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Analysis of Students' Mathematical Reasoning in Triangles by Learning Style Preferences

Rakha Pradestya*, Sudirman, Ardi Dwi Susandi
Master's Program in Mathematics Education, Universitas Terbuka, Indonesia
*530084086@ecampus.ut.ac.id

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Abstract

This study analyzes students' mathematical reasoning abilities concerning triangles and special lines, considering their individual learning styles. The qualitative case study was conducted at Khalifah Boarding Junior High School, involving three grade VIII students representing visual, auditory, and kinesthetic learning styles. The selection of these students was based on their learning style preferences identified through a questionnaire. Data collection included mathematical ability tests and interviews, which were then analyzed by triangulating answer sheet observations and interview findings. Initial data revealed a distribution of 50% visual learners, 42% auditory learners, and 8% kinesthetic learners. Subjects were purposively selected based on the highest scores in each learning style group. The subjects demonstrated differences in understanding and approaching problem-solving, influenced by their learning styles. This study highlights specific challenges and recommendations for each subject, emphasizing the importance of a tailored learning approach to improve mathematical understanding and problem-solving skills. The research underscores the significance of recognizing and accommodating diverse learning styles to optimize students' academic achievements in mathematics.

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INTRODUCTION

Mathematics as a universal science that underlies the development of modern technology and plays an important role in various disciplines is an important foundation in the development of human thinking (Leonard, 2013). Therefore, mathematics education provides the ability to use calculations or formulations, accompanied by reasoning and analysis skills in solving everyday problems (Mukhlis et al., 2024). Reasoning ability is a thinking process to find relationships between facts and produce conclusions (Cindyana et al., 2022). Reasoning ability is key in learning mathematics. Reasoning allows students to find and connect elements contained in the learning process, resulting in a more complex understanding. Even in the critical thinking indicators proposed by Susandi (2020), reasoning is defined as the ability to provide reasons based on relevant facts or evidence at each step in decision making. This strengthens the argument of how important reasoning skills are in mathematics for students.

Mathematical reasoning has a wide impact in students' daily lives and academic development. It improves problem-solving skills, develops critical thinking skills, prepares students for the future, increases independence, and encourages creativity. Indicators of mathematical reasoning that will be examined in this study, according to Mullis et al. (2009), include the abilities of analysis, generalization, synthesis, justification, and non-routine problem solving. These abilities include analyzing information, making generalizations, connecting concepts, providing evidence, and solving problems in various contexts.

Although the importance of mathematical reasoning has been recognized by teachers, many students have difficulty learning mathematics. These difficulties are caused by various factors, including difficulty in understanding abstract mathematical concepts (Damayanti & Qohar, 2019), a rigid learning approach that is less connected to the real world (Dahlan, 2018), and a lack of opportunities for students to find their own solutions. These factors cause Indonesian students to have low mathematical reasoning ability. The difficulties experienced by each student due to the low mathematical reasoning ability of students cannot be separated from how good the student's cognitive abilities are. Students experience difficulties when they have not reached the required level of cognitive ability (Pradestya et al., 2020). Based on the results of PISA data, the mathematical reasoning ability of Indonesian students is still low, below the international average. In 2015, Indonesia was ranked 63 out of 70 countries (OECD, 2016), then in 2018 it was ranked 73 out of 79 countries (OECD, 2019), and in 2022 it was ranked 68 out of 81 countries (OECD, 2023). This low ability is caused by various factors, including difficulty in representing mathematical abstraction, so that students are unable to understand what is being learned. The majority of Indonesian students have not achieved high-level thinking cognitive abilities (levels 5 and 6) (OECD, 2023).

Field evidence also shows that Indonesian students have difficulty in mathematical reasoning. A pilot test of mathematical reasoning questions on 12 students showed that none of them achieved 50% of the maximum score, with scores ranging from 15-30. Students admitted to having difficulties in analyzing new situations, generalizing, synthesizing, making logical assumptions, explaining ideas, giving proper reasons, and making conclusions. They also admit that the conventional learning they receive only makes them follow what the teacher does, without digging up information and connecting information themselves in solving problems.

Various studies have been conducted to address the problem of low mathematical reasoning ability. Learning models such as Problem Based Learning, the Indonesian Realistic Mathematics Approach, Lesson Study for Learning Community, the Novick learning model, Connected Mathematics Project, and Discovery Learning have been implemented (Marfu'ah et al., 2022). However, the fact that low mathematical reasoning ability is still not resolved suggests that a more comprehensive approach is needed. Factors that contribute to low mathematical reasoning ability, according to Aprilianti and Zanthy (2019) are that students easily forget the material they have learned, do not have ideas for solving problems, lack accuracy in understanding the problems in the problem, do not understand which formula to use in solving the problem, and do not understand the concept of the material.

