Jurnal Pendidikan Matematika
https://doi.org/10.22342/jpm.v18i1.pp39-58

Junior High School Students' Habits of Mind in Solving Mathematical Problems

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Abstract

One of mathematical cognitive skills is the problem-solving ability. It is imperative for each student to have a range of abilities in order to deal with or resolve a problem. Habits of mind are abilities that can influence students' ability to solve mathematical problems. It is the aim of this study to examine junior high school students' problem-solving thinking skills. The survey method was used, as opposed to critical observation or qualitative approaches. The sample of this study consisted of 29 ninth graders of junior high school. Data collection was conducted by a test and interviews. According to the findings from the data analysis in this study, students with strong problem-solving abilities exhibited four indicators of thinking habits: persistence, thinking about thinking, thinking flexibility, and the ability to apply past knowledge to new situations. Students with average problem-solving abilities also displayed four indicators of thinking habits, but were lacking in three of them: thinking about thinking, thinking flexibility, and applying past knowledge. Students with poor problem-solving abilities, on the other hand, laked all the indicators of thinking habits.

Keywords: Analysis, Habits of Mind, Solving Mathematical Problems

How to Cite: Nauli, N., Harisman, Y., Armiati, & Yerizon. (2024). Junior high school students' habits of mind in soving mathematical problems. *Jurnal Pendidikan Matematika, 18*(1), 39-58. https://doi.org/10.22342/jpm.v18i1.pp39-58

INTRODUCTION

The process of overcoming perceived difficulties to achieve the desired results is referred to as problem-solving (Ariawan & Nufus, 2017). In the case of students, as stated by Malasari (2019) problem-solving can mean the process of one taking on challenges. Sumartini (2016), meanwhile, defined problem-solving as a process for overcoming the difficulties faced to achieve the expected goals. A problem-solving process will provide an opportunity for students to play an active role in learning, searching, and finding their own information/data to be processed into concepts, principles, or conclusions (Rahzianta & Hidayat, 2016). Students' improved ability to receive and respond to questions, will allow them to actively participate in overcoming or solving problems (Manalu, 2021). The increasing activity of students in each meeting encourages an increase in the maximum score, minimum score and average score of their mathematical abilities (Bakar et al., 2020).

Earlier studies showed that school students were unfamiliar with the design strategy and used different problem-solving methods. A mindset is a way of assessing and drawing conclusions from a certain point of view based on reasons (Septirahmah & Rizkha, 2021). A lack in this ability to assess and draw conclusions is evident when students are unable to formulate questions using a mathematical model. Students are accustomed to dealing with questions in the form of statements rather than using mathematical models. In an earlier study Sriwahyuni & Maryati (2022) found that students had low levels of mathematical abilities, especially in choosing and applying strategies to solve mathematical and non-mathematical problems, explaining, interpreting, and re-cheking their solutions to those

Received February 14, 2023; Revised May 29, 2023; Accepted January 13, 2024

problems, and applying mathematics meaningfully.

Polya explained that when students solve mathematical problems, they go through several stages, namely understanding the problems, planning their solutions, implementing problem-solving plans, and re-checking their solutions. Students need to develop the abilities to read and understand questions that are presented, in mathematical models, make calculations from story models, and complete non-routine problems (Lusiana et al., 2022).

According to the description above, it is critical to develop mathematical problem-solving abilities. However, earlier research findings showed, students' incapability to solve mathematical problems well, indicating poor problem-solving abilities. Oktaviyanthi & Agus (2019) stated that students of all levels of education encounter difficulties in learning, developing, and gaining familiarity with problem-solving. Students whose mathematical abilities have a hard time understanding problems, devising and implementing problem-solving plans, and evaluating their solutions (Hidayat et al., 2022).

Solutions to a problem do not just come out of nowhere; it requires smart thinking, to find them. According to Costa & Kallick, (2005), smart thinking or habit of mind is behavior one demontrates when confronted with a problem whose solution is not readily known. A positive mindset can be beneficial in understanding and solving real-world problems. There are four indicators of thinking considered to be related to students' mathematical problem-solving; (Costa & Kallick, 2005; Imanah et al., 2018; Maryono & Saputri, 2019), (1) persistence, which refers to students' studying hard; (2) Thinking about thinking, or metacognition, which refers to whether students are accustomed to devising strategies to generate the information required to solve problems and to describing the steps they take to solve problems; (3) Flexible thinking, which refers to wheter students are accostumed to using a variety of ways to solve the same problem; and (4) the application of prior knowledge to new situations, where students derive meaning from their experiences to deal with new situations.

The students were found to demonstrate persistence in solving problems. It takes persistence for students to solve problems (Masni, 2017; Mustaqiim, 2019; Yanti et al., 2021). It is also important that they have flexible thinking to plan and solve problems. When solving mathematical problems, students must think flexibly and come up with a variety of ideas, because it is not enough to solve problems with a single solution (Bonitasya et al., 2021; Mubarok & Kurniasari, 2019). Additionally, as stated by Maryono & Saputri (2019), problem-solving necessitates the use of previous knowledge.

Mindset influences students' beliefs about their capacities and abilities, includeding their academic strategies and achievements at school (Rohmah et al., 2021). Task formulation that uses mathematical models and the application of mathematical concepts, procedures, and facts necessitate careful problem-solving, flexible thinking, and the application of prior knowledge. These are referred to as habits of mind (Malasari, 2019; Muchtar & Suryani, 2019).

