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STUDENTS' DIFFICULTIES IN SOLVE TRIGONOMETRY PROBLEM SOLVING ACCORDING TO STEP POLYA'S

Khofifah[1], Rosyadi[2*], Farid Gunadi[3], Nandang[4], Runisah[5]
[1,2,3,4,5]Departement of Mathematics Education, Universitas Wiralodra, Indramayu, West Java, Indonesia
*Correspondence: rosyadi@unwir.ac.id

ABSTRACT
This study aims to describe students' difficulties in solve trigonometry problem solving according Polya's steps. Determining research subjects by giving students difficulty test questions using Polya steps to 36 students of class X MIPA 8 SMAN 1 Indramayu. From these results, 6 subjects were selected purposively as a sample with subjects falling into the high, medium and low score categories. The instruments used were diagnostic tests of students' difficulties in solving trigonometric problems using Polya's problem solving and interviews. The data analyzing technic in the research started with collecting information in the fields, interviews, and documentations which are collected by coding. By considering into account the results obtained from this study, the difficulty of students in handling problem solving of trigonometry problems according to Polya's steps owned by students of class X MIPA 8 SMA Negeri 1 Indramayu is able to solve a problem using Polya's steps. When students who have high test scores will have little difficulty learning because the subject can explain and solve problems well and there are no difficulties. While it is different when students who have low scores feel confused, difficult, wrong in solving a problem. In fact, in this study, the highest score and the lowest score both answered the questions correctly, the only difference was the student's accuracy and overestimation, causing the student to get a low score. The research results show that the students with high score category had less difficulty than students with low score categories. Therefore, teachers must be more careful in paying attention to students and teachers must also explain Polya's stages gradually without rushing. It is expected that students can understand Polya's stages as a whole so as to reduce student learning difficulties.
Keywords: Student Difficulties, Trigonometry, Polya Steps Problem Solving

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PRELIMINARY

In mathematics there are many symbols and numbers that cause students to find it difficult and avoid mathematics lessons. Many people think negatively about mathematics and underestimate and even avoid mathematics lessons, this is due to the learning carried out by the teacher ineffective (Mcclure et al., 2017). therefore, a teacher must able to choose a model or method appropriate learning so that students can gain complete knowledge so that learning outcomes increase (Dalimunthe, 2021). Before making a decision, students need to serve various ideas about the mathematics subject being studied

in order to fulfill the learning target (Li & Schoenfeld, 2019). The fulfilled of targets in maximum learning is not far from the mathematics concepts that students know. Mathematics concepts that are often ignored by students are as follows: 1) when working on problems, students are accustomed to doing the work directly without writing down the stages of the procedure; 2) many students have difficulties in categorizing known objects, making it difficult for students to find ideas to use; 3) many students explain with the wrong concept, some even fail to explain the concept; 4) students are not used to solving problems by writing what is known and asked first; 5) students have difficulty in applying concepts to a problem (Rachman & Purwasih, 2021). In addition to students being able to know mathematics concepts, teachers also need to improve their students' abilities. Teachers must continue to improve students' abilities by monitoring, organizing, and evaluating student learning in order to improve students' abilities (Du, 2020). In addition, Kholil & Zulfiani (2020) arguest that the ability that students must have in learning and understanding mathematics is logical thinking. Logical thinking skills can be obtained when students often question everything that is received during the learning process. Lack of logical thinking makes it difficult for students to pay attention to lessons. One of the factors that cause students to pay less attention to class learning is the lessons they consider difficult to remember and memorize, one of the materials that are considered difficult is trigonometric material.

Trigonometry is an important mathematics subject, but is considered to be difficult by some students. Therefore, it requires a deeper understanding to determine students' ability to solve trigonometric problems (Johan , 2019). Understanding in this trigonometry material has a big impact on students, if students understand it, it will be easy for students to solve it. In line with the opinions of Wijaya, Ying, and Purnama (2020) stated that trigonometry is one of the subjects that is considered difficult to learn, in trigonometry there is material such as finding angle magnitudes, trigonometric identities, etc. So that many students still find it difficult to proving trigonometry. Lack of understanding concepts causes students to find it difficult to work on them. One of the mathematics concepts that students rarely understand is trigonometry material, trigonometry is disliked because of the many formulas that must be memorized before applying it (Gunadi & Nurafifah, 2020). Lack of understanding of trigonometry material can cause difficulties for students.

According to Loureiro and Cardoso (2022) after a long discussion about the phenomenon of learning difficulties and there are scientific causes of learning difficulties,

namely about the potential contribution of neuroscience, psychology, and pedagogy based on a new paradigm that supports the complete development of students. In addition to the phenomenon proven by these sciences, there are other causes that make students experience learning difficulties. The phenomenon of students experiencing difficulties due to failure to achieve a certain qualification level for learning outcomes, measured based on the success criteria specified in the teaching objectives (Nugraha et al., 2019). There are several factors that cause students to find it difficult to learn, namely internal factors and external factors. Learning difficulties are influenced by inward factors like learning ettitude, learning motivation, concentration, intelligence, and interest. While external factors include teachers, facilities and infrastructure, as well as the social environment of students and families. Each student has a different learning method to understand some information and lessons taught (Susanti et al., 2020). From the explanation of the factors that influence learning difficulties, there are many things that can overcome these learning difficulties. One of them is by looking for suitable problem solving used by teachers to overcome the difficulties experienced by their students.

Problem solving has developed into an important solution in education and has never lost meaning in the teaching and learning process (George et al., 2019). One solution to overcome students who are difficult in teaching is to find the right problem solving for students and with problem solving students can also gain new experiences. Problem solving is part of an important need because students can gain experience using knowledge and skills to solve problems faced daily (Davita & Pujiastuti, 2020). It often happens that students make basic mistakes such as writing mathematics problems incorrectly and lacking in calculations. Students often make mistakes in writing and speaking when solving mathematics problems and students are also good at answering questions but lacking in calculations (Sulistyaningsih & Rakhmawati, 2017). Mathematics problem solving is basically very important to find information or lessons that are not yet known or known, but are confused to do it. There are various ways to solve problems, one of which uses Polya's problem solving steps. Mathematics problem solving is basically very important to find information or lessons that are not yet known or known, but are confused to do it. There are various ways to solve problems, one of which uses Polya's problem solving steps.

Before using problem solving according to Polya's steps, first understand how to understand a problem. There are several ways to understand a problem, namely by reading it repeatedly, asking yourself what is known, what is unknown, and the purpose of the

mathematics problem (Widodo & Sujadi, 2017). When students already understand a problem, it will be easy to solve the problem. According to Rojas Bello & Marysol del Rosario (2020), Polya's problem solving is highly valued by students and is considered to have a positive and easily understood impact on student learning outcomes. Polya also has a solution step that is considered appropriate by some people. Polya stated that problems in mathematics are grouped together into two types, namely (1) problems to find or questions to find and (2) problems to prove or questions to prove. The search problem is to find, determine or obtain some unknown value in the problem and fulfill certain conditions. While the problem of proof is a procedure to determine whether or not a statement is true. There are four steps to solving mathematics problems: (1) master the problem; (2) make a plan; (3) implement the plan; and (4) review the answer (Katon & Arigiyati, 2018). It can be a way for teachers to apply it because it can make students understand the mathematics lessons taught with the Polya problem solving sequence.

Based on the explanation above, trigonometric difficulties can be solved if have found the right problem solving. The right problem solving to solve problems is one of them from Polya. So that researchers are interested in conducting research entitled "Student Difficulties in Solving Trigonometry Problem Solving According to Polya's Steps".

