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PROBLEM-SOLVING ON NUMERACY LITERACY PROBLEMS BASED ON POLYA'S THEORY IN TERMS OF HABITS OF MIND

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ABSTRACT

Problem-solving abilities are one of the requirements that must be owned in facing the 21st century. In order for the problem-solving ability to be owned by everyone, it needs to be developed from school age. However, in fact, students' problem-solving ability is still low, especially in solving numeracy literacy problems. In addition, to prove problem-solving ability, habits of mind are needed as an attitude that allows individuals to develop behavioral intelligence based on stimulus in the process of solving problems. This study aims to describe and analyze students' problem-solving ability in solving numeracy literacy problems based on Polya's Theory in terms of habits of mind. The research questions are: 1) How is the problem-solving ability of students who have high habits of mind? 2) How is the problem-solving ability of students who have moderate habits of mind? and 3) How is the problem-solving ability of students who have low habits of mind? The subjects of this study were 28 eighth-grade students in one of the junior high schools in Bandung City, West Java. Data collection in this study used numeracy literacy problem-solving ability tests, habits of mind questionnaires, and interview guidelines to confirm the problem-solving ability tests and habits of mind questionnaires. The analysis results showed that: 1) Students with high habits of mind have high and moderate problem-solving ability; 2) Students with medium habits of mind have high and medium problem-solving ability; and 3) Students with low habits of mind have medium and low problem-solving ability.
Keywords: problem-solving ability, habits of mind, numeracy literacy problem, Polya's Theory.

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PRELIMINARY

Education is one of the essential factors for the advancement of a country. A country is recognized by other countries because there is a role of education that makes people qualified for human resources in advancing their country. Therefore, the government, through schools as formal educational institutions, plays an important role in helping and guiding students as future generations of the nation. One of the efforts is to teach students hard-skills through subject matter, namely mathematics.

Mathematics is a science and the study of quality, structure, space, and change. According to Curriculum 2004 (Depdiknas, 2003), mathematics is a subject that has an

abstract object of study and is built through a deductive reasoning process, namely the truth of a concept obtained as a logical result of previously accepted so that the relationship between mathematical concepts is very strong and clear. Therefore, mathematics needs to be learned by students because it will be very useful for everyday life (Harahap & Hasanah, 2023), both in real life and as a language and tool in science and technology. In addition, mathematics needs to be learned by students to equip them with ways of thinking, reasoning, and logic in forming an understanding of facts, concepts, principles, operations, relationships, problems, and mathematical solutions (Kemdikbud, 2022). As stated by NCTM (2000), one of the roles of mathematics is for problem solving. Seeing the abstract nature of mathematics and mathematics as problem-solving, good problem-solving abilities are needed to understand it.

Problem-solving is important because it helps students think logically, analytically, and creatively, apply their experience and knowledge, and develop other mathematical abilities. Vula et al., (2017) said that problem-solving involves a complex cognitive process in which a problem solver must be able to use linguistic information, identify problems to be solved, identify missing information, and then make verification/arguments to prove the problem-solving strategy. Thus, those who can understand the facts and relationships in a problem completely and accurately are good problem solvers (Nguyen et al., 2023). Meanwhile, those who often fail to realize the importance of reading and understanding the information given correctly are poor problem solvers because they fail to solve problems (Whimbey et al., 2013). Therefore, students must have problem-solving abilities to be able to deal with the complexity of the tasks given.

Despite the importance of problem-solving abilities, Indonesian students still have a relatively low ability to find solutions to the problems they face. The low problem-solving ability of Indonesian students in the PISA event made Indonesia ranked 74th out of 79 countries in 2018 (OECD, 2019) and ranked 69th out of 80 countries in 2022 (OECD, 2023). As it is known that the questions in PISA are indirectly related to problem-solving, the low mathematical problem-solving ability will result in the low-quality of human resources (Indriana & Maryati, 2021). On the other hand, (Yusri, 2018) said that problem solving is still considered as one of the difficult activities in mathematics, although this activity is important, in reality, at school, there are still many students who are unable to solve problems. Students' failure to solve math problems will have an impact on their mathematics abilities, which are very important for student development (Ismiranda et al., 2024). This is because the learning has not provided opportunities for students to develop

their ability to solve problems (Cahyani & Setyawati, 2016). Thus, to facilitate students in finding solutions, a process with steps or stages of solving problems is needed, one of which is Polya's steps or stages.

