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The Students' Mathematical Literacy in Solving HOTS Problems: Does Learning Style Make a Difference?

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Abstract. Differences in students' learning styles, whether visual, auditory, or kinesthetic, affect the way of students in absorbing, processing, and understanding the mathematical information provided. This statement indicates that differences in learning styles also affect students' mastery of mathematical literacy and students' skills in solving problems involving higher-order thinking skills. So, this study aims to describe students' mathematical literacy skills in solving higher-order thinking skills (HOTS)-oriented problems in terms of students' learning styles. The research used descriptive qualitative research that is involving 6 eighth-grade students at a junior high school in Blora, Central Java, Indonesia, as research subjects selected using simple random sampling techniques. The instruments used were a learning style questionnaire to identify students' learning styles, HOTS-oriented equation of a straight line problems to reveal students' mathematical literacy, and interviews to confirm the answers given by students in the test. Data were analyzed using an interactive model, namely data reduction, data presentation, and data verification, accompanied by triangulation techniques to ensure the validity of the data. The results showed that students with a visual learning style were more dominant in mastering communication skills and the ability to use language and symbolic, formal, and technical operations. In contrast, students with auditory learning styles are only dominant in mastering communication skills. While students with kinesthetic learning styles are more dominant in mastering language use skills and symbolic, formal, and technical operations.

Keywords: HOTS Problems; Learning Styles; Mathematical Literacy

Abstrak. Perbedaan gaya belajar siswa, baik visual, auditori, maupun kinestetik, mempengaruhi cara siswa dalam menyerap, mengolah, dan memahami informasi matematika yang diberikan. Pernyataan ini menunjukkan bahwa perbedaan gaya belajar juga mempengaruhi penguasaan literasi matematika dan keterampilan siswa dalam memecahkan masalah yang melibatkan keterampilan berpikir tingkat tinggi. Maka, penelitian ini bertujuan untuk mendeskripsikan keterampilan literasi matematika siswa dalam memecahkan masalah berorientasi keterampilan berpikir tingkat tinggi (HOTS) ditinjau dari gaya belajar siswa. Penelitian ini menggunakan penelitian kualitatif deskriptif yaitu melibatkan 6 siswa kelas VIII SMP di Blora, Jawa Tengah, Indonesia, sebagai subjek penelitian yang dipilih menggunakan teknik *simple random sampling*. Instrumen yang digunakan adalah angket gaya belajar untuk mengidentifikasi gaya belajar siswa, soal persamaan garis lurus berorientasi HOTS untuk mengungkap literasi matematika siswa, dan wawancara untuk mengonfirmasi jawaban yang diberikan siswa dalam tes. Data dianalisis menggunakan model interaktif, yaitu reduksi data, penyajian data, dan verifikasi data, disertai teknik triangulasi untuk memastikan keabsahan data. Hasil penelitian menunjukkan bahwa siswa dengan gaya belajar visual lebih dominan dalam menguasai keterampilan komunikasi dan kemampuan menggunakan bahasa serta operasi simbolik, formal, dan teknis. Sebaliknya, siswa dengan gaya belajar auditori hanya dominan dalam menguasai keterampilan komunikasi. Sementara siswa dengan gaya belajar kinestetik lebih dominan dalam menguasai keterampilan penggunaan bahasa dan operasi simbolik, formal, dan teknis.

Kata kunci: Gaya Belajar; Soal HOTS; Literasi Matematika

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INTRODUCTION

Mathematics plays a vital role because it is a basic science widely used in various fields of life. Mathematics is the most fundamental science among other sciences and directs students to solve everyday problems and develop their logic skills to form attitudes (Hartini & Setyaningsih, 2023). By learning mathematics, students can think critically and are skilled in counting and have the ability to apply basic mathematical concepts to other subjects as well as to mathematics itself and in everyday life (Afsari et al., 2021).

The mathematical skills is usually mentioned as mathematical literacy. According to the Organization for Economic Cooperation and Development (OECD, 2021), literacy skills include the capacity of individuals to reason logically, formulate, solve, and interpret mathematical problems encountered in everyday life (Kusuma et al., 2022). Mathematical literacy is considered as an understanding of mathematics that is essential to prepare young people for life in modern society, both in simple everyday life and in preparation for professional careers (Stacey, 2015). Mathematical literacy gives people awareness and understanding of the role of mathematics in the world because mathematical literacy involves using mathematics to act in real life, so people need to be mathematically literate in various situations (Genc & Erbas, 2019).

Mathematical literacy is more than just numeracy skills; it includes the capacity to communicate effectively, reason, and engage in mathematical thinking (Fitriyaningsih & Ni'mah, 2023). Mathematical literacy indicates an individual's ability to use, design, and interpret mathematical principles in various scenarios, including mathematical reasoning and utilization of mathematical concepts, procedures, factual knowledge, and instruments to explain, describe, and anticipate events. Many of the challenges in mathematical literacy relate to the way students think when solving problems, in accordance with the first CCSS standard that emphasizes problem understanding and perseverance in solving them (Hillman, 2014).

In PISA (OECD, 2019) there are seven primary basic abilities in the mathematical literacy process; communication, representation, reasoning and argumentation, problem-solving strategies, use of language and symbolic, formal and technical operations, and use of mathematical tools. In this study, the description of students' mathematical literacy skills is based on the five components of the mathematical literacy process consisting of; communication, mathematization, designing problem-solving strategies, use of language and symbolic, formal, and technical operations, and reasoning and argumentation.

In the modern era, human resources are expected to have three primary skills: problem-solving, critical thinking, and creative thinking, collectively known as higher-order thinking skills (HOTS). Integrating higher-order thinking skills along with strategies and critical thinking skills is

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very influential in mathematics education (Acharya, 2021). Kurtuluş & Ada (2017) stated that only about two-thirds of prospective teachers are in higher-order cognitive learning categories (such as evaluating, analyzing, or creating). The development of learning models by teachers for HOTS learning generally consists of three main components, namely encouraging students to participate in non-routine problem solving; facilitating the development of evaluation, creativity, and analysis skills; and encouraging students to accept their knowledge (Apino & Retnawati, 2017).

Everyone basically has unique characteristics, including their respective learning styles. Fajaryani (2017) states that learning style is a person's way of absorbing, organizing, and processing information or learning materials. A person can learn easily if they find a suitable learning style, because each individual has a different way of receiving, processing, and interpreting information (Putri et al., 2019). Deporter & Hernachi (2007) conveyed that learning styles are grouped into three main types: visual, auditory, and kinesthetic. Visual learning style means learning occurs by seeing. Students with this learning style require visual evidence to understand concepts, which is characterized by a significant reliance on visual information. While, auditory learning style means learning by hearing. These students usually learn more effectively through verbal interaction and hearing explanations from the teacher. Lastly, kinesthetic learning style is based on physical activities and direct experience. Students with this learning style learn best through movement, using all five senses, and tactile involvement. Previous study found that students with visual learning styles could fulfill all indicators of mathematical literacy skills, while students with auditorial and kinesthetic learning styles only fulfill some indicators (Azizah et al., 2019).