METHODS

This research uses a qualitative approach, using descriptive research methods. The subjects of this research were six people from 36 students of class. Polya problem solving have fout stages: 1) master the problem 2) make a plan; 3) carry out the plan; and 4) check again. Students who have a score between 80-100 are included in the high problem solving ability category, students who score between 65-79 are included in the medium problem solving category, and students who score <65 are included in the low problem solving category who have previously studied trigonometry. Subject selection in this research was based on data from diagnostic test results for learning difficulties in the form of descriptions. Based on the scoring results, it is known that of the 36 students who worked on the test questions, 9 people were in the high problem solving category, 19 people were in the medium problem solving category, and 8 people were in the low problem solving category. After getting data on student categories based on the level of learning difficulty. The next step was purposive subject selection and six students were selected as research subjects. Next, scoring is carried out on the results of the tests carried out by students. S1

with a score of 100 is in high problem solving, S2 with a score of 96 is in high problem solving, S3 with a score of 78 is in medium problem solving, S4 with a score of 76 is in medium problem solving, S5 and S6 have low scores. the same, namely 60, falls into low problem solving. Data analysis in this research began with data collection in the form of field notes, interview transcripts, and documentation which were grouped by coding, after which analysis was carried out using the Miles and Huberman model, namely data reduction, data presentation, and drawing conclusions (Hadi et al. , 2021). Before carrying out the analysis method steps, first test the validity of the data using source triangulation.

RESULT AND DISCUSSION

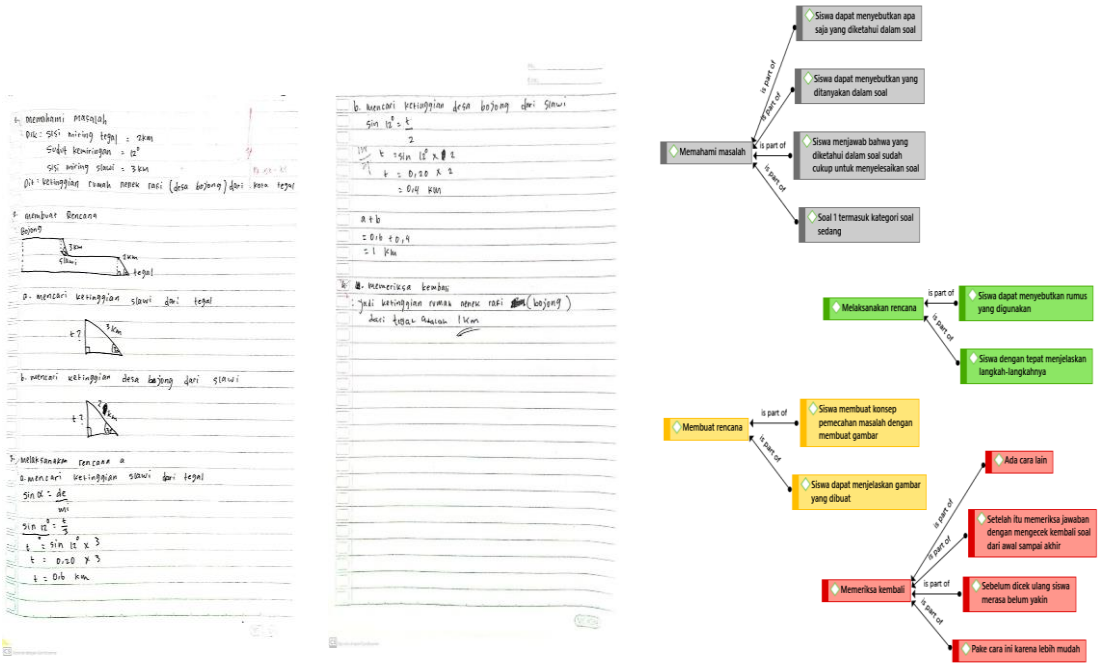
In this study, the research subjects were determined based on data obtained from the test results of trigonometry questions. On Friday, February 17, 2023, researchers distributed test questions to students of class X MIPA 8 SMA Negeri 1 Indramayu. After that, the researcher gave scores to the test results conducted by students. Students who have scores between 80 to 100 are included in the high problem solving ability category. Students who score between 65-79 are included in the medium problem solving category. Students who score <65 are included in the low problem solving category. Based on the scoring results, it is known that out of 36 students who worked on the test questions, 34 students, 9 people were in the high problem solving category, 19 people were in the medium problem solving category, and 8 people were in the low problem solving category. After obtaining data on student categories based on the level of learning difficulty. The next step is purposive selection of subjects. Six students were selected as research subjects. Details of the selected research subjects are presented in the following table:

Table 1. Subject Retrieval Table

No	Student Code	Scor Test
1	S1	100
2	S2	96
3	S3	78
4	S4	76
5	S5	60
6	S6	60

After getting a research subject based on a diagnostic test to find out students' learning difficulties in solving problem solving problems according to Polya's steps on

trigonometry material, which was held on Friday, February 17, 2023. Furthermore, scoring is carried out on the test results done by students. S1 with a score of 100 entered into high problem solving, S2 with a score of 96 entered into high problem solving, S3 with a score of 78 entered into moderate problem solving, S4 with a score of 76 entered into moderate problem solving, S5 and S6 have the same score of 60 entered into low problem solving. The test results and data reduction results of each research subject are as follows:



English Version

1. Understand the problem
   Known: Tegal hypotenuse: 2 KM
   Tilt angle: 120^0
   Slawi sloping side: 3 KM
   Asked: The height of Rafi's grandmother's house (Bojong Village) from Tegal City
2. Make a plan
   a. Looking for the height of Slawi from Tegal
   b. Looking for the heights of Bojong village from Slawi
3. Implement the plan
   a. Looking for the height of Slawi from Tegal
   b. Looking for the height of Bojong village from Slawi
4. Check again
   So the height of Rafi's grandmother's house (Bojong) from Tegal is 1 KM

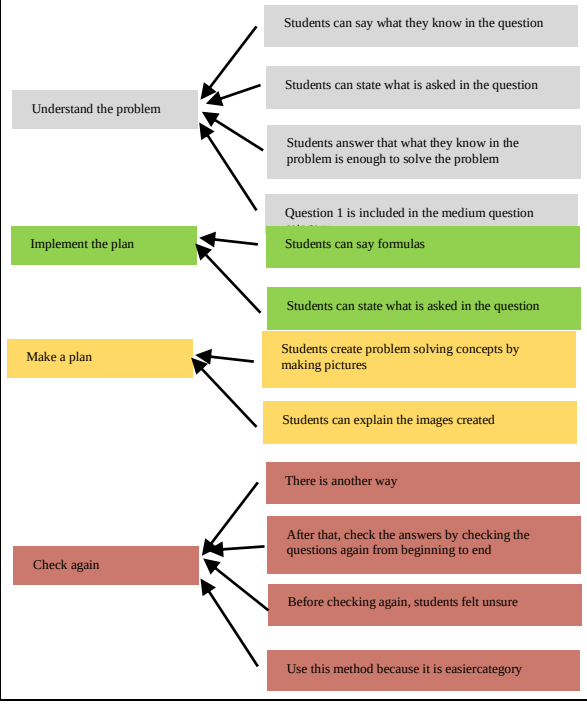
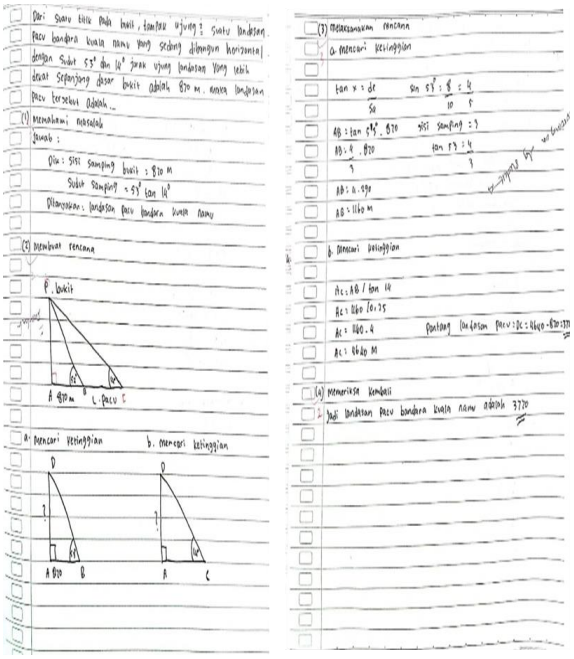
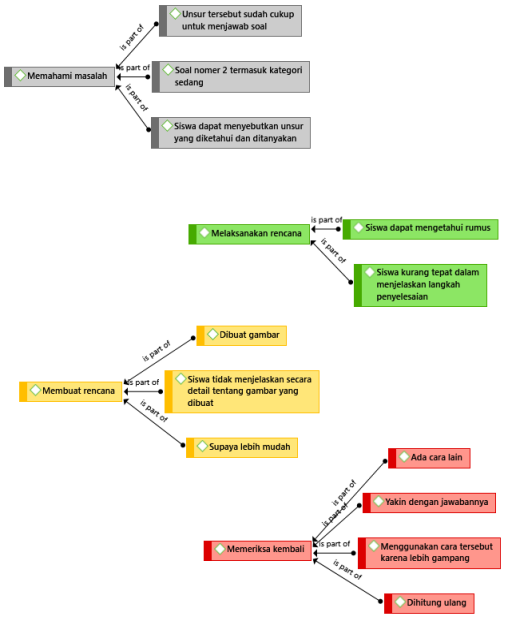