Problem-solving is influenced by habits of mind (Qadarsih, 2017). A habit of mind plays an important role in the development of individuals' ability to solve problems (Aringga et al., 2020). Dwirahayu et al. (2018) posited that a person's habits of mind will determine his success, including in

studying mathematics at school. Huda (2016) added that students' habits of thinking together with other people are important for improving their quality of learning. These habits become prominent when students refuse to give up on thinking when faced with a problem and developing strategies to solve it. It can be concluded that mindset is the way of students dealing with a problem whose solution is not easily found, which necessitates smart thinking in problem-solving. Habits of mind are developed through discipline to the extent that and individual acquires the ability to take wiser and smarter actions. All course of action taken by an individual is the result of their habits of thinking.

To stimulate and train students' thingking abilities in learning mathematics, teachers need to use appropriate teaching methods or techniques that can stimulate students to use all their thinking potential (Yani et al., 2016). Masni (2017) has found that there is a link between mathematical problem-solving abilities and mathematical thinking abilities. Nurmala et al. (2018) similarly discovered that mindset influences student problems-solving abilities. Habits of mind have an important role in solving problems. As stated by Costa & Kallick (2005) students who have the habit of never giving up thinking will try to develop strategies to solve the problem at hand.

Masni (2017) figured that the relationship between mathematical problem-solving abilities and mathematical habits of mind in students was in a fairly high category (24.80%). Yandari et al., (2019) also found problem-solving abilities as significantly affecting mathematical problem-solving abilities, (67.40%). Aziz (2022) discovered that habits of mind affected students' mathematical problem-solving abilities with an effect size of 21.7%, while 78.3% of the effect originated from other factors not measured in his research. Questioning and posing problems were the strongest habit of mind with an effect of 20.62%, while applying past knowledge to new situations was the weakest with an effect of 1.32%.

In the light of the description above, researchers took an interest in studying the influence of habits of mind on students' mathematical problem-solving abilities, and to what extent based on test results and interviews.

METHODS

The survey method was applied in this study to obtain information about a specific topic and field. The information collected was processed and interpreted before decisions were made. Students' ability to solve mathematical problems was measured following Polya (2004). The criteria for evaluating each problem-solving area are shown in Table 1:

Table 1. Problem-solving scoring guidelines according to Polya (2004)

Rated aspect	Score	Description
Understanding the problem	0	Misunderstand the problem completely
	1	Some of the questions are misinterpreted, and some of the wording of the questions is omitted
	2	Understand the issue as a whole
Devising a problem-solving plan	0	Make no plan at all or make an unrelated plan
	1	Create an impracticable problem-solving strategy
	2	Make an appropriate plan but produce wrong result or no result
	3	Make a plan in accordance with applicable procedures that lead to the best solution
	4	Make a plan in accodance with applicable procedures that leads to the right solution
Planning/Calculating	0	No calculations
	1	Perform a correct operation and provide a correct answer, but make an error in calculation
	2	Do the right thing and get the right result. There is no confirmation or other information
Rechecking results	0	No confirmation/other information
	1	The inspection has not been completed
	2	Verify that the procedure is correct

Table 1 shows the aspects that were to be assessed, as well as the scores given to each point that was true to the students in problem-solving. A description was provided for each point on each aspect or indicator used to guide the evaluation of the students' mathematical problem-solving abilities. The final value was calculated using the following equation.

$$N = \frac{Score\ obtained}{max\ score}\ x\ 100$$

Source: Hadi & Radiyatul (2014)

Table 2 depicts the relationship between the indicators of habits of mind and students' mathematical problems-solving.

Table 2. Indicators of habits of mind and steps to solve problems

Habits Of Mind Indicator	Problem-Solving Steps
Persistence	Understand the problem
	Create a problem-solving plan
Thinking about thinking	Implement the problem-solving plan
Thinking Flexibly	Create a problem-solving plan
	Implement the problem-solving plan
Applying Past Knowledge to New Situations	Create a problem-solving plan
	Implement the problem-solving plan
	Re-check the results

Table 2 shows the four indicators of thinking habits used in this research, as well as the activies that may accur in solving problems for each indicator used. Two variables were used in this study: habits of mind (X1) and mathematical problem-solving (X2). The study aim to determine how habits of thinking influence students' mathematical problem-solving.

A test and interview guide were the two instruments used to collect data. A mathematical problem-solving test was used to examine students' thinking habits in solving a problem. This mathematical problem-solving test took the form of an essay with two questions on sequences. In addition, an interview guide was developed to guide the interviews with students the on problem-solving. Through these interviews, the students could express their opinions regarding their problem-solving. These interviews were also conducted to explore and find out students' thinking habits in solving problems. Data from the interviews were complementary to the data from the mathematical problem-solving test data. The interview results demonstrated how students were thinking about mathematical problems. Reduced data gave the researcher a clear picture and made it easier for them to collect more information.

A total of 29 students in grade 9 at SMPN 2 Gunung Tuleh in the 2022/2023 school year were involved in this study. The research subjects were selected by purposive sampling, a techniqe of selecting a sample based on the judgment or views of excerpts according to the aims or objectives of the research (Rudiansyah et al., 2016). The questions posed during the interviews are provided in Table 3.

Table 3. Questions about students' habits of mind in solving mathematical problems

Indicator of student's habits of mind in solving mathematical problems	Questions
Persistence	1. How many times did you read a question to understand the problem? 2. Could you write down what is known and asked in the question? 3. Did you try to solve the problem? What efforts did you make? 4. How did you solve the problem? 5. By doing so, did you obtain an answer?
Thinking about thinking	6. Did you turn in an assignment on time? 7. Did you understand the material given? 8. Did you think about what method you used before solving a problem? 9. Did you write down the formula that you used in solving the problem?
Thinking flexibly	10. Do you think your answer is correct? 11. Is there another way to solve the problem? 12. In solving the problem, did you use a different method than what your teacher taught you?