Mathematical literacy, which includes an individual's ability to apply mathematical concepts in various daily life situations, can be improved through the use of HOTS questions that challenge students to think critically, creatively and analytically. HOTS questions not only test basic mathematical abilities, but also encourage students to develop more complex problem-solving skills. On the other hand, each student's learning style, whether visual, auditorial or kinesthetic, affects the way they absorb, process and understand the mathematical information provided.

This research can provide a deeper understanding of how different learning styles impact students' abilities when solving HOTS problems. Mathematical literacy, which involves the ability to understand, analyze and apply mathematical concepts in various situations, is an essential skill in this era. The results of this study will help develop more effective learning strategies that suit the needs of individual students by analyzing the relationship between visual, auditorial and kinesthetic learning styles and mathematical ability. So, this study aims to determine the mathematical literacy skills of seventh-grade students in solving HOTS-oriented problems on the linear equations topic in terms of learning styles.

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METHOD

The type of research used in this study is qualitative research that aims to analyze mathematical literacy skills based on students' learning styles in solving HOTS-oriented problems. This study involved grade VII junior high school students in one of the Blora Regencies, Central Java, Indonesia as research subjects. The instruments used for data collection were learning style questionnaires, HOTS questions, and interview questionnaires. All instruments used have been validated by experts in the field of mathematics education and junior high school mathematics teachers so that they are suitable for use.

The learning style questionnaire consists of 30 statements to reveal students' learning style preferences based on DePorter & Hernacki (1992), namely auditory, visual, and kinesthetic. 10 statements to measure auditory learning styles, 10 statements to measure visual learning styles, and 10 statements to measure kinesthetic learning styles. Table 1 shows the indicators and examples of statements used in the learning style questionnaire. Each statement is scored according to a Likert scale, 1 for very inappropriate to 4 for very appropriate. Students are grouped based on their learning style similarities.

Table 1. Indicators of Learning Style and Examples of Statements in Questionnaire

Aspects	Indicators	Example of Statement
Visual	Neat and thorough	My handwriting is neat
	Speak quickly	When expressing my opinion, I express it quickly
	Good long-term planners and organizers	I often make a list of activities that I will do tomorrow
	Remember what is seen rather than heard	I like to take notes on lessons delivered by the teacher to remember them
	Enjoys reading but dislikes long talks	I prefer reading to listening
Auditorial	Easily distracted by commotion	I cannot concentrate on learning in crowded situations
	Moves lips while reading	I do not focus when reading silently
	Finds writing difficult but is excellent at telling stories	I prefer to tell stories in person rather than through text messages
	Usually, I am an eloquent speaker	I like to talk to myself during activities
	Better at remembering things heard	I prefer music to fine arts
Kinesthetics	Speaks rather slowly	I speak with slow intonation
	Memorize by walking and looking	I cannot memorize lessons by sitting still
	Stand close when talking to others and touch them to get attention	When talking to other people, I like to be nearby
	Always physically oriented and moves a lot	I cannot sit still for a long time
	Learning through manipulation and practice	I like to learn through manipulation, practice, and trial and error

Furthermore, 2 students were selected from each learning style group to complete HOTS-oriented problems to reveal students' mathematical literacy achievements. The test consists of 2 HOTS-based essay questions with levels C4 and C5 on the topic of linear equations. The two questions are presented here.

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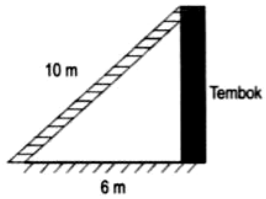
Problem 1. *Rino was going to pick up the stuck kite, so he took a ladder and leaned it against the wall, as shown in the figure. How high is the wall? Find the gradient of the ladder concerning the wall! Model the equation of the straight line!*



Problem 2. *Felix had just bought a 20 cm tall plant. After 3 days, it grew to 60 cm tall. How long will it take for Felix's plant to be 140 cm tall? Draw a graph! Calculate how long it will take for Felix's plant to be 100 cm tall. Does it match the graph you made?*

After completing the test, the research subjects were interviewed to clarify the students' answers to each question as well as to reveal in depth the achievement of each indicator of students' mathematical literacy. The results of the identification of mathematical literacy indicators are presented in table form namely communication; mathematization; designing problem-solving strategies; use of language and symbolic, formal, and technical operations; and reasoning and argumentation.

The results of the study were analyzed using data analysis techniques using an interactive model (Miles and Huberman), namely data reduction, data presentation, and data verification. The validity of the data in this study used the triangulation technique, namely the researcher used different data collection techniques to obtain data from the same source.

RESULTS AND DISCUSSION

This study found that the majority of students exhibited an auditory learning style, accounting for 16 students (50%), followed by students with a kinesthetic learning style, totaling 10 students (31.25%), and those with a visual learning style, totaling 6 students (18.75%). These findings align with previous studies indicating that auditory learning styles are often the most dominant among students (Ahyansyah, 2019), however other study reveal that most students have a visual learning style (Amaliya & Fathurohman, 2022).

Mathematical Literacy Skills of Students with Visual Learning Style

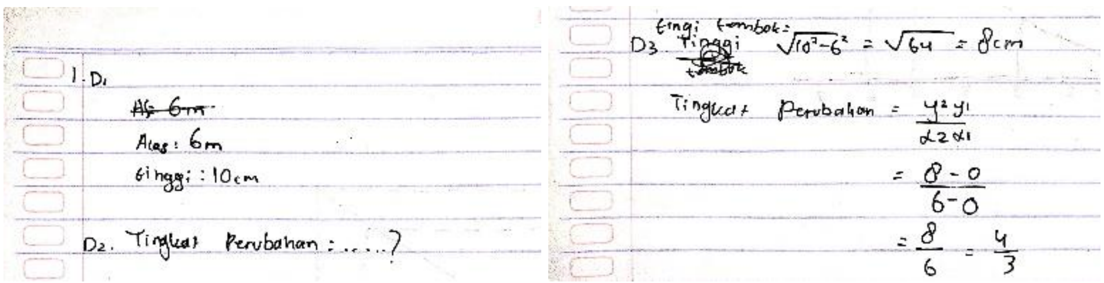


Figure 1. S1's Work on Problem 1

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Figure 1 and the interview with S1 highlights several areas where mathematical literacy, as defined by key indicators, can be further developed. In terms of communication, S1 struggled to fully explain the known and asked elements of the problem. While S1 was able to mention some details, such as the lengths of the stairs and the distance to the wall, the explanation lacked clarity, particularly when asked to describe what was being asked in the problem. This limited S1's ability to fulfill the communication indicator, as a clear and coherent explanation was not provided.

