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ANALYSIS OF STUDENT' MISTAKES IN SOLVING PROBLEM ON PYTHAGORAS THEOREM AT SMP NEGERI PALU

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ABSTRACT

The purpose of this study is: to describe students' mistakes in solving Pythagorean Theorem problems at SMP Negeri 9 Palu using qualitative research methods. The subjects of this study were 3 students who were taken from 26 students who had studied the Pythagorean theorem. The selection of research subjects took into account: (1) these students made more mistakes; (2) different errors; (3) represent mistakes made by other students; (4) students' ability to communicate well and (5) recommendations from math teachers. Data collection techniques used are assignments and interviews. The analysis in this study uses Gagne's theory. The results of this study indicate that some of the mistakes students experienced in solving Pythagorean theorem problems were: (1) Subjects EN and SF made mistakes in using the Pythagorean theorem formula; (2) Subjects EN and SF made mistakes in writing mathematical symbols; (3) Subjects EN, MR and SF made mistakes in determining the hypotenuse of a right triangle; (4) Subjects EN, MR and SF made the mistake of not using the rank; (5) Subjects EN, MR and SF made mistakes in not writing down work procedures completely and accurately and (6) Subjects SF made mistakes in not doing calculations correctly.

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1. INTRODUCTION

Mathematics is an important science but in reality mathematics lessons are less attractive, feared and boring for students (Novriani & Surya, 2017). As stated by Sujiwo (2017) that in reality mathematics in schools is still considered difficult and frightening for

students, as a result students' mathematics learning achievement is always at the lowest level of other subjects. One of the materials that students consider difficult is the Pythagorean Theorem. The Pythagorean theorem is a math material taught in class VIII that explains the relationship or relations between the lengths of the sides of a right triangle. The theorem states that the square of the length of the hypotenuse (hypotenuse) in a right triangle is equal to the sum of the squares of the lengths of the other sides. The Pythagorean theorem is basic material for developing science, can be used as a concept in mathematical calculations and can be used to calculate various things in life (Ulandari et al, 2019).

When studying the Pythagorean theorem students often experience difficulties. This can happen because students do not really understand how to determine formulas that emphasize the basic concepts and principles of the material. Agrees with research by Yadrika et al (2019) which states that the Pythagorean theorem material is still considered difficult for students. There are still many mistakes made by students in solving Pythagorean theorem material questions. Mistakes made by students need serious attention from teachers in order to support a good and continuous learning process because mathematics material is interrelated material. Students will have difficulty understanding the next material if they do not really understand the material taught previously. Mistakes made by students can be researched and studied in more depth based on the work procedures carried out by students. Problem solving is important for students (Peranginangin & Surya, 2017). Error analysis is carried out with the aim of describing the locations of errors made by students in solving Pythagorean theorem questions, which are then attempted to provide alternative solutions, so that the same errors can be minimized or will not even be repeated in the future, in order to improve student learning outcomes in Pythagorean theorem material.

Based on the results of interviews conducted by researchers with class VIII mathematics teachers at SMP Negeri 9 Palu, there are still many students who make mistakes when solving problems on the Pythagorean theorem. The research results of Pangestu & Kadarisma (2021) show that students' mistakes in solving Pythagorean theorem questions include: errors in carrying out arithmetic operations, errors in understanding the concept, errors occur when students answer questions not in accordance with the solution steps because they are in a hurry and error in understanding the language of the question. Meanwhile, in research conducted by Rina & Bernard (2021), the mistakes experienced by students in working on Pythagorean theorem questions were (1) not really mastering the concepts or prerequisites regarding the Pythagorean theorem; (2) mistakes in using the Pythagorean theorem formula; (3) lack of accuracy in calculating and the process used to solve problems is not very precise; (4) does not make a mathematical model; and (5) do not understand simplifying the square root form.

In this research, the analysis used is the error analysis expressed by Palunsu et al (2015) using Gagne's theory, namely conceptual errors, fact errors, principle errors and skills errors. The research that is relevant to this research is research conducted by Rohmah (2020), where the relevance of this research lies in the research focus, namely the analysis of student errors in the Pythagorean theorem material. While the difference lies in the type of error, the errors in Rohmah's research are conceptual errors, errors in understanding the language of the questions and principle errors, while in this research the types of errors used are concept errors, fact errors, principle errors and skills errors. This research aims to describe students' mistakes in solving problems on the Pythagorean Theorem material. The author hopes that

by knowing the types of mistakes students make, students will no longer repeat the same mistakes when solving Pythagorean theorem problems.

2. METHOD

The research method used is descriptive qualitative with the aim of describing students' mistakes in solving questions on the Pythagorean Theorem material. This research was conducted in Palu, Central Sulawesi, Indonesia. The subjects in this research were 3 students taken from 26 students who had studied the Pythagorean theorem material. The selection of research subjects took into account considerations, namely: (1) the student made more mistakes; (2) different errors; (3) represent mistakes made by other students; (4) students' ability to communicate well and (5) recommendations from math teachers.

