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An Analysis of Students' Mathematical Problem-Solving Skills in Rational Numbers Through Polya's Problem-Solving Stages at MTs Negeri 1 Banda Aceh

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ABSTRACT

This study aims to analyze students' mathematical problem-solving abilities in rational number material based on Polya's stages at MTs Negeri 1 Banda Aceh. This study employed a descriptive qualitative research design. The subjects consisted of six seventh-grade students selected through purposive sampling and categorized into high, moderate, and low ability levels based on the results of a problem-solving test. Data were collected through essay tests, interviews, and documentation, and then analyzed using the Miles and Huberman model. Data validity was ensured through technique triangulation. The results showed that students with high ability were able to complete all stages of Polya's problem-solving process. Students with moderate ability generally completed all stages but still made errors in their final answers due to a lack of accuracy. Meanwhile, students with low ability experienced difficulties in planning, carrying out the solution, and reviewing their results. It can be concluded that students' mathematical problem-solving abilities differ across different levels of ability.

KEYWORDS

Mathematical problem-solving skills
Rational numbers,
Polya's problem-solving stages
Qualitative research
Junior high school students

1. Introduction

Mathematical problem-solving ability is one of the essential competencies that students must possess to meet the challenges of 21st-century learning. Analyzing students' mathematical problem-solving ability in rational numbers based on Polya's stages at Islamic junior high schools (MTs) is crucial, considering the relatively low performance of Indonesian students in this area, as evidenced by international assessments. According to the Programme for International Student Assessment (PISA) 2022, Indonesia ranked 70th among 81 participating countries, indicating that students' abilities in analysis, reasoning, communication, and problem solving are still relatively low (OECD 2023). Mathematical problem-solving ability is one of the essential skills that students need to possess in mathematics learning. The importance of this ability is increasingly evident from the results of the 2026 Academic Competency Test (TKA) at the junior high school/Islamic junior high school (SMP/MTs) level. Based on the TKA results, the national average mathematics achievement score of SMP/MTs students was only 40.34. This achievement indicates that students' mathematical abilities still require attention and further strengthening. The Ministry of Primary and Secondary Education (Kemendikdasmen) also stated that the TKA results provide an important signal regarding the need to strengthen logical thinking, mathematical reasoning, and problem-solving skills in mathematics learning. Therefore, mathematical problem-solving ability needs to be given greater attention in the learning process, as students are not only expected to master mathematical concepts and procedures but also to understand problems, determine appropriate strategies, carry out the solution strategies, and evaluate the results obtained (Kementerian Pendidikan Dasar dan Menengah, 2026). This national trend is also reflected in the learning context of MTs Negeri 1 Banda Aceh, where preliminary observations revealed that many seventh-grade students experienced difficulties in understanding rational number concepts, selecting appropriate solution strategies, and verifying their answers when solving mathematical problems. These conditions highlight the need to examine students' mathematical problem-solving skills in the context of rational numbers at the school. These findings are in line with those of Tampubolon, Sihombing, and Sinaga (2023) who found a positive relationship between conceptual understanding and students' mathematical problem solving ability, indicating that students with a better understanding of mathematical concepts are more likely to solve mathematical problems accurately. Furthermore, Hanifah (2022) highlighted that problem-solving ability is essential not only in educational settings but also in daily life.

Mathematical problem-solving ability is one of the primary goals of mathematics education because it enables students to understand problems, devise solution strategies, implement the planned procedures, and evaluate the obtained results. This ability is essential for developing students' critical and logical thinking skills. Aini, Ermawati, and Hilyana (2024) also emphasized that mathematical problem-solving ability encompasses understanding the problem, devising an appropriate strategy, carrying out the solution, and reviewing the final answer, making it a fundamental competency that should be continuously developed in mathematics learning.

The problem-solving process employed in this study was based on Polya's indicators, which include how students understand the problem, devise a plan, carry out the plan, and evaluate the obtained solution (Pólya 1973). Although introduced by Polya, the four stages of problem solving, which include understanding the problem, devising a plan, carrying out the plan, and looking back, are still used in mathematics education research to analyze students' mathematical problem-solving processes. Putri et al., (2026) used Polya's stages to analyze students' abilities in solving mathematical problems presented as contextual AKM (Minimum Competency Assessment) questions, while Fauztina & Sutarni, (2026) used them to identify junior high school students' abilities in solving problems involving sequences and geometric series. Meanwhile, Pookhung et al., (2026) applied the Polya approach in learning operations involving powers to develop a more structured mathematical thinking process. The findings of these studies indicate that Polya's stages can be used as a systematic framework for identifying students' processes and abilities in solving mathematical problems. In this study, the four stages are used as a reference for analyzing students' mathematical problem-solving abilities in rational number material.