In the area of mathematization, S1 faced challenges in transforming the verbal problem into a mathematical model. When tasked with converting the problem into a mathematical expression, S1 incorrectly calculated the height of the wall and did not demonstrate the expected process of memorization. This inability to convert the problem into a mathematical model indicates a gap in mathematization skills. Similarly, when asked about the strategy for solving the problem, S1's response was insufficient, highlighting a lack of development in designing problem-solving strategies. The brief and incomplete explanation given by S1 suggests that more effective problem-solving strategies need to be cultivated.

S1 demonstrated partial success in the use of symbolic, formal, and technical language and operations. Although S1 made an error when initially writing the gradient formula, they corrected it upon further reflection, showing some understanding of the technical language involved. Additionally, S1 was able to draw the graph correctly after being prompted, indicating a reasonable grasp of the symbolic operations required. However, S1 struggled with reasoning and argumentation when asked for a conclusion, offering only partial information about the height of the wall and the distance to the wall without providing a full, logical argument. This suggests a need for further development in making sound reasoning and conclusions based on mathematical work.

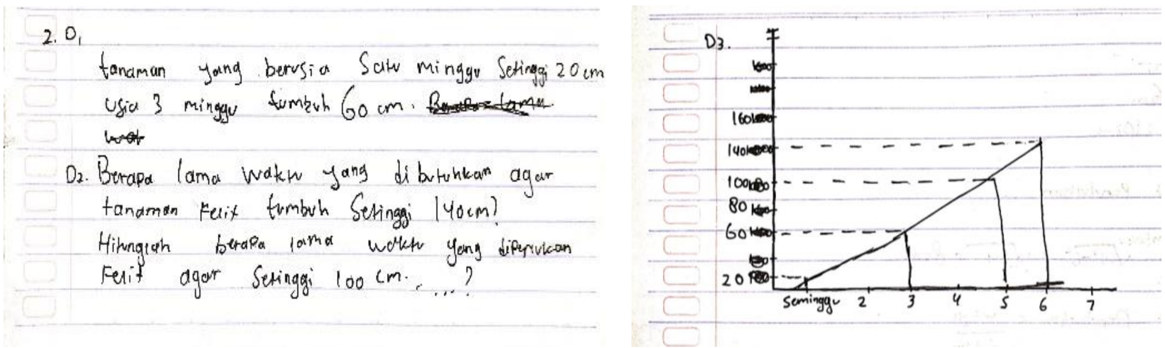

Figure 2. S1's Work on Problem 2

Figure 2 and the interview results with S1 indicate progress in some areas of mathematical literacy but also highlight areas for further development. In terms of communication, S1 was able to effectively explain what was known and asked in the problem. When prompted about the details of the problem, S1 correctly identified the plant's height at different ages and accurately

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summarized what was being asked, such as the time it would take for the plant to reach 140 cm and the need to draw a graph. This demonstrates S1's ability to fulfill the communication indicator by providing clear explanations of the problem's details.

However, S1 faced challenges in the mathematization process. When asked to convert the problem into a mathematical model, S1 struggled to memorize the necessary variables and their relationships. Although S1 was able to draw a graph, the inability to translate the problem into a mathematical form showed that S1 had difficulty applying the necessary memorization steps to solve the problem. This gap in mathematization skills indicates a need for further development in converting verbal problems into mathematical models.

S1 also encountered difficulties in designing problem-solving strategies. During the interview, S1 could not articulate the steps to solve the problem, instead focusing solely on drawing a graph. However, with guidance, S1 was able to use the correct mathematical symbols and techniques to draw the graph accurately and identify the correct solution for the plant's growth time. S1 also successfully provided the conclusions after additional prompting, showing that they could fulfill the reasoning and argumentation indicator when given sufficient support. S1's ability to complete the graph and offer conclusions suggests that with further practice and guidance, S1 could strengthen their mathematical literacy, particularly in terms of problem-solving strategies and reasoning.

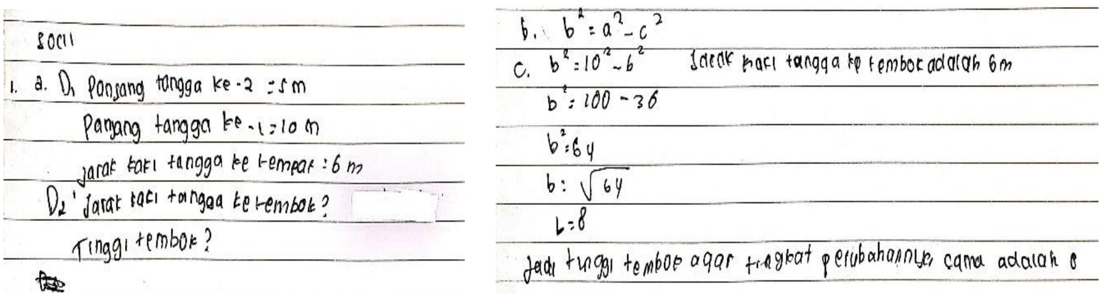

Figure 3. S2's Work on Problem 1

Figure 3 and the interview results with S2 reveal strengths and weaknesses in several key areas of mathematical literacy. In terms of communication, S2 was able to explain what was known and asked in the problem clearly. When asked about the details of the problem, S2 correctly identified the lengths of the stairs and the distance from the foot of the first stair to the wall, and also accurately summarized what was being asked, such as the rate of change and the distance from the second stair to the wall. This shows that S2 could fulfill the communication indicator by providing a clear explanation of the problem's elements.

However, S2 struggled with mathematization, as S2 was unable to correctly apply the Pythagorean theorem or define the variables appropriately. When asked about the Pythagorean

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formula and the meaning of the variables, S2 showed a lack of understanding, confusing the variables and not correctly identifying which value to solve for. This difficulty in translating the problem into a mathematical model indicates a gap in S2’s ability to perform the mathematization process.

In terms of designing problem-solving strategies, S2 faced challenges in explaining the steps to solve the problem. Although S2 understood the first step—applying the Pythagorean theorem to find the distance from the foot of the stairs to the wall—S2 was unable to provide further details or complete the solution. Despite these difficulties, S2 demonstrated a better understanding during the interview. With guidance, S2 was able to operate mathematical symbols, mention the correct formulas, and draw the graph accurately. However, S2 struggled with reasoning and argumentation, as they could not provide a full conclusion, offering only partial information about the height of the wall and the distance from the stairs to the wall. This suggests that S2 needs further development in reasoning and making well-supported conclusions based on mathematical calculations.