This error analysis uses Gagne's theory, namely conceptual errors, fact errors, principle errors and skills errors.

1. Conceptual errors
   Indicators of conceptual errors in solving Pythagorean theorem problems are:
   a. Mistakes in understanding the concept of the Pythagorean theorem,
   b. Errors in modeling mathematical problems.
2. Fact errors
   Indicators of factual errors in solving Pythagorean theorem problems are:
   a. Error in writing the arithmetic operation sign,
   b. Errors in writing mathematical symbols.
3. Principle errors
   Indicators of principle errors in the Pythagorean theorem material are:
   a. Errors in determining the hypotenuse of a right triangle,
   b. Error in writing the Pythagorean theorem formula,
   c. Error not using rank.
4. Skills errors
   Indicators of skill errors in solving Pythagorean theorem problems are:
   a. Errors due to incomplete and correct work procedures,
   b. Error unable to perform calculations correctly.

The data collection techniques used in this research were written assignments and interviews. The main instruments in this study were the researchers themselves and their supporting instruments, namely interview guidelines and written assignments containing questions about the Pythagorean theorem. The researcher gave an assignment to find out students' mistakes in solving problems on the Pythagorean theorem material. The written assignments used in this study were in the form of descriptions given to each research subject to find out students' mistakes in solving problems on the Pythagorean theorem material. Based on the analysis of the answers given by the respondents, the researchers conducted interviews by asking various questions. The interviews in this study aimed to obtain clearer information about students' mistakes in solving problems on the Pythagorean theorem material so that the results obtained were more accurate.

Content validation was carried out by 1 lecturer and 2 teachers. Data validity was carried out using Member Check, which is a technique for testing the credibility of data by obtaining a match between the data presented by the researcher and what the subject knew when providing the data. The data analysis technique used in this study refers to the three

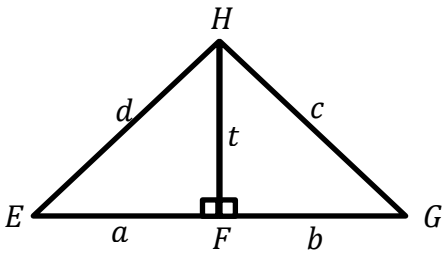
stages of data analysis from Miles and Huberman (Sugiyono, 2019), namely: Data condensation of data presentation and conclusion/verification.

3. RESULTS AND DISCUSSION

3.1. Results

Based on the grouping of errors made by students in completing the Pythagorean theorem assignment. Three subjects were selected, namely EN, MR and SF students. The reason the researcher chose these 3 students was because these students made more mistakes than other students, the mistakes they made were different, the mistakes they made represented the mistakes of other students, the students had the ability to communicate well and there were recommendations from the mathematics teacher. In this study, researchers gave three questions about the Pythagorean theorem to class VIII junior high school students. The questions along with the analysis of student answers are as follows:

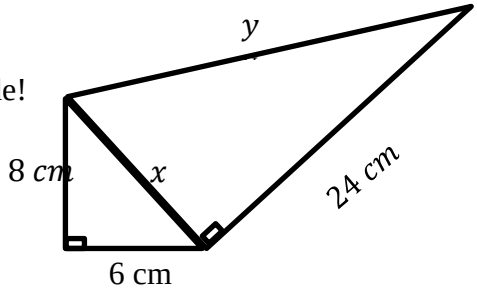
1. Pay attention to ΔEGH in the following picture!



The triangle EGH on the side is a combination of two right triangles EFH and GFH. Determine the Pythagorean formula to determine:

a. Side lenght a
b. Side lenght c
c. Side lenght t

2. Determine the value of y in the picture beside!



3. A ladder 8 m long leans against a wall 4 m high. If the foot of the ladder is 3 m from the wall, then the length of the ladder remaining above the wall is...

Data Analysis of EN Subject Errors in Solving Pythgorean Theorem Problems.

The following is EN's answer to task number 1 on the Pythagorean theorem.

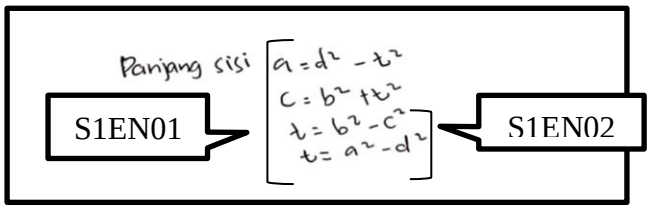


Figure 1. EN's answer to question number 1

Based on Figure 1, the results of EN's answer to question number 1 are that EN does not write the rank on the sides being asked [S1EN01]. Then in [S1EN02] EN wrote the wrong answer, the correct answer should be $t^2 = c^2 - b^2$. In the question t is the high side,

c is the slanted side, and b is the base side. So the correct formula for finding the high side is the square of the high side equal to the square of the slanted side minus the square of the base side. But in the picture it can be seen that EN is reversed in writing the formula. Furthermore, researchers conducted interviews with EN to obtain further information. The following is the result of an interview with EN on question number 1.