Figure 1. Test Results and Reduction Results from S1 Question 1





English Version

From a point on the hill you can see the tip of a Kuala Namu airport runway which is being built horizontally at an angle of 53^0 and 14^0. The distance to the end of the runway that is closer along the base of the hill is 870 m. So the runway is

1. Understand the problem
   Answer: Known: side of the hill: 820 m side corners 53^0 and 14^0
   Asked: Airport runway
2. Make a plan
   a. Looking for heights
   b. Looking for heights
3. Carry out the plan
   a. looking for height
   b. looking for height
4. Check again
   So the Kuala Namu airport runway is 3720

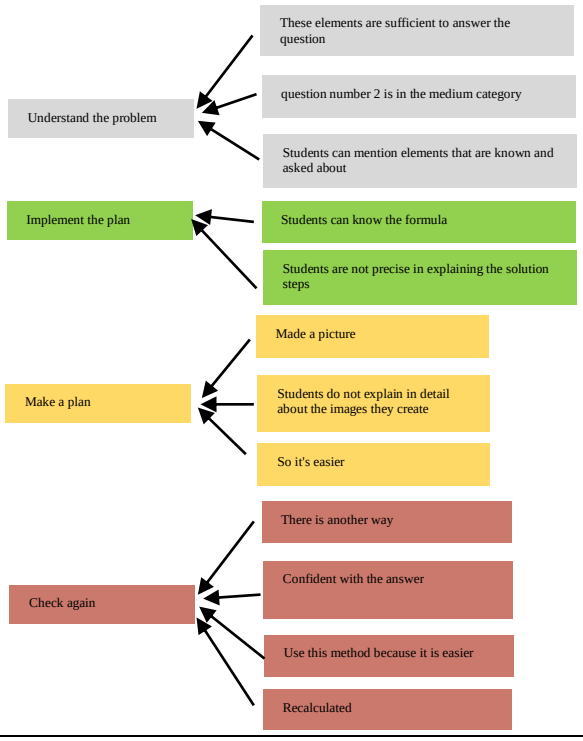
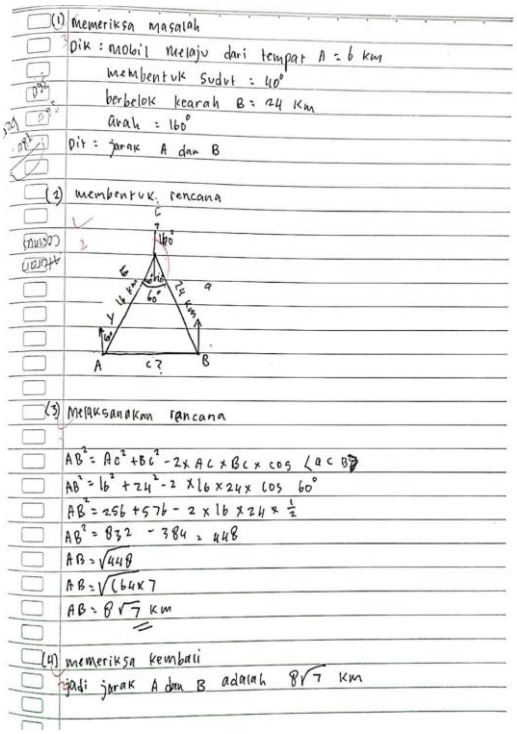
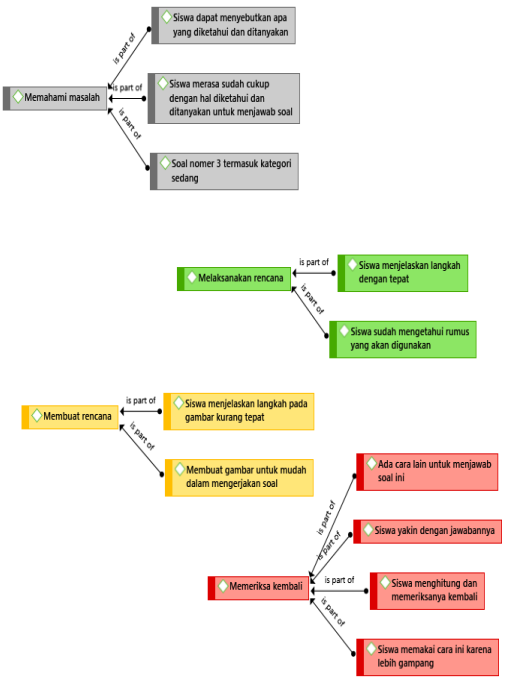


Figure 2. Test Results and Reduction Results from S1 Question 2





English Version

1. Check for problems
   Known: The car drove from place A: 6 KM. Form a 40^0 angle
   Turn towards B: 24 KM. Direction 60^0
   Asked: Distance between A and B
2. Forming a plan
3. Implement the plan
4. Check again
   So the distance between A and B is $8\sqrt{7}$ KM