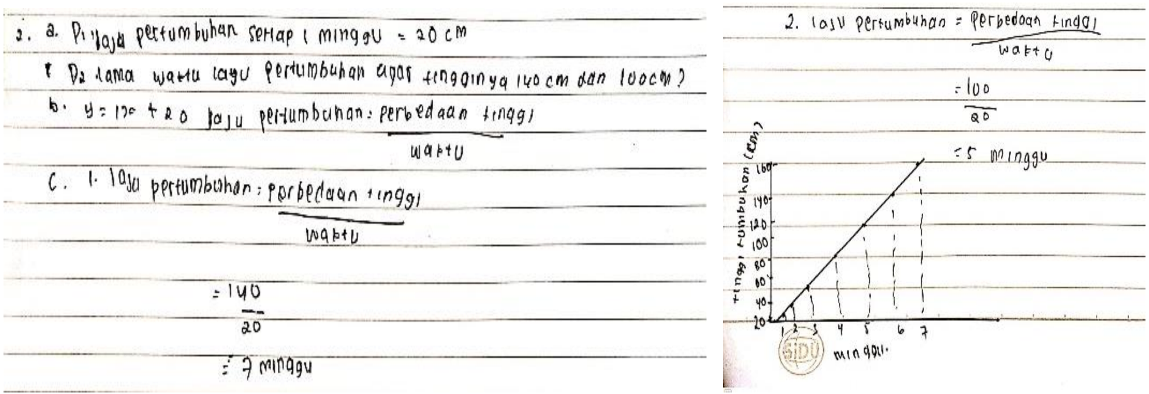

Figure 4. S2's Work on Problem 2

Figure 4 and the interview results with S2 demonstrate progress in communication and reasoning, with some challenges in other areas of mathematical literacy. In terms of communication, S2 was able to clearly explain what was known and what was being asked in the problem. S2 accurately identified the heights of Felix's plant at one and three weeks and summarized the key points of the question, such as determining the time it would take for the plant to reach 140 cm and 100 cm, as well as drawing a graph. This shows that S2 successfully fulfilled the communication indicator by providing a clear explanation of the problem's components.

However, S2 encountered difficulties with mathematization. S2 incorrectly translated the problem into a mathematical model, writing "y = 1x + 20" without fully understanding the relationship between the variables. This indicates that S2 was unable to apply the proper memorization and conversion of the problem into a mathematical form, thus failing to meet the mathematization indicator. S2’s approach was also somewhat rushed, as indicated by the comment,

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"To make it quick," showing a lack of attention to the necessary steps for constructing an accurate model.

S2 showed some strength in designing problem-solving strategies. During the interview, S2 was able to explain the steps taken to solve the problem, including calculating the time for the plant to reach a height of 140 cm and 100 cm, as well as drawing the graph. S2 was also able to use mathematical symbols and correctly draw the graph, fulfilling the indicator of using symbolic, formal, and technical language and operations. Furthermore, S2 successfully provided a conclusion, stating that the plant grows 20 cm each week, which demonstrates the ability to fulfill the reasoning and argumentation indicator. This shows that, while S2 faced challenges with the mathematical model, they were able to reason through the problem and arrive at a conclusion based on the information given.

Mathematical Literacy Skills of Students with Auditory Learning Style

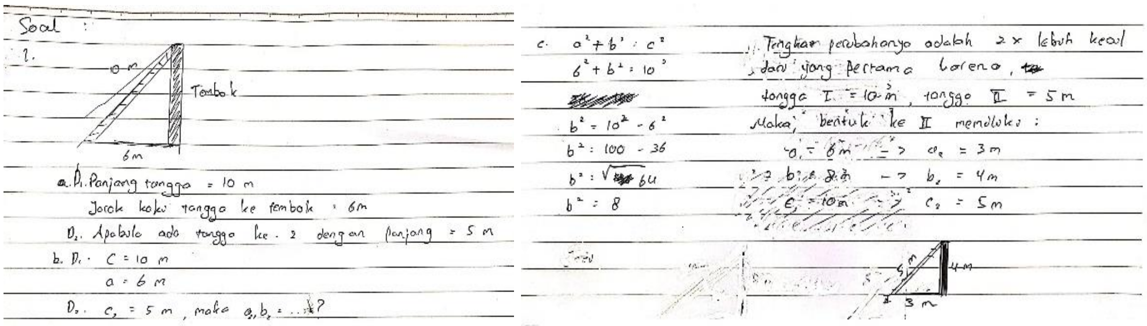

Figure 5. S3's Work on Problem 1

Figure 5 and the interview results with S3 reveal some strengths in communication and mathematization, but also highlight several challenges in other areas of mathematical literacy. In terms of communication, S3 was able to clearly explain the known information and what was being asked. S3 identified the lengths of the first and second staircases and the distance from the foot of the first staircase to the wall, as well as the rate of change, the graph, and the distance of the second staircase to the wall. This indicates that S3 successfully fulfilled the communication indicator, offering a clear verbal explanation during the interview.

Regarding mathematization, S3 demonstrated the ability to memorize and apply the Pythagorean theorem correctly, identifying the correct variables: "a is the distance from the foot of the ladder to the wall," "b is the height of the wall," and "c is the length of the ladder." However, while S3 understood the correct application of the formula, the ability to translate the problem fully into a mathematical model was not completely realized, as S3 struggled with some calculations and lacked clarity in forming precise formulas. This suggests S3 met the mathematization indicator but needed more attention to detail.

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S3 also showed the ability to design problem-solving strategies but faced difficulties in executing them. During the interview, S3 explained using the Pythagorean formula to find the height of the wall but did not consider calculating the rate of change, indicating a gap in the strategy's precision. S3 also struggled with drawing the graph correctly, which affected the ability to fulfill the indicator of using symbolic, formal, and technical language and operations. Furthermore, S3 could not provide a clear conclusion, stating, "The rate of change is difficult," showing an inability to fulfill the reasoning and argumentation indicator. While S3 demonstrated understanding in some areas, the lack of precision in both calculation and reasoning prevented full success in the indicators for mathematical literacy.