PN1-005	:	Before that, I want to ask you, do you know what the Pythagorean theorem is?
EN1-006	:	I don't know, sis.
PN1-011	:	Now I want to ask if in the Pythagorean theorem all types of triangles can be calculated using the Pythagorean theorem?
EN1-007	:	Can sis.
PN1-008	:	Can? Certain?
EN1-014	:	No sis.
PN1-054	:	Note that in part a adek subtracts the slanted side from the high side, while in part c adek subtracts the base side from the slanted side. Why is that deck? Why doesn't part c adek subtract the slanted side from the base side?
EN1-055	:	It's okay, sis,
PN1-060	:	Is there really no deck rank on the sides in question? Or how?
EN1-061	:	There is actually a rank, but I forgot to write it down.
PN1-062	:	How could you forget?
EN1-063	:	Hurry up sis.

From the results of the interview it was discovered that EN did not know what the Pythagorean theorem was [EN1-006], EN knew that the Pythagorean theorem was used to find the sides of a triangle but did not know what type of triangle could be calculated using the Pythagorean theorem formula. It is known that when the researcher asked whether in the Pythagorean theorem all types of triangles could be used [PN1-011], EN answered no [EN1-014]. EN also misunderstood the Pythagorean theorem formula, EN stated that if what was sought was not the hypotenuse then the formula was subtracted. However, in the statement that EN gave, it can be seen that EN was arbitrary in subtracting the sides, this can be seen when the researcher asked why EN subtracted the slanted side from the high side but in the next answer EN subtracted the base side from the sloping side [PN1-054], then EN answered no why, sis [EN1-055]. Furthermore, EN made a mistake when writing the rank, EN did not write the rank on the side in question. EN said that he forgot to write down the rank because he was in a hurry [EN1-061] [EN1-063].

The following is EN's answer to task number 2 on the Pythagorean theorem.

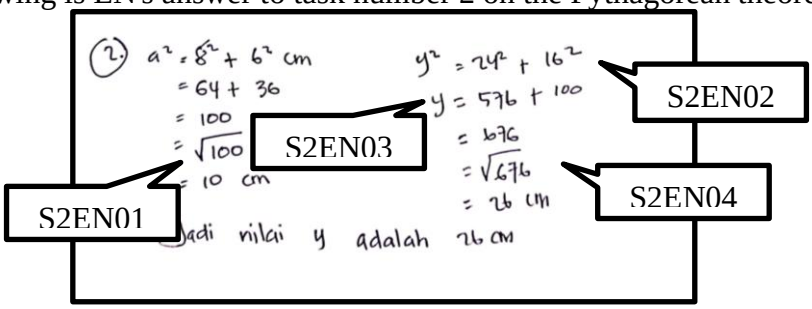


Figure 2. EN's answer to question number 2

The result of EN's answer to question number 2 in Figure 2 is that EN writes $a^2 = 8^2 + 6^2$ [S2EN01]. EN writes a even though in the question what is looked for before y is

x. EN is wrong in transforming questions into answers. Then when looking for the y EN side it writes 16 which somehow comes from the 16 [S2EN02]. EN also suddenly removes the square on y in the second line [S2EN03], in essence if we want to remove the square on the left side then the right side must be rooted but EN does not write the root on the right side. Then EN also wrote $\sqrt{676}$ [S2EN04], EN suddenly rooted 676 even though the left side of the y side no longer had a power so it was not known where the root came from. Furthermore, researchers conducted interviews with EN to obtain further information. Following are the results of the interview with EN on question number 2.

PN2-070	:	So how do you find the y value?
EN2-071	:	First, I'll look for the a value first, sis.
PN2-082	:	The answer, this little brother, is that in the third line 100 there are no roots. Then why is it $\sqrt{100}$ in the fourth line.
EN2-083	:	I don't understand why it can be rooted, but as far as I remember, once we got the results, it was immediately rooted, sis.
PN2-104	:	16^2 where does it come from?
EN2-105	:	From x, sis. Gosh, sis, it's not 16 but 10, I wrote it wrong, sis.
PN2-108	:	Take a look at the first line, you still raise the y to the power, then in the second line you don't raise the y to the power. Could you please explain why is that?
EN2-109	:	I don't know sis. I just remember the way it went like that.
PN2-113	:	Do you understand how to use the rank?
EN2-114	:	I don't understand sis.
PN2-115	:	So what is the reason for removing the exponent in y in the second line?
EN2-116	:	There's no reason sis. I just remember how it works like that.
PN2-119	:	Does that mean you don't know where this root comes from?
EN2-120	:	Yes sis no. The point is there are roots sis. Because as far as I remember there is.