Indicator of student's habits of mind in solving mathematical problems	Questions
Applying old knowledge in new situations	13. Had you used the method that you used in solving this problem before? 14. Did you use the knowledge you gained before to understand the problem? 15. Did you try to remember your lessons when working on the problem?

Table 3 shows the interview guide used to assess students' thinking habits. The interview questions presented in Table 3 were asked to the sample students to elicit their responses. Data were collected from these responses and then analyzed.

RESULTS AND DISCUSSION

A test was used to assess students' problem-solving abilities. The data collected from the test were then processed, and student scores were then obtained. The questions posed in the problem-solving test are presented in Figure 1.

Answer the questions below properly and correctly.

1. Each bacterium is observed to split in two. If every bacterium splits every 30 minutes and there are 20 of them at 07.30, determine the number of bacteria at 11.30?
2. Lisa is stacking chairs that are 86 cm tall each. The height of a stack of 2 chairs is 92 cm, the height of a stack of 3 chairs is 98 cm, and the height of a stack of 4 chairs is 104 cm. How tall is a stack of 11 chairs?

Figure 1. Mathematical problem-solving test questions

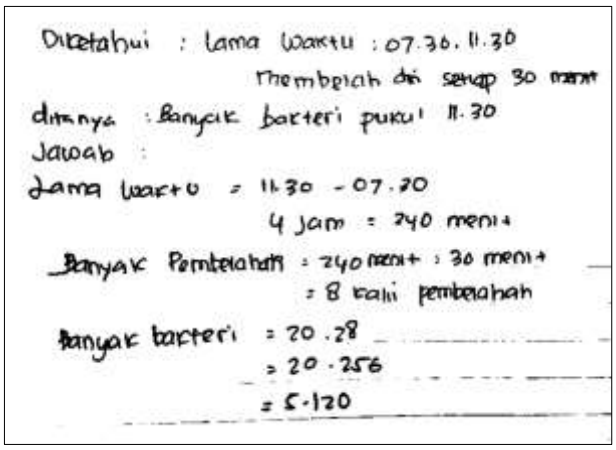
Figure 1 presents the questions given to the students. They were asked to solve problems to see the level of their problem-solving abilities. The test questions given were of a systems of linear equations in two variables. The students' answers were analyzed to score their problem-solving ability level. The following is a guide for categorizing the students' problem-solving abilities based on the result.

Table 4. Problem-solving categories

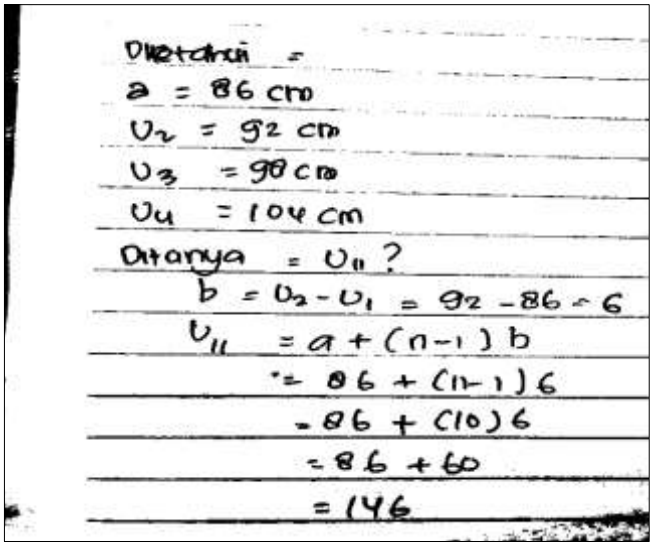
No	Score Interval	Criteria	Number of Students	Percentage
1	65– 100	High	4	13.8%
2	55– 64	Medium	10	34.5%
3	0– 54	Low	15	51.7%
	Total		29	

According to Table 4, there were four students with high problem-solving abilities, ten with medium abilities, and fifteen with low abilities. A total of 51.7% of the students received a score between 0 and 54, indicating that some students had a poor ability to solve problems. The following are some results of the mathematical problem-solving tests and interviews.

Analysis of a Student's Answers in the High Category



Translated to English:
Known:
Time extends from 07.30 to 11.30
Division occurs every 30 minutes.
Asked:
The number of bacteria at 11.30?
Answer :
Duration = 11.30-07.30
4 hours = 240 minutes
Number of devisions = 240 : 30
= 8 divisions
Number of bacteria = $20. 2^8$
= 20. 256
= 5.120



Known :
a = 86 cm
U_2 = 92 cm
U_3 = 98 cm
U_4 = 104 cm

Asked : U_{11} ?
b = $U_2 - U_1$ = 92 – 86 = 6
U_{11} = a + (n-1) b
= 86 + (11 – 1) 6
= 86 + 60
= 146

Figure 2. Student 1's answers

Persistence

According to Figure 2, the student understood the problem and could write down what was known and what was asked about the problem. The student was also able to properly plan problem-solving using geometric and arithmetic sequences concepts. The student was considered to be determined to solve the mathematical problem. This finding was supported by the following except of the interview with the said student.

Researcher : How many times did you read the questions to understand the problems?
First Student : I read the questions 3 times.
Researcher : After reading 3 times, could you write down the information provided in the questions and what asked?
First Student : Yes, I could.
Researcher : Did you try to solve the problems? What efforst did you make to do so?
First Student : Yes, i did by writing down what was known and asked first
Researcher : How did you solve the problems?
First Student : By finding the formulas to use to solve the problems, in which case question number 1 used a geometric sequence formula and question number 2 used an arithmetic sequence formula.