Polya identified four stages in problem solving, namely understanding the problem, developing a plan, implementing the plan, and looking back (Polya, 1985). Understanding the problem is the first stage. Without understanding the given problem, students are unlikely to be able to solve the problem correctly. Once students can understand the problem correctly, they can devise a problem-solving strategy. Their ability to devise these strategies is highly dependent on their expertise in solving problems. The more experience students have in solving problems, the more likely students are to innovate to develop ideas or plans on solving problems. If the problem-solving strategy has been developed, it will be easy to carry out problem solving. The fourth stage is to look back at what has been done. By doing these four stages, errors can be minimized until the most appropriate solution is found (Samosir & Dasari, 2022). According to Lasak (2017), Polya's stages have a positive effect on problem-solving abilities, meaning that Polya's stages can improve students' mathematical problem-solving abilities.

Problem solving abilities must be owned by every student to solve problems in learning, including numeracy literacy problems. The problems presented in numeracy literacy are related to the context of real situations that are relevant to the daily lives of individuals. Wolf & McCoy (2019) said that numeracy literacy is a depiction of social development and conditions that affect daily life. Numeracy literacy is very close to life activities, especially for career success (Hall & Zmood, 2019) which is in line with 21st century competencies (Harahap, in Hakim et al., 2023). Individual awareness of the usefulness of numeracy literacy is the initial capital needed to develop numeracy literacy. For this reason, students need to be introduced and accustomed to solving problems in the learning process. If students are continuously given various problems, then they will be able to persist in solving whatever the problem is. This positive habit of problem-solving is called habit of mind.

Habits of mind are one of the affective aspects that contribute to students' mathematics learning ability. Habits of mind are attitudes that allow individuals to develop behavioral intelligence based on stimuli in the thinking process to solve problems. As revealed by Dwirahayu et al., (2018) that habits of mind behaviors such as persistence and metacognition (thinking what you think), have developed well in mathematics learning

without the teacher realizing it. In other words, students' success and habits in solving problems will have an impact on their habits of mind.

Based on this description, this study aims to describe and analyze the problem-solving ability of eighth-grade students in solving numeracy literacy problems in terms of habits of mind. In this study, the researcher made three research questions. The first research question is, how is the problem-solving ability of students who have high habits of mind? The second research question is, how is the problem-solving ability of students who have moderate habits of mind? The third research question is, how is the problem-solving ability of students who have low habits of mind?

METHODS

This research uses a qualitative approach with a case study design that aims to describe and analyze students' problem-solving ability on numeracy literacy problems based on Polya's theory in terms of habits of mind. The subjects were eighth-grade students in one of the public junior high schools in Bandung City, Province of Jawa Barat, totaling 28 students. The selection of respondents was based on the habit of mind questionnaire, which is categorized as high, medium, and low categories. In this study, nine subjects were selected based on the category of habits of mind and students' problem-solving answers to numeracy literacy questions for interviews, ensuring the results followed the research objectives (Hardani et al., 2020).

Table 1. Below Present About The Subject Information

Subject Code	Gender
S1	Girl
S2	Girl
S3	Girl
S4	Boy
S5	Girl
S6	Girl
S7	Boy
S8	Boy
S9	Boy

Data was collected through numeracy literacy problem-solving tests, habits of mind questionnaires, and interview. The problem-solving test consisted of three problems about the system of two-variable linear equations. Each problem was measured based on Polya's problem-solving steps, namely understanding the problem, devising a plan, carrying out the plan, and looking back. The habits of mind questionnaires consist of 32 statements with

four response options, namely strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS). The habits of mind indicators used totaled 16 indicators (Costa & Kallick, 2012). The interview consisted of two types of guidelines, namely interview guidelines to confirm the problem-solving ability test and interview guidelines to confirm the habits of mind questionnaire.