Based on interviews, EN made a mistake in transforming questions into answers. EN looks for the value of a before$y$, but in the question what is looked for first before the value of y is the value of x. In the interview EN did not give a reason why he wrote a instead of x. EN also did not understand where the roots he wrote [EN2-083] came from, he only knew that when learning about the Pythagorean theorem there were parts to the roots. Furthermore, EN entered the value of x incorrectly, EN wrote 16 instead of 10 [EN2-105] This error occurred because EN was in a hurry to solve the problem.

The following is EN's answer to assignment number 3 on the Pythagorean theorem.

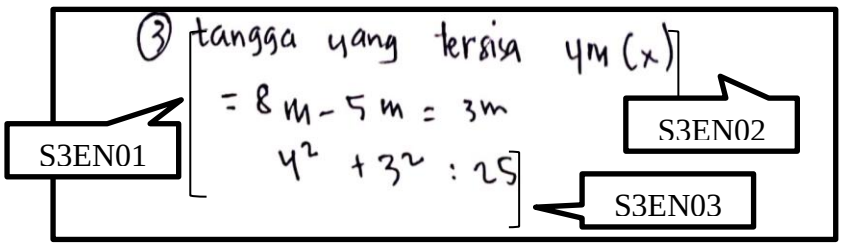


Figure 3. EN's answer to question number 3

The results of EN's answer to question number 3 were that EN did not write down the correct steps in answering [S3EN01], in the picture it can be seen that EN immediately wrote $8\,m - 5\,m = 3\,m$. Then EN writes $4^2 + 3^2 : 25$ [S3EN03], instead of using the " = "

sign EN instead uses the ":" sign. After that EN seemed to give the final answer, namely $4m$ [S3EN02]. EN was wrong in giving the final answer, the correct answer is $3m$. Furthermore, researchers conducted interviews with EN to obtain further information. The following is the result of the interview with EN on question number 3.

PN3-127	:	How do you do it?
EN3-128	:	I don't know how.
PN3-135	:	Brother understand how it works.
EN3-136	:	No sis.
PN3-137	:	What do you think you don't understand in question number 3? even though number 1 and number 2 can work together even if there is a slight deviation.
EN3-138	:	Sis, if he has a picture, I understand, but if it's like this, it's difficult, sis.
PN3-139	:	You can take a picture first before doing it so you understand.
EN3-140	:	But I don't understand what the picture looks like.
PN3-145	:	So the answer is just 3 m. Where's that 3 deck from?
EN3-146	:	From 8 m − 5 m sis.
PN3-149	:	Why can it be forgotten? Then on the third line, what is $4^2 + 3^2 : 25$? Or how to find?
EN3-150	:	I forgot sis.
PN3-171	:	Your answer is correct 3 m but the steps are wrong. Try to look again at $4^2 + 3^2 : 25$. What is that?
EN3-172	:	Not ":" that's sis but " = ".
PN3-173	:	That's how " = " is written. Next time, pay close attention to your symbol writing, okay?
EN3-174	:	Yes sis. Hurry up sis.

From the results of the interview it was discovered that EN did not know how this 3rd question worked because when the researcher asked subject EN [PN3-127] how it worked, EN answered that he did not know [EN3-128]. EN was confused when answering questions because there were no pictures in questions [EN3-138]. EN is also wrong in writing the equals symbol, instead of writing " = "EN instead writing ":" [EN3-172]. This happened because EN was in a hurry when answering questions [EN3-174]. EN's final answer is correct but EN doesn't know how this 3rd question works.

Data Analysis of MR Subject Errors in Solving Pythgorean Theorem Problems.

The following is MR's answer to assignment number 2 regarding the Pythagorean theorem.

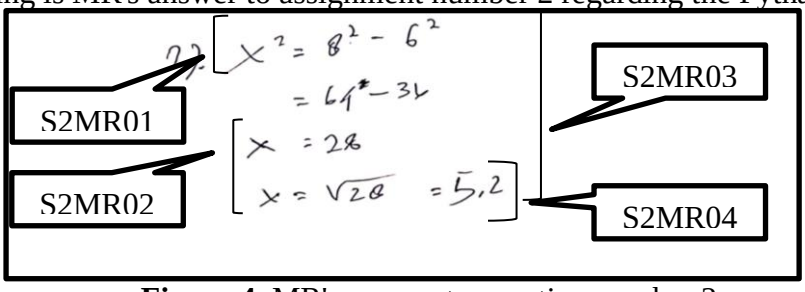


Figure 4. MR's answer to question number 2

Based on Figure 4, the result of MR's answer to question number 2 is that MR did not use the Pythagorean theorem formula correctly, MR wrote the formula $x^2 = 8^2 - 6^2$ [S2MR01]. MR should have written $x^2 = 8^2 + 6^2$ because it is known that x is the hypotenuse, so the correct formula is to use the plus sign. Because MR wrote the formula wrong from the start, MR's final answer was also wrong [S2MR04]. MR removes the power on x on the left side but does not add a root on the right side [S2MR02], so if MR wants to

