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Characteristics of Problem Solving Ability of Students in Integer Operation Material

Runinda Silviana[1*], Dwi Rahmawati[1], Rina Agustina[1]

[1]Mathematics Education Study Program, Faculty of Teacher Training and Education, University of Muhammadiyah Metro

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ABSTRACT

Problem-solving skills have a close relationship with real life and can be used to deal with everyday life. The problems faced by students in one of the Private Junior High Schools in Metro City, specifically grade VII, have diverse problem-solving skills. This study aims to analyze students' problem-solving abilities in analyzing problems using *the polya* stage with NCTM indicators, namely understanding problems, designing strategies, solving problems, and reviewing solutions. This study uses a descriptive qualitative approach through *purposive sampling techniques*. A total of 17 students, 7 students were selected as research subjects based on the criteria of the results of the test description of problem-solving abilities in integer operation material. The category of students' abilities is determined based on the number of polya problem-solving stages that are met. The research instrument was in the form of a test of problem-solving ability on integer operation materials and semi-structured interviews. Data analysis is carried out through data reduction, data presentation, and drawing conclusions. The results of this study show a difference, namely students with high abilities are able to meet all three stages of problem-solving ability, although they have not been completely completed in all aspects, especially in re-examination. Subjects with moderate ability are able to understand the problem and formulate strategies even though the strategies used are not clear, complete the plan and do not write conclusions in the final stage as a re-examination of the solution, while the low category has difficulties from the stage of understanding the problem to the final stage. These findings imply the need for learning that is tailored to the category of students, starting from strengthening the stages of re-examination in high students, consistency in the implementation of plans in medium students to understanding problems in low students.

Corresponding Author:

Runinda Silviana,
Mathematics Education Study Program,
Faculty of Teacher Training and Education,
University of Muhammadiyah Metro,
Jl. Ki Hajar Dewantara No.116, Iringmulyo, East Metro District, Metro City, Lampung 422445, Indonesia
runindasilviana9@gmail.com

Introduction

Mathematics education is very important for students, in accordance with the main goal of mathematics to train students' thinking skills to solve various problems (Lidu et al., 2023). Therefore, in the mathematics learning process, the teacher's ability is needed to manage activities in the classroom so that teaching and learning activities run in an interesting and effective way. Problem-solving skills are skills in solving problems that have a close relationship with real life and can be used to face challenges in daily life, so problem-solving skills are needed because through this process these skills can train students to understand problems well (Siswanto, 2024; Putri et al., 2022.; Mutialawati et al., 2024).

Problem-solving skills according to (NCTM, 2000) state that in the implementation of mathematics learning in schools, teachers must demonstrate mathematical skills, namely: connection, reasoning, communication, problem-solving, and representation, this is supported by the Regulation of the Minister of Education number 12 of 2025 concerning content standards at the secondary education level which states that students are able to master simple problem-solving in concrete objects systematically, effectively, efficiently, and optimally with computational thinking. The Ministry of Education's Standards, Curriculum, and Assessment Agency states that problem-solving skills include the ability to understand problems, design mathematical models, solve models, or interpret permissible solutions.

Students have low problem-solving skills because some students perceive math as a difficult subject and lack of student skills in solving problems that require problem-solving skills (Nuriavani et al., 2024). Students who have low problem-solving skills are influenced by several factors such as, the differences in each individual's thinking ability and the level of ability each student has (Nr et al., 2026). The purpose of learning mathematics is to develop the problem-solving skills that students have, but the reality is that there are still many students who are not able to master the basics of mathematical calculation operations (Sugiyarto et al., 2025). Students who have high, middle, and low problem-solving skills still have difficulties when facing problems packaged in daily life, students directly write answers without interpreting the questions so that students cannot review the process and answers (Rio & Pujiastuti, 2020). This is in line with research Amila et al. (2023) that students still have difficulty solving problems in integer material, students do not write down in detail the stages or information obtained according to what is known and requested, so students still cannot review the process and answers.

Hermawati & Jumroh (2021) in this study analyzed students' overall problem-solving abilities without distinguishing between ability categories, so that the characteristics of student mistakes at each ability level were not specifically identified. Meanwhile, the study Febriyanti & Ariyanto (2024) only involved high and medium students, so the error characteristics of low-ability students who have the potential to have the most complex error patterns are the most complex. However, a number of studies that have involved high, medium, and low categories simultaneously, such as Sugiyarto et al. (2025), generally still stop at the quantitative descriptive stage in the form of the percentage of achievement in each category, without systematically tracing the location and causes of student errors at each stage of problem-solving. The gap in this research does not lie in the absence of studies involving three categories of abilities at once, but in the lack of research that in-depth analyzes the characteristics of the errors of each category of ability at each stage of completion. This gap is what prompted this study to explore and compare the characteristics of problem-solving errors from the three categories of abilities systematically in integer operation material.

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
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This study is specifically used to explore the characteristics of the mathematical problem-solving process based on three categories of students' abilities in class VII integer operations, which have not been qualitatively studied in the existing literature. Pratiwi (2020) discussed students' problem-solving skills in single-variable linear equation material and Setiana et al. (2021) used trigonometric material. Based on the results of interviews with Class VII B mathematics teachers at one of the Metro City Private Junior High Schools, information was obtained that out of 17 students, the results of the daily test on integer operation material, there were only 6 students (35.3%) who achieved the Learning Goal Achievement Criteria (KKTP). The teacher also said that students still often make mistakes in determining the results of the operation of addition, minus, multiplication and division. The teacher said that some students still had difficulties when given questions in the context of problems. This condition shows that students' problem-solving skills still need to receive more in-depth attention. Based on the results of previous research, there are still many students who have difficulties in the process of working on the questions and only some students achieve complete learning, while others have low learning outcomes. Students still have great difficulty in calculating the number of negative and positive numbers, as well as difficulty distinguishing between negative and positive scores (Nafisah, 2022).