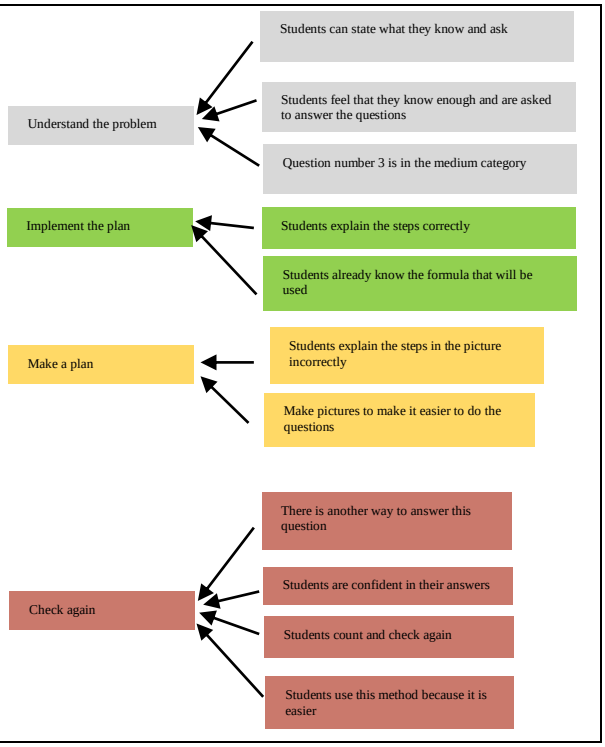
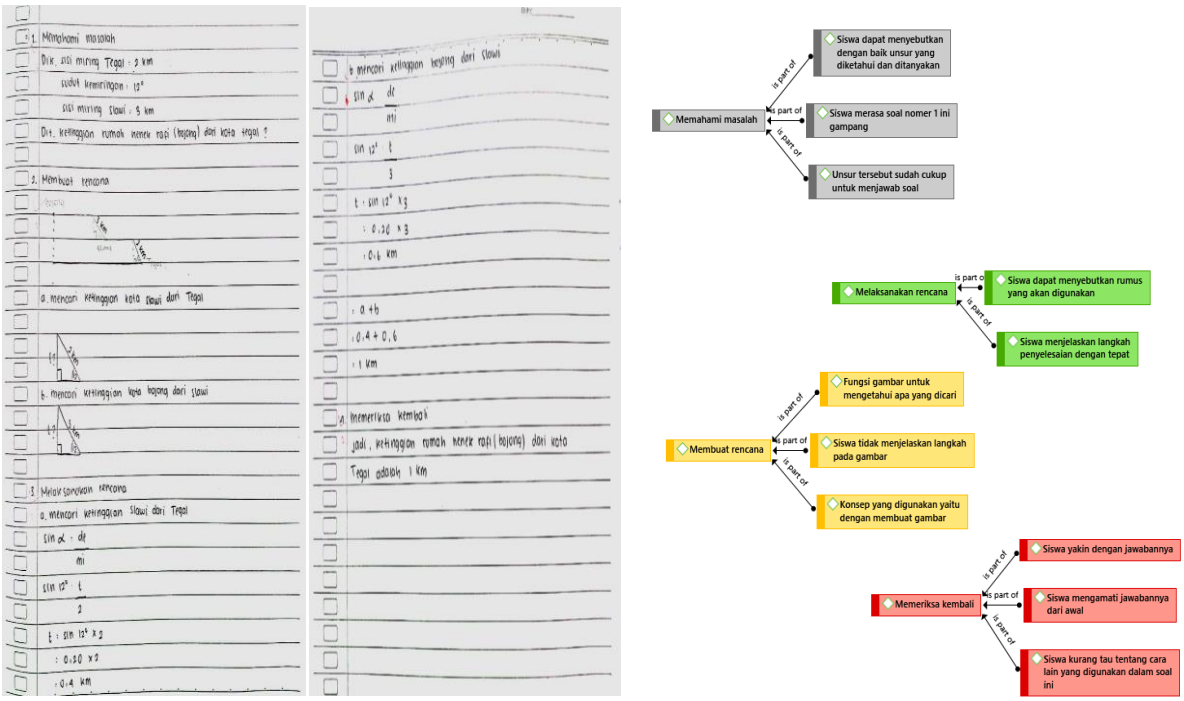


Figure 3. Test Results and Reduction Results from S1 Question 3



English Version

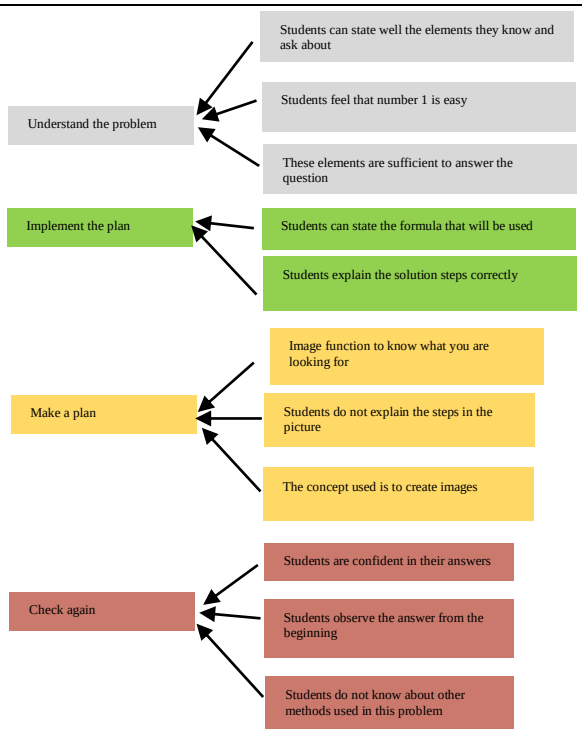
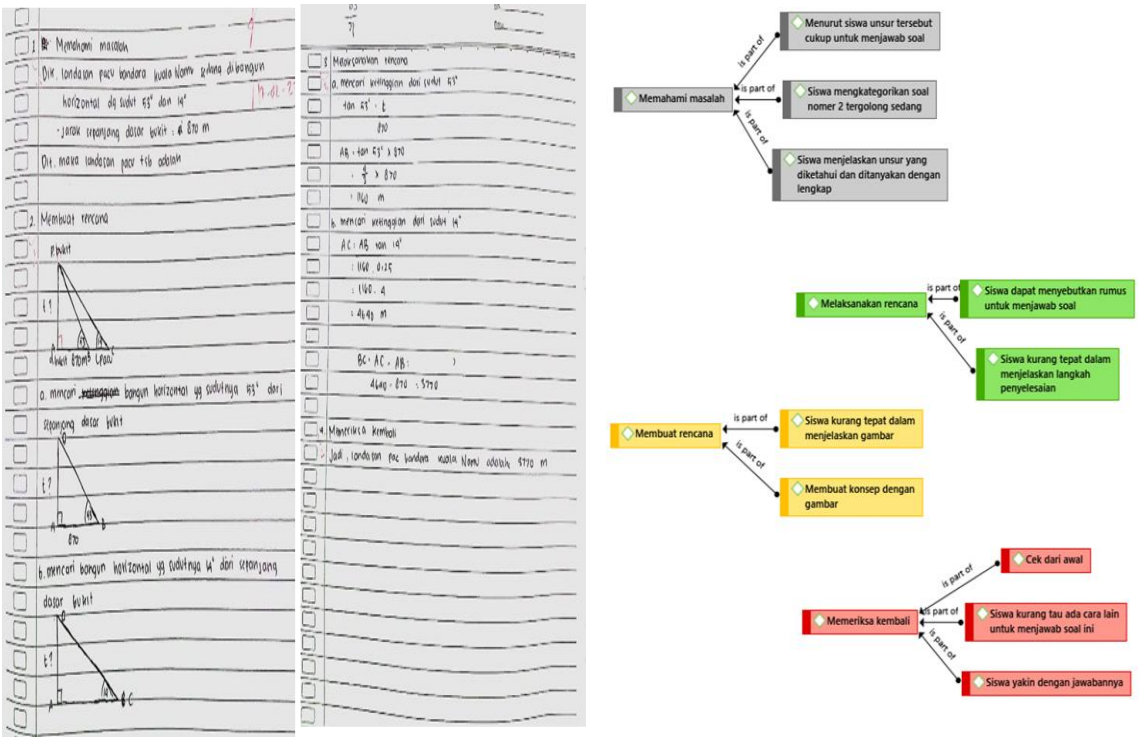
1. Understand the problem Known: Tegal sloping side: 2 KM Tilt angle 12 Slawi sloping side 3 KM Asked: The height of Rafi's grandmother's house (Bojong) from Tegal city 2. Make a plan a. Looking for the height of the city of Slawi from Tegal b. Looking for the height of the city of Bojong from Slawi 3. Implement the plan a. Looking for the height of Slawi from Tegal b. Looking for the height of Bojong from Slawi 4. Check Back So the height of Grandma Rafi's house (Bojong) from Tegal city is 1 KM	