The test instrument and questionnaire were validated by the supervisor and readability test was conducted with students. The instrument readability test was conducted by focus group discussion (FGD) to three students with different levels of mathematical ability. The results of the questionnaire instrument readability test given to students had no revisions. Students are able to understand the contents of the statements in the questionnaire. The results of the readability test of the question test instrument have been revised in question number 2, that is, the information in the question is made into two paragraphs. Because students know the information more clearly than being made into one paragraph.

After students are given the questions and questionnaire, data collection is carried out to assess student answer results based on problem-solving indicators. The test data was also used during interviews with the subjects to collect more in-depth information about problem-solving ability. Then, the data was analyzed in three stages: data reduction, data presentation, and conclusion/verification.

RESULT AND DISCUSSION

From the 28 students who had taken the test and questionnaire, nine subjects were selected for further research and interviews. The results of the problem-solving ability test on the selected subjects are presented in Table 2.

Table 2. Test Results of Subject Problem-Solving Ability

Subject Code	Problem-solving
S1	High
S2	High
S3	Medium
S4	High
S5	Medium
S6	Medium
S7	Medium
S8	Low
S9	Low

Based on Table 2, the nine students selected are three students with high-category problem-solving abilities, four students with medium-category problem-solving abilities, and two students with low-category problem-solving abilities. Table 3 presents the results of the habits of mind questionnaire on the selected subjects.

Table 3. Questionnaire Results of Subject Habits of Mind

Subject Code	Habits of Mind
S1	High
S2	High
S3	High
S4	Medium
S5	Medium
S6	Medium
S7	Low
S8	Low
S9	Low

Table 3 shows that of the nine students selected, there are 4 students with high habits of mind category, 3 students with medium habits of mind category, and 3 students with low habits of mind category. The following is also presented in Table 4 excerpts of interview results with some of the selected subjects.

Table 4. Excerpts of Interview Results with Subject

Researcher	Subject S1	Subject S4	Subject S5	Subject S8
What do you do if you encounter difficulties in working on problems like this?	"I'll ask the teacher."	"I try to calculate it again, or look for the formula first in a math book or on the internet. If I can't find it, I ask my friends. But sometimes friends don't know either. So I look for it myself."	"I still do it, but I ask my friends."	"I will ask my friend or ask the teacher."

Table 4 above shows the interviews of several subjects regarding the methods used if they encountered difficulties with the problems given. Subject S1, who has high habits of mind, will ask the teacher if he encounters difficulties. Subjects S4 and S5, who have moderate habits of mind, will try to find it themselves but ask a friend if they encounter difficulties. Subject S8, who has low habits of mind, will ask his friend or teacher if he has difficulty solving the problem.

The following presents the results of the analysis of the answers of nine subjects, with the questions given as follows.

Question no. 1

In Cimaung, there is a chicken and duck farm built by Mr. Anton. The farm is managed by his son, Indra. Every month, Indra sells his animals at the market. Last month, Indra sold 50 chickens and 30 ducks for a total of Rp2,700,000. This month, Indra earned Rp2,000,000 from the sale of 20 chickens and 35 ducks. Based on the two months' sales, what is the price of a chicken and a duck?

1. **Problem-solving ability of students with high habits of mind category**

For this problem, students fulfill all four problem-solving indicators on the easy-level numeracy literacy test. The analysis results show that S1, S2, and S3 can understand the information in the problem (understanding the problem), they can write down the mathematical model even though there are errors in defining variables and do not compile the written solution steps that they will use in implementing the plan (devising a plan) as shown in Figure 1, students can solve the problem with the right process (carrying out the plan), and students can provide conclusions from the solution results and only read the solution by re-reading at the answer sheet (looking back). One of the mistakes found in one of the students is that S2 did not write completely the known information (understanding the problem), as shown in Figure 1. When the researcher asked about this, S2 said that she forgot to write, could recognize her mistakes, and could give the other known information. Furthermore, during the interview, all three revealed that they tried to persevere in solving this problem even though it took time to read and were careful in understanding the problem.