The mathematical problem-solving ability in this study was analyzed using stages Polya. (2004) which consisted of four stages, namely understanding the problem, developing strategies, implementing plans, and checking back. This research strengthens the basis of assessment at each stage using the problem-solving ability indicator developed by NCTM (2000), which was formulated by Mauleto (2019), namely students are able to identify information that is known, asked, and the adequacy of the information needed, students are able to formulate mathematical models and determine appropriate strategies or solution approaches, students are able to use the right strategies to solve problems, and students are able to explain the results according to the initial problem and use mathematics meaningfully. The *polya* stages are used as a structural framework that describes the flow of students' thinking processes, while the NCTM indicators are used as criteria to assess the quality of student achievement at each stage, so that these two frameworks complement each other in measuring problem-solving skills. Nofita & Damayanti (2022) in this study only used the polya stage as the only analytical framework in finding the characteristics of students' problem-solving abilities. However, the use of the polya stage only describes the procedural flow without providing a clear benchmark for the standard of problem-solving skills that students must achieve at each stage.

Research on problem solving has been extensively explored by various researchers Hamapinda et al. (2021), Sagala et al. (2024), and Suartania et al. (2026). The study maps the level of students' problem-solving ability based on high, medium, and low categories, but the analysis only stops at the percentage of achievement without unraveling the location of students' mistakes at each stage of completion. The researcher only identified student errors generally stemming from weaknesses in reading and analyzing the questions, but did not explicitly link them to the problem-solving stages in each skill category.

The novelty of this researcher lies in the effort to systematically trace the location and types of mistakes made by students in the high, medium, and low ability categories at each stage of problem solving, starting from understanding the problem, planning the solution, implementing the plan, to checking back on the integer operation material. Based on this approach, this study not only describes how much students are capable in each category, but also reveals the stages at which mistakes occur, thus providing a more detailed understanding than previous research which tends to stop at the quantitative deductive level. This study was conducted to find out how the characteristics of problem solving skills of grade VII students in integer operation material were reviewed from the polya stage with NCTM indicators and to find out the difficulties or mistakes experienced by students in the high, middle, and low categories in solving problem-solving problems. In line with the formulation of the problem. This study aims to describe the characteristics of students' problem-solving ability in integer material and compare it between high, medium, and low ability students. The results of this study are expected to be a reference for teachers in designing more adaptive learning according to the level of students' ability, especially in integer material.

Method

Types of Research

This type of research is descriptive qualitative research according to Sugiyono (2022), qualitative research uses "*social situations"* or social situations consisting of three elements, namely: place, actors, and activities. The descriptive qualitative approach aims to describe in depth the problem-solving ability of students in solving integer operation problems. Descriptive qualitative research, the researcher aims to reveal the thinking process of students at each stage with problem-solving indicators according to NCTM, namely understanding the problem, designing strategies, solving problems, and reviewing solutions through data analysis in the form of test results, description of problem-solving skills, and semi-structured interviews.

Participants

The population in this study is all students of grade VII B in one of the Metro City Private Junior High Schools which totals 17 students, all students are involved in the initial data collection in the form of a written test of problem-solving skills in integer operation materials. Based on the results of the written test, students are grouped into three categories of high, medium, and low with grouping criteria. In-depth interviews were selected by 7 students as interview subjects, namely 2 students of high ability, 3 students of medium ability, and 2 students of high ability. The selection of in-depth interview subjects uses purposive sampling techniques, with students having the highest, middle and lowest scores in each category, and students' abilities at each stage of problem-solving ability. Purposive sampling in this study was carried out specifically at the stage of selecting in-depth interview subjects. The seven subjects used in this study were coded according to the high, medium, and low categories, as follows the coding Table 1 used in this study.

Table 1. Subject Coding

Code	Remarks
P	Questioner
ST1	The subject of the first high ability
ST2	The subject of the second high ability
SS1	First medium ability subject
SS2	The subject of the second medium ability
SS3	Third medium ability subject
SR1	The first low-ability subject
SR2	The subject of the second low ability

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https://doi.org/10.51574/kognitif.v6i3.5645 Volume 6, No 3, July - September 2026, pp. 1221 –1241

Instruments

The study used test instruments to describe problem-solving skills and semi-structured interview guidelines. Three descriptive test questions were used to measure students' problem-solving abilities in integer operation material, which is a form of test in the form of contextual questions that require students to understand the problem, design strategies, solve problems, and review according to the polya stage. Semi-structured interview guidelines are used to explore in-depth information about students' thinking processes in solving integer operation problems. The validation of this content was carried out by two mathematics education lecturers and one mathematics subject teacher who concluded that the instrument was well used. The questions used to analyze the problem-solving capabilities in the integer operation description test are shown in the Table 2.

Table 2. Description of Material Troubleshooting Capabilities and Test Indicators

Material	Polya Stages	Indicator
A submarine was at a depth of 80 meters. The ship went down another 25 meters. What is the depth of the ship now?	Understanding the problem	Students identify the information and magnitude of the "decline" changes that are known and asked in the questions
	Planning a strategy	Students formulate systematic problems through mathematical models such as integer operations
	Execute the plan	Students perform integer reduction calculations to determine the depth of the cap.
	Review solutions	Students re-examine the final position results against the real context of depth below sea level.
The initial balance of Dimas' account is IDR 500,000. He withdraws Rp 250,000 and then deposits Rp 100,000. What is the final balance?	Understanding the problem	Students identify debit and credit transactions that occur sequentially.
	Planning a strategy	Students draw up the appropriate sequence of addition and subtraction operations to calculate the balance.
	Execute the plan	Students calculate the final balance by applying integer operations in a row.
	Review solutions	Students double-check the final balance stipulated by the recorded transaction.
It is known that the rules for the entrance test to a junior high school are that the correct answer is given a score of 4, the wrong answer is given a score of -2, and the non-answer is given a score of 0. The total number of questions is 50. What is the highest and lowest score that can be obtained?	Understanding the problem	Students identify scoring rules with positive and negative integers

Material	Polya Stages	Indicator
	Planning a strategy	Students devise a calculation strategy to determine the combination of high and low scores
	Execute the plan	Students perform multiplication and integer summation operations to determine maximum and minimum scores
	Review solutions	Students double-check the correctness of the highest and lowest scores obtained according to the assessment rules.