Figure 4. Test Results and Reduction Results from S2 Question 1



English Version

1. Understand the problem
   The Kuala Namu airport runway is being built horizontally at angles 53^0 and 14^0. Distance along the base of the hill: 870 m
   Asked: then the runway is
2. Make a plan
   a. Looking for a horizontal shape at an angle of 53^0 from the bottom of the hill
   b. Looking for a horizontal shape at an angle of 14^0 from the bottom of the hill
3. Carry out the plan
   a. Find the height of angle 53^0
   b. Find the height of angle 14^0
4. Check again
   So the Kuala Namu airport runway is 3770 m

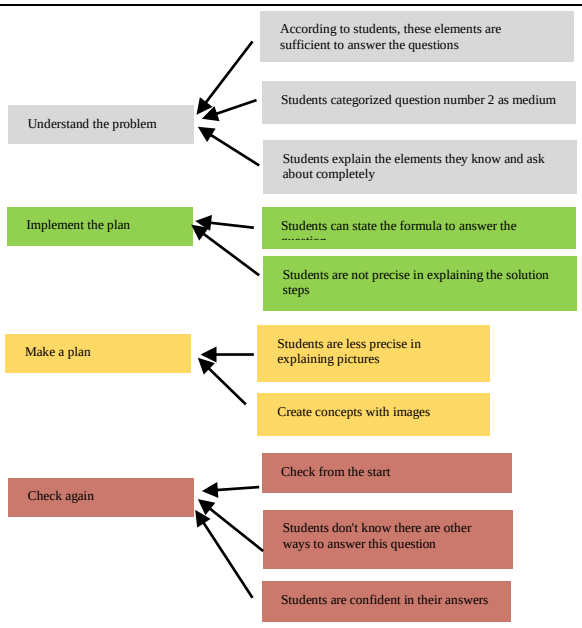
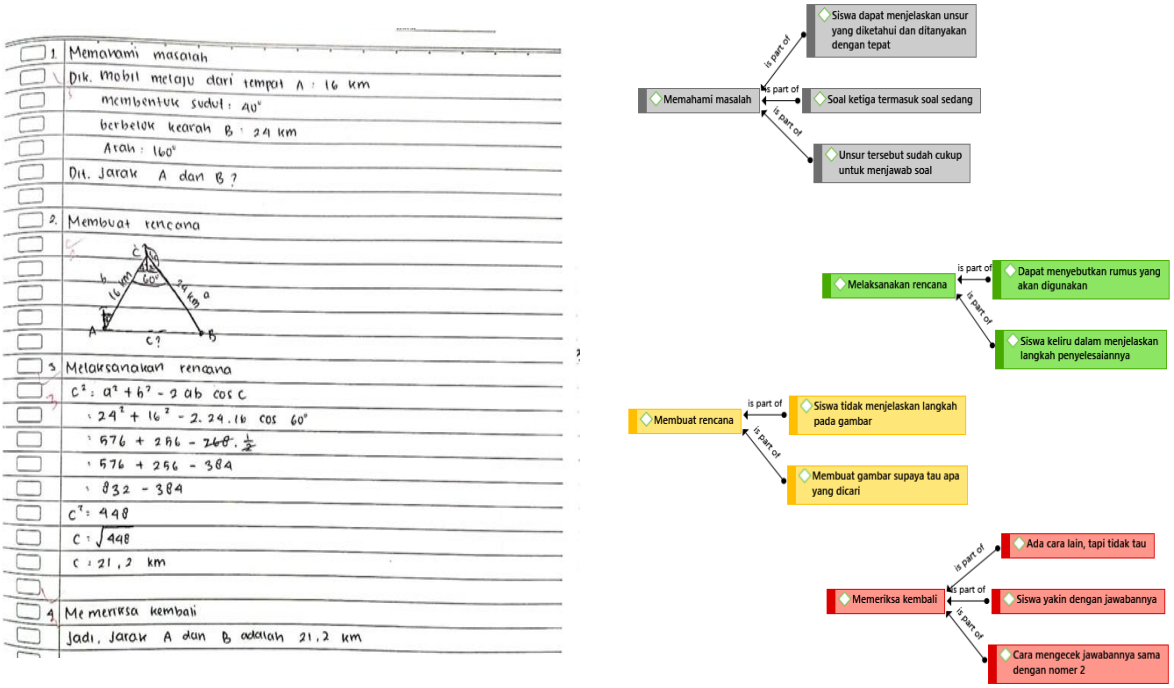


Figure 5. Test Results and Reduction Results from S2 Question 2



English Version

1. Understand the problem
   Known: the car travels from place A: 16 KM making an angle of 40^0 turning towards B: 24 KM
   Direction: 160^0
   Asked: Distance between A and B?
2. Forming a plan
3. Implement the plan
4. Check again
   So the distance between A and B is 21,2 KM

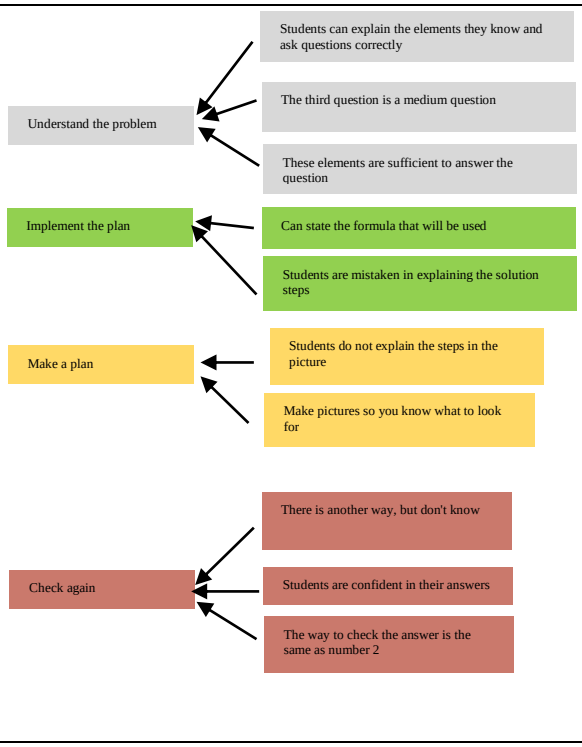
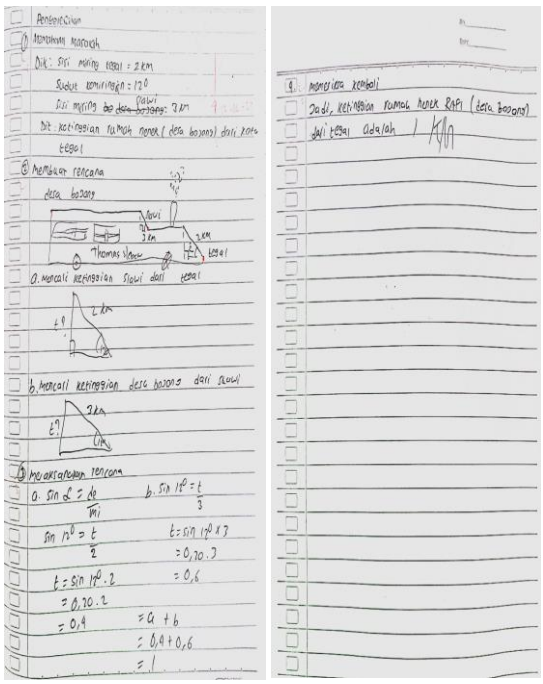
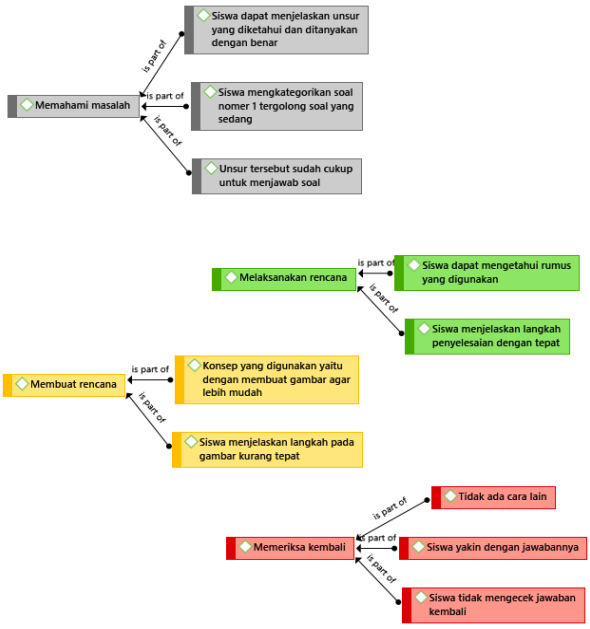