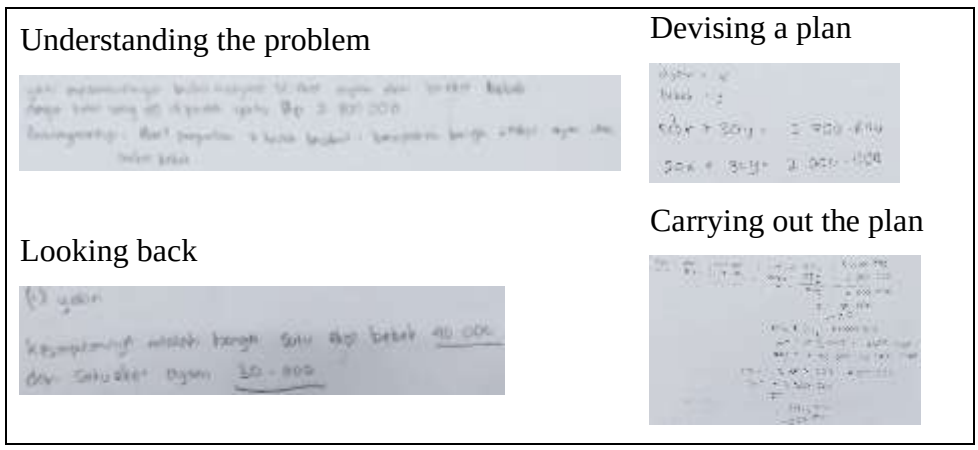

Figure 1. S2's answer

2. Problem-solving ability of students with medium habits of mind category

For this problem, students fulfill all four problem-solving indicators on the easy-level numeracy literacy test. The analysis results show that S5 and S6 can understand the information in the problem (understanding the problem), they can write down the mathematical model even though there are errors in defining variables and do not write the solution steps that they will use in implementing the plan (devising a plan), students can solve the problem with the right process (carrying out the plan), and students can provide conclusions from the solution results and only read the solution by re-reading at the answer sheet (looking back). At the step of understanding the problem and the step of carrying out the plan, S4 is the same as S5 and S6, but S4 can write a solution plan (devising a plan), and provide proof of the answer results (looking back) as done by subject S4 in Figure 2. When interviewed, S4 was able to explain the solution steps he used well and the proof of the answer results he obtained, and S5 and S6 were able to explain the solution methods they used.