The standard problem-solving process of NCTM (2000) is basically comprehensive and non-sequential, in contrast to the polya (2004) stages which are in the form of four sequential cognitive stages. The mapping of NCTM indicators to the polya stage is based on the suitability of cognitive demands at each stage, referring to the NCTM indicators formulated (Mauleto, 2019). A similar approach has also been used in previous studies that integrate the polya and NCTM stages in analyzing students' mathematical problem-solving abilities (Table 3).

Table 3. Polya Levels with NCTM Indicator

Polya Stage	Indicator NCTM	Theoretical Justification
Understanding the problem	Students are able to identify information that is known, asked, and the adequacy of the information needed.	Both concepts require the same cognitive ability, namely recognizing and interpreting the elements of the problem before taking action to solve (Polya, 2004; Mauleto, 2019).
Planning a Strategy	Students are able to formulate mathematical models and determine appropriate strategies or solution approaches	The preparation of mathematical models and the selection of strategies are the core of the polya stage, which is to formulate a solution approach before execution (Polya, 2004).
Execute the plan	Students are able to use the right strategies to solve problems.	The systematic execution of strategies is in line with the polya stage, this process is also the foundation of the construction of new mathematical knowledge as emphasized by NCTM (2000), because understanding develops through the act of solving problems actively.
Revisit the solution	Students are able to explain the results according to the initial problem and utilize mathematics meaningfully	Explaining the conformity of the results with the initial problem and reflecting on its meaning is a stage of re-examining as evaluating the truth (Polya, 2004)

Semi-structured interviews were conducted with selected subjects from the high, medium, and low categories by referring to aspects of learning outcomes that included knowledge (Jamiah, 2023), comprehension (Alifiana et al., 2025), and supporting and inhibiting factors (Padilla et al., 2024). The interview aspect was mapped into four stages of polya problem-solving with the NCTM indicator (Table 4).

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
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Table 4. Aspel's Conceptual Map Interview with Polya-NCTM Stages

Aspects	Polya-NCTM	Questions
Knowledge	Understanding the Problem, the subject can understand what is known and asked in the question	1. What do you understand from the question? 2. What information do you know? 3. Do you think the information provided is enough to solve this problem? 4. Do you have trouble understanding the problem?
Understanding	Planning strategies, and executing plans, subjects can formulate systematic problems through mathematical models to solve problems	1. After understanding the problem, what steps do you think about to solve it? 2. What integer concept or operation do you use? 3. Why do you have to subtract and then add them? 4. Why did you write down the immediate completion step? 5. Why do you immediately determine a strategy with a stack-down calculation?
Supporting and inhibiting factors	Checking back, the subject is able to explain the results according to the initial problem and make meaningful use of mathematics	1. After getting the answer, did you check the results again? 2. Do you think your answer is correct? 3. Is there anything that hinders you in working on these questions?

Data Collection

The study used a data collection method based on problem-solving ability tests and semi-structured interviews. The main technique of this study to collect data is the problem-solving ability test, this test consists of a written description with integer operation material. Student data on problem-solving is collected through tests. The researcher examines the answers given after the students have finished answering the questions to identify which students will participate in the interview. Interviews conducted in a semi-structured type were conducted after students had finished working on questions related to integer operation material and after the research subjects were selected based on high, medium, and low ability, with each category represented by a subject who met these criteria. The goal is to learn more about students' problem-solving abilities as well as difficulties and the factors that cause them at each category level. This study uses primary sources because primary data is collected directly by researchers from original sources so that they can provide real and accurate information (Undari, 2024). Figure 1 is the order of data collection used in this study.

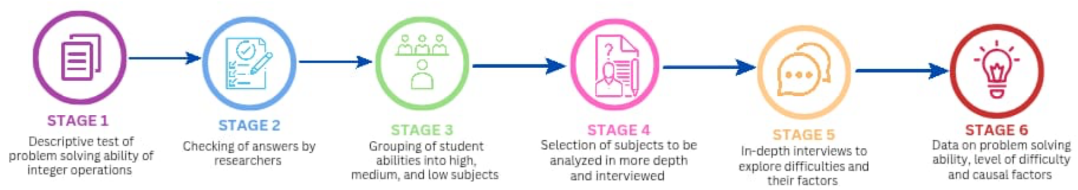

Figure 1. Data collection process

Data Analysis

The data analysis in this study uses descriptive qualitative data analysis techniques that refer to the Miles and Huberman model data analysis which states that the activities that occur in qualitative data analysis are carried out interactively and directly until completion, namely data collection, data presentation, and conclusion making (Safarudin et al., 2023).