Figure 6. Test Results and Reduction Results from S2 Question 3





English Version

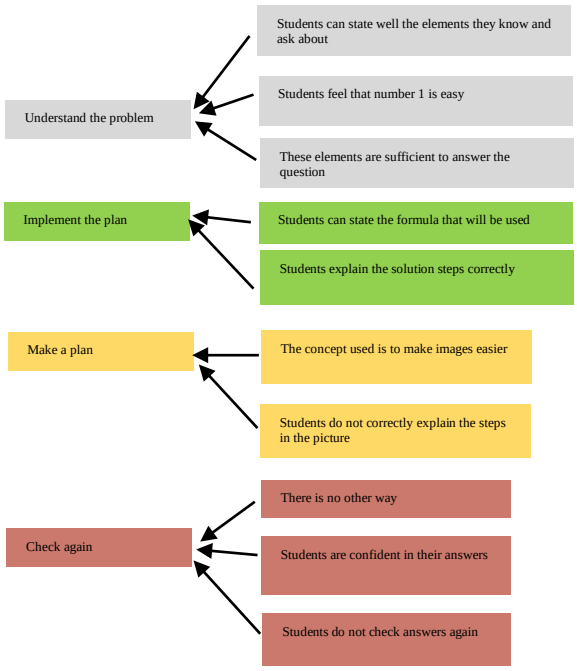
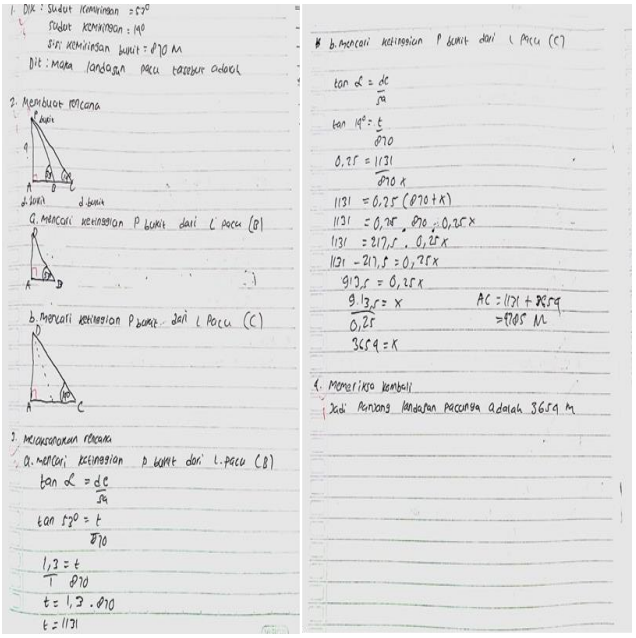
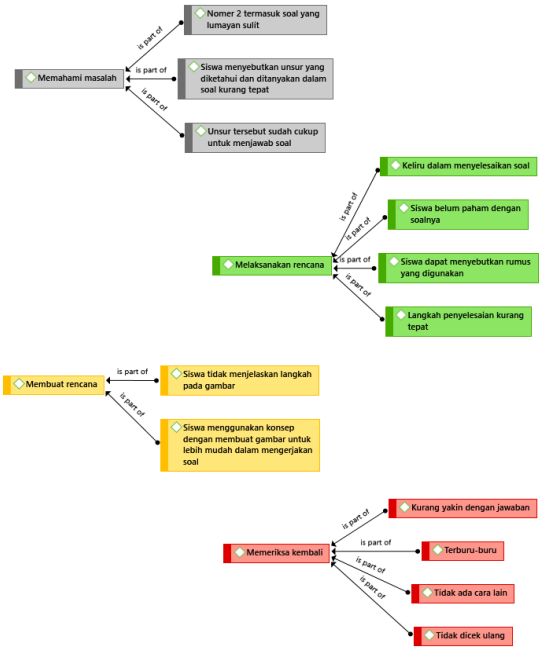
1. Understand the problem Known: sloping side of Tegal: 2 Km Tilt angle: 120 Slawi sloping side: 3 KM Asked: The height of Rafi's grandmother's house (Bojong village) from Tegal city 2. Make a plan a. Looking for the height of the city of Slawi from Tegal b. Looking for the height of the city of Bojong from Slawi 3. Implement the plan 4. Check Back So the height of Grandma Rafi's house (Bojong village) from Tegal city is 1 KM	

Figure 7. Test Results and Reduction Results from S3 Question 1





English Version

1. Known: The slope angle is 53^0, the slope angle is 140^0, the slope of the hill is 870 M
   Asked: So the runway is
2. Make a plan
   a Find the height P of the hill from the runway (B)
   b. Find the height P of the hill from the runway (C)
3. Implement the plan
   a Find the height P of the hill from the runway (B)
   b. Find the height P of the hill from the runway (C)
4. Check again
   So the length of the runway is 3654 M

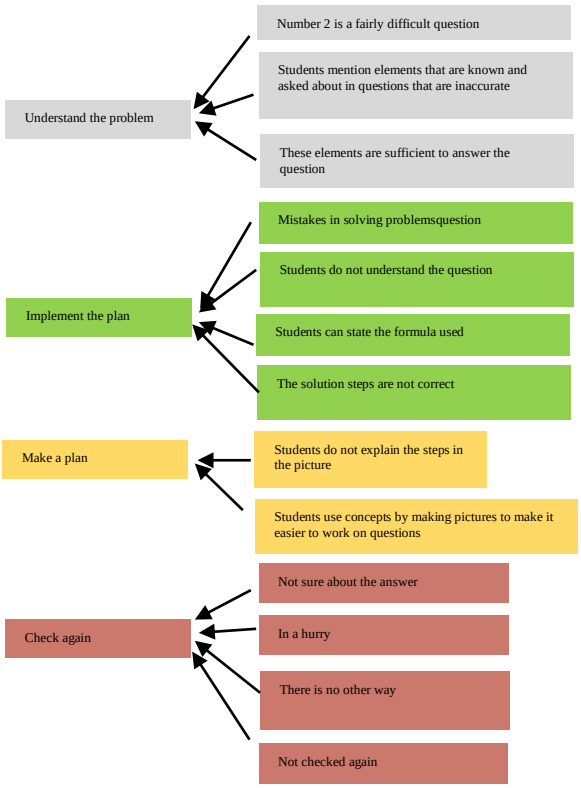
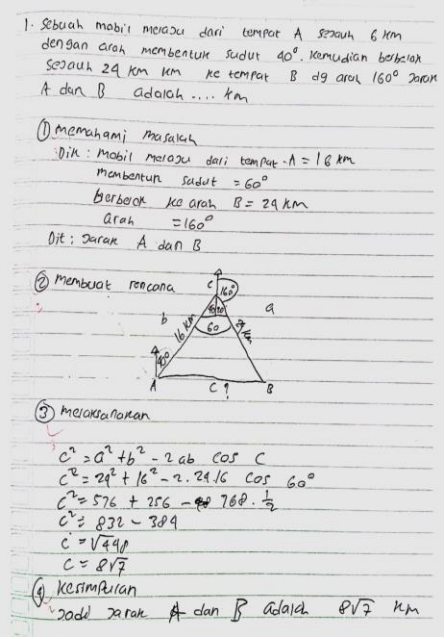