Mathematical problem-solving ability is important to investigate because students' success in solving problems depends not only on their computational skills but also on their ability to understand information, determine relationships between quantities, select appropriate strategies, and apply relevant concepts. Rational numbers were chosen as the focus of this study because solving problems involving rational numbers requires not only accuracy in performing calculations but also an understanding of various forms of numbers, such as fractions, decimals, and integers. Students need to determine the appropriate representation and operations based on the information provided in the problem. Errors may occur not only during calculations but also when students understand the problem or determine the steps for solving it. Therefore, rational number material can more clearly demonstrate students’ abilities to understand problems, plan and carry out solutions, and review their answers. Based on these considerations, this study was conducted to determine students’ mathematical problem-solving abilities in rational number material.

However, evidence from the field indicates that Phase D students experience fundamental difficulties in learning rational numbers, including fractions, decimals, positive and negative numbers, and the relationships among numbers. This finding is consistent with the observations conducted at SMP Negeri 10 Tarakan by Setia Widia Rahayu et al. (2025), which revealed that many students had not yet mastered the basic concepts of rational numbers, particularly in determining appropriate operations and applying numerical concepts in everyday contexts. Furthermore, Pangesti & Dian Anggraeni (2025) reported that students encountered difficulties at each stage of Polya's problem-solving process, including understanding the problem, devising a plan, carrying out the plan, and looking back. However, these studies primarily identified the types of students' difficulties without providing an in-depth analysis of the underlying factors contributing to those difficulties, particularly across different ability levels. Therefore, further research is needed to examine students' mathematical problem-solving skills in rational numbers by analyzing their performance at each stage of Polya's problem-solving process and identifying the factors underlying their difficulties.

Based on observations and interviews with a seventh-grade mathematics teacher at MTs Negeri 1 Banda Aceh, students still experience difficulties in solving rational number problems, particularly in identifying relevant information, devising appropriate solution strategies, carrying out solution procedures correctly, and evaluating the accuracy of their answers. The teacher also reported that many students relied on memorized procedures rather than conceptual understanding, making it difficult for them to solve non-routine rational number problems. These classroom findings indicate the need for further investigation of students' mathematical problem-solving skills in rational numbers. Similar findings were reported by Diana (2024), who identified epistemological, ontogenic, and didactical obstacles that hinder students' understanding of rational and irrational number concepts, ultimately affecting their mathematical performance. Likewise, Khairani and Ningsih (2026) found that seventh-grade students frequently experienced misconceptions in rational number concepts and procedural errors when solving contextual mathematical problems. Unlike previous studies, this study combines Polya-based problem-solving tasks with in-depth interviews to examine students' mathematical problem-solving skills across different ability levels. This approach provides a more comprehensive understanding of students' performance at each stage of Polya's problem-solving process and the factors underlying their difficulties in solving rational number problems.

Furthermore, Rahmawati, Y. et al. (2023) pointed out that learning practices that primarily emphasize memorization and routine exercises result in limited student engagement and ineffective instructional strategies that fail to promote independent thinking. In addition, inadequate mastery of the fundamental concepts of rational numbers has been identified as a major contributing factor. These difficulties are similar to those experienced by Phase D students in learning rational numbers. When students do not possess a solid understanding of numerical concepts, they are prone not only to procedural errors, such as incorrect calculations or inappropriate solution steps, but also to difficulties in evaluating the correctness of their answers. This tendency is reflected in students' habit of writing down answers without reviewing them, as they lack a sufficient understanding of the properties of rational numbers that should serve as the basis for obtaining correct solutions. Hidayat et al., (2026) reported that conceptual understanding is closely related to mathematical problem-solving ability, as a strong understanding of concepts enables students to select appropriate strategies when dealing with mathematical problems.

Although numerous studies have investigated students' mathematical problem-solving skills based on Polya's problem-solving stages, most have merely described students' performance at each stage without providing an in-depth analysis of the factors contributing to difficulties encountered in each indicator, particularly in learning rational numbers. Furthermore, previous studies have generally been conducted at different educational levels or focused on different mathematical topics. Consequently, the characteristics of junior secondary students' problem-solving skills in rational numbers, particularly in Islamic junior high schools (MTs), remain underexplored. Considering that rational numbers constitute a fundamental mathematical topic and serve as a prerequisite for learning more advanced mathematical concepts, further investigation is necessary. Therefore, research is needed not only to describe students' achievement at each stage of Polya's problem-solving process but also to identify the underlying causes of their difficulties through the analysis of test results and in-depth interviews.

Mathematical problem-solving ability needs to be analyzed because it reflects the process by which students apply their mathematical knowledge when facing a problem. In solving problems, students may experience different difficulties, such as failing to understand the given and required information, choosing an inappropriate strategy, making errors in calculations, or not reviewing the results obtained. These errors cannot be identified simply by looking at whether the final answer is correct or incorrect. Through an analysis of problem-solving ability, students’ solution processes can be examined more clearly, making it possible to identify the aspects they have mastered and those that still pose difficulties. The results of this analysis are important as a basis for improving instruction, enabling teachers to provide appropriate assistance according to the difficulties students experience in solving mathematical problems.