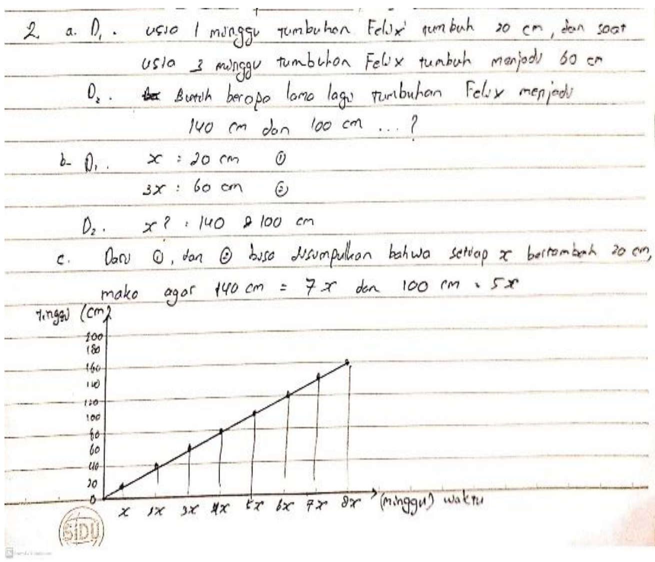

Figure 6. S3's Work on Problem 2

Figure 6 and the interview results with S3 show several strengths in communication and mathematization, but also some challenges in other areas of mathematical literacy. In terms of communication, S3 was able to clearly explain the known information and what was being asked. For example, when asked about what was known from question number 2, S3 accurately responded: "1-week-old plant is 20 cm tall, 3 weeks tall is 60 cm." S3 also correctly identified what was asked, including the time it would take for the plant to reach a height of 140 cm and 100 cm, as well as the need to draw a graph. This indicates that S3 successfully fulfilled the communication indicator by providing a clear and concise verbal explanation during the interview.

Regarding mathematization, S3 was able to correctly apply the relevant formulas to solve the problem. S3 memorized and used the correct approach, such as in calculating the time needed for the plant to grow to a height of 140 cm and 100 cm. For example, S3 used the formula "140 = 20x" to calculate that the time required for the plant to reach 140 cm was 7 weeks. This demonstrates that S3 met the mathematization indicator by translating the problem into a mathematical model

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and performing the necessary calculations. However, some minor issues arose with precision in forming formulas, indicating that more attention to detail was needed.

S3 also demonstrated the ability to design problem-solving strategies and use symbolic, formal, and technical language and operations. For example, S3 clearly explained the steps to solve the problem and used appropriate mathematical symbols. However, S3 struggled with some aspects of the problem-solving process, such as drawing the graph correctly and providing a well-structured conclusion. When asked about the conclusion, S3 said, "Felix's plant grows 20 cm tall every week," but this conclusion lacked deeper reasoning. This suggests that while S3 showed competence in applying mathematical methods, there was room for improvement in reasoning and argumentation. The lack of a more thorough explanation reflects a gap in the reasoning and argumentation indicator, preventing S3 from fully succeeding in this area of mathematical literacy.

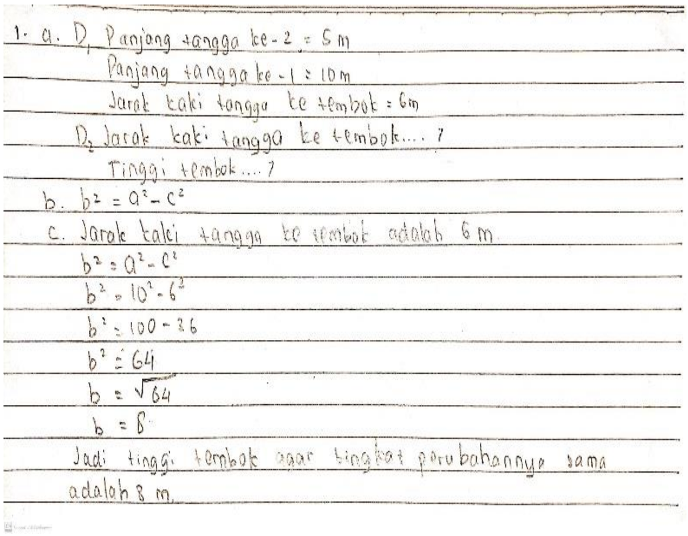
1. a. D1 Panjang tangga ke-2 = 5 m
Panjang tangga ke-1 = 10 m
Jarak kaki tangga ke tembok = 6m
D2 Jarak kaki tangga ke tembok.... ?
Tinggi tembok.... ?
b. $b^2 = a^2 - c^2$
c. Jarak kaki tangga ke tembok adalah 6 m.
$b^2 = a^2 - c^2$
$b^2 = 10^2 - 6^2$
$b^2 = 100 - 36$
$b^2 = 64$
$b = \sqrt{64}$
$b = 8$
Jadi tinggi tembok agar tingkat perubahannya sama adalah 8 m.

Figure 7. S4's Work on Problem 1

Figure 7 and the interview results with S4 reveal some strengths in communication, but also significant challenges in other areas of mathematical literacy. In terms of communication, S4 was able to explain the known information and what was being asked. For instance, when asked about the details of question number 1, S4 correctly identified that the first staircase is 10 m long, the second is 5 m, and the distance from the foot of the first staircase to the wall is 6 m. S4 also identified what was being asked, including the rate of change, the graph, the distance from the foot of the stairs to the wall, and the height of the wall. This indicates that S4 successfully fulfilled the communication indicator by providing a clear verbal explanation during the interview.

However, S4 faced difficulties with mathematization, as indicated by the inability to memorize or convert the problem into a mathematical model. When asked about the formula used, S4 mentioned "Phytagoras," but did not apply it correctly. S4 also struggled with explaining the steps to solve the problem, such as calculating the rate of change and drawing the graph, which

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highlights a lack of clarity and precision in translating the problem into mathematical language. This suggests that S4 did not fulfill the mathematization indicator and needed further support to strengthen the ability to translate word problems into appropriate mathematical formulas and models.

S4's difficulties extended to designing problem-solving strategies, using symbolic, formal, and technical language and operations, and providing reasoning and argumentation. While S4 could not recall the correct formula for the rate of change and struggled with symbolic notation, S4 was able to draw the graph correctly. However, this was not sufficient to meet the required indicators. Furthermore, S4 was unable to provide a conclusion, stating that the distance from the foot of the ladder to the first wall is 4, which did not reflect a correct or reasoned conclusion. This highlights that S4 was unable to fulfill the reasoning and argumentation indicator, as the conclusion was not based on logical reasoning or supported by the mathematical work done during the interview.