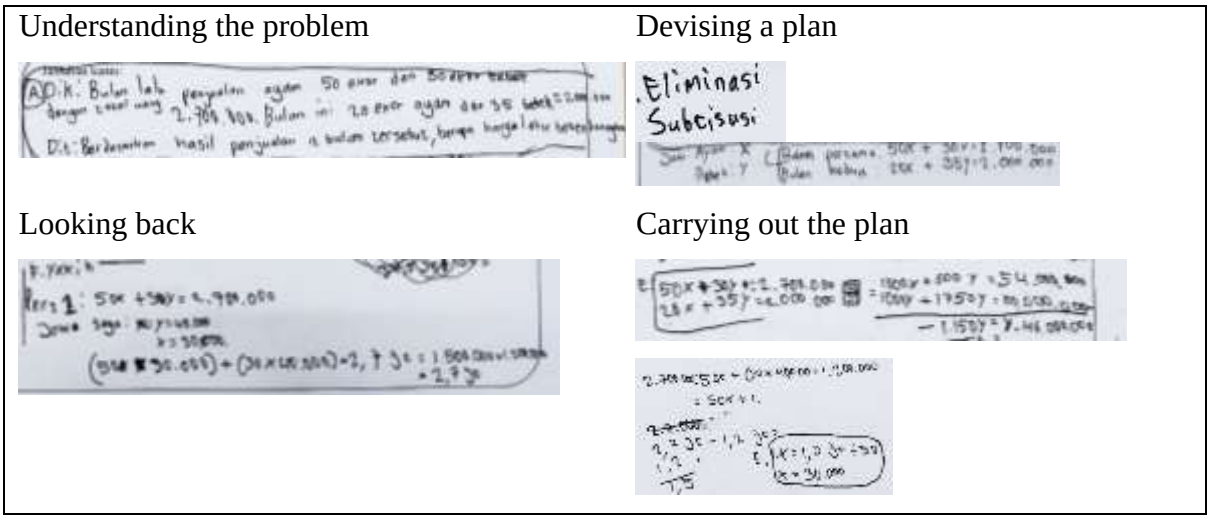

Figure 2. S4's answer

3. Problem-solving ability of students with low habits of mind category

For this problem, students fulfill two problem-solving indicators on the easy-level numeracy literacy test. The analysis results show that S7 and S8 can understand the information in the problem (understanding the problem) and they can write down the mathematical model even though there are errors in defining variables and do not write the solution steps that they will use in implementing the plan (devising a plan), while the next two stages can only be fulfilled by S7 like he can solve the problem with the right process (carrying out the plan), and he can provide conclusions from the solution results (looking

back). S9 also fulfilled the two first indicators of problem-solving, but on the indicator of understanding the problem, he wrote down all the information in the problem without simplifying first, as shown in Figure 3, even though he knew the difference between the known information and the asked information. In addition, S9's mistakes were not defining variables, and there were errors in making mathematical models (devising a plan). When interviewed, S8 and S9 said that they still did not know how to solve it and gave up on working on it.

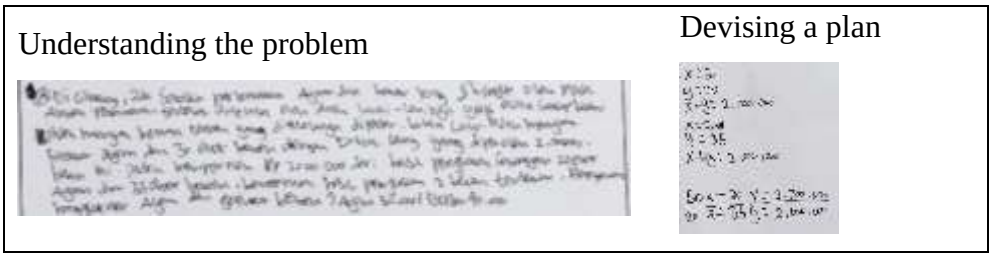

Figure 3. S9's answer

Question no. 2

Umar, his father, mother, and brother were going to attend his brother's wedding in Cimahi. They chose travel as the mode of transportation to take them from their home in Jatinangor to the Cimahi pool. Arriving at the Cimahi pool, they went to the wedding location using angkot. The total fare spent on the trip was Rp140,000.

After attending their brother's wedding, they returned to the pool using angkot. At the Cimahi pool, they met a neighbor who was also returning to Jatinangor. Umar's family had a good relationship with the neighbor, so Umar's family paid the travel fare. The total fare spent on the return trip was Rp170,000. Based on this information, suppose you will be asked to calculate the cost of each person's travel fare and angkot fare.

1. **Problem-solving ability of students with high habits of mind category**

For this problem, students fulfill all four problem-solving indicators on the moderate-level numeracy literacy test. The analysis results show that S1, S2, and S3 can understand the information in the problem and can communicate information (understanding the problem), students can make mathematical models even though there are errors in defining variables and do not write the solution method that will be used in the next plan (devising a plan) as shown in Figure 4, student can solve the problem correctly (carrying out the plan), and student can provide conclusions from the solution results by re-reading the solution done (looking back). One of the errors found in the results of S3's answers, as shown in Figure 4, is that S3 did not write the asked information. During the interview, S3 knew her

mistake and was able to provide the missing information. Furthermore, when interviewed, both S1, S2, and S3 said that it was quite difficult if not careful. The difficulty is in counting people to make the mathematical model.