Based on these considerations, this study aims to analyze students' mathematical problem-solving skills in rational number topics based on Polya's problem-solving stages across different ability levels at MTs Negeri 1 Banda Aceh. It also investigates the factors underlying students' difficulties at each stage through Polya-based problem-solving tasks and in-depth interviews. The findings are expected to inform the design of differentiated instructional strategies that enhance students' mathematical problem-solving skills in rational number learning.

2. Method

2.1 Research Design

This study employed a qualitative approach with a descriptive research design. A qualitative approach was selected because it enabled the researchers to obtain an in-depth understanding of students' mathematical problem-solving skills through preliminary observations, written responses from problem-solving tests, and interviews. A descriptive research design was considered the most appropriate because the study aimed to systematically describe and analyze students' mathematical problem-solving processes based on Polya's problem-solving stages across different ability levels, rather than exploring participants' lived experiences (phenomenology) or conducting an in-depth investigation of a particular case within its real-life context (case study). The study was conducted at MTs Negeri 1 Banda Aceh during the second semester of the 2025/2026 academic year.

2.2 Participants

The research subjects consisted of six seventh-grade students from class VII-11, which was an advanced class selected using purposive sampling. The mathematics teacher recommended the research subjects based on predetermined criteria, including students' mathematics learning outcomes as reflected in their daily test scores, their performance during the learning process, and their problem-solving abilities. To represent different levels of mathematical ability, the research subjects were selected from high-, medium-, and low-ability groups. After all subjects completed the mathematical problem-solving ability test on rational number material, their responses were analyzed in greater depth based on their written answers and interview results.

2.3 Research Instruments

Three instruments were employed in this study: (1) a mathematical problem-solving test, (2) an interview guide, and (3) documentation. The mathematical problem-solving test consisted of six essay questions on rational numbers developed based on Polya's four problem-solving stages: understanding the problem, devising a plan, carrying out the plan, and looking back. These stages served as the indicators for assessing students' mathematical problem-solving skills. The interview guide was designed to explore students' reasoning, problem-solving processes, and the factors contributing to their difficulties at each stage of Polya's framework. Documentation included students' written responses to the test, which served as supporting data during the analysis.

The mathematical problem-solving test and interview guide were developed based on the research objectives and relevant literature on Polya's problem-solving framework. To ensure content validity, both instruments were reviewed by one mathematics education expert and one experienced mathematics teacher. The validation focused on the alignment of the instruments with the research objectives, the appropriateness of the indicators, the clarity of the language, and the suitability of the rational number content. The instruments were revised based on the reviewers' feedback before being administered to the participants.

2.4 Data Collection

Data were collected in three stages. First, all selected participants completed the mathematical problem-solving test on rational numbers. Second, based on the test results, one student representing each ability level (high, medium, and low) was selected for individual semi-structured interviews conducted after the completion of the test to obtain a deeper understanding of their thinking processes and the factors influencing their problem-solving performance. The interview questions were developed based on Polya's four problem-solving stages and explored how students understood the problem, devised a solution plan, carried out the solution, and evaluated their answers. Additional probing questions were asked when necessary to clarify students' responses and identify the factors contributing to their difficulties at each stage. Finally, students' written work was collected as supporting documentation for data analysis.

2.5 Data Analysis

The data were analyzed using the interactive model proposed by Miles and Huberman (Sugiyono 2022) which consists of three stages: data reduction, data display, and conclusion drawing. During data reduction, the researchers selected, organized, and simplified relevant data obtained from the tests, interviews, and documentation. Students' written responses and interview transcripts were coded according to Polya's four problem-solving stages: understanding the problem, devising a plan, carrying out the plan, and looking back. The codes were then grouped into categories representing students' problem-solving performance and the factors underlying their difficulties across different ability levels. The reduced data were then presented in narrative form according to Polya's problem-solving stages to facilitate interpretation. Finally, conclusions were drawn by identifying patterns in students' problem-solving processes and the factors contributing to their difficulties.

To ensure the trustworthiness of the findings, technique triangulation was employed by comparing students' written responses with the interview results. This process enabled the researchers to verify the consistency of the data and obtain a more comprehensive understanding of students' mathematical problem-solving skills (John W and J. David 2023). In addition, the trustworthiness of the study was established based on the criteria of credibility, transferability, dependability, and confirmability. Credibility was achieved through technique triangulation, transferability through detailed descriptions of the research context and participants, dependability through systematic documentation of the research procedures, and confirmability by ensuring that the findings were grounded in the collected data and supported by an audit trail of the analysis process.

2.6 Scoring Rubric

The instrument used to measure students' mathematical problem-solving abilities in rational number material consisted of six essay questions. The scoring rubric for the mathematical problem-solving ability test is presented in Table 1. The scoring rubric was adapted from Sa'adah et al. (2024) and modified to align with the objectives of the study and the four stages of Polya's problem-solving process. Students' responses were assessed by the researcher using the adapted scoring rubric.