remove the power on the left side, MR can add a root on the right side. MR added a root on the right side of the next row but who knows where the root came from. Then it seemed that MR had not finished solving the answer to question number 2 [S2MR03], because it was known that the question number 2 that he was looking for was the y side but MR only solved it up to the x side. Next, the researcher conducted an interview with MR to obtain further information. The following are the results of the interview with MR on question number 2.

PN2-023	:	So how do you determine it?
MR2-024	:	The trick is to find the x value first, sis, but I don't understand which side is the slanted side. So, I wrote down the formula $x^2 = 8^2 - 6^2$.. I got the answer $5{,}2\ cm$ sis.
PN2-025	:	Why did you write $x^2 = 8^2 - 6^2$ can you explain?
MR2-026	:	Because, I think x is not the hypotenuse, so I subtracted it. I don't understand the picture sis.
PN2-027	:	What do you not understand from the picture, sis?
MR2-028	:	The pictures are crooked so I'm confused. It's not like question number 1. If it's number 1, you can see the slanted side, sis. If number 2 is confused sis.
PN2-061	:	You do 28 later on the 4th line, while you remove the exponent of x in the third line. Don't you know that the rank of x doesn't disappear until it is rooted?
MR2-062	:	Yes, I know.
PN2-063	:	So why is the rank in x missing sis?
MR2-064	:	I forgot to write down the rank sis.

The results of the interview above prove that MR has correctly looked for the length of the x side first before looking for the length of the y side, but when determining the formula for finding the length of the x side MR did not know which side was the hypotenuse so MR was wrong in writing the formula. MR wrote the formula $x^2 = 8^2 - 6^2$ and got the final answer $5{,}2\ cm$ [MR2-024]. MR no longer understands how to find the length of the y side, because MR is confused about determining the slanted side of the image, so MR does not continue his work. Then, due to the carelessness of the writer, when the researcher asked again about where $\sqrt{28}$ came from, MR replied that $\sqrt{28}$ came from x^2, but MR forgot to write down the square in the next line [MR2-064].

The following is MR's answer to assignment number 3 regarding the Pythagorean theorem.

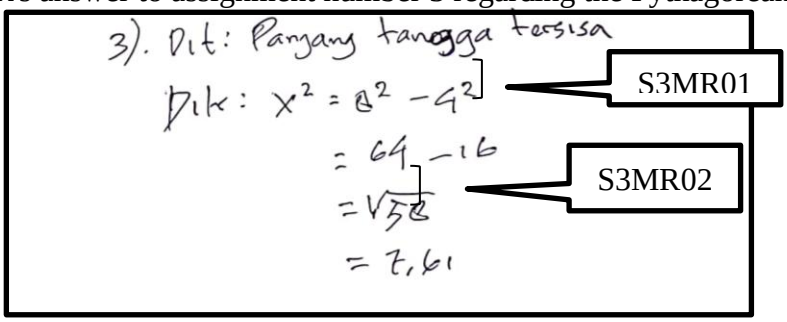


Figure 5. MR's answer to question number 3

The result of MR's answer to question number 3 is that MR wrote the formula incorrectly to find the remaining length of the stairs, MR wrote $x^2 = 8^2 - 4^2$ [S3MR01] because MR wrote the formula incorrectly so that the final result of MR's answer was also wrong, MR wrote the final result 7,61 [S3MR02]. The correct formula to use in problem number 3 is $AC^2 = AB^2 + BC^2$, AC is the length of the stairs or sloping side, AB is the

height of the wall and BC is the distance from the foot of the wall to the stairs or pedestal side. So that the result is $5m$. After getting the sloping side, find the remaining length of the ladder using $AD = CD - AC$, AD is the remaining length of the ladder and CD is the total length of the ladder. So that the final result is $3m$. In the picture, it can be seen that MR did not finish or was not complete in writing the answer. Next, the researcher conducted an interview with MR to obtain further information. The following are the results of the interview with MR on question number 3.

PN3-071	:	How do you find the rest of the stairs?
MR3-074	:	So sis, I don't think the length of the stairs is enough for the height of the walls, sis. So I can get the rest.
PN3-075	:	Why is the length of the stairs minus the height of the wall?
MR3-076	:	Let me get the rest of the stairs, sis.
PN3-091	:	If you have already drawn it, why can you do it?
MR3-092	:	It's easier if you use pictures.
PN3-093	:	So do you think it's difficult to use story questions?
MR3-094	:	Yes, it's hard.