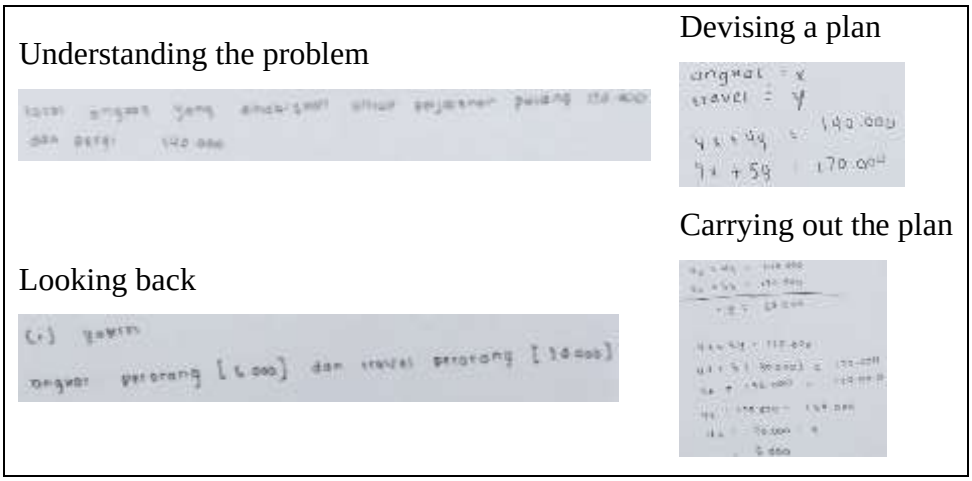

Figure 4. S3's answer

2. Problem-solving ability of students with medium habits of mind category

For this problem, only S4 fulfilled all four problem-solving indicators on the moderate-level numeracy literacy test, while S5 and S6 did not write their answers and gave blank answer sheets. The analysis results based on Figure 5 show that S4 can know the asked information correctly even though there are errors in the presentation of the information they know (understanding the problem), student can write down the solution method used and make a mathematical model even though there are still errors in defining variables (devising a plan), student can write the solution with the right calculation process (carrying out the plan), and student can draw conclusions by providing proof of the results of the solution he made (looking back). When interviewed, S4 said that this problem was the same as problem number 1, not too difficult, while S5 and S6 said that this problem was difficult and the time given to work on it was not enough.

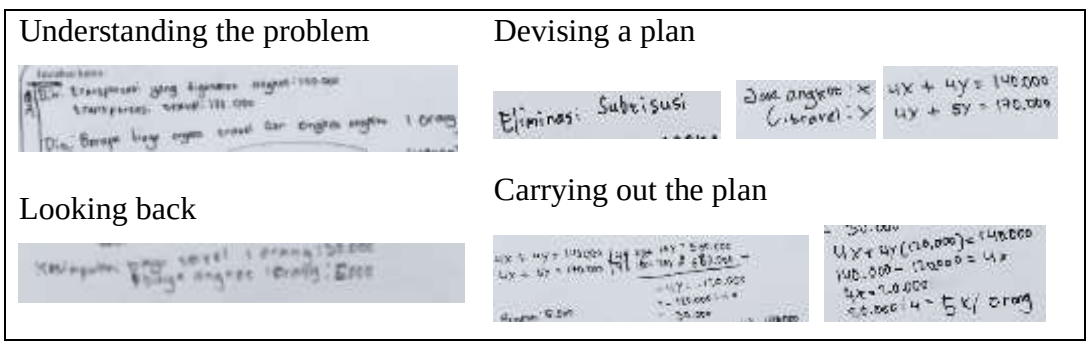

Figure 5. S4's answer

3. Problem-solving ability of students with low habits of mind category

Based on the test results, students did not fulfill the four problem-solving indicators and were unable to work on a moderate-level numeracy literacy test. S7, S8, and S9 give a blank answer sheet. When interviewed, S7 said that this problem was difficult for him because he was unable to solve problems about the cost or distance of a location. Similarly, S8 and S9 said that they also did not understand the problem and lacked time to work on it. Furthermore, S9 added that he had difficulty working on it because he was afraid of giving the wrong answer.