Many studies have tried to answer the factors. Especially since the implementation of the Independent Curriculum in schools. The Independent Curriculum encourages the use of differentiated learning models to accommodate differences in student characteristics in learning. Research by Nur'azizzah et al. (2023) shows that mathematical reasoning abilities can increase after the implementation of differentiated learning that considers students' learning styles. By implementing differentiated learning, namely learning that is adjusted by prioritizing differences in students' interests, potential, and talents, learning will be more meaningful and more effective. By paying attention to the diversity of ways students learn (Yuwanita et al., 2020), learning will be more useful. Learning that suits students' learning styles will be easier to understand (Supit et al., 2023). However, this evidence needs to be explored further to ensure that this conclusion applies comprehensively. Therefore, research is needed that analyzes students' mathematical reasoning abilities based on their learning styles.

The urgency of this research is to dig deeper into the strengths and weaknesses of students with their respective learning styles related to their mathematical reasoning abilities. The results of this study are expected to help each teacher in recognizing students who have different learning styles so that teachers can design learning that can accommodate the needs of each student.

RESEARCH METHODS

This research used a qualitative approach with a case study method to understand students' mathematical reasoning abilities based on their learning styles. Data were collected through mathematical reasoning ability tests and interviews with the research subjects. The research was conducted at Khalifah Boarding School Junior High School, Sukabumi Regency, West Java, involving three grade VIII students who have different learning styles. The selection of research subjects was based on purposive sampling techniques, by selecting the highest scores in the learning style group determined through a learning style questionnaire. The research instruments include a learning style questionnaire, mathematical reasoning test sheet, and interview guidelines that have been validated by experts. The classification of students' learning styles was determined based on the scores obtained in the questionnaire, with a tendency to one learning style seen from the largest score in each student.

Measuring and analyzing students' mathematical reasoning ability in the context of triangle material and special lines in triangles was carried out using a mathematical reasoning test instrument. This test instrument is designed to measure the achievement of the previously described indicators of mathematical reasoning ability, namely analysis, generalization, synthesis, justification, and non-routine problem solving. The administration of this test instrument will be carried out for all students who become research subjects, and the data obtained will be analyzed to determine the level of students' mathematical reasoning ability on each indicator.

The last step in this research is an interview with each research subject to explore the factors that hinder the development of their mathematical reasoning skills. The following are the interview guidelines. The data that has been collected will be analyzed through triangulation. Triangulation is a data analysis technique that combines information contained from various data that has been collected through predetermined data collection methods. Data triangulation in this study is by connecting observations of students' answers to the mathematical reasoning ability test and interviews. The results of the analysis will be in the form of a description of each research subject that has been determined based on the procedure for determining the research subject using a student learning style questionnaire. In summary, the flow of data analysis can be described as follows.

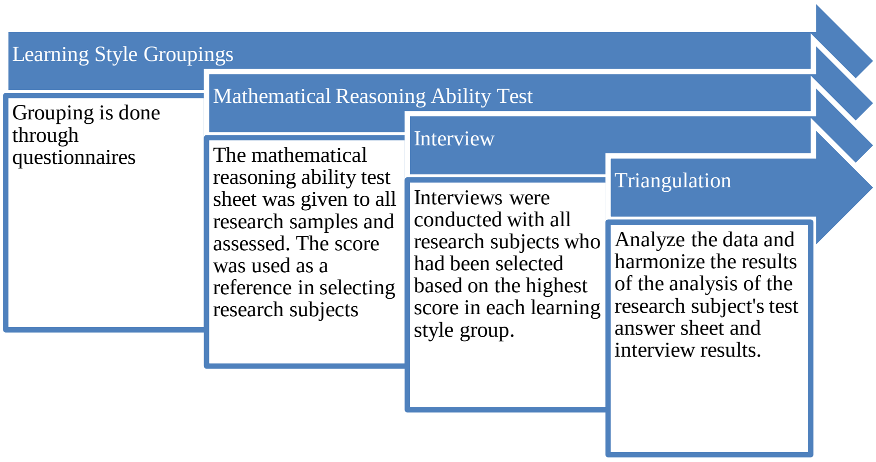


Figure 1. Data analysis flow

RESEARCH RESULTS

Initial data is obtained from the results of the learning style questionnaire acquisition score. The learning style questionnaire was given to 12 students through a questionnaire sheet when learning took place. The learning style with the highest score in the questionnaire shows the learning style of each student. The following is the learning style data obtained.

Table 1. Learning styles groupings

Learning style	Student code
Visual	S1, S2, S4, S6, S9, S12
Auditory	S3, S5, S7, S8, S11
Kinesthetic	S10

Analysis of the learning style questionnaire data shows that this class is dominated by students with auditory and visual learning styles, which indicates that most students in this class absorb information more easily through hearing and vision. On the other hand, there is only one student with a kinesthetic learning style. Figure 2 is a summary of data regarding learning styles generated from the learning style questionnaire given to students.