Based on the interview transcript, it is known that MR wrote the formula incorrectly. MR wrote the formula $x^2 = 8^2 - 4^2$MR said that the way to find the remainder of the ladder is the length of the ladder minus the height of the ladder [MR3-074]. MR was confused because there was no picture in question number 3 [MR3-092] because MR determined the final result incorrectly.

Data Analysis of SF Subject Errors in Solving Pythgorean Theorem Problems.

following is SF's answer to assignment number 1 regarding the Pythagorean theorem.

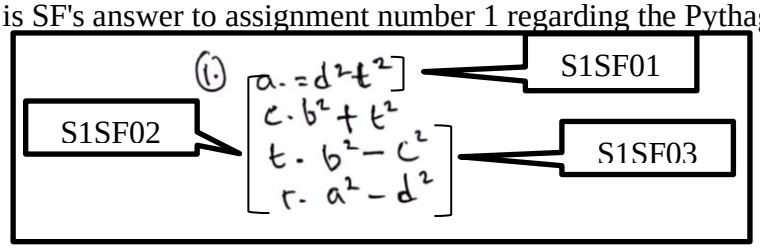


Figure 6. SF's answer to question number 1

Based on Figure 6, the result of SF's answer to question number 1 is that SF did not write down the operation sign [S1SF01] and did not write the rank on the side being asked [S1SF02], SF should have added a minus sign and exponent on the side being asked so the formula becomes $a^2 = d^2 - t^2$. Then SF was wrong in writing the formula for finding the height or side t [S1SF03], SF wrote $t.b^2 - c^2$, SF's answer was clearly wrong besides SF not using the " = " sign, SF was also wrong in subtracting the sides. If you ask about the high side, the formula should be $t^2 = c^2 - b^2$ because side c is the sloping side. Next, researchers conducted interviews with SF to obtain further information. The following are the results of the interview with SF on question number 1.

PN1-005	:	First, I want to ask you, do you know what the Pythagorean theorem is?
SF1-006	:	I don't know, sis.
PN1-009	:	Do you know the formula for the Pythagorean theorem?
SF1-010	:	No sis.
PN1-030	:	Why can you say the formula is wrong?
SF1-031	:	Actually I don't understand the formula sis, I'm just random sis.

PN1-033	:	Then the d^2t^2 is multiplication sis? Or how?
SF1-034	:	I forgot sis.
PN1-035	:	Okay fine, if the c. How is this sis? What does it mean? Sis, I see that all the answers in your formula use all points from $a.c.t.r$. what do you mean? Does this dot mean multiplication or what?
SF1-036	:	I forgot, bro, I'm also confused about my formula.
PN1-037	:	Does that mean you don't understand the formula you use?
SF1-038	:	Yes, I don't understand.
PN1-039	:	Do you know what side number 1 is?
SF1-040	:	Side $a, c,$ with t sis.
PN1-041	:	Then what is the r in the formula that you are using?
SF1-042	:	I don't know either. I'm wrong sis.

Based on the interview above, it is known that SF does not know the concept of the Pythagorean theorem. This was proven when SF was asked what the Pythagorean theorem was. SF answered that he did not know [SF1-006] and even the formula for the Pythagorean theorem, SF did not know it, SF answered the question without knowing how [SF1-010]. SF looked doubtful when the researcher asked whether he thought his answer was correct. From the results of the answers, it can be seen that SF uses dots on each side that is asked. When interviewed, SF answered that he was also confused about his own formula [SF1-036]. Then in his answer SF did not write the operation sign in one answer and this happened because SF forgot [SF1-034]. SF even created a new problem where he wrote the side being asked was r [SF1-042] even though there was no command to find the r side in the problem. SF's lack of attention to the problem and SF's lack of understanding of the concept made MR make many mistakes in writing formulas.

The following is SF's answer to assignment number 2 regarding the Pythagorean theorem.