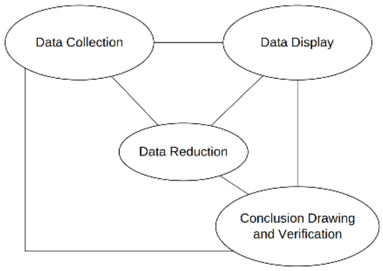

Figure 2. Miles *and Huberman Model Data Analysis* Image

The stages of data analysis *of the Miles* and *Huberman* model used in this study are as follows. The first stage is data collection, where the researcher collects data from the field through semi-structured interviews, providing a test description of problem-solving skills and documentation. The data that exists at this stage is still original data that has not been analyzed. The second stage is data reduction, at this stage the process of selection, simplification, focus, and abstraction of the data obtained, important data is summarized and classified with the research theme. The third stage is data presentation, where the subtracted data is then compiled and presented in a more organized form, such as narratives, images, and tables to make it easier for researchers to see the relationships between the data. The last stage is conclusions, the last stage is the making of conclusions about the meaning of the data that has been presented and then re-verified so that the resulting conclusions are valid. With these stages, the results of the analysis are expected to provide an in-depth description of students' mathematical problem-solving abilities. The result categories of mathematical problem-solving skills scores are as follows in Table 5.

Table 5. Distribution of Students' Mathematical Problem-Solving Abilities

Presentase	**Category**
$x \geq 81$	Height
$65 \leq x \leq 80$	Medium
$x \leq 64$	Low

Source: (Hafizah et al., 2025)

The analysis in this study focuses on students' mathematical problem-solving ability based on four polya stages: understanding the problem, designing strategies, implementing plans, and re-examining solutions. The results of the mathematical problem-solving ability test were first analyzed to group the research subjects into three categories of problem-solving skills, namely high, medium, and low based on the scores obtained at each stage of polya. Then the data selection stage is carried out, the researcher selects and focuses on the results of the mathematical problem-solving skills test as well as interview data that is relevant to the research

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objectives and the ability categories that have been determined. Taranskip interviews related to students' math problem-solving skills are then coded. The interview coding in this study is, "P" is indicated for the researcher or questioner, "ST1" The first high-ability subject, "ST2" The second high-ability subject, "SS1" The first medium-ability subject, "SS2" The second medium-ability subject, "SS3" The third medium-ability subject."SR1" The first low ability subject, "SR2" The second low ability subject. The selected data is then presented in the form of descriptive narratives, images, and interview excerpts to facilitate the identification of the characteristics of students' problem-solving abilities in each category. Conclusions are drawn and verified through triangulation of sources in order to compare the information obtained through several different subjects' problem-solving abilities. Based on the verification process, a comprehensive description of the characteristics of students' mathematical problem-solving skills in each category of ability is provided based on four polya stages.

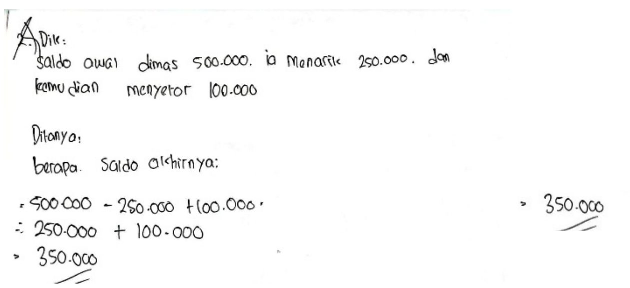
Research Findings

Based on the results of the math problem-solving ability test, grade VII students were corrected to be grouped based on the level of students' math problem-solving ability. At this stage, the data that has been sorted and compiled will be grouped by certain categories to make it easier to read and understand the meaning. In this way, researchers can see patterns of relationships and relationships between data in a clearer and more structured way.

High Ability Subject

Based on the results of the students' scores on the problem-solving ability test. The results of the student's Mathematical Problem-Solving Ability Test Category showed that there were 2 students who had problem-solving skills in the high category with a score of 81.3. The following are the results of the test questions and interviews with one of the subjects who had

the first high ability of ST1 shown in the Figure 3.



(3a) (3b)

Figure 3. Results of the First High Ability Subject Description Test (ST_1)

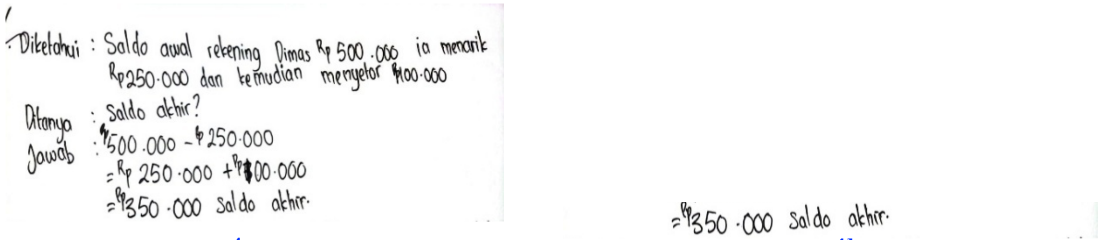
Based on Figure 3a of the ST1 description test results and Figure 3b is the final result of ST1 to strengthen the validation of the findings, the diats image is complemented by semi-structured interview results.

P	:	*"What do you understand from this matter?"*
ST1	:	*"About the Balance of Your Own Account"*
P	:	*"What information did you get from the question?"*
ST1	:	*"I know the initial balance is dimas, then he withdraws and then deposits it again"*

P	:	*"After understanding the problem, what steps do you think of to solve it?"*
ST1	:	*"I immediately thought of addition and subtraction"*
P	:	*"What integer concept or operation will you use (addition, subtraction, multiplication, or division)? Why choose that?*
ST1	:	*"Because there is a sentence of withdrawing money and depositing money"*
P	:	*"Why do you have to reduce the balance in the mas and then add it up? Why not a direct calculation?"*
ST1	:	*"Because it will be easier to see the results of the reduction"*
P	:	*"After getting the answer, did you check the results of your work again? How to do it?*
ST1	:	*"Yes, I have read what the problem is.*

Based on the results of the description test in Figure 3 and the semi-structured interview, the first high category subject (ST1) already understood the information well. The subject can already write down the initial balance until depositing the money back in an orderly and precise manner, as well as write down what is asked clearly in the "known" and "asked" sections. ST1 plans a settlement with the right number operation, this strategy is right to use for balance transaction problems. The steps of the sequence of operations are correct and systematic. The subject did not write down the stage of re-checking the results or re-verifying the calculation or conclusion of sentences such as "So Dimas' final balance is 350,000.

