assessed through tests, interviews, and observations. The researcher identified the indicator with the highest percentage of achievement among the students: understanding the problem. The achievement of this indicator was measured by students' ability to extract and write down relevant information from the problem and to clearly understand the question being asked. Based on the analysis of students' answer sheets, nearly all students demonstrated the ability to meet this indicator. However, some students failed to meet this criterion due to rushing through the problem, preventing them from fully grasping its meaning. This was confirmed through interviews and observations.

In contrast, the indicator with the lowest percentage of achievement was checking the results and the steps taken to solve the problem. The accomplishment of this indicator involves students making conclusions, revisiting their results, and reviewing the steps followed during the problem-solving process. According to the analysis of the students' answer sheets, as well as the interviews and observations, the majority of students were unable to fulfill this indicator.

#### **4. CONCLUSION**

Based on the findings outlined earlier, the study involved three student samples with varying levels of mathematical ability. One student, with a high level of mathematical proficiency, was able to solve mathematical problem-solving tasks while meeting nearly all indicators (3-4 indicators). A second student, with moderate mathematical ability, could solve the problems while meeting some of the indicators (2-3 indicators). Lastly, a student with lower mathematical ability was able to solve the tasks, but only met 1-2 indicators. The indicator that achieved the highest percentage among the students was "understanding the problem," whereas the indicator with the lowest achievement percentage was "rechecking the results and steps taken."

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