Table 1. Scoring Rubric for the Mathematical Problem-Solving Skills Test

Indicator	Score	Students' Responses to the Questions (Problems)
Understanding the Problem	0	Does not write down or state the known information and what is being asked in the problem.

	1	Correctly writes down or states only the known information or what is being asked.
	2	Writes down or states both the known information and what is being asked, but both are incorrect
	3	Writes down or states both the known information and what is being asked, but one of them is incorrect.
	4	Correctly writes down or states the known information and what is being asked.
Devising a Plan	0	Does not write down a solution strategy.
	1	Writes down an incorrect solution strategy.
	2	Writes down a solution strategy, but it is inappropriate or incomplete.
	3	Writes down only part of the solution strategy.
	4	Writes down an appropriate and correct solution strategy.
Carrying Out the Plan	0	Does not provide a solution to the problem
	1	Provides a solution, but the procedure is unclear
	2	Provides an incomplete solution, resulting in an answer with unclear procedures.
	3	Provides a correct solution, but it is incomplete or not systematic.
	4	Provides a correct, complete, and systematic solution
Looking Back	0	Does not check the process or answer and does not provide a conclusion.
	1	Does not check the process or answer and provides an incorrect conclusion.
	2	Checks the process or answer but does not provide a conclusion, or provides a conclusion without checking the process or answer.
	3	Checks the process and answer but provides an inaccurate conclusion.
	4	Correctly checks the process and answer and provides an appropriate conclusion.

2.7 Ability Classification

The six research subjects completed the mathematical problem-solving ability test and were categorized into high, medium, and low ability levels based on their test results. The students' final scores for mathematical problem-solving ability were calculated using a percentage formula adapted from Sa'adah et al. (2024), as follows:

$$Score = \frac{Obtained\ Score}{Maximum\ Score} \times 100\%$$

3. Results and Discussion

3.1 Result

Based on the results of the mathematical problem-solving ability test administered to the six selected students, the data reduction process yielded the following findings:

Table 2. Reduced Data of Students' Mathematical Problem-Solving Skills Test Results

No.	Code	Score	Percentage (%)	Category
1	ML	89	92,70	High
2	AGK	80	83,33	High
3	SVA	76	79,16	Medium
4	AAM	50	52,08	Medium
5	RFA	42	43,75	Low
6	NSA	27	28,12	Low

As shown in Table 2, two student was categorized as having a high level of mathematical problem-solving ability, two students were categorized as having a medium level, and two student was categorized as having a low level. After analyzing the results of the mathematical problem-solving ability test.

Although the mathematical problem-solving ability test consisted of six essay questions, only Problem 1 is presented for detailed analysis because it comprehensively represents Polya's four problem-solving stages: understanding the problem, devising a plan, carrying out the plan, and looking back. Therefore, this problem provided sufficient evidence to compare the mathematical problem-solving processes of students across the high-, medium-, and low-ability groups. The analysis of the remaining five problems showed patterns of students' performance that were consistent with those identified in Problem 1, supporting its representativeness as the basis for the detailed qualitative analysis. The remaining problems were used to support the overall assessment of students' mathematical problem-solving ability and the selection of participants but are not presented in detail due to space limitations. The findings obtained from the three selected participants based on their responses to Problem 1 are presented as follows.

Problem: A shopkeeper offers a 25% discount on a bag, resulting in a discounted price of Rp180,000. If a customer wishes to determine the original price of the bag, how can this problem be solved by applying the concept of converting percentages into fractions? Furthermore, verify the obtained answer to ensure its correctness.

3.1.1 High Level Subject

Based on the test results and data analysis, the high-level subject exhibited a high level of mathematical problem-solving ability by fulfilling all four stages of Polya's problem-solving process: understanding the problem, devising a plan, carrying out the plan, and looking back. During the interview, the subject clearly explained the reasoning behind each step in a logical and systematic manner.

Figure 1. High Level Subject's ML Answer

As shown in Figure 1, the high-level subject correctly identified the discounted price of Rp180,000 and the discount rate of 25%, indicating an understanding of the problem. The subject did not explicitly write the solution strategy or formula on the answer sheet. However, according to the interview, the subject solved the problem directly using a memorized formula without writing the planning stage because it was considered time-consuming. The written solution showed that the subject first determined that Rp180,000 represented 75% of the original price, calculated the value of the 25% discount, and then obtained the original price of Rp240,000. The subject also correctly carried out the calculations using multiplication, division, and percentage operations and concluded the solution by restating the final answer.