According to the interview results, the student demonstrated an indicator of persistence by reading the questions three times to understand the problems and then trying to solve the problems by writing down what was known and what was asked in questions. The student then answered the questions using the correct concepts. In conclusion the student exhibited determination in solving the mathematical problems.

Thinking About Thinking

According to Figure 2, the student used the concept of geometric sequences to solve problem number 1 and the concept of arithmetic sequences to solve problem number 2. It indicates the habit of mind of thinking about thinking. This finding was supported by the second excerpts of the interview with the said student.

Researcher : Did you understand the material provided?
First Student : I did, the first problem was about a geometric sequence, and the second was about an arithmetic sequence.
Researcher : Did you think about the method to use before working on a problem?
First Student : Yes.
Researcher : Did you write the formula to answer a question?
First Student : Yes, I wrote down the U_n formula.

According to the interview results, the student showed the indicator of mental habits of thinking about thinking. The student was able understand the material related to the questions posed, think about what method to use to solve the problems, and plan the problem-solving by writing down the formulas to use to find answers. The student was found to possess the habit of thinking about thinking when solving mathematical problems.

Think Flexibly

According to Figure 2, the student designed and implemented a problem-solving plan to solve problem number 1 using the concept of geometric sequences and to solve problem number 2 using the concept of arithmetic sequences. It indicates that the student had the ability to think flexibly, as shown by their ability to understand how to solve the problems correctly. The following excerpt from the interview with the said student supported this finding.

Researcher : In your opinion, were the answers that you have obtained correct?
First Student : Yes, they are
Researcher : Is there another way for you to solve the problems?
First Student : There is. You can use the $un = a.rn-1$ formula.

According to the interview excerpt above, the students displayed a flexible mindset because they were aware of other ways to solve the problems. In other word, the student exhibited the indicator of flexible thinking when solving mathematical problems.

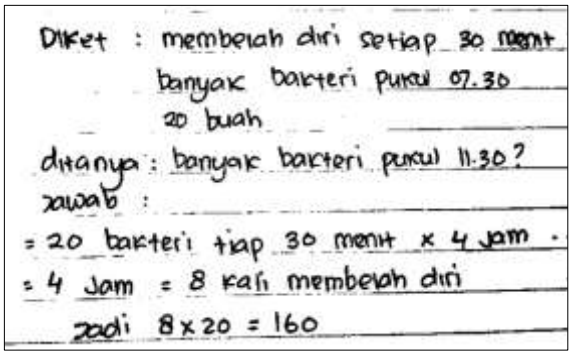
Applying Past Knowledge to New Situations

Figure 2 shows that the student designed and implemented a problem-solving plan using the concept of geometric sequences for problem Number 1 and the concept of arithmetic sequences for problem Number 2. This means that the student applied their past knowledge to new situations. This finding was supported by the following excerpt of the interview with the said student.

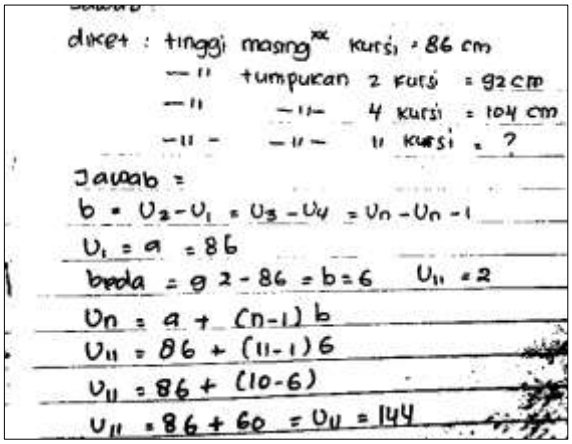
Researcher : Have you ever used the a formulas to solve problems of this like before?
First Student : I have
Researcher : Did you use your prior knowledge to solve the problems here?
First Student : Yes, I used the geometric and arithmetic series formulas that I had previously studied

Based on the interview results, the student performed a habit of mind of applying old knowledge to new situations evidenced by their use of existing formulas.

Analysis of a Student's Answers in the Medium Category



Translated to English:
Known: Division occurs every 30 minutes.
There are 20 bacteria at 07.30
Asked: How many bacteria are there at 1.30?
Answer: 20 bacteria every 30 minutes × 4 hours
= 4 hours = 8 divisions
So, 8 × 20 = 160



Known : The height of each chair is 86 cm
The height of a stack of 2 chairs = 92 cm
The height of a stack of 4 chairs = 104 cm
The height of a stack height of 11 chairs =?
Answer :
$b = U_2 - U_1 = U_3 - U_2 = Un - Un - 2$
$U_1 = a = 86$
difference = $92 - 86 = b\ 6\ U11 = 2$
$Un = a + (n-1)b$
$U11 = 86 + (11-1)6$
$U11 = 86 + (10+6)$
$U_{11} = 86 + 60$
$U_{11} = 144$

Figure 3. Student 2's answers

Persistence

Based on Figure 3, the student was able to understand the problems and wrote down what was known and what was asked in the questions. The student was also able to plan problem-solving using the concepts of geometric sequences and arithmetic sequences. It can be concluded that the student was determined to solve the mathematical problems. The following excerpts of an interview with the said student supported this finding.

Researcher : How many times did you read the questions to understand the problems?
Second Student : I read the questions twice.
Researcher : After reading twice, could you write down what was known and asked in the questions?
Second Student : Yes, I could.
Researcher : Did you try to solve the problems? What efforts did you make?
Second Student : Yes, by writing down what was known and asked first.
Researcher : How did you solve the problems?
Second Student : By looking for the formula to use to solve the problems.