After the learning style groups were formed, all students were given a mathematical reasoning ability test so that the scores obtained by the samples became the basis for determining the research subjects.

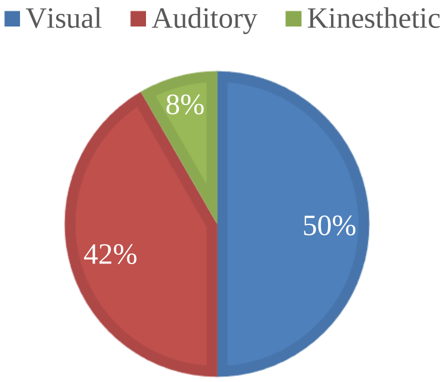


Figure 2. Graph of students learning styles

The selection of research subjects was carried out by purposive sampling. Purposive sampling is a non-random sampling method where researchers ensure the citation of illustrations through a method of determining a special identity that matches the research objectives so that it is expected to be able to respond to research cases (Lenaini, 2021). Since what will be studied is the difference in mathematical reasoning abilities possessed by students with different learning styles, the research subjects were selected based on the highest scores on the mathematical reasoning ability test in each learning style group except for the kinesthetic learning style group because only one sample was included in it. The purpose of selecting research subjects by considering the highest scores is to analyze the mathematical reasoning abilities of the best students from each learning style group. The following is the score of each student.

Table 2. Acquisition of mathematical reasoning ability test score

Learning Style	Student code (Test score)
Visual	S1 (40), S2 (24), S4 (31), S6 (31), S9 (33), S12 (71)
Auditory	S3 (27), S5 (51), S7 (42), S8 (54), S11 (56)
Kinesthetic	S10 (89)

Based on Table 2, three research subjects were selected with the provision that these students get the highest score in each learning style group. The three students who were used as research subjects were Student 12 (S12) as Subject 1 (SC1) with visual learning style, Student 11 (S11) as Subject 2 (SC2) with auditory learning style, and Student 10 (S10) as Subject 3 (SC3) with kinesthetic learning style.

The next step is to analyze the answer sheets of the research subjects that have been selected. The analysis was carried out by matching the answers of the research subjects on each item with indicators of mathematical reasoning ability. The results of the analysis showed that all research subjects met the analysis and generalization indicators in question numbers 1a and 1b, showing the ability to understand the question and provide answers in accordance with the question request. However, only SC2 achieved the synthesis indicator in these two problems, showing the ability to connect information to conclude in a more complex manner.

In question 1b, SC1 also achieved the justification indicator by including a sketch drawing as evidence. In problem 1c, SC2 did not achieve the analysis and generalization indicators, but achieved the synthesis and justification indicators. SC1 achieved the analysis, generalization, and justification indicators, but did not achieve synthesis. SC3 achieved all indicators in this problem. Problem number 2 was only answered by SC1 and SC3, with SC1 achieving the justification indicator and SC3 achieving the synthesis indicator. SC2 did not answer this question.

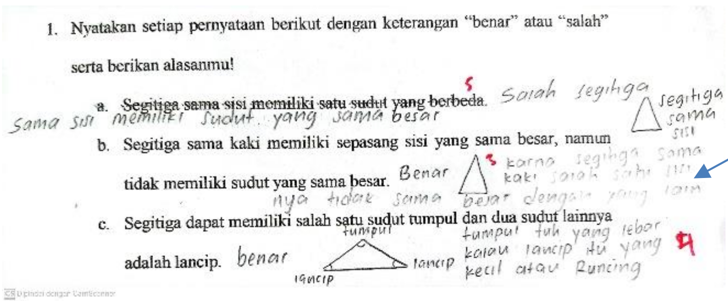
Problem number 3, which is a story problem (contextual) to measure non-routine problem solving ability, was answered by SC2 and SC3, showing their ability to solve non-routine problems. SC1 only achieved the generalization indicator, indicating difficulty in solving non-routine problems. To strengthen or weaken the observation results, interviews with the research subjects will be conducted to clarify their answers and understand more deeply their mathematical reasoning ability.

SC1 is a student with a visual learning style. The following is a recap of the observation results of SC1's answers to each item given.

Table 3. Observation results of SC1

Indicator	Question Item				
	1(a)	1(b)	1(c)	2	3
Analysis	✓	✓	✓	✓	✓
Generalization	✓	✓	✓	✓	✓
Synthesis	-	-	-	✓	-
Justification	-	✓	✓	✓	-
Non-routine problem solving	-	-	-	-	-

The observation result in Table 3, it is evidenced by SC1's answer in Figure 3.