This finding was reinforced by ML's interview response, as follows: *"I usually solve the problem directly using the formula that I remember, without writing down a plan first. I feel that once I know the formula, I can immediately solve the problem. I also rarely write the planning steps explicitly because I think doing so is time-consuming."*

3.1.2 Medium Level Subject

Based on the test results and interviews, the medium-level subjects demonstrated relatively good mathematical problem-solving abilities, although some indicators were not fully achieved. The subjects were able to understand the problem and devise appropriate solution strategies; however, they still encountered difficulties in carrying out the plan and reviewing the obtained solutions. During the interviews, the subjects were able to explain the steps they had taken, although some of their explanations were not entirely based on a thorough conceptual understanding. These findings indicate that the medium-level subjects possessed an adequate foundation in mathematical problem solving but still required improvement in terms of accuracy, conceptual understanding, and the evaluation of their solutions.

Figure 2. Medium Level Subject's SVA Answer

As shown in Figure 2, the subject demonstrated an understanding of the given and required information in the problem, namely that the discounted price after a 25% reduction was Rp180,000 and that the original price before the discount needed to be determined. The subject also indicated that the percentage concept was used to determine the amount of the discount and then added the discount value to the discounted price. However, an error occurred during the calculation process because the subject assumed that 25% of Rp180,000 was Rp45,000, even though Rp180,000 represented the price after the discount and therefore could not be directly used as the basis for calculating the discount amount. This error indicates that SVA was able to identify the problem, devise a solution strategy, carry out the planned steps, and review the obtained answer. However, the subject lacked accuracy in understanding the relationship between the discounted price and the original price. Consequently, the final answer obtained, namely Rp225,000, was incorrect.

As reflected in the interview, the subject stated: *"I made a mistake because I directly calculated 25% of Rp180,000. I should have determined the original price before the discount first, so my answer was incorrect."*

This statement indicates that the error made by the subject was not due to an inability to understand the problem or to devise a solution strategy, but rather resulted from a misconception in applying the percentage concept to a discount situation. The subject was able to identify the given and required information, determine an appropriate strategy, and carry out the planned procedures. However, a lack of accuracy in identifying the correct basis for percentage calculation led to an incorrect result. Therefore, the error was more closely related to the subject's conceptual understanding of discounts and the relationship between the original price and the discounted price than to the ability to follow Polya's stages of problem solving.

3.1.3 Low Level Subject

Based on the test results and interviews, the low-level subject demonstrated mathematical problem-solving abilities that did not meet most of the indicators. Although the subject was able to understand the problem, difficulties were encountered in almost all subsequent stages of problem solving, including devising a plan, carrying out the selected strategy, and evaluating the obtained solution. During the interview, the subject was often unable to explain the reasoning behind the steps taken and exhibited uncertainty in determining an appropriate solution method. The responses provided tended to be incomplete or inconsistent with the requirements of the problem. These findings suggest that the low-level subject lacked sufficient conceptual understanding and required more structured guidance to develop mathematical thinking and problem-solving skills.

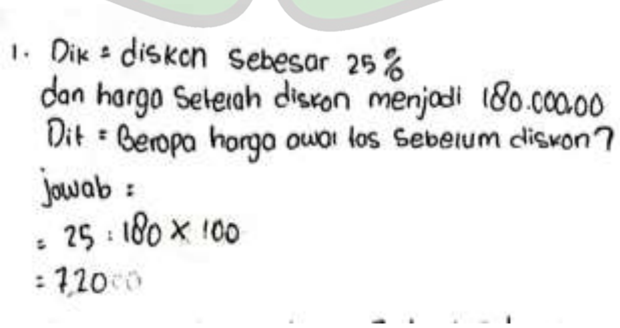

Figure 3. Law Level Subject's NSA Answer

As shown in Figure 3, the results of the written test and interview revealed that the subject fulfilled the indicator of understanding the problem, as evidenced by the ability to identify the given information, namely a 25% discount and a discounted price of Rp180,000, as well as to recognize that the problem required finding the original price before the discount. However, NSA did not fulfill the indicator of devising a plan because no appropriate strategy was demonstrated to determine the original price. Instead, the subject directly performed calculations without first relating the given information to the appropriate percentage concept. Consequently, at the stage of carrying out the plan, NSA made incorrect calculations, resulting in an inaccurate answer. Furthermore, the subject did not satisfy the indicator of looking back, as there was no evidence of attempts to review or evaluate the obtained result.

During the interview, the subject stated: *"I understood that the given information was a 25% discount and a discounted price of Rp180,000, and that I had to find the original price. However, I was confused about how to determine the original price before the discount, so I simply calculated it using a method that I thought was correct. After finishing, I did not check my answer again because I felt that I had already completed the problem."* This statement is consistent with the student's written response, which correctly identified the given information but did not include a clear solution plan and contained errors in the calculation of the original price. Furthermore, no evidence of checking or revising the final answer was found in the written work, supporting the interview findings that the student did not perform the looking-back stage.

This statement indicates that NSA was able to understand the information provided in the problem and identify what was being asked. However, the subject still experienced difficulties in selecting an appropriate strategy to solve the problem. The inability to relate the given information to the concept of percentages prevented the subject from devising a suitable solution plan. As a result, the calculations performed were inaccurate and led to an incorrect answer. Furthermore, the subject did not review the completed work, making it impossible to detect or correct the errors that had occurred. Therefore, NSA fulfilled only the indicator of understanding the problem, whereas the indicators of devising a plan, carrying out the plan, and looking back were not achieved.