Figure 8. Test Results and Reduction Results from S3 Question 2



1. Sebuah mobil melaju dari tempat A sejauh 6 km dengan arah membentuk sudut 40°. Kemudian berbelok sejauh 24 km ke tempat B dg arah 160° Jarak A dan B adalah .... km

① Memahami masalah
Dik : Mobil melaju dari tempat A = 16 km
membentuk sudut = 60°
berbelok ke arah B = 24 km
arah = 160°
Dit : Jarak A dan B

② membuat rencana

③ Melaksanakan
$c^2 = a^2 + b^2 - 2ab \cos C$
$c^2 = 24^2 + 16^2 - 2.24.16 \cos 60°$
$c^2 = 576 + 256 - 768 . \frac{1}{2}$
$c^2 = 832 - 384$
$c = \sqrt{448}$
$c = 8\sqrt{7}$

④ Kesimpulan
Jadi Jarak A dan B adalah $8\sqrt{7}$ km

English Version

A car drives from place A for 6 KM in a direction at an angle of 40^0. Then it turns 24 KM to place B in a direction of 160^0. The distance between A and B is... Km

1. Understand the problem
   Known: The car drove from place A: 16 Km
   forms an angle of 40^0, turns towards B: 24 KM in a direction of 160^0
   Asked: Distance A and B
2. Make a plan
3. Implement
4. Conclusion
   So the distance between A and B is $8\sqrt{7}$Km

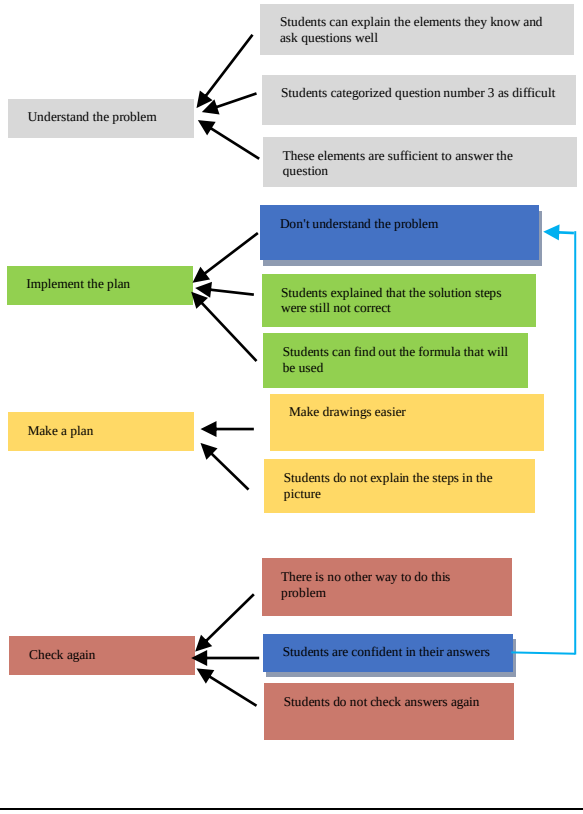
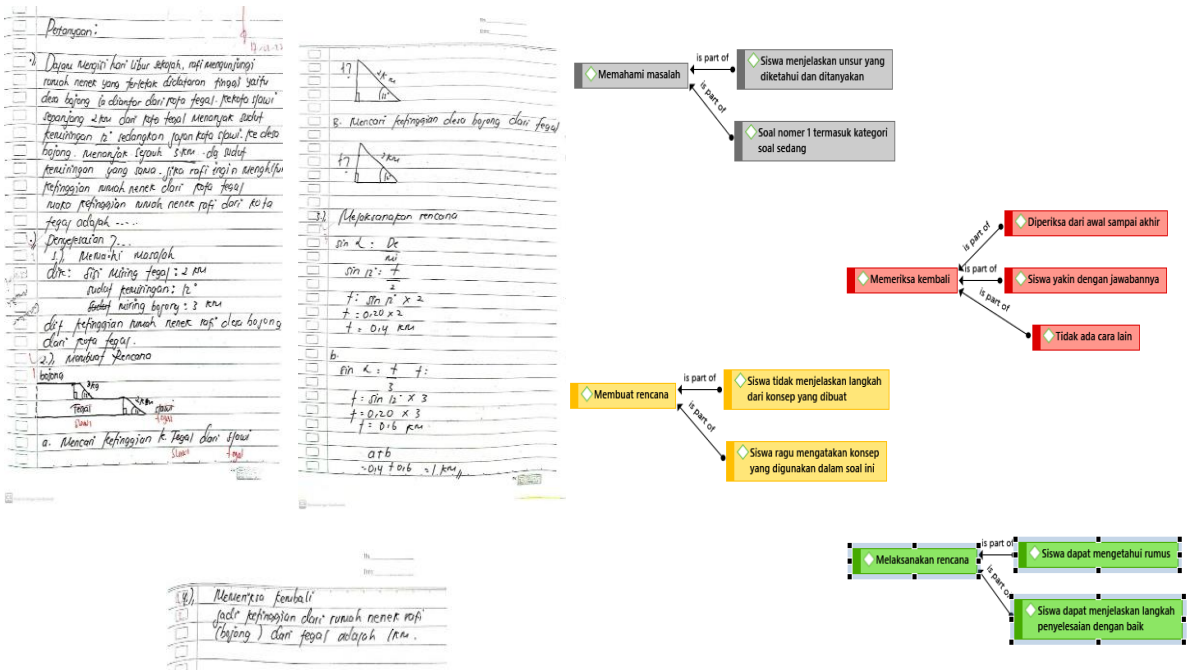


Figure 9. Test Results and Reduction Results from S3 Question 3



English Version

During the school holidays, Rafi visited his grandmother's house which is located in the highlands, namely Bojong Village. He was taken from Tegal city to Slawi city for 2 KM. From Tegal city the slope angle is 12^0, while the Slawi city road to Bojong Village climbs 3 KM with the same slope angle. If Rafi wants to calculate the height of his grandmother's house from Tegal, what is the height of Rafi's grandmother's house to the city of Tegal?

1. Understand the problem
   It is known: Tegal's slant is 2 KM, slope angle is 12^0, Bojong's slant is 3 KM
   Asked: The height of Rafi's grandmother's house, Bojong village, Tegal city
2. Make a Plan
   a. Looking for the height of the city of Tegal from Slawi
   b. Looking for the height of Bojong village from Tegal
3. Implement the plan
4. Check again
   So the height of Rafi's grandmother's house (Bojong) from Tegal is 1 KM