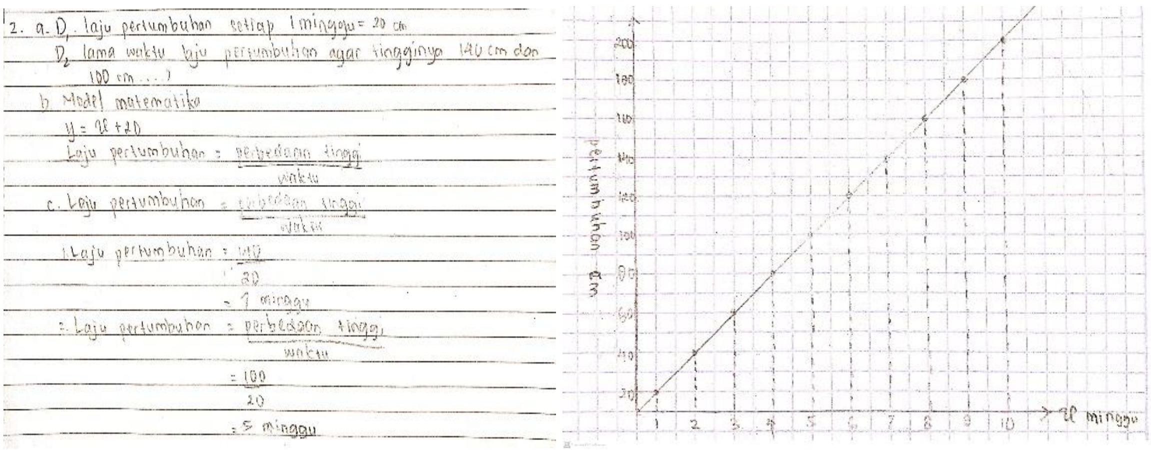

Figure 8. S4's Work on Problem 2

Figure 8 and the interview results with S4 show some strengths in communication, but also reveal challenges in other aspects of mathematical literacy. In terms of communication, S4 was able to explain clearly what was known and what was being asked in the problem. When asked about the known information, S4 correctly stated that the plant height in 1 week is 20 cm and in 3 weeks is 60 cm. S4 also identified what was being asked, such as how long it would take for the plant to reach 140 cm and 100 cm, and the need to draw a graph consistent with the given information. This demonstrates that S4 was able to fulfill the communication indicator by providing clear verbal explanations during the interview.

However, S4 struggled with mathematization, as evidenced by the difficulty in converting the question into a mathematical model. When asked about the formula written, S4 responded with "y = x + 20," explaining that the plant grows 20 cm every week. While this is a reasonable interpretation of the growth pattern, S4 could not fully develop it into a clear mathematical model,

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indicating that the mathematization indicator was not fully met. S4 also demonstrated limited ability to recall and apply the necessary formulas to solve the problem.

On the other hand, S4 was able to demonstrate an understanding of designing problem-solving strategies. When asked about the steps to solve the problem, S4 clearly outlined the process: first, find the time required for the plant to grow to 140 cm and 100 cm, and then draw the graph. Additionally, S4 was able to use symbolic, formal, and technical language and operations to operate mathematical symbols correctly and draw the graph appropriately. S4 also provided a correct conclusion, stating, "The plant grows 20 cm tall every week," which fulfilled the reasoning and argumentation indicator. While S4 showed some weaknesses in the application of mathematical models, the reasoning process was generally sound, and S4 met the expectations for reasoning and argumentation.

Mathematical Literacy Skills of Students with Kinesthetic Learning Style

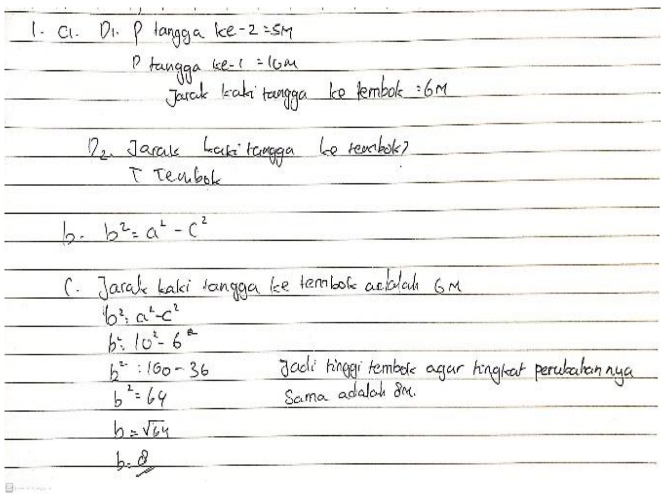

Figure 9. S5's Work on Problem 1

Figure 9 and the interview results with S5 reveal some strengths in communication, but challenges in several other aspects of mathematical literacy. In terms of communication, S5 was able to verbally explain the known information and what was being asked in the problem. When asked about the known information, S5 correctly identified the lengths of the two staircases and the distance from the foot of the first staircase to the wall. S5 also accurately stated what was being asked, including the rate of change, the graph, and the height of the wall for the 5-meter staircase. This shows that S5 successfully fulfilled the communication indicator during the interview by providing clear verbal explanations.

However, S5 struggled with mathematization, as they were not able to fully convert the problem into a mathematical model in writing, although they managed to do so during the interview. S5 recalled the Pythagorean theorem, correctly identifying the variables (a as the base, b

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as the height of the wall, and c as the length of the stairs). Despite this, S5 had difficulty fully translating the problem into a proper mathematical sentence and was unable to recall the correct formula at first. This suggests that S5's ability to meet the mathematization indicator was incomplete.

S5 also faced challenges in designing problem-solving strategies. When asked to explain the steps for solving the problem, S5 mentioned using the Pythagorean formula to find the height of the wall but was unable to provide further details or proceed with the solution. S5 did not draw the graph and admitted to being careless when writing the formula. While S5 was able to use symbolic, formal, and technical language and operations correctly in parts, such as recalling the Pythagorean formula, they struggled with the actual application and visualization of the problem. S5 was also unable to provide conclusions during the interview, which meant that they did not fulfill the reasoning and argumentation indicator. Thus, while S5 showed some understanding of key concepts, their overall performance did not meet the expected indicators for designing problem-solving strategies, reasoning, and argumentation.