Based on the interview excerpt above, the student demonstrated an indicator of persistence in their attempt to understand the problems by reading the problems twice. Then, the student tried to solve the problems by writting down what was known and asked in the questions. In addition, the student also answered the questions using the correct concepts. It can be concluded that the student was persistent in solving mathematical problems.

Thinking About Thinking

Based on Figure 3, the student carried out a problem-solving plan using the concept of arithmetic sequences to solve problem number 2. However, the student failed to solve problem number 1 correctly. Their failure to solve the problem indicated that the student lacked a habit of mind of thinking about thinking. This was supported by the following excerpts from the interview with the said student.

Researcher : Did you understand the material given?
Second Student : I had no idea about the first question, but the second question was about an arithmetic sequenc.e
Researcher : Did you think about the method to use before working on the problems?
Second Student : Yes.
Researcher : Did you write down the formulas to use in answering the questions?
Second Student : I wrote one to answer question number 2.

The interview excerpt above shows that the student did not show the habit of mind of thinking about thinking as they did not understand the material related to a problem given and did not find the correct solution to it. In other words, the student lacked deep thinking to solve mathematical problems.

Thinking Flexibly

Based on Figure 3, the student designed and implemented problem-solving using the concept of arithmetic sequences to solve problem number 2. The student was able to devise a plan to solve problem number 1 failed to make a correct solution. The student failed to show flexible thinking as they were unable to solve problem number 1 correctly. This was supported by the following excerpt.

Researcher : In your opinion, were the answers that you obtained correct?
Second Student : Yes.
Researcher : Did you use a different way of answering the questions than what the teacher has taught you?
Second Student : I did not.

Based on the excerpt above, the students lacked flexible thinking as they did not know any other ways of solving the problems. It can be concluded that the indicator of flexible thinking in solving mathematical problems was absent in the student.

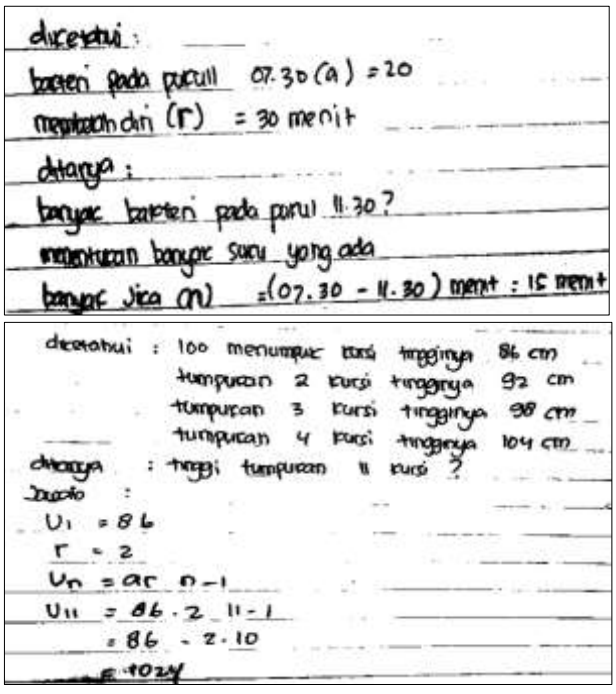
Applying Past Knowledge to New Situations

Based on Figure 3, the student designed and implemented a problem-solving plan using the concept of arithmetic sequences to solve question number 2. However, to question number 1, the student was unable to find a correct solution using the concept of geometric sequences. This means that the student was unable to apply past knowledge to new situations. The following excerpt supported this finding.

Researcher : *Have you used the formulas to solve problems of this like before?*
Second Student : *Yes.*
Researcher : *In understanding the problems here, did you use the knowledge that you had obtained before?*
Second Student : *Yes.*

As the interview excerpt above shows, the student claimed to have applied old knowledge to new situations, and it was known that the student had used an existing formula. It can be concluded that the student displayed the indicator of applying past knowledge to new situations.

Analysis of a Student's Answers in the Low Category



Translated to English:
Known:
Bacteria at 07.30 (a) = 20
split (r) = 30 minutes
Asked:
How many bacteria are there at 11.30?
to determine the number of terms that exist. The number of terms (n) = (07.30–11.30) minutes
= 15 minutes
Known:
Lisa is stacking chairs 86 cm tall each
The height of a stack of 2 chairs is 92 cm.
The height of a stack of 3 chairs is 98 cm.
The height of a stack of 4 chairs is 104 cm.
Asked: How tall is a stack of 11 chairs?
Answer:
$U_1 = 86$ $r = 2$
$U_n = ar \times n–1$
$U_{11} = 86 \times 2 \times n – 1 = 86 \times 2 \times 10 = 1.024$

Figure 4. Student 3's Answers

Persistence

Based on Figure 4, the student understood the problems as shown by their ability to write down what was known and asked about the problems. The student was able to devise problem-solving plans. It was concluded that the student was determined to solve mathematical problems. This was also supported by the following excerpt from an interview with the said student.

Researcher : How many times did you read the questions to understand the problems?
Third Student : I read the questions twice.
Researcher : After reading twice,could you write down what was known and asked about the problem?
Third Student : Yes, I could.
Researcher : Did you try to solve the problems? What efforts did you make?
Third Student : Yes, by finding out what was known an asked from the questions.
Researcher : How did you solve the problems?
Third Student : I could not solve question number 1.