1. Nyatakan setiap pernyataan berikut dengan keterangan "benar" atau "salah" serta berikan alasanmu!
   a. ~~Segitiga sama sisi memiliki satu sudut yang berbeda.~~ Salah segitiga sama sisi memiliki sudut yang sama besar
   b. Segitiga sama kaki memiliki sepasang sisi yang sama besar, namun tidak memiliki sudut yang sama besar. Benar karna segitiga sama kaki salah satu sisinya tidak sama besar dengan yang lain
   c. Segitiga dapat memiliki salah satu sudut tumpul dan dua sudut lainnya adalah lancip. benar tumpul tuh yang lebar kalau lancip itu yang kecil atau runcing

SC1 made a mistake in connecting his explanation with the chosen answer (synthesis). SC1 understood that in an isosceles triangle there is one side that has a different length from the other two sides. However, SC1 confirmed that the statement in the statement was wrong.

Figure 3. The SC1's answer to question number 1

Analysis of SC1's answer to question number 1 showed that he was able to understand the question, analyze, and generalize the argument well. However, SC1 showed weakness in synthesizing the decomposed facts into a more complete explanation. Nonetheless, the clarification given by SC1 in the interview showed that he had a deeper understanding than was apparent in his written answer. Here is a little excerpt of the interview:

R : *You don't understand the relationship of two equal sides forming two equal angles in an isosceles triangle?*

SC1 : *I do, sir. But I don't think it needs to be written down, because I think it's enough to explain it and give a sketch of the drawing. That's clear to me.*

Based on the interview excerpt, it can be said that SC1 did not understand the relationship between the facts that were still decomposed, but SC1 with a visual learning style felt sufficient to explain using the sketch of the Figure given on the answer sheet. So it can be concluded that SC1's synthesis ability is good, it's just not illustrated in the answers given. Next is question item number 2.

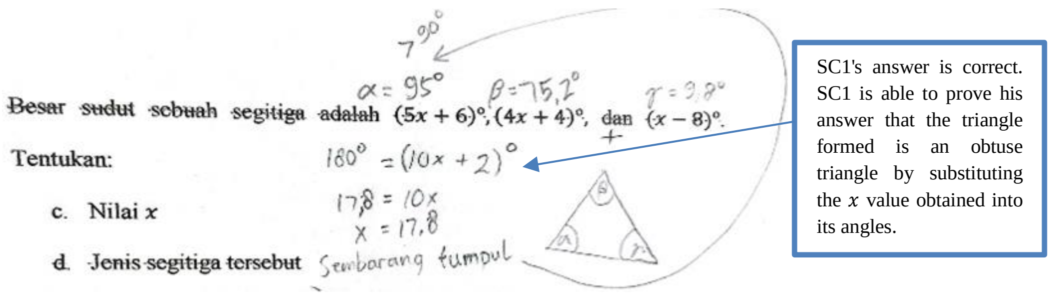


Figure 4. The SC1's answer to question number 2

Based on Figure 4, it is evident that SC1 was able to answer completely equipped with the evidence needed, even though the sketch of the Figure shown did not match the amount of angle obtained from the answer. SC1 was able to find the value of x by first connecting the knowledge related to the total angles of the triangle which amounted to 180° with the angles whose x values were unknown. SC1 was also able to determine the magnitude of each angle after knowing the x value. SC1 was also able to determine that the triangle formed was an obtuse triangle, as evidenced by the direction of the arrow pointing to one of the obtuse angles, namely 95°. This proves that SC1 has also been able to solve problem number 2 and prove his answer, so SC1 has reached the “justification” indicator in mathematical reasoning ability. Next is question number 3.

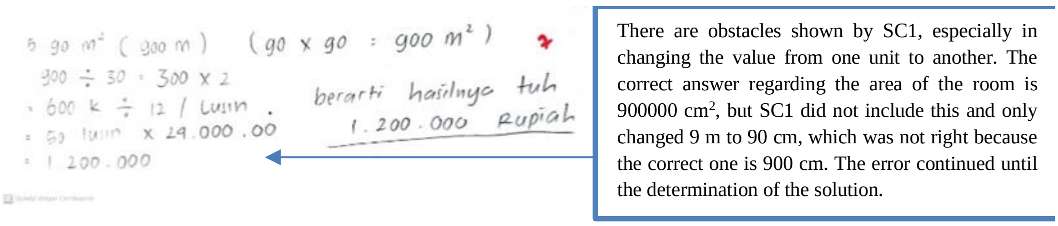


Figure 5. The SC1’s answer to question number 3

Based on Figure 5, SC1 was able to analyze the information needed to solve problem item number 3. SC1 was also able to utilize a general understanding of unit ladder comparison to solve this problem. However, there was a slight mistake, namely not paying attention to the power of two in the unit so that the area of the room was not correct. The correct answer regarding the area of the room is 900000 cm^2, but SC1 did not include that and only changed 9 m to 90 cm and even then it was not correct because the correct one is 900 cm. SC1 also did not utilize the information on the length of the base and height of the triangular ceramic correctly so that the problem solving was not as it should be. This indicates that the synthesis did not go well in solving problem number 3, resulting in the evidence given was not correct. Based on the Figure, SC1 was unable to solve non-routine problems such as question number 3. This is corroborated by SC1's explanation in the interview which states that the most difficult problem is question number 3.