The overall results of the high-, medium-, and low-level subjects are presented in Table 3.

Table 3. Overall Results of the Subjects

Subject Level	Indicator				Descrip
	Understanding the Problem	Devising a Plan	Carrying Out the Plan	Looking Back	
High	✓ Successfully fulfilled the indicator of understanding the problem.	✓ Successfully fulfilled the planning indicator, although the plan was not explicitly written.	✓ Successfully carried out the solution correctly.	✓ Successfully reviewed and evaluated the solution.	The subject fulfilled all indicators but preferred a more concise approach and tended to save time by omitting the written planning stage.
Medium	✓ Successfully fulfilled the indicator of understanding the problem.	✓ Successfully fulfilled the planning indicator, although the plan was not explicitly written.	✓ Fulfilled the implementation indicator, but lack of accuracy resulted in an incorrect final answer.	✓ Attempted to review the solution, but the verification of the final answer was inaccurate.	The subject fulfilled all indicators but preferred a concise approach and tended to save time. A lack of accuracy during the solution process led to an incorrect final answer for Problem 1.
Low	✓ Successfully fulfilled the indicator of understanding the problem.	✗ Did not fulfill the planning indicator.	✗ Did not fulfill the implementation indicator; the solution process and final answer were incorrect.	✗ Did not fulfill the evaluation indicator.	The subject was able to identify the given information but was unable to devise a plan, carry out the solution, or evaluate the obtained result

The findings of this study indicate that several factors contributed to the absence of the planning indicator. These factors included students' lack of understanding of the material, limited habituation to explicitly writing solution plans, and their tendency to prefer concise and time-saving approaches. Meanwhile, regarding the indicator of carrying out the plan, some students were able to complete the solution process but obtained incorrect final answers due to a lack of accuracy in calculations and insufficient understanding of the underlying concepts.

Overall, the results showed that the students demonstrated varying levels of achievement across Polya's problem-solving indicators, namely understanding the problem, devising a plan, carrying out the solution, and looking back. Among the six seventh-grade students of MTs Negeri 1 Banda Aceh who participated in the mathematical problem-solving test on rational numbers, differences were observed in their ability to fulfill these indicators. Although several students were able to identify problems, devise solution strategies, implement them, and evaluate their answers, difficulties were still encountered, particularly in planning, conceptual understanding, computational accuracy, and reviewing the obtained solutions.

Table 4. Percentage of Achievement for Polya's Problem-Solving Indicators

No.	Polya's Indicator	Percentage of Students' Scores	Category
1	Understanding the Problem	83,33%	Very High
2	Devising a Plan	20,13%	Low
3	Carrying Out the Plan	64,50%	High
4	Looking Back	45,83%	Moderate

Based on the percentage results of the problem-solving indicators presented above, the first indicator, understanding the problem, achieved a percentage of 83.33%, which falls into the very high category. This result indicates that students at all ability levels were able to identify the given and required information in the problems effectively. In contrast, the second indicator, devising a plan, obtained only 20.13%, which is categorized as low. The low percentage suggests that medium- and low-level students experienced difficulties in determining appropriate strategies or steps to solve the problems. This finding indicates that although students were able to understand the problems, they were not yet capable of systematically formulating solution plans.

The third indicator, carrying out the plan, achieved a percentage of 64.58%, which is classified as high. This result shows that students at all ability levels were generally able to perform the necessary calculations and solution procedures once a clear plan had been established. Finally, the fourth indicator, looking back, obtained a percentage of 45.83%, which falls into the moderate category. This finding suggests that low-level students were not accustomed to reviewing and evaluating their solutions, resulting in a relatively high likelihood of errors remaining undetected.

3.2 Discussion

The findings of this study indicate that the mathematical problem-solving ability of seventh-grade students at MTs Negeri 1 Banda Aceh on rational number material was not yet optimal across several of Polya's indicators. In general, the highest percentage was obtained for the indicator of understanding the problem (83.33%), whereas the lowest percentage was found for the indicator of devising a plan (20.13%). These findings are also consistent with Wahab et al. (2024), who reported that students most frequently encounter difficulties during the stages of devising solution strategies and evaluating their answers within Polya's problem-solving framework.. Similar results were reported by Pangesti & Dian Anggraeni (2025) who concluded that students' primary obstacle lies in the planning stage rather than in understanding the mathematical content itself. However, the present study extends these findings by providing a more in-depth analysis through the integration of Polya-based problem-solving tests and interview data across different ability levels. This approach not only identifies the stages at which students experience difficulties but also reveals the underlying reasons for those difficulties, thereby providing more comprehensive insights into students' mathematical problem-solving processes in rational number topics. This finding is consistent with Madzkiyah, Subanji, and Arifin (2024), who found that analysis based on Polya's stages combined with interviews and written tests can reveal students' difficulties in each stage of the problem-solving process. This finding is consistent with Choiriyah, Hartati, and Listiana (2026), who demonstrated that analysis through Polya's stages can reveal differences in students' problem-solving processes and identify specific difficulties experienced at each stage.