The following test results and interviews with one of the subjects who have high Keuda ST2 abilities are shown in the following Figure 4.



4a 4b

Figure 4. Results of High Subject Work 2 (ST2)

Based on Figure 4a of the ST2 description test results and Figure 4b is the final result of ST2 to strengthen the validation of the findings, the diats image is complemented by semi-structured interview results.

P	:	*"What integer concept or operation will you use (addition, subtraction, multiplication, or division)? Why choose that?*
ST1	:	*"Because there is a sentence of withdrawing money and depositing money"*
P	:	*"Why do you have to reduce the balance in the mas and then add it up? Why not a direct calculation?"*
ST1	:	*"Because it will be easier to see the results of the reduction"*
P	:	*"After getting the answer, did you check the results of your work again? How to do it?*
ST1	:	*"Yes, I have read what the problem is."*

Based on Figure 4. The results of the second ST2 high-ability subject description test and the semi-structured interview in the first stage were met. ST2 writes down what is known and asked completely and clearly. ST2 arranged the planned operation, which was to reduce the initial balance first and then add up. ST2 performs systematic and sequential calculations. However, in the final result, the subject only writes the caption "Final balance" does not appear

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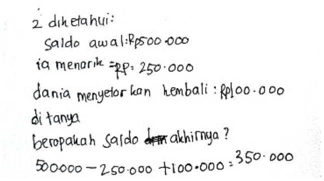
https://doi.org/10.51574/kognitif.v6i3.5645 Volume 6, No 3, July - September 2026, pp. 1221 –1241

explicitly. ST2 has written the final statement regarding the last balance but it is not clear because there is no written re-verification process

The results of the Mathematical Problem-Solving Ability Test Category and the semi-structured interviews that have been conducted show that ST1 and ST2 have a similar answer pattern, at the stage of drawing up the plan, ST1 and ST2 choose the subtraction and addition operations based on the keywords "interesting" and "deposit" in the question. At the stage of implementing the plan, the subject chooses to complete it gradually with the reason that it is easier to see the results of the calculation. At the re-examination stage, ST1 and ST2 admitted to checking by re-reading the questions to ensure the suitability of the answers to the problems asked. The phenomenon that occurs in ST1 and ST2 in answering questions is that they tend to write the final result without an explicit written reverification process.

Medium Ability Subject

Based on the results of the students' scores on the problem-solving ability test. The results of the students' Mathematical Problem-Solving Ability Test Category showed that there were 5 students who had problem-solving skills in the medium category with varying scores. The first medium subject was selected based on the subject being able to meet the first stage well, but in the second and third stages SS1 was less explicit in developing a strategy The following test results and interviews with one of the subjects who had moderate SS1 ability are shown in the Figure 5.


2 diketahui:
saldo awal: Rp500.000
ia menarik = Rp. 250.000
dania menyetorkan kembali : Rp100.000
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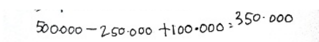
500000 − 250.000 + 100.000 = 350.000


500000 − 250.000 + 100.000 = 350.000

5a 5b

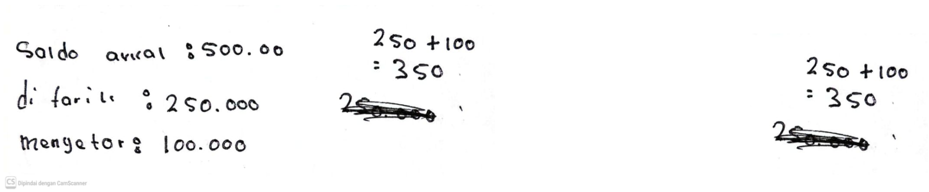
Figure 5. Results of the Medium Ability Subject Description Test. (SS_1)

Based on Figure 5a of the SS1 description test results and Figure 5b of the final results of SS1 to strengthen the validation of the findings, the diats image is complemented by semi-structured interview results.

P : *"What do you understand from this?"*
SS1 : *"Balance of Accounts"*
P : *"What information did you get from the question?"*
SS1 : *"I know the initial balance of the dimas"*
P : *"Why did you write down the completion steps directly?"*
SS1 : *"I think the calculation is still easy so I wrote it down right away"*
P : *"Did you double-check your answers?*
SS1 : *"No, because I already understand the problem"*

Based on the results of the description test in Figure 5 and the semi-structured interview, the subject with the medium category can already understand the problem and the information is well marked SS1 can write down what is known and asked. SS1 has correctly arranged addition and subtraction operations even though the strategies used are shorter than ST1 and ST2. The subject does not write down the stage of re-verification of the calculation or the conclusion of the sentence. SS1 writes a short strategy plan and does not write the final conclusions of the results obtained by the subject. At the stage of preparing a plan, the subject admitted that he did not write an explicit solution plan because he thought the problem was easy, so he immediately wrote down the solution steps. At the re-examination stage, the subject openly stated that he did not double-check his answer because he felt that he already understood the question.

The second medium subject was selected based on the subject being able to fulfill the first stage well, but in the second and third stages SS2 was less explicit in strategizing and there was no stage of re-examining the solution. The following test results and interviews with one of the subjects who have SS2 ability are shown in the following picture.



6a 6b

Figure 6. Results of the Subject Description Test for Medium Ability (SS2)

Based on Figure 6a is the result of the SS2 description test and Figure 6b is the final result of SS2 to strengthen the validity of the findings, the figure above is complemented by the results of the semi-structured interview as follows.