R	:	*Which problem was the hardest?*
SC1	:	*Number 3, sir!*
R	:	*Why?*
SC1	:	*I can't imagine it, sir. There are no figures, so it's hard to imagine. So it's hard to get there.*
R	:	*But can you answer like this? Why not check it again?*
SC1	:	*Yes sir because from the beginning I wasn't sure so I just did it*

Based on the explanation and interview excerpts, it can be concluded that SC1 with a visual learning style had difficulty in solving the non-routine problem. The reason presented was because the item was not accompanied by a sketch of the Figure and was not sure from the beginning of the work.

SC2 is a student who has an auditory learning style. The following is a recap of the observation results of SC2's answers to each item given.

Table 4. Observation results of SC2

Indicator	Question Item				
	1(a)	1(b)	1(c)	2	3
Analysis	✓	✓	-	-	✓
Generalization	✓	✓	-	-	✓
Synthesis	✓	✓	✓	-	✓
Justification	-	-	✓	-	✓
Non-routine problem solving	-	-	-	-	✓

The observation result in Table 4, it is evidenced by SC2's answer in Figure 6.

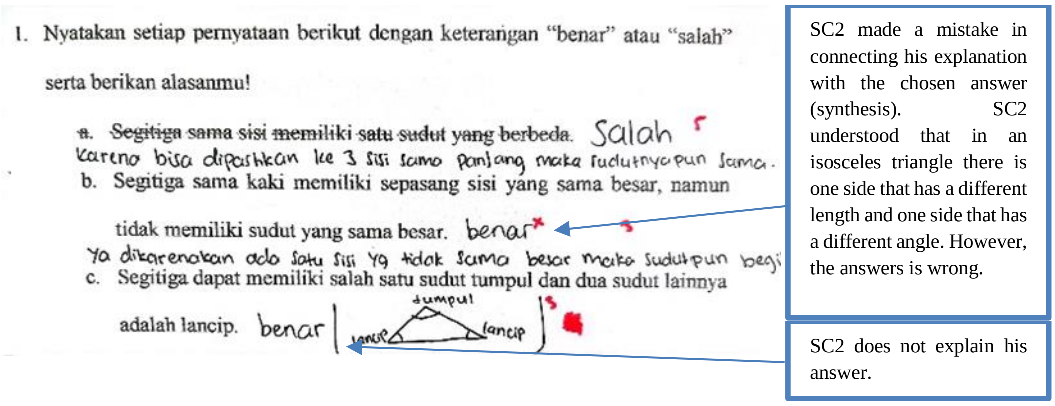


Figure 6. The SC2's answer to question number 1

SC2 showed the ability to analyze, generalize, and synthesize in questions 1a and 1b. He was able to connect the relationship between sides and angles in equilateral and isosceles triangles, although his explanation was brief. However, SC2 did not provide evidence or justification for his answer. The interview showed that SC2 understood the concept of proof but did not feel the need to write it down explicitly. The following is his acknowledgment of the explanation.

R	:	*Why don't you prove your answer first, so your conclusion doesn't match your explanation?*
SC2	:	*Hehe I didn't know I had to prove it, sir. I thought that was enough.*
R	:	*But you can prove it*
SC2	:	*I can, sir. So the angle formed by two legs of an equal length triangle with respect to the base will form a pair of equal angles as well.*

SC2 showed the ability to synthesize and justify through oral explanation, although he did not write it explicitly on the answer sheet. This is in line with his auditory learning style, which prefers speaking over writing. In question number 1c, SC2 showed an understanding of the characteristics of acute and obtuse angles through the Figure. However, he did not explain his reasoning, thus not achieving the analysis and generalization indicators. SC2 was not unable to explain and generalize, but SC2 felt sufficient with the drawings he made. The clarification from SC2 on the incomplete answer to question number 1c is as follows:

R	:	*Why don't you explain?*
SC2	:	*I think a drawing is enough, sir! I drew an isosceles triangle with an obtuse top angle*
R	:	*That's right. But it's not only isosceles triangles like this that are obtuse. There's more.*
SC2	:	*Yes, sir? Oh yes, an arbitrary triangle that is obtuse also has one angle*

Based on the explanation related to the answer to question number 1, SC2 has the ability to understand, analyze, generalize, synthesize, and prove well. However, SC2 is better at conveying answers through speech than writing. This is evidenced by the clarification regarding the incompleteness of the answers written, SC2 was able to explain well.