At the high-ability level, the subject was able to understand the problem, devise a plan, carry out the plan, and evaluate the obtained solution. These findings are consistent with those reported by Sa'adah et al. (2024) , who stated that high-achieving students are generally able to perform the stages of problem solving systematically and thus arrive at correct solutions. Unlike previous studies that primarily described students' overall problem-solving performance, the present study provides a more detailed analysis by combining Polya-based problem-solving tasks with in-depth interviews to reveal students' reasoning and difficulties at each stage of the problem-solving process across different ability levels. These findings suggest that mathematics teachers should explicitly guide students through each stage of Polya's problem-solving process and provide differentiated support, particularly in planning solution strategies and evaluating final answers, to improve students' mathematical problem-solving skills in rational number learning**.** However, during the planning stage, the subject did not explicitly write the solution plan on the answer sheet. Based on the interview results, the subject admitted to being accustomed to directly applying memorized formulas without documenting the planning steps, as this approach was considered more practical and time-efficient. This finding indicates that the subject possessed the ability to devise a plan, although the planning process remained implicit rather than being explicitly presented in the written response. According to Pólya (1973), the planning stage is an essential component of problem solving because it helps determine appropriate strategies before carrying out the solution. Writing the plan systematically can assist students in maintaining a logical sequence of thought and minimizing errors during the solution process. These findings are consistent with those of Nurussama et al. (2025) who reported that high-ability students often omit the written planning stage because they feel they already understand the procedures required to solve the problem. Such a tendency may be influenced by instructional practices that place greater emphasis on obtaining the final answer than on documenting each stage of the problem-solving process.

For the medium-level subject, all of Polya's problem-solving indicators were fulfilled. The subject was able to understand the problem, devise a solution plan, carry out the planned procedures, and evaluate the obtained result. These abilities indicate that the subject possessed the fundamental skills required to follow the problem-solving process systematically. Nevertheless, the solution process still exhibited errors caused by insufficient conceptual understanding and a lack of accuracy in calculations. Febrianty et al. (2024) emphasized that mathematical reflective thinking plays an important role in helping students evaluate their solution processes, identify errors, and improve the accuracy of their final answers. His result is also supported by Utari et al. (2026) who stated that students' reasoning abilities influence their success in connecting mathematical concepts, selecting strategies, and evaluating solutions during the problem-solving process.

Conceptual understanding plays a crucial role in mathematical problem solving because it provides the foundation for identifying relationships among given information, selecting appropriate strategies, and correctly implementing solution procedures. When conceptual understanding is not fully developed, students are likely to make errors even though they are able to devise appropriate solution plans. This finding is consistent with Hidayat et al., (2026) who reported that conceptual understanding is closely related to mathematical problem-solving ability, and that students with incomplete conceptual mastery tend to make mistakes during the solution process despite being able to determine suitable strategies. Similarly, Tampubolon et al., (2023) found that students with stronger conceptual understanding generally demonstrate higher levels of problem-solving ability than those with weaker conceptual understanding. Furthermore, Pramuswara & Haerudin (2024) explained that conceptual understanding contributes significantly to students' success in solving problems by enabling them to connect the given information with appropriate procedures. In addition to conceptual understanding, accuracy is another essential aspect of problem solving. Minor computational errors may lead to incorrect final answers even when the solution procedures are appropriate. This finding is supported by Lapele et al., (2024) who reported that students with partial conceptual understanding often encounter difficulties during the implementation and evaluation stages because they lack accuracy in interpreting and verifying their results. Therefore, besides being able to follow the stages of problem solving, strong conceptual understanding, computational accuracy, and the habit of reviewing solutions are critical factors in obtaining correct answers and enhancing mathematical problem-solving ability effectively.

For the low-level subject, only the indicator of understanding the problem was fulfilled. The subject was able to identify and write down the given and required information but was unable to devise an appropriate solution plan. Instead, the subject immediately performed incorrect calculations without following procedures consistent with the information provided in the problem. This finding is in line with Pradiarti (2026), who reported that students' difficulties in solving contextual problems are often related to their inability to determine appropriate strategies and organize solution procedures systematically. Consequently, during the stage of carrying out the plan, inaccurate calculations were made, resulting in an incorrect answer. Furthermore, the subject did not review or evaluate the obtained result. These findings indicate that the subject's major difficulties were concentrated in the planning, implementation, and evaluation stages. This finding is consistent with Wibowo et al., (2023) who reported that the planning and evaluation stages are the most problematic because students are not accustomed to formulating strategies and reviewing their answers. This finding is further supported by Sutardi, Anwar, and Muksar (2026), who found that students often experience difficulties in connecting the information provided in problems with appropriate mathematical strategies, particularly when solving contextual problems. This finding is further supported by Wahab et al. (2024), who reported that students commonly experience difficulties in devising strategies, implementing solutions, and evaluating their answers within Polya's problem-solving stages.