P : *"What do you understand from this?"*
SS2 : *"Balance of Your Own Account"*
P : *"What information did you get from the question?"*
SS2 : *"I know the initial balance is dimas"*
P : *"Why did you write down the completion steps directly?"*
SS2 : *"I think the calculation is still easy so I wrote it down right away"*
P : *"Why is there a scribble in the results section of your answer sheet?"*
SS2 : *"Because there was a calculation error"*
P : *"Did you double-check your answers?*
SS2 : *"Yes."*

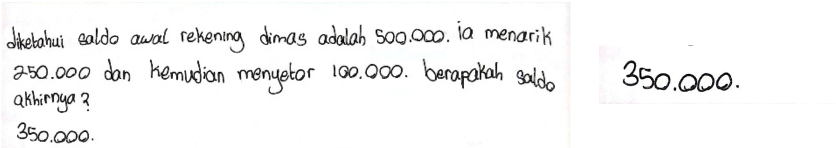
Based on the images and semi-structured interviews above, it can be seen that SS2 only writes down the information that is known, but does not write the "asked" part, so it does not appear explicit how the subject understands what the question is actually asking for. There is no explanation of the order of the completion plan written before the calculation, SS2 jumps straight to "250 + 100=350" with no clear conclusion or final confirmation sentence. SS2 is not clear in developing a completion strategy, as well as the presence of scribbles on the answer sheet that indicate confusion in obtaining results. SS2 subjects also did not write down the conclusions of the results found.

SS2 subjects show a pattern almost similar to SS1. At the stage of understanding the problem, the subject only explains the information in general and incomplete (the "initial balance of the dimas"), without mentioning the details of the withdrawal and deposit process. At the stage of preparing a plan, the subject admitted that he did not write an explicit solution plan because he thought the problem was easy so he immediately wrote down the completion steps. At the stage of implementing the plan, it was found that the subject had experienced a mistake in calculating, which can be seen from the scribbling on the answer sheet and confirmed directly by the subject during the interview.

The third medium subject selected based on SS3 did not write down the strategy design used in answering the questions and did not show any re-examination stages. However, the

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i3.5645 Volume 6, No 3, July - September 2026, pp. 1221 –1241

subject can write down what information and problems are in the question. The following test results and interviews with one of the subjects who had the first high ability of SS3 are shown in the following Figure 7.



7a 7b

Figure 7. Results of the Medium Ability Subject Description Test (SS3)

Based on Figure 7a is the result of SS3 description test and Figure 7b is the final result obtained by SS3 to strengthen the validity of the findings, the image above is complemented by the results of the semi-structured interview as follows.

P : *"What do you understand from this?"*
SS3 : *"Balance of the Account"*
P : *"What information did you get from the question?"*
SS3 : *"I know the initial balance of the dimas"*
P : *"Why didn't you write down the steps to solve it?"*
SS3 : *"I use direct stacking, so I don't write it on the answer sheet"*
P : *"Are you sure that the results you obtained are correct??"*
SS3 : *"Yes I am sure"*
P : *"Did you double-check your answers?*
SS3 :*"No"*

Based on the images and semi-structured interviews above, it shows that SS3 has been able to correct the information in the question. However, the subject writes it down in the form of a narrative like a question. SS3 doesn't appear to have written down the strategy plan used but SS3 got the results right. In addition, SS3 does not write a conclusion as an affirmation of the final result obtained. Based on the image above, it can be seen that the subject does not write down the strategy design used until the final result is obtained. SS3 does not write a conclusion at the end as the re-examination stage. SS3 can understand the information in the problem, SS3 does not list the strategy used because SS3 uses direct calculations so that the subject only writes down the answer. The subject admitted that he did not verify the results at all.

The results of the Mathematical Problem-Solving Ability Test Category and the semi-structured interviews that have been conducted show that the three subjects with moderate ability show quite similar patterns in solving problems. The problem understanding stages, SS1, SS2, and SS3 can only explain the general understanding of "Dimas account balance" and mention one piece of information (initial balance). SS2 doesn't even write the "asked" part on the answer sheet. In the planning phase, the three did not record the solution strategy in writing for the same reason, namely considering the problem easy (SS1, SS2) or getting used to calculating directly and making sequences without the need to write it down (SS3). At the time of the execution of the plan, SS1 and SS2 got the right final result without any problems, while SS2 suffered from the calculation errors that were visible from the notes on the answer sheet and acknowledged directly in the interview, before finally being corrected. In the re-examination phase, SS1 and SS3 expressly stated that they did not re-verify because they felt that they understood or were sure of their answers, while SS2 admitted that they had re-checked but this step was more reactive due to the mistakes that had occurred, The three subjects also did not include a conclusion sentence as an affirmation of the final result.

Low Ability Subjects

Based on the results of the students' scores on the problem-solving ability test. The results of the students' Mathematical Problem-Solving Ability Test Category showed that there were 10 students who had low problem-solving skills with varying scores. SR1 was chosen based on SR1 did not write down what information and problems were, SR1 wrote a different strategy design, but the use was still wrong. The following test results and interviews with one of the subjects who had the first low ability of SR1 are shown in the following Figure 8.

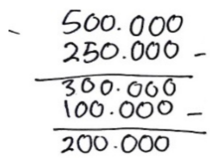


Figure 8. Results of the First Low Category Subject Description Test (SR1)

Based on Figure 8 to strengthen the validity of the findings, the image above is complemented by the results of the semi-structured interview as follows.