This caused no indicators to be met based on the observation of SC2's answer to question number 2. SC2 did not understand what was asked in the question. This evidence was obtained from the interview conducted. The following is an excerpt from the interview.

R	:	*Among all the problems. Which one is the most difficult?*
SC2	:	*Number 2, sir.*
R	:	*Why?*
SC2	:	*I don't understand it at all. Hehehehe*
R	:	*This is every corner point. You just don't know the x value. How many total angles do you know?*
SC2	:	*180?*
R	:	*That's right! The point of each bracket is each angle. So just add them up and you'll get the x value after calculating.*
SC2	:	*Oh yes, sir is right! Forgot.*
R	:	*If given a problem like this again, can you do it?*
SC2	:	*Yes sir, God willing. So you just have to add it up, sir, and then you can get the x value, right?*
R	:	*Yes.*

Based on the interview excerpt, SC2 remembered the concept used in problem number 2 but did not think about it when working on the problem. SC2 was actually able to analyze the forgotten concept in the problem. This indicates that SC2 has reached the analysis and generalization indicators. However, the main weakness in this case is the weakness in synthesizing the results of the information obtained from the problem analysis. Furthermore, SC2 was unable to prove anything in his answer. This resulted in the mathematical reasoning indicator in question number 2 not being met by SC2. Next is question number 3.

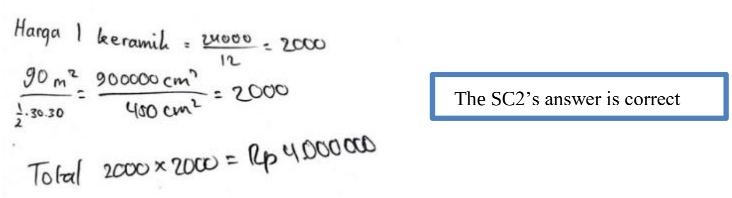


Figure 7. The SC2's answer to question number 3

Based on Figure 7, it can be stated that SC2 was able to solve non-routine problems. This is evidenced by the answers that were written completely from determining the unit price of ceramics to the total costs that must be incurred. SC2 was able to understand the meaning asked in story problem number 3. SC2 was also able to generalize the information obtained, so that it could be used in solving problems. SC2 was able to connect the information described in the problem, such as determining the number of ceramics needed to cover the bottom surface of the room and connecting the fact that the total cost incurred will be obtained from the product of the unit price of ceramics and the number of ceramics needed.

SC3 is a student with a kinesthetic learning style. The following is a recap of the observation results of SC3's answers to each item given.

Table 5. Observation results of SC3

Indicator	Question Item				
	1(a)	1(b)	1(c)	2	3
Analysis	✓	✓	✓	✓	✓
Generalization	✓	✓	✓	✓	✓
Synthesis	-	-	-	✓	✓
Justification	-	-	✓	-	✓
Non-routine problem solving	-	-	-	-	✓

The observation result in Table 5, it is evidenced by SC3's answer in Figure 8. SC3 showed the ability to analyze and generalize in questions 1a and 1b, but he was unable to synthesize the decomposed facts into a complete explanation. SC3's answer in number 1b showed that SC3 understood the meaning of the question and could construct an argument even though it was not correct. It should be "wrong", while SC3 answered "right". However, SC3 had answered using a sentence that is general and applies to every similar triangle. This indicates that SC3 was able to generalize his understanding. He also did not provide evidence or justification for his answer.

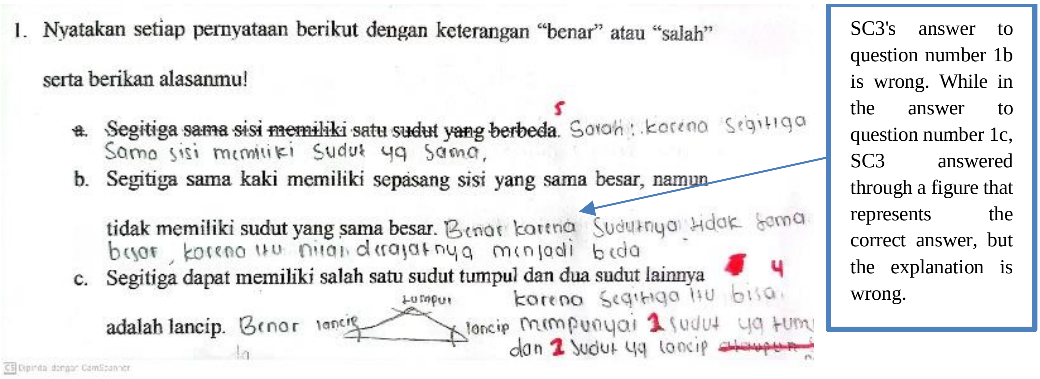


Figure 8. The SC3's answer to question number 1

Nevertheless, SC3 showed a good understanding of acute and obtuse angles in question number 1c, and was able to synthesize the known facts to explain the relationship between angles in a triangle. Although, in his answer SC3 understood between acute and obtuse angles in the opposite way. This is explained in the following interview excerpt:

R	:	*Are you mixing up acute and obtuse angles?*
SC3	:	*Hehehe, yeah, sir. I don't know why, but I got them mixed up back then. I thought acute was obtuse. Even though I know they're different.*

Based on the explanation by SC3, (s)he demonstrates a good ability to comprehend, analyze, and generalize arguments in relation to question number 1. However, SC3 still exhibits weaknesses in synthesizing the presented facts into a more comprehensive explanation, although in question 1c, SC3 was able to prove their answer through a sketch of an arbitrary isosceles triangle with one obtuse angle. Next, we move on to question number 2.

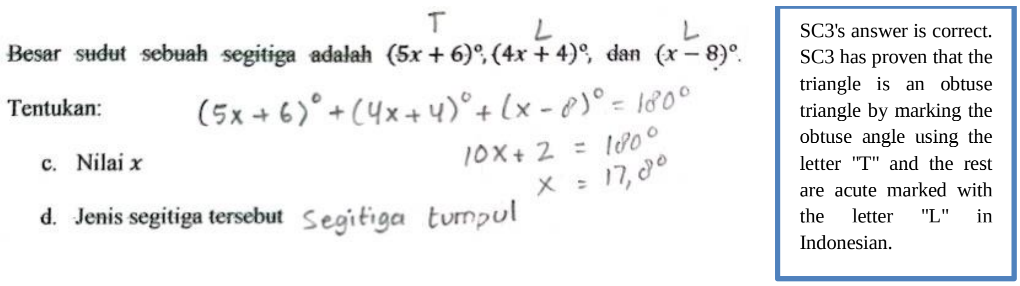


Figure 9. The SC3's answer to question number 2

Figure 9 demonstrates that SC3 was able to provide a complete answer with the necessary evidence, although the sketch provided does not accurately reflect the angle measurements derived from their answer. SC3 was able to find the value of x by first connecting their knowledge of the total angles in a triangle equaling 180° with the angles whose values were unknown (x). SC3 was then able to determine the size of each angle after finding the value of x. SC3 was also able to determine that the resulting triangle was obtuse, as evidenced by the arrow pointing to one of the angles with the letter "T." This proves that SC3 was able to solve question number 2. Based on this explanation, it can be concluded that SC3 was able to solve question number 2 and achieve the "justification" indicator, as SC3 demonstrated that the initial angle was obtuse through calculation, even though it was not written on the answer sheet. Question number 2 is not considered a non-routine question, so the indicator was not achieved. Next, we move on to the answer to question number 3.

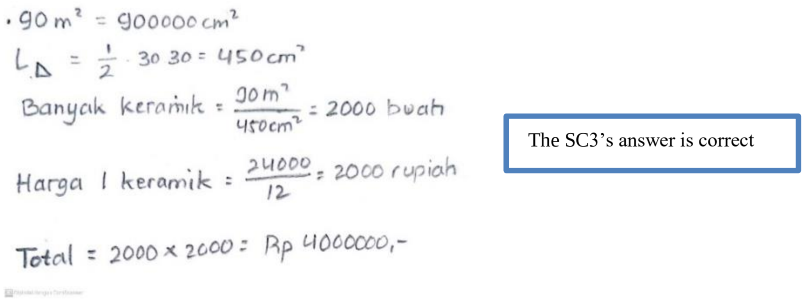


Figure 10. The SC3's answer to question number 3

Based on Figure 10, it can be stated that SC3 was able to solve a non-routine problem. This is evidenced by the complete answer provided, starting from determining the unit price of the tiles to the total cost that needs to be spent. SC3 was able to understand the meaning of the question asked in the story problem number 3. SC3 was also able to generalize the information obtained, which could then be used to solve the problem. SC3 was able to connect the information presented in the problem, such as determining the number of tiles needed to cover the floor of the room, and connecting the fact that the total cost incurred would be obtained by multiplying the unit price of the tiles by the number of tiles needed.