Based on the interview excerpt above, the student lacked persistence as s(he) did not try to make a solution plan to solve question number 1. However, the student tried to understand the problem by reading the problem twice and then tried to solve the problem by finding out about what was known and asked from the question. It was concluded that the student lacked persistence to solve mathematical problems.

Thinking About Thinking

Based on Figure 4, the student carried out a problem-solving plan in the wrong way to solve question number 2 and was unable to solve the problem in question Number 1. The student's inability to solve both questions correctly indicated a lack of the habit of thinking about thinking. This was supported by the following excerpt of the interview with the said student.

Researcher : Did you understand the material given?
Third Student : I did not really understand it
Researcher : Did you write down the formulas to use in answering the questions?
Third Student : Yes, I wrote one down for question number 2.

The excerpt above supported the finding that the student lacked the habit of mind of thinking about thinking because they could not understand the material related to the questions given and could not plan problem-solving properly. In other words, the habit of thinking about thinking in solving mathematical problems was absent in the student.

Thinking Flexibly

Based on Figure 4, the student was unable to design and implement a problem-solving plan to solve both questions. This means that the student does not have a flexible thinking habit of mind, as shown by their inability to solve both questions correctly. The following excerpt supported this finding.

Researcher : In your opinion, were the answers that you obtained correct?
Third Student : Yes.
Researcher : Do you have any other way to solve the problems here?
Third Student : I do not have.

Based on the interview excerpt above, the student lacked a flexible thinking habit of mind. The student did not know any other way of solving the problems. In conclusion, the habit of flexible thinking in solving mathematical problems was absent in the student.

Applying Past Knowledge to New Situations

Based on Figure 4, the student was unable to design and carry out a problem-solving plan to solve question number 1, and they used the wrong concept in solving question number 2. This shows that the student was unable to apply past knowledge to new situations. This finding was supported by the following excerpt.

Researcher : Have you used the formulas to solve problems of this like before?
Third Student : Yes.
Researcher : In understanding the problems, did you use the knowledge that you gained before?
Third Student : Yes, I did.
Researcher : Have you ever worked on the same problem as the one given?
Third Student : Yes, but the solution was different.

The student lacked the ability to apply past knowledge to new situations, as proven by their inability to apply formula that they had previously used to solve the two problems. At large, the relationship between habits of mind and problem-solving laid out in the Table 5.

Table 5. The relationship between habits of mind and problem-solving

Habits of Mind Indicators	Problem-Solving Steps	Questions
Persistence	Understand the problem	1. Can you explain what was known from the problem? 2. Can you explain what was being asked in the question?
	Define a problem-solving plan	3. Can you make a mathematical model of the problem?

Habits of Mind Indicators	Problem-Solving Steps	Questions
		4. What method did you use to solve the problem?
Thinking flexibly	Implement the problem-solving plan	5. Why did you use the formula? 6. What was the plan that you arrange? Please explain.
Applying past knowledge to new situations	Define a problem-solving plan	7. Is there another way to solve the problem? if yes, please explain.
	Implement the problem-solving plan	8. What is the way to solve the problem?
Thinking about thinking	Define a problem-solving plan	9. Have you ever found the same problem as given? 10. If yes, how did you solve it? If not, how to finish it?
	Implement the problem-solving plan	11. What method did you use in solving this problem? Have you used it before?

Based on the findings described above, the student who had strong problem-solving abilities displayed four mental indicators of problem-solving. Masni (2017) has also previously found that students with strong problem-solving skills also have strong mental habits. Meanwhile, the student who was lacking in some indicators of mental habits fell into the moderate problem-solving and habits category. The student who was lacking in all four thinking indicators had poor problem-solving abilities and poor thinking habits.

The students were found to demonstrate persistence in solving problems. This strengthens research conducted by Masni (2017) that the association between problem-solving abilities and mathematical thinking habits is the aspect that is expressed most often, namely controlling impulsivity and the aspect that is done least frequently is the aspect of being responsible. Meanwhile, in research conducted by Mustaqiim (2019) students were categorized into three categories, namely high, medium and low. For each category of habits of mind in the step of designing a solution plan, all students are unable to determine the mathematical model of the problem. Therefore, in learning mathematics, writing mathematical models when solving mathematical problems should receive more attention during the mathematics learning process. In line with research by Hidayat et al. (2022) that students who have low mathematical abilities have a poor level of problem solving ability because they are unable to understand problems, create and implement solution plans and evaluate solutions. Students might know about a concept or information, but could not say (Noto et al., 2017). It can be concluded that students who do not have a poor level of problem-solving abilities do not have planning and evaluation skills. This shows the importance of student persistence to be able to solve problems well.

The importance of flexible thinking was also stated by Bonitasya et al. (2021) and Mubarok & Kurniasari (2019) that the third collaboration skill indicator is showing flexibility. In this indicator there

are four aspects that are observed, namely: (1) receiving criticism and suggestions; (2) negotiating differences of opinion; (3) always compromise; and (4) accepting every assignment given. The results of research conducted by Maryono & Saputri (2019) explain that applying a past knowledge at new situation, students who have this habit have indicators: being able to draw meaning from their experiences in new situations. When faced with a new, confusing problem, students tend to connect it with their past experiences to solve the problem.

According to the findings of this field's researchers, students with problem-solving skills exhibit all four indicators of mental use. Students with moderate problem-solving abilities have four indicators but lack three, namely thinking indicators, thinking flexibility, and applying old knowledge to new situations. Students with poor problem-solving skills are also deficient in indicators of thinking habits. According to research Masni (2017) and Nurmala et al. (2018) there is a link between intelligence and students' problem-solving abilities. The better the student's problem-solving skills, the better his or her mental habits, and vice versa. This leads to the conclusion that the better the student's attitude, the better the student's ability to solve problems.