P	: *"What information do you know about the matter?"*
SR1	: *"About the money"*
P	: *"Do you have trouble understanding the problem?"*
SR1	: *"Yes, I have trouble understanding the words deposit and withdraw"*
P	: *"What do you think of when you say deposit and withdraw"*
SR1	: *"Reducing the amount of money"*
P	: *" Did you check your answers again after you finished your work?"*
SR1	:*"No"*
P	: *"Why do you use stack down?"*
SR1	: *"Because I don't know what to write on my answer sheet"*

Based on the images and semi-structured interviews above, it shows that the first low-ability subject did not write down what was known and asked, the subject wrote the strategy design in the form of stacking downwards however, the writing was not correct, the strategy design used addition and subtraction but SR1 solved the problem by using the entire subtraction operation, so that the subject got an inappropriate answer. SR1 did not write any conclusions and did not indicate any re-examination because the results found were consistently wrong until the end. The failure of SR1 does not lie in the ability to calculate, but in the ability to represent the distinction between the meaning of "deposit" which means to increase and "attract" which means to decrease. This low ability is carried from the stage of understanding the problem, then continuing to the stage of making a plan, until finally ignoring the stage of re-examination.

SR2 is chosen based on the stages of solving the subject who only writes answers, this is the main problem of what causes are experienced so that the subject is weak in each stage of polya in the question that is still categorized as medium The following are the results of the test questions and interviews with one of the subjects who have low ability both SR2 is shown in the following Figure 9.

https://doi.org/10.51574/kognitif.v6i3.5645 Volume 6, No 3, July - September 2026, pp. 1221 –1241

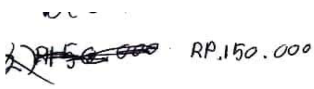


Figure 9. Results of the Low Ability Subject Description Test (SR2)

Based on Figure 9 to strengthen the validity of the findings, the image above is complemented by the results of the semi-structured interviews as follows.

P : *"What do you understand from the question given?"*
SR2 : *"The question about the balance of the dimas account"*
P : *"What do you think we should look for in this matter?"*
SR2 : *"money is in the market now"*
P : "*After knowing the information in the question, what are your next steps?"*
SR2 : "*I'm just trying to count"*
P : "*Where did you get this number 150?*
SR2 : "*I just guessed"*
P : " *Did you check your answers again after you finished your work?"*
SR2 :*"No"*
P : "*Why did you write the answer right away?"*
SS2 : "*I'm confused about what to write it like"*

Based on the results of tests and semi-structured interviews showing that SR2 fails at almost all stages of polya, SR2 says that subjects only guess answers, absence of strategy, low on representation comprehension, and lack of verification result in incorrect final answers. The results of the Mathematical Problem-Solving Ability Test Category and the semi-structured interviews that have been conducted show that the two low-ability subjects show failure at almost all stages of polya, but with different root causes. SR1 failure stems from a misconception of the understanding of the terms deposit and withdrawal, so that being able to calculate and strategize the end result is still wrong. SR2 is that the whole subject does not have a strategy or understanding of representation. Both subjects did not do the re-examination stage, so that mistakes occurred due to misconceptions and the absence of strategies were never corrected until the final answer.

Discussion

These findings show that students in the high category are able to meet all three stages of polya with the NCTM indicator in solving integer operation problems. This is because students in the high category have the ability to understand the problem more deeply so that they can identify relevant information before developing a solution strategy, in addition, subjects with high abilities write a fairly comprehensive strategy design. However, in this study, subjects with high ability did not perform the last stage of polya, i.e. reexamination. The reason why the subjects did not do the re-examination stage was supported by in-depth interview data with both high-ability subjects stating that the re-examination stage was missed was because the subjects felt that it was enough to just re-examine the questions and the calculation was still easy so there was no need to write explicit conclusions. Problem-solving skills are very important because they make students able to solve every problem that exists (Lasdianto et al., 2023). This condition is in line with the view (Aini & Rosyidi, 2023) which states that in the statistical material problem-solving ability test, subjects with high abilities are able to understand problems well but experience problems during the reexamination stage. These findings are also in line with a study Usman et al. (2022) on testing problem-solving abilities on SPLTV material from high-ability subjects who did not experience obstacles in performing the three stages of polya. However, the subject did not perform the last stage, i.e. re-examination because the subject was satisfied with the final result without re-analyzing the results that had been obtained. In this study, high-category subjects did not undergo a reexamination stage because they felt it was enough to understand the question and get the correct answer.

Students with moderate ability levels tend to be able to meet several stages of polya with the NCTM indicators, especially at the stage of understanding the problem and strategizing, but have difficulty at the stage of solving problems and reviewing solutions. This condition is caused by students in the middle category who are not yet fully accustomed to reflecting on the results of their work, so that small errors in calculations are often not detected, through in-depth interviews that have been conducted with the three subjects of medium ability it can be found that the subject with medium ability has the same answers as the subjects of high ability stating that the subject feels sufficient just by re-examining the questions and The calculation is still easy so it does not require writing an explicit conclusion. Sagita et al. (2023) stated that students' weaknesses in reviewing the questions that have been discussed are weak. This is in line with research Sasih et al. (2022) which states that students with a test of problem-solving skills in fractional material are said to be in the intermediate category if they have met several indicators. The study stated that subjects experienced weakness in executing the plan that had been prepared and re-examined because the subjects often had miscalculations and the subjects would run out of time if they checked the answers again. Pertiwi et al. (2022) This study involved students with moderate category problem-solving skills where students were able to meet two indicators of problem-solving ability. However, this is still weak at the stage of implementing the plan and reviewing the solution, the subject has been able to implement the plan but is not yet complete and the results obtained are not correct.