Question no. 3

Mr. Andre has a son named Hamid. Five years ago, Mr. Andre was three times Hamid's age. Ten years later, Mr. Andre's age is twice Hamid's age. Is it true that the sum of Mr. Andre's age and Hamid's age is 75 now?

1. Problem-solving ability of students with high habits of mind category

For this problem, students were only able to fulfill one problem-solving indicator on the hard-level numeracy literacy test. The analysis results show that S1, S2, and S3 can understand the known and questionable information (understanding the problem), and they can create variables from an object even though they are still wrong in defining variables (devising a plan), as shown in Figure 7. Some things that are not fulfilled by S1, S2 and S3 are that they are not able to make mathematical models (devising a plan), they cannot solve the problem (carrying out the plan) and they cannot make conclusions or proof (looking back). When interviewed, they said that this was the most difficult problem, it could not be solved. They also said that if one of the ages is known, then it is easy to solve.

Figure 7. S1's answer

2. Problem-solving ability of students with medium habits of mind category

For this problem, students were not able to fulfill all problem-solving indicators on the hard-level numeracy literacy test. The analysis results show that S4, S5, and S6 can understand the known and asked information correctly (understanding the problem), and they can make two object variables correctly (devising a plan) but have not been able to make the mathematical model, students try to solve the problem in other ways even though

they do not use the right SPLDV solution procedure (carrying out the plan) as shown in Figure 8, and they cannot provide conclusions or proof of solution results (looking back). When interviewed, S4, S5, and S6 said that they did not know how to solve it. Furthermore, they said that they tried to include some guesses of Mr. Andre and Hamid's ages, then solved it in their own way.

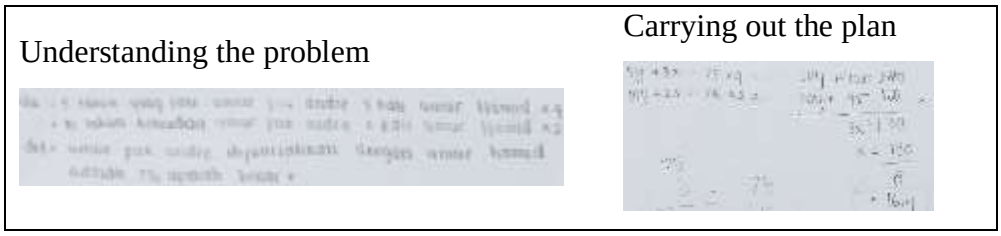

Figure 8. S5's answer

3. Problem-solving ability of student with low habits of mind category

For this problem, students were not able to fulfill four problem-solving indicators on the hard-level numeracy literacy test. The analysis results show that S7 can understand the problem. In contrast, S8 and S9 cannot understand the problem and choose to write down all the information in the problem without separating the known and asked information (understanding the problem), as shown in Figure 6. S7 and S8 can create two variables even though they are still wrong in defining the variables and not making a solution method (devising a plan), and they are not able to compile a mathematical model or the solution method used, not able to solve the problem (carrying out the plan), and cannot provide conclusions or proof of the solution results (looking back). When interviewed, S7, S8, and S9 said that this problem was difficult, so they could not solve it.