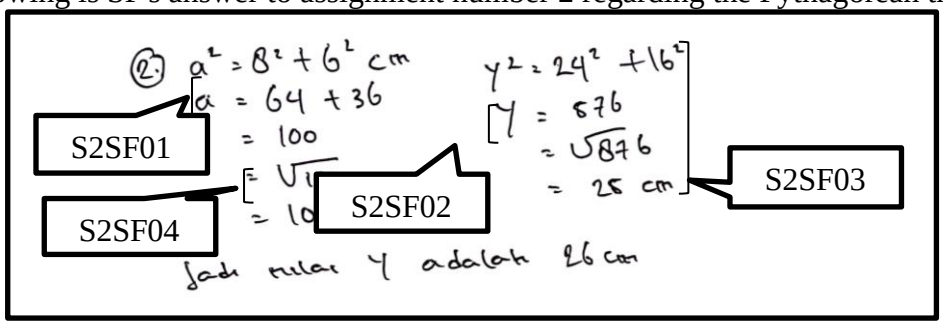


Figure 7. SF's answer to question number 2

Based on Figure 7, the result of SF's answer to question number 2 is that SF does not write the powers on side a [S2SF01] and side y [S2SF02], so if SF wants to remove the powers on these sides, SF needs to add a root on the right side. Actually SF has added the root [S2SF03], [S2SF04] but the method is not correct or the steps for using the root sign are not correct. Then in the code [S2SF03] SF wrote 16^2 but it is not known where this 16 came from. After that, SF operated it on the picture. It can be seen that SF only raised it to the power of 24 and got the result 576, but SF did not raise it to the power of 16. Then in the next line SF suddenly root 876 which is not clear where it came from, then SF returns 25 cm. It is clear that SF is wrong in the calculation process. Next, the researcher conducted interviews with SF for further information. Following are the results of the interview with SF on question number 2.

PN2-043	:	Okay, then continue with question number 2, right? In the answer, you wrote the formula $a^2 = 8^2 + 6^2$, why did you write a while in the question there is no symbol a?
SF2-044	:	I don't know, sis. I just wrote like that sis.
PN2-045	:	So just write this down? So, in the formula, you wrote a^2, so why is it only a in the second line?
SF2-046	:	I forgot to write down the square.
PN2-049	:	Okay, now why on the fourth line did you write$\sqrt{100}$, where does it come from sis?
SF2-050	:	I don't know where it came from, but as far as I remember, it took root, bro, and got the results.
PN2-051	:	Then $y^2 = 24^2 + 16^2 2$, 24 is in the question but 16 isn't in the question. Where did you get that from?
SF2-052	:	I forgot sis.
PN2-053	:	The second line is y, why is the rank missing, then where did you get the 576 from?
SF2-054	:	576 is the result of $24^2 + 16^2$, and I forgot to write the square sis.
PN2-057		Are you sure that 576 is the result of $24^2 + 16^2$?
SF2-058		Yes, I'm sure.
PN2-061	:	Let's look at your answer in the second line, it's 576why suddenly in the third line you root it's actually 876, where does that come from 876?
SF2-062	:	I wrote it wrong, sis.

Based on the interview transcripts, it is known that SF did not know where the a side was written from [SF2-044]. This means that SF does not understand what to look for first before the y side, if you pay attention to the problem the side to look for first before the y side is the x side. Then when the researcher asked what was the reason for SF removing the rank on side a in the second row, SF answered that he forgot to write the square [SF2-046]. SF also did not know where the roots he used came from, MR only remembered that there were roots used in working on the Pythagorean theorem [SF2-050]. SF doesn't know the value 16 when looking up the y value where it came from [SF2-052]. Furthermore, the value of 576 SF is obtained from the result of adding up $24^2 + 16^2$ [SF2-054] even though the value of 576 is the result of 24^2, SF made a mistake in doing the calculation. After that, when the researcher asked SF 876 where it came from, SF said that he had written it wrong, SF should have written 576 [SF2-061]. This indicates that SF is not thorough in answering questions. Because of the carelessness of SF itself, the final result of SF is also wrong.

The following is SF's answer to task number 3 on the Pythagorean theorem

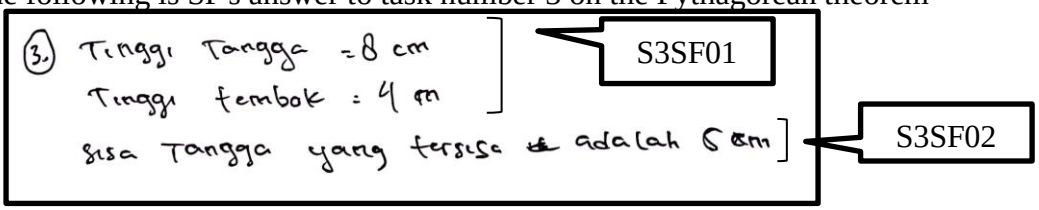


Figure 8. SF's answer to question number 3

Based on Figure 8, the results of SF's answers to question number 3 are that SF did not write down the formula for the Pythagorean theorem to find the remainder of the ladder, SF also did not write down the steps in working on the problem. SF only writes things that are known [S3SF01] and the final answer [S3SF02]. It can be seen that SF is also wrong in writing the final answer, the correct answer is 3 m. Next, researchers conducted interviews

with SF to obtain further information. The following is the result of the interview with SF on question number 3.

PN3-083	:	How many stairs are left?
SF3-084	:	5 m sis.
PN3-085	:	How do you do it?
SF3-086	:	I don't know sis.
PN3-089	:	Then why can you answer that the rest of the stairs are 5 meters, sis?
SF3-090	:	I'm just guessing, sis.