The two low-level subjects in this study showed difficulty in almost all stages of polya with the NCTM indicator, especially at the stage of understanding the problem and developing a solution plan. This difficulty is caused by a weak understanding of the basic concepts of integer operations, such as the rules of signs in addition and subtraction, which makes it difficult for students to represent the problem into proper mathematical forms. In-depth interviews conducted with both low-ability subjects supported the state of the test results they wrote, the subjects were hesitant in answering what they found in the questions that had been presented, the low-ability subjects still had difficulty in devising a solution strategy so that the subjects made a complete mistake in doing the test. Salsabila & Kurniati (2022) stated that problem-solving skills are a very important component and are basic skills in mathematics learning in order to improve learning. These findings are in line with research Hadi & Sari (2024) that students with low-category math problem solving were unable to formulate the appropriate sequence of solving operations and failed to answer and analyze the results. Students who are unable to express mathematical problems in daily life into mathematical language, this can be seen in students' inappropriate answers (Hakim, 2019). This research makes a new contribution by specifically looking for the causes of the difficulty through in-depth analysis, which confirms that misunderstandings about the rules of numerical operation are at the root of the main problem.

Based on the analysis in the study, there is a difference, namely subjects with high problem-solving skills and are able to identify information that is known and asked appropriately from the beginning. Low-ability subjects also show an understanding of the problem, but this understanding is superficial and has not been followed by the ability to relate it to the solution strategy. The strategy design stage of high-ability subjects can write strategies that are used sequentially, while medium abilities tend to formulate strategies more concisely. Low-ability subjects experience errors in devising solution strategies. High and medium ability subjects are able to implement the strategies that have been prepared and obtain the appropriate

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i3.5645 Volume 6, No 3, July - September 2026, pp. 1221 –1241

final results. Low-ability subjects, as a result of a strategy error at the previous stage, obtain a final result that is not as it should be. The last stage, which is to re-examine the three subjects, shows weaknesses at this stage, the subjects are high and are not writing conclusions by saying that they are enough to just examine the problem without explicitly writing conclusions. The two low-ability subjects did not write a conclusion at the end because the low-ability subjects in this study still needed a deep understanding of problem-solving skills.

These findings show that high mathematical ability is able to meet all three stages of polya with the NCTM indicator where the subject can identify information, develop the right strategy, can solve problems systematically according to the NCTM problem solving indicator, the subject is able to identify information, formulate a strategy that is quite simple but get the appropriate final result, both subjects are still lacking in explaining the suitability of the results with initial problems and interpret the solution mathematically such as the NCTM indicator according to (Mauleto, 2019). Based on these findings, the implications for mathematics learning are the need to strengthen problem-solving learning that does not only stop at finding solutions, but also instills reflective habits through the re-examination stage. The fact that high- and moderately capable subjects are still weak at this stage shows that the learning process so far tends to emphasize how students get answers, but it does not habituate students to re-evaluate the truthfulness, fairness, and consistency of the answers obtained. Teachers need to explicitly teach verification strategies, such as by redistributing the results to the initial question, comparing them with rough estimates, or asking students to explain why the answer makes sense, so that the re-examination stage of polya problem-solving skills is not seen as an optional step but an integral part of the problem-solving process. Meanwhile, the differences in strategy design stages between high-ability subjects are more subtle and clear and medium-capable subjects that are less systematic, as well as overall weaknesses in low-ability subjects at all stages of polya, indicating the need for differentiated learning according to students' ability levels.

Conclusion

Based on the results of research and discussion on the analysis of class VII problem-solving ability using the polya stage with the NCTM indicator in completing the description test on integer material, there are differences in the category of problem-solving ability. Subjects in the high ability category are able to understand problems, design strategies in a coherent manner, implement plans well, and meet the NCTM indicators in these three stages. However, the subjects of high ability still showed weaknesses at the re-examination stage, so that the polya stages and NCTM indicators related to verification and evaluation of results have not been fully fulfilled. The medium category subjects showed the same pattern as the high-ability subjects, namely being able to do the three stages of understanding the problem, designing a strategy even though the strategy used was less clear and less coherent, implementing the plan according to the NCTM indicators, the category subjects were experiencing weakness at the re-examination stage which indicated that the answer verification process had not become a consistent habit carried out by the five subjects in the high and medium categories. Meanwhile, subjects with low ability have not fully fulfilled the four stages of polya and NCTM indicators as a whole, so that the subjects with low ability in this study are classified as the lowest compared to the other two categories. This study has limitations because it only uses 7 subjects as research subjects. The instructional implication of these findings is the need to strengthen learning at the re-examination stage for high- and moderate-capable students, for example through the habit of comparing the results with the problems found. For low-ability students, more intensive assistance is needed at all stages of problem-solving by providing guiding questions to help students build a more structured solution strategy.

Conflict of Interest

The author declares no conflict of interest.

Auhor Contributions

R.S. understands the research ideas presented and collects data. The other two authors (D.R. and R.A.) actively participate in the development of theory, methodology, organization and analysis of data, discussion of results and approval of the final version of the work. All authors declare that the final version of this paper has been read and approved. The total percentage of contributions to the conceptualization, compilation, and correction of this paper is as follows: R.S.: 60%, D.R.: 20%, and R.A.: 20%.

Data Availability Statement

The authors state that data supporting the results of this study will be provided by the relevant author, [R.S.], if reasonably requested.

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Authors Biography

	**Runinda Silviana,** Mathematics Education Student, Faculty of Teacher Training and Education, Muhammadiyah Metro University, East Metro, Lampung, Indonesia. ✉ runindasilviana9@gmail.com
	**Dwi Rahmawati,** Lecturer of Mathematics Education, Faculty of Teacher Training and Education, University of Muhammadiyah Metro, East Metro, Lampung, Indonesia. ✉ dwirahmawati@ummetro.ac.id
	**Rina Agustina,** Lecturer of Mathematics Education, Faculty of Teacher Training and Education, University of Muhammadiyah Metro, East Metro, Lampung, Indonesia. ✉ rinaagustina@ummetro.ac.id