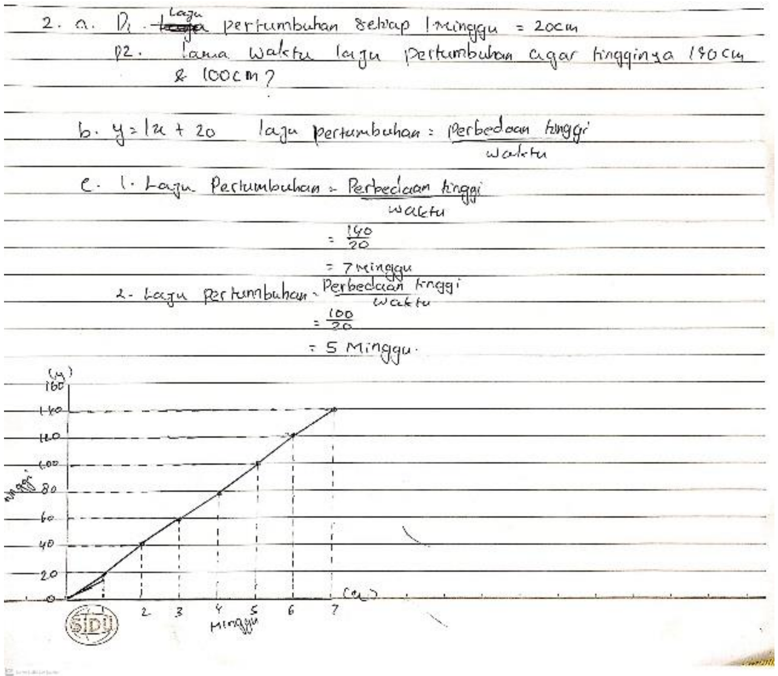

Figure 10. S5's Work on Problem 2

Figure 10 and the interview results with S5 demonstrate some strengths in communication, but several challenges in other aspects of mathematical literacy. In terms of communication, S5 was able to clearly explain the known information and what was being asked. S5 identified the plant's height at one and three weeks as well as the key question: how long it would take for Felix's plant to reach 140 cm and 100 cm in height, and whether the graph was consistent with this

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information. This shows that S5 successfully fulfilled the communication indicator by providing clear verbal explanations during the interview.

However, S5 struggled with mathematization. Although S5 wrote the equation "y = 1x + 20," they were unable to fully convert the word problem into a proper mathematical model. S5 also struggled to articulate why this equation was chosen, stating that it was done "just because." Additionally, while S5 identified x as the plant height and y as time, the equation itself did not effectively model the problem. This suggests that S5 had difficulty fulfilling the mathematization indicator and lacked a clear understanding of how to translate the situation into a mathematical representation.

S5 also encountered difficulties in designing problem-solving strategies. When asked to explain the first step to solve the problem, S5 remained silent, indicating an inability to plan a structured approach to the solution. While S5 was able to operate mathematical symbols and draw a graph, they did not provide a coherent strategy for solving the problem. Furthermore, S5 could not provide conclusions during the interview, instead offering the word "multiples," which was not relevant to the problem at hand. As a result, S5 was unable to meet the indicators of reasoning and argumentation. Overall, while S5 showed some ability in communication and symbolic operations, the lack of a solid problem-solving strategy and unclear reasoning meant they did not fully meet the expectations for mathematical literacy.

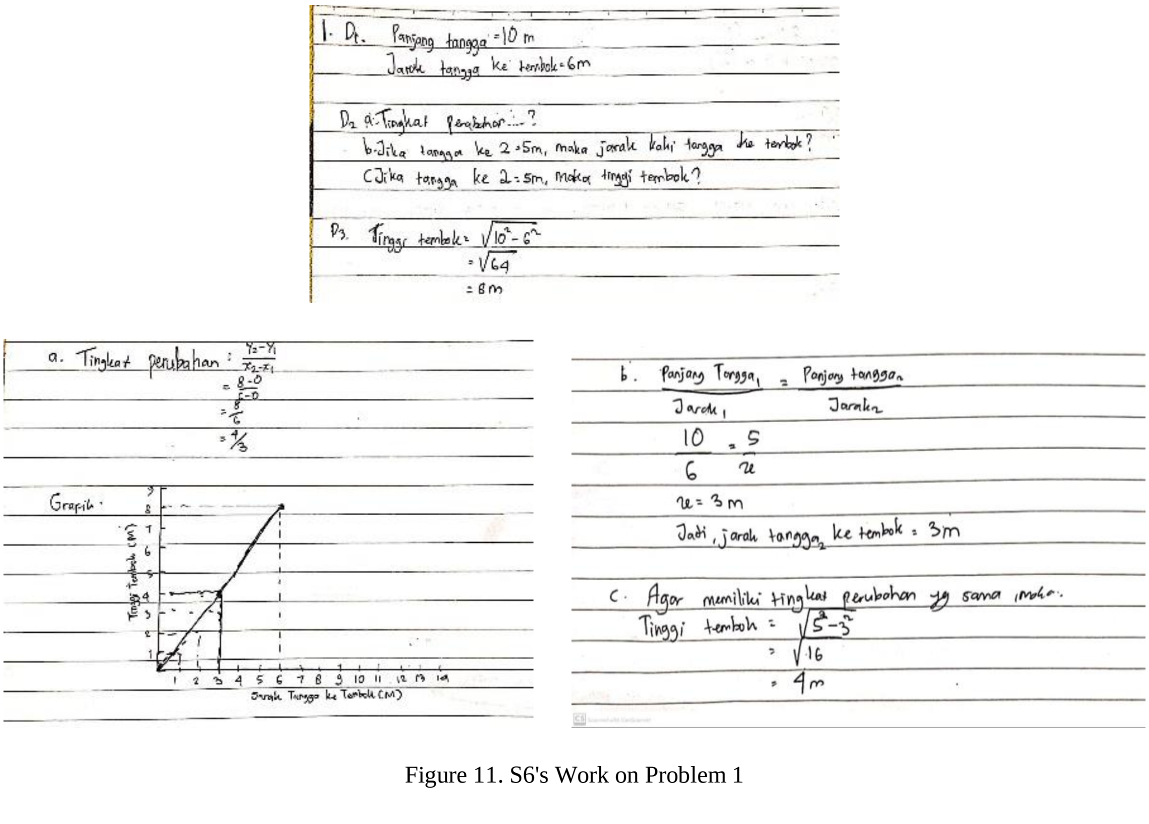

Figure 11. S6's Work on Problem 1

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Figure 11 and the interview results with S6 reveal a mix of strengths and challenges in different areas of mathematical literacy. In terms of communication, S6 was able to clearly explain the known information, including the lengths of the stairs and the distance from the foot of the first staircase to the wall. S6 also provided a clear explanation of the question being asked, which was to find the rate of change and calculate the relevant distances and wall height for the second ladder to maintain the same rate of change. This indicates that S6 successfully fulfilled the communication indicator by offering clear verbal explanations during the interview.

S6 demonstrated competence in mathematization by memorizing and correctly applying the Pythagorean and gradient formulas. When prompted to explain the variables used, S6 correctly identified the distance from the foot of the ladder to the wall as "a," the height of the wall as "b," and the length of the ladder as "c." This suggests that S6 fulfilled the mathematization indicator by effectively translating the problem into a mathematical model.

In terms of designing problem-solving strategies, S6 was able to articulate a clear plan for solving the problem. The strategy involved using the Pythagorean formula to find the wall's height, applying the gradient formula to find the rate of change, drawing a graph, and determining the necessary distances for the second ladder. This demonstrates that S6 was able to meet the designing problem-solving strategies indicator. Furthermore, S6 was able to use symbolic, formal, and technical language and operations appropriately, including correctly applying the Pythagorean and gradient formulas and drawing a graph.