The results of this study are also in agreement with those of Tampubolon et al., (2023) who stated that weak conceptual understanding leads to difficulties in devising appropriate problem-solving strategies. In addition, insufficient habituation to reviewing solutions and poor time management contributed to the low level of students' problem-solving ability. These findings are further supported by Hidayat et al., (2026) who found that students with limited conceptual understanding tend to experience difficulties in determining appropriate procedures and are less capable of evaluating the results they obtain. Similarly, Pramuswara & Haerudin, (2024) demonstrated that conceptual understanding has a significant influence on students' mathematical problem-solving ability; therefore, students who do not possess a deep understanding of concepts are likely to encounter difficulties in determining appropriate solution steps. Lapele et al., (2024) also reported that students who understand concepts only at a verbal level, without a deeper conceptual comprehension, tend to face obstacles in the problem-solving process and are unable to complete all stages of the solution systematically. Therefore, strengthening conceptual understanding and fostering the habit of applying systematic problem-solving procedures are essential to enable students to perform more effectively at each stage of Polya's problem-solving process.

Based on interview results, the subject stated that they did not recheck their answers because they were in a hurry or felt that the final result was sufficient. However, evaluation is an important stage in problem solving to detect possible errors. This finding is consistent with Fatimah and Nasution (2024) who reported that students' errors in writing final answers generally occur because they do not recheck their calculations or verify the conclusions they have drawn. In general, differences across levels show a gradual pattern: at the upper level, subjects do not explicitly write a solution plan; at the middle level, errors begin to appear in the final answer due to a lack of accuracy in the planning and calculation stages; while at the lower level, subjects experience weaknesses across all stages, including understanding the problem, planning, executing, and evaluating the solution. This pattern is also consistent with Fauziyah et al. (2025)who found that high-ability students were able to fulfill all stages of Polya's problem-solving process, whereas low-ability students experienced difficulties in devising strategies, implementing solutions, and evaluating their answers. Therefore, the implementation of learning strategies should be differentiated, with an emphasis on strengthening rational number concepts as a foundation, habituating students to systematically write solution plans, and consistently encouraging the habit of evaluating results. These findings also indicate that analysis based on Polya's four problem-solving indicators can reveal the root of students' difficulties more deeply, which is not always visible from the final answer alone.

The findings also have important implications for mathematics instruction. Teachers should explicitly teach each stage of Polya's problem-solving process rather than focusing only on obtaining correct answers. To strengthen students' planning skills, teachers can encourage students to identify the known and unknown information and write down a solution strategy before performing calculations. To improve conceptual understanding, learning activities should emphasize the relationships among rational number concepts through contextual problems and guided discussions instead of relying solely on memorized formulas. Furthermore, teachers should promote reflective thinking by encouraging students to review their solution steps, verify the accuracy of their calculations, and consider alternative solution strategies. Such instructional practices may help students develop more systematic and effective mathematical problem-solving skills in learning rational numbers.

4. Conclusion

Based on the research findings, the three participants representing high-, medium-, and low-ability levels demonstrated different mathematical problem-solving performances on rational number tasks across Polya's four problem-solving stages. The high-ability participant successfully completed all stages, although the planning stage was often performed implicitly rather than being explicitly written. The medium-ability participant also completed all four stages but made errors in the final answer due to inaccuracies in applying rational number concepts and performing calculations. In contrast, the low-ability participant was only able to fulfill the stage of understanding the problem and experienced difficulties in devising a plan, carrying out the solution, and looking back. These findings suggest that, within the participants involved in this study, higher mathematical ability was associated with more complete performance across Polya's problem-solving stages.

The findings also indicate that students' difficulties were influenced by different factors at each ability level. For the high-ability participant, the absence of an explicit planning stage was related to the habit of applying memorized formulas directly and the intention to save time. For the medium-ability participant, difficulties were mainly associated with limited conceptual understanding of rational numbers and a lack of accuracy in calculations and checking the final answer. Meanwhile, the low-ability participant experienced difficulties due to weak conceptual understanding, inability to determine appropriate solution strategies, limited planning before performing calculations, and insufficient reflection on the obtained solution. These findings imply that mathematics instruction should place greater emphasis on strengthening conceptual understanding of rational numbers, explicitly guiding students through each stage of Polya's problem-solving process, encouraging students to write systematic solution plans, and developing reflective thinking through routine answer verification.

As this study involved only three participants selected for in-depth qualitative analysis, the findings should be interpreted within the context of this study and are not intended for broad generalization. Instead, they provide transferable insights that may inform mathematics instruction and future research in similar educational contexts involving students' mathematical problem-solving skills in rational number learning.

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