Based on interviews, it is known that SF does not know how to find the remaining stairs [SF3-086], SF only guesses that the final result is 5 m [SF3-090]. Because the incomplete procedure in SF's answer makes SF imprecise in determining the final result.

3.2. Discussion

Conceptual errors made by subjects EN and SF were in the form of errors in understanding the concept of the Pythagorean theorem, namely errors in not knowing the type of triangle used in the Pythagorean theorem. Based on the results of the assignment and interview results on question number 1 subject EN and SF misunderstood the concept of the Pythagorean theorem, EN was confused in answering that the triangle used in the Pythagorean theorem is a right triangle. Because not understanding the concept of the Pythagorean theorem made EN and SF wrong in writing the Pythagorean theorem formula, the correct formula should be used is the square of the hypotenuse minus the square of the other side but subjects EN and SF instead use the formula for the square of the other side minus the square of the hypotenuse. In question number 2 MR was wrong in writing the Pythagorean theorem formula, MR should have used the formula for finding the hypotenuse but MR instead used the formula for finding the other side, and in question number 3 subjects EN and SF did not write down the formula for the Pythagorean theorem so that the final result was in error. Whereas the MR subject wrote down the formula but used the wrong formula, the formula should have been the formula for finding the hypotenuse but MR used the formula for finding the other side. In line with the results of research conducted by Rina & Bernard (2021) that conceptual errors made by students were errors in using the Pythagorean theorem formula.

Fact errors were only made by EN and SF subjects. These errors were in the form of errors in writing mathematical symbols. Based on the results of the assignment and the results of the interview on question number 1, subject SF made a factual error because he did not write the " = " sign but "." sign. then in question number 3 the subject EN made a fact error where EN wrote the ":" sign instead of the " = " sign. The proper use of symbols in mathematics is necessary for the symbolism of a concept. The reason why students write symbols incorrectly is because students are not careful in answering questions. In line with the results of research conducted by Yadrika et al (2019) that one of the factors causing student errors in solving Pythagorean theorem questions is that students are not thorough in answering questions.

The principle mistakes made by subjects EN, MR and SF were in the form of errors in determining the slanted side, errors in writing formulas and errors in not using exponents. Based on the results of the assignment and interview results on question number 1, subjects EN and SF were wrong in determining the hypotenuse when answering the question, making subjects EN and SF wrong in writing the Pythagorean theorem formula. Apart from that, EN and SF subjects did not write the exponent of the side in question even though the Pythagorean theorem formula is that the square of the hypotenuse is equal to the sum of the squares of the other sides. In question number 2, subjects EN, MR and SF also made a

principle error, namely not using exponents on the side in question and making a mistake in simplifying the root form, subject MR also did not understand how to determine the hypotenuse in the question. Furthermore, in question number 3 MR also made a principle error because he did not understand how to determine the hypotenuse. The principle of the Pythagorean theorem must be mastered by students so that students understand when working on Pythagorean theorem questions. In line with the results of research conducted by Rohmah (2020), students must master the principles to make it easier to work on the questions presented.

Skill errors made by subjects EN, MR and SF were in the form of errors due to not writing down the processing steps correctly and precisely as well as errors in carrying out calculations in accordance with the results of research conducted by Pangestu & Kadarisma (2021) that when working on the Pythagorean theorem students often do errors in performing calculation operations. Based on the results of the assignment and interviews, it was found that the three subjects made skills errors because they did not write down the work steps correctly, some even did not write down the steps at all and immediately wrote down the final results. Even though the steps in mathematics are important so that teachers can find out whether their students understand the Pythagorean theorem material. In addition to the SF subject's steps being wrong in doing the calculations. This is due to the lack of skills and accuracy that students have in carrying out calculation operations and writing down steps. This is in line with what Hidayat (2013) stated that operations are algebraic calculations and other tasks. Algebraic calculations emphasize aspects of the skills possessed by students.

4. CONCLUSION

Based on the results of the research and discussion, it was concluded that the types of errors made by class VIII A students of SMP Negeri 9 Palu in solving the Pythagorean theorem material problems were conceptual errors, fact errors, principle errors and skill errors.

1. Conceptual errors made by EN, MR and SF subjects in solving the Pythagorean theorem questions were errors in applying the concept in the form of errors in not using the Pythagorean theorem formula correctly when working on the questions.
2. Fact errors were only made by subjects EN and SF, fact errors made by both subjects in solving Pythagorean theorem problems, namely errors in writing symbols.
3. The principle errors made by subjects EN, MR and SF in solving the Pythagorean theorem problem were errors in determining the hypotenuse, errors in simplifying the root form and errors in not using exponents.
4. Skill errors made by EN, MR and SF subjects in solving Pythagorean theorem problems, namely errors in not writing down the processing steps correctly and wrong calculations.

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