However, despite these strengths, S6 struggled to provide a conclusive answer. Although they offered the statement that "the numbers must be multiples so that the rate of change is the same," this conclusion lacked clarity in its connection to the problem's requirements. Nonetheless, this shows that S6 was able to meet the reasoning and argumentation indicator, albeit in a less precise manner. Overall, S6 demonstrated proficiency in several areas of mathematical literacy, but the conclusion could have been more thorough and better supported by logical reasoning.

Figure 12 and the interview results with S6 show strong communication skills. S6 was able to clearly explain what is known from the problem, such as the plant's height at different weeks, and what was being asked, namely, finding the time for the plant to reach certain heights (140 cm and 100 cm) and drawing the corresponding graph. This demonstrates that S6 fulfilled the communication indicator by providing clear and accurate oral explanations.

S6 also succeeded in fulfilling the mathematization indicator by converting the word problem into a mathematical model. S6 correctly identified the variables y for plant height and x for time, and formed the equation $y = 20x$ based on the given data (the plant grows 20 cm every

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week). This shows that S6 met the mathematization indicator by converting the word problem into an appropriate mathematical expression.

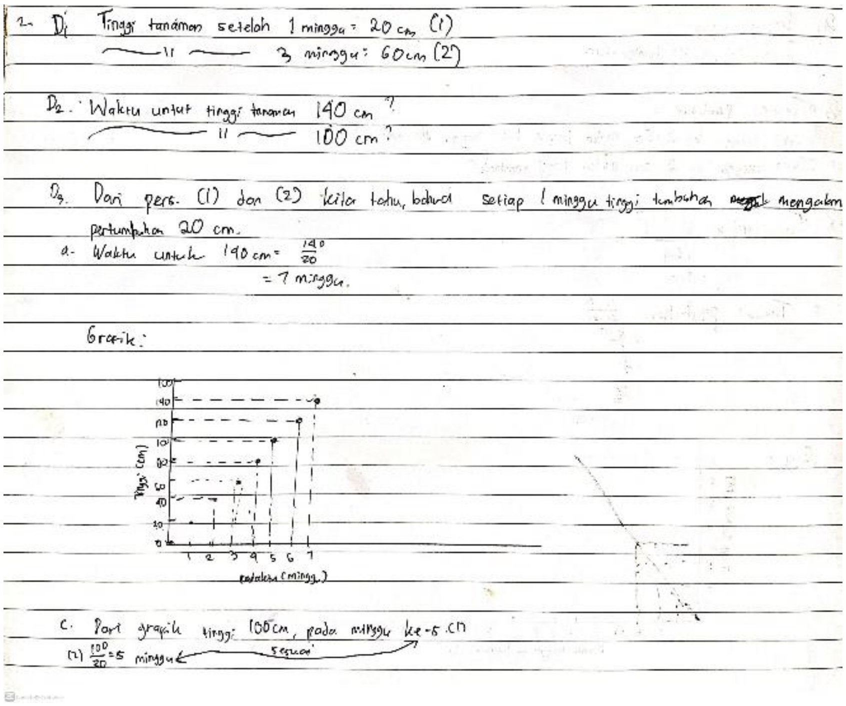

Figure 12. S6's Work on Problem 2

Regarding problem-solving strategy, S6 demonstrated a clear understanding of how to solve the problem. S6 identified the steps to find the time for the plant to reach 140 cm (7 weeks) and 100 cm (5 weeks), and explained how to plot the corresponding graph. S6 was also able to use symbols, formal language, and mathematical operations accurately. In conclusion, S6 fulfilled the indicators for designing a problem-solving strategy and using symbolic and technical mathematical language and operations.

Table 2. The Results of Identification of Mathematical Literacy Indicators

No	Mathematical Literacy Skills	Visual				Auditorial				Kinesthetic			
		S1		S2		S3		S4		S5		S6	
		Question Number											
		1	2	1	2	1	2	1	2	1	2	1	2
1	Communication	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Mathematization	×	×	×	×	✓	✓	×	×	✓	×	✓	✓
3	Designing Problem-Solving Strategies	×	×	×	✓	✓	✓	×	✓	×	×	✓	✓
4	Use of Symbolic, Formal, and Technical Language and Operations	✓	✓	✓	✓	×	✓	×	✓	✓	✓	✓	✓
5	Reasoning and Argumentation	×	✓	×	✓	×	✓	×	✓	×	×	✓	✓

Based on Table 2, communication skills shows strong engagement across all learning styles (visual, auditorial, and kinesthetic), with nearly all students actively participating in tasks related to communication skills. This indicates that communication can be effectively mastered by all types of learners. Students with an auditorial learning style are able to fulfill communication skills best, this is in line with other research (Annur et al., 2018). In contrast, mathematization shows lower

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engagement among visual and kinesthetic learners, with only a few students actively participating in tasks related to mathematical thinking. Auditorial learners, on the other hand, exhibit better engagement, suggesting that the auditorial style may be more conducive to engaging with mathematical processes compared to visual and kinesthetic styles. This finding is contrast with previous research that state students with kinesthetic learning styles are able to write down memorization and mathematical models (Mahmudin et al., 2023).

Designing problem-solving strategies sees good participation from auditorial and kinesthetic learners, with these students demonstrating strong abilities in devising strategies. While visual learners are somewhat involved, their engagement is not as strong as the other two styles, indicating that kinesthetic learners, who tend to focus more on physical activity, may be more easily involved in solving problems that require hands-on activities. Use of symbolic, formal, and technical language and operations shows excellent engagement across all learning styles, with all students demonstrating strong skills in using symbolic and formal language, suggesting that mathematical language is accessible to a variety of learning styles. Finally, reasoning and argumentation is an area where auditorial and kinesthetic learners perform better, with these learners actively participating in argumentative and reasoning tasks. Visual learners, while still engaged, show somewhat weaker performance in this area, with some students demonstrating lower levels of involvement in reasoning and argumentation-related tasks. However, previous study found that students with visual learning styles could fulfill all indicators of mathematical literacy skills, while students with auditorial and kinesthetic learning styles only fulfill some indicators (Azizah et al., 2019).

CONCLUSION

In conclusion, auditorial and kinesthetic learners show strong engagement across most indicators, particularly in mathematization, designing problem-solving strategies, and reasoning and argumentation. Visual learners, while strong in communication and use of symbolic language, face greater challenges in mathematization and reasoning and argumentation. Overall, kinesthetic and auditorial styles excel in tasks that require practical application or verbal discussion, while visual learners thrive in activities that involve symbolic or visual representation.

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