CONCLUSION

From the investigation into junior high school students' thinking habits in solving mathematical problems, it was found that students with strong problem-solving abilities displayed four indicators of thinking habits: persistence, thinking about thinking, thinking flexibility, and applying past knowledge to new situations. Students with moderate problem-solving abilities also exhibited four indicators, but were weak in three of them: thinking about thinking, thinking flexibility, and applying past knowledge to new situations. Students who were poor problem-solvers were lacking in all the indicators of thinking habits. It can be concluded that students' thinking habits could influence their problem-solving abilities. However, this research was not without a weakness. For one, the test questions posed here were routine questions. It is hoped that future resesarchers can conduct research on students' thinking habits when solving non-routine problems, especially mathematical ones.

ACKNOWLEDGMENTS

We thank the model teacher and students of class IX B of SMPN 2 Gunung Tuleh for their active participation in this research.

REFERENCES

Ariawan, R. & Nufus, H. (2017). Relationship between mathematical problem solving ability and students' mathematical communication ability [in Bahasa]. *Theorems (The Original Research of Mathematics)*, *1*(2), 82–91. https://www.unma.ac.id/jurnal/index.php/th/article/view/384/363.

Aringga, D., Shodiqin, A., & Albab, I. U. (2020). Exporing student's mathematical habits of mind in solving fraction number story problems in terms of cognitive style [in Bahasa]. *Thinking Skills and Creativity Journal*, *2*(2), 121–129. https://ejournal.undiksha.ac.id/index.php/TSCJ/article/view/22666.

Aziz, A. (2022). The influence of habits of mind on students' mathematical problem-solving ability (study on class xi students of sma negeri 1 simpang pematang even semester 2021/2022 academic year) [in Bahasa]. http://digilib.unila.ac.id/64833/3/3.

Bakar, M. T., Nani, K. L., Harisman, Y., & Amam, A. (2020). Mathematical understanding capability of class VII junior high school students on collective material through the discovery learning model [in Bahasa]. *Theorems: Teori dan Riset Matematika*, 5(2), 271-279. https://jurnal.unigal.ac.id/teorema/article/view/3819/3415.

Bonitasya, D. A., Widiyatmoko, A., & Sovansophal, K. (2021). The effect of blended learning with a collaborative problem solving approach on students' cognitive learning outcomes and collaboration skills in science learning [in Bahasa]. *Jurnal Penelitian dan Pembelajaran IPA*, *7*(2), 152-167. https://doi.org/10.30870/jppi.v7i2.12670.

Costa, A. & Kallick, B. (2005). *Habits of mind: a curriculum for community high school of Vermont student* [in Bahasa]. Hawker Brownlow. Vermont. http://www.chsvt.org/wdp/Habits_of_Mind_Curriculum_VT_WDP.pdf.

Dwirahayu, G., Kustiawati, D., & Bidari, I. (2018). The influence of habits of mind on mathematical generalization ability [in Bahasa]. *Jurnal Penelitian dan Pembelajaran Matematika*, *11*(2), 91-104. https://jurnal.untirta.ac.id/index.php/JPPM/article/view/3757/2751.

Hadi, S. & Radiyatul. (2014). Problem solving method according to Polya to develop students' ability in mathematical problem solving in junior high school [in Bahasa]. *EDU-MAT: Jurnal Pendidikan Matematika*, *2*(1), 53–61. https://ppjp.ulm.ac.id/journal/index.php/edumat/article/view/603/0.

Hidayat, R., Siregar, E. Y., & Elindra, R. (2022). Analysis of factors of the low mathematical problem solving ability of students at the private vocational school teruna padang sidimpuan [in Bahasa]. *Journal MathEdu (Mathematic Education Journal)*, *5*(3), 114–120.. https://journal.ipts.ac.id/index.php/MathEdu/article/view/3944/2734.

Huda, U. (2016). Analysis of junior high school students' habits of thinking interdependently (HTI) in cooperative learning [in Bahasa]. *Ta'dib*, *19*(1), 15-22. https://doi.org/10.31958/jt.v19i1.447.

Imanah, Kartimi, & Gloria, R. Y. (2018). Application of formative feedbacck assessment attributes to the reprodutive system concept to form habits of mind of class xi man 2 cirebon city students [in Bahasa]. *Indonesian Journal of Nature Science*, *1*(3), 135–146. https://www.syekhnurjati.ac.id/jurnal/index.php/jia/article/view/5281/2450.

Lusiana, Armiati, & Yerizon. (2022). Learning independence and students' perceptions of teachers on the mathematical problem-solving ability of vocational school students [in Bahasa]. *Mosharafa: Jurnal Pendidikan Matematika*, *11*(1), 155–166. https://karya.brin.go.id/id/eprint/16075/1/Jurnal_Lusiana_Universitas Negeri Padang_2022.pdf.

Malasari, P. N. (2019). Contribution of habits of mind to students' mathematical literacy ability in

geometry material [in Bahasa]. *Jurnal Pendidikan Matematika (Kudus)*, *2*(2), 153–164. https://doi.org/10.21043/jpm.v2i2.6361.

Manalu, M. (2021). Improving high school students' mathematical problem-solving abilities through the REACT (Relating, Experiencing, Applying, Cooperating, Transferring) strategy at SW Parsaoran High School [in Bahasa]. *Cartesius: Jurnal Pendidikan Matematika*, *4*(1), 43–64. https://ejournal.ust.ac.id/index.php/CARTESIUS/article/view/1700.