DISCUSSION

Based on the triangulation results, there are differences in abilities between SC1, SC2, and SC3. SC1 has met the indicators for analysis, generalization, synthesis, and justification, but still struggles with solving non-routine problems. The main factor hindering SC1 is the difficulty in visualizing the conditions in non-routine problems. Based on the answers provided, SC1 was able to gather the necessary information but did not solve the problem correctly due to the lack of a sketch to guide the mathematical procedure, resulting in an incorrect solution. SC1 also did not review their answers, leaving mistakes uncorrected. This deficiency was similarly observed in Soleha et al.'s (2019) research, which found that students with visual learning styles often struggle with correct mathematical procedures because they do not review their work. This shows that students with visual learning styles only need to practice their non-routine problem-solving skills. The non-routine questions given on the test instrument did not present supporting visual images, so SC1 was unable to visualize the situation in the non-routine questions. This weakness is related to indicators of visual learning style, namely learning visually and having difficulty receiving verbal instructions (Purbaningrum, 2017). Efforts that can be made to improve these abilities are by practicing solving non-routine problems so that the mathematical procedures used are better and reviewing the answers obtained with the help of visual sketches that can help in solving non-routine problems.

Meanwhile, SC2 has fulfilled the mathematical reasoning indicators, but in the comprehension questions, SC2 has not been able to write down the answer in writing. However, SC2 is able to explain the answer verbally. This is in line with the opinion of Sundayana (2016) who stated that students with an auditory learning style tend to enjoy talking, discussing, and explaining material in detail. In routine questions, SC2 was completely unable to answer. SC2 did not write anything on the answer sheet to answer question number 2. As a result of SC2's inability to synthesize, SC2 was unable to plan a solution properly. This was also found in the research of Soleha et al. (2019), namely the difficulty in determining strategies due to incomplete problem-solving planning. However, strangely, SC2 was actually better at solving non-routine questions. This shows that SC2 understands verbal instructions better in these non-routine questions. This is in line with the auditory learning style indicators stated by Purbaningrum (2017) which states that students with an auditory learning style understand verbal instructions better than visual instructions. This fact refutes that SC2 is weak in synthesis.

SC3 had a little difficulty in synthesizing the relationship between elements of understanding a concept, as seen from the answers given to the comprehension questions. SC3 also tended to use inappropriate arguments in explaining concepts. For example, SC3 still had weaknesses in synthesizing the facts presented into a more comprehensive explanation, even though in question number 1c, SC3 was able to prove his answer through a sketch of an arbitrary isosceles triangle with one obtuse angle. SC3 seemed to show his thoughts through a figures and not through narration. This shows that SC3 is weak in carrying out verbal activities, in this case writing a narrative explanation of the intended answer. This is in line with Purbaningrum's (2017) opinion that the indicator of a kinesthetic learning style is weak towards verbal activities. SC3 manipulated his understanding through the Figures given. This manipulation ability is indeed possessed by people with a kinesthetic learning style (Sundayana, 2016). However, SC3 was able to solve non-routine questions. This means that SC3 only needs to slightly improve his synthesis ability to be able to solve other types of problems, and this deficiency is not a fatal weakness for SC3.

CONCLUSION

The analysis results show that all three research subjects have good mathematical reasoning abilities, each with their own strengths and weaknesses. SC1, with a visual learning style, demonstrates good analytical, generalization, synthesis, and justification skills, but still struggles with solving non-routine problems. SC2, with an auditory learning style, has excellent reasoning abilities, is able to solve non-routine problems, but still needs to improve their analytical skills. SC3, with a kinesthetic learning style, also demonstrates excellent reasoning abilities, is able to solve non-routine problems, but needs to develop their synthesis skills. Despite their shortcomings, all three subjects show good potential in mathematical reasoning.

The findings in this study are in the form of a fact that proves that students with different learning styles have the same mathematical reasoning abilities. Although each student with a certain learning style has their own shortcomings, these shortcomings are in line with the learning style indicators possessed by the student. SC1 with a visual learning style and SC3 with a kinesthetic learning style have weaknesses in verbal activities. SC2 with an auditory learning style has weaknesses in visual activities.

The implications of this research are that there are differences in how each research subject understands and answers questions. Through these differences in understanding and answering, the researcher provides the following suggestions: (a) SC1 had difficulty answering non-routine questions because there was no visual aid in the question, so SC1 was unable to visualize and imagine the conditions in the question. Therefore, it is necessary to accustom learning that utilizes imagination so that conditions can be visualized, either through sketches or clear directions that support their imagination. (b) SC2 was unable to answer question number 2 in writing, but after being asked in an interview, SC2 was able to answer it. Therefore, it is necessary to give them opportunities to speak and explain verbally. SC2 also still has difficulty with synthesis, so routine practice is needed so that their synthesis skills can develop, which will eventually foster their ability to justify the answers they obtain. (c) SC3 has difficulty synthesizing the relationships between information in the question because SC3 is unable to imagine the real-world conditions in the question. SC3 is unable to imagine real-world conditions and the elements needed in those conditions, so the elements are not perfectly synthesized. Therefore, it is necessary to accustom them to practical learning so they become accustomed to representing mathematical conditions in a real-world form. There needs to be a work project that involves the elements needed to support the development of mathematical reasoning skills in students with a kinesthetic learning style.

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