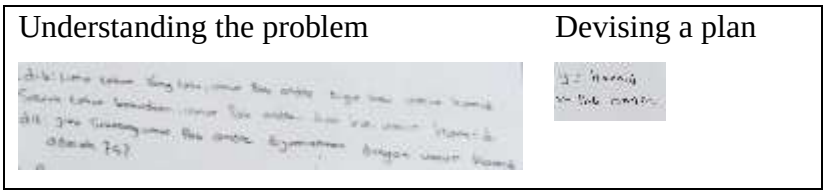

Figure 9. S8's answer

The research results obtained will be discussed by the researcher based on the Polya's theory, there are four steps of understanding the problems, devising a plan, carrying out the plan, and looking back.

The step of understanding the problem is the step where students must be able to understand the terms used in the problem, formulate what is known and what is asked, whether the information obtained is sufficient, or write the problem in a more operational form so that it is easier to solve. The problems on easy and moderate-level numeracy

literacy tests can be understood by most students, while problems on hard-level numeracy literacy tests are still difficult for students to understand. Students who can understand the problem and the meaning of a sentence, can identify the known, unknown, and the relationship between information, and know the previously learned concepts needed to solve the problem (Hung et al., 2016). In line with Simatupang, et al. (2020), students' inability to connect information will result in students not knowing the mathematical concepts that will be used to solve problems.

The step of devising a plan is the step where students look for possibilities that can occur and then compile the solution procedure. Most students did not write down the steps of the solution and they immediately solved it. Devising a plan is important to choose the right strategy to solve the problem. Students' dislike of reading long and non-routine problems are also one of the reasons students make mistakes when devising a plan (Simatupang, et al., 2020). In line with those research (Pradana & Murtiyasa, 2020; Cruz & Lapinid, 2014), carelessness, lack of understanding, value changes, and unfamiliar words are some of the common difficulties faced by students in understanding the problems.

The step of carrying out the plan is to implement the strategy that has been made with perseverance and thoroughness to get a solution. At this step, students generally make errors in calculations. When students are faced with a problem that they think is easy, students will be able to solve it. However, if faced with a difficult problem, students will try to solve it by all means, as students with high and medium habits of mind do. There are two views of students regarding difficult problems. First, he knows that the problem is difficult, so he chooses not to complicate it by not solving it (Nurmeidina et al., 2024). Second, he knows that the problem is difficult, so he chooses to try to solve it using his existing abilities. (Nurmeidina et al., 2024).

The step of looking back is to interpret the results obtained into the problem context. At this step, students check the correctness of the results of their answers (Nurmeidina et al., 2024; Pradana & Murtiyasa, 2020), but common mistakes made by students are their inability to make conclusions without linking and interpreting the final answer obtained into the problem context and providing arguments/verification.

CONCLUSION

Based on the research results and discussion on the numeracy literacy questions given, three conclusions were obtained. *First,* students with high habits of mind have high and medium-category problem-solving abilities. They are able to understand the problem,

make a mathematical model, carry out the plan, provide conclusions that are in accordance with the context of the problem, try to persist in solving difficult problems, and know the mistakes they made. *Second,* students with moderate habits of mind have high and moderate-category problem-solving abilities. Students with high problem-solving ability is able to understand the problem, devise a plan and make mathematical models, carry out the plans, provide conclusions that are in accordance with the context of the problem, and try to persist in solving difficult problems. Students with moderate problem-solving ability are able to understand the problem, make mathematical models, carry out plans, make conclusions without connecting to the context of the problem, and know the mistakes they made. *Third,* students with low habits of mind have moderate and low-category problem-solving abilities. Students with moderate problem-solving ability are able to understand the problem, make mathematical models on easy-level numeracy literacy problems, carry out the plans, and make conclusions without connecting to the context of the problem. Students with low problem-solving ability are only able to write down the known information and the asked information.

There are limitations to this study. First, the data collection process was carried out for 4 meetings. The next research can be conducted more than 4 times with the condition that the data obtained is saturated. The longer the research process, the more consistent the findings will be. Second, the numeracy literacy problems in this study are based on personal and work contexts. The next research can be given numeracy literacy about social and scientific contexts

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