Maryono, I. & Saputri, R. O. (2019). Developing students' problem-solving abilities and mathematical habits of mind through self-explanation techniques [in Bahasa]. *Journal of Analysis*,*5*(2), 152–160. https://journal.uinsgd.ac.id/index.php/analisa/article/view/6258.

Masni, E. D. (2017). Problem solving ability association and mathematical habits of mind of middle school students [in Bahasa]. *Jurnal Penelitian Pendidikan INSANI*, *20*(1), 38–44. https://ojs.unm.ac.id/Insani/article/view/4426/2561.

Mubarok, M. A. & Kurniasari, I. (2019). Students' creative thinking in solving mathematical problems in view of field independent cognitive style and gender [in Bahasa]. *MATHEdunesa: Jurnal Ilmiah Pendidikan Matematika*, *8*(2), 142–147. https://ejournal.unesa.ac.id/index.php/mathedunesa/article/view/27474.

Muchtar, D. & Suryani, A. (2019). Character education according to the Ministry of Education and Culture (MoEC) [in Bahasa]. Edumaspul: *Jurnal Pendidikan*, *3*(2), 50–57. https://ummaspul.e-journal.id/maspuljr/article/view/142.

Mustaqiim, S. (2019). Analysis of students' mathematical problem solving abilities in solving hot questions judging from habits of mind [in Bahasa]. *Thesis*, Sunan Ampel State Islamic University: Surabaya. http://digilib.uinsa.ac.id/38633.

Noto, M. S., Harisman, Y., Harun, L., Amam, A., & Maarif, S. (2017). Adult gesture in collaborative mathematics reasoning in different age. *Jornal of Physics: Conference Series*, *895*(1), 012048. https://doi.org/10.1088/1742-6596/895/1/012048.

Nurmala, N., Rohaeti, E. E., & Sariningsih, R. (2019). The influence of habits of mind on mathematical problem solving in middle school students [in Bahasa]. *Journal on Education*, *1*(2), 163–168. https://www.jonedu.org/index.php/joe/article/view/41.

Oktaviyanthi, R., & Agus, R. N. (2019). Exploration of problem-solving abilities based on mathematical literacy process categories [in Bahasa]. *Jurnal Pendidikan Matematika*, *13*(2), 163–184. https://doi.org/10.22342/jpm.13.2.7066.163-184.

Polya, G. (2004). *How to solve it. in stochastic optimization in continuous time*. Princeton University Press Princeton and Oxford. https://doi.org/10.1017/cbo9780511616747.007.

Qadarsih, N. D. (2017). The influence of thinking habits on mastery of mathematical concepts[in Bahasa]. *Susunan Artikel Pendidikan*, *2*(2), 181–185. http://dx.doi.org/10.30998/sap.v2i2.2091.

Rahzianta & Hidayat, M. L. (2016). Science learning service learning effort to form habits of mind and masyery of inventive thinking skills [in Bahasa]. *USEJ - Unnes Science Education Journal*, *5*(1), 1128–1137. https://journal.unnes.ac.id/sju/index.php/usej/article/view/9646.

Rohmah, F., Wahidah, N., Setyadi, E. J., & Grafiyana, G. A. (2021). Effectiveness of growth mindset training for high school students [in Bahasa]. *Psycho Idea*, *19*(1), 103–114. https://jurnalnasional.ump.ac.id/index.php/PSYCHOIDEA/article/view/9147.

Rudiansyah, Amirullah, & Yunus, M. (2016). Teachers' efforts to overcome student anxiety in facing tests (achievement of learning outcomes) at smp negeri 3 banda aceh [in Bahasa]. *Scientific Journal of Unsyiah Citizenship Education Students*, *1*(1), 96–109. https://jim.usk.ac.id/pendidikan-kewarganegaraan/article/view/464.

Septirahmah, A. P., & Rizkha, H. M. (2021). Internal factors that influence discipline: characteristics, awareness, interest and motivation, and mindset [in Bahasa]. *Journal of Educational Management and Social Sciences, 2*(2), 618–622. https://dinastirev.org/JMPIS/article/view/602.

Sriwahyuni, K. & Maryati, I. (2022). Students' mathematical problem solving ability in statistics material [in Bahasa]. *Plusminus: Journal of Mathematics Education*, 2(2), 335–343. https://garuda.kemdikbud.go.id/documents/detail/3016163.

Sumartini, T. S. (2016). Increasing students' mathematical problem solving abilities through problem based learning [in Bahasa]. *STKIP Garut Mathematics Education Journal, 5*. https://proceeding.unnes.ac.id/snpasca/article/view/294/277.

Yandari, I. A. V., Supartini, S., Pamungkas, A. S., & Khaerunnisa, E. (2019). The role of habits of mind (hom) on student's mathematical problem solving skills of primary school [in Bahasa]. *Al-Jabar : Jurnal Pendidikan Matematika, 10*(1), 47–57. https://doi.org/10.24042/ajpm.v10i1.4018

Yani, M., Ikhsan, M., & Marwan. (2016). Junior high school students' thinking process in solving mathematical problems based on polya steps viewed from the adversity quotient [in Bahasa]. *Journal of Mathematics Education, 10*(2), 43–58. http://ejournal.unsri.ac.id/index.php/jpm/article/view/3278.

Yanti, S., Fauzi, A., & Mulyono. (2021). Analysis of students' thinking habits through learning based on a metacognitive approach [in Bahasa]. *Paradigm Mathematics Education Journa*l, *14*, 11–21. https://doi.org/https://jurnal.unimed.ac.id/2012/index.php/paradikma/article/view/27767.