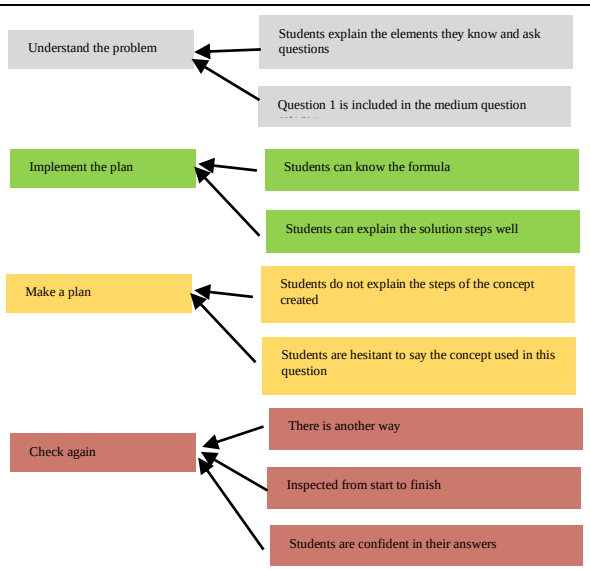
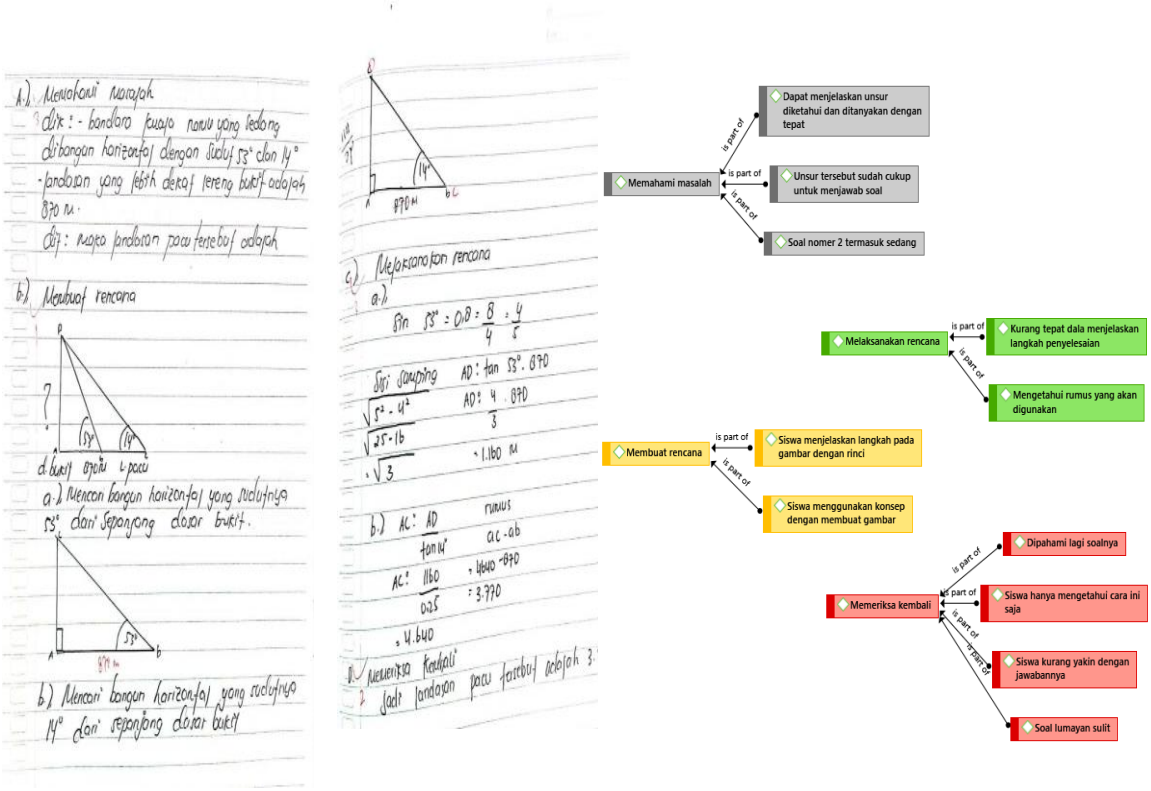


Figure 10. Test Results and Reduction Results from S4 Question 1



English Version

1. Understand the problem
   The Kuala Namu airport runway is being built horizontally at angles 53^0 and 14^0. Distance along the base of the hill: 870 m
   Asked: then the runway is
2. Make a plan
   a. Looking for a horizontal shape at an angle of 53^0 from the bottom of the hill
   b. Looking for a horizontal shape at an angle of 14^0 from the bottom of the hill
3. Carry out the plan
   a. Find the height of angle 53^0
   b. Find the height of angle 14^0
4. Check again
   So the airport runway is 3770 m

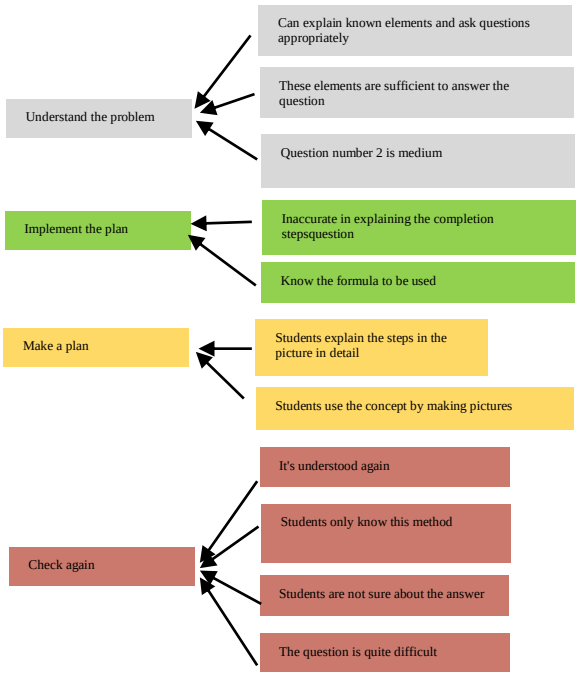
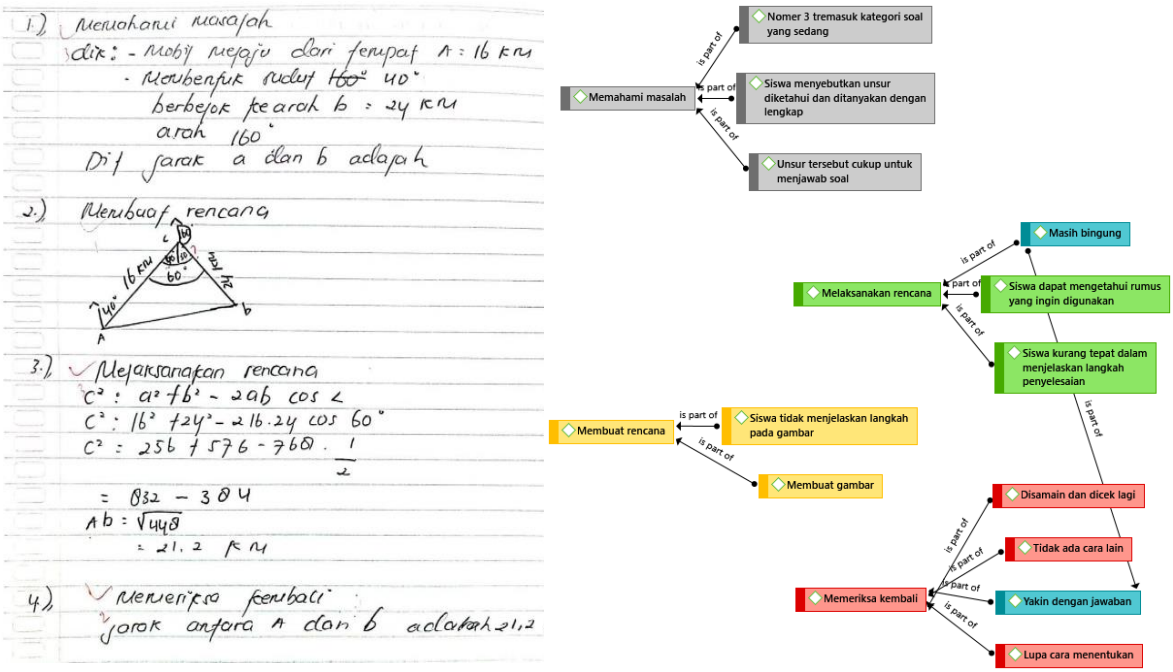


Figure 11. Test Results and Reduction Results from S4 Question 2



English Version

A car drives from place A for 6 KM in a direction at an angle of 40^0. Then it turns 24 KM to place B in a direction of 160^0. The distance between A and B is... Km

1. Understand the problem
   Known: The car drove from place A: 16 Km
   forms an angle of 40^0, turns towards B: 24 KM in a direction of 160^0
   Asked: Distance A and B
2. Make a plan
3. Implement
4. Conclusion
   So the distance between A and B is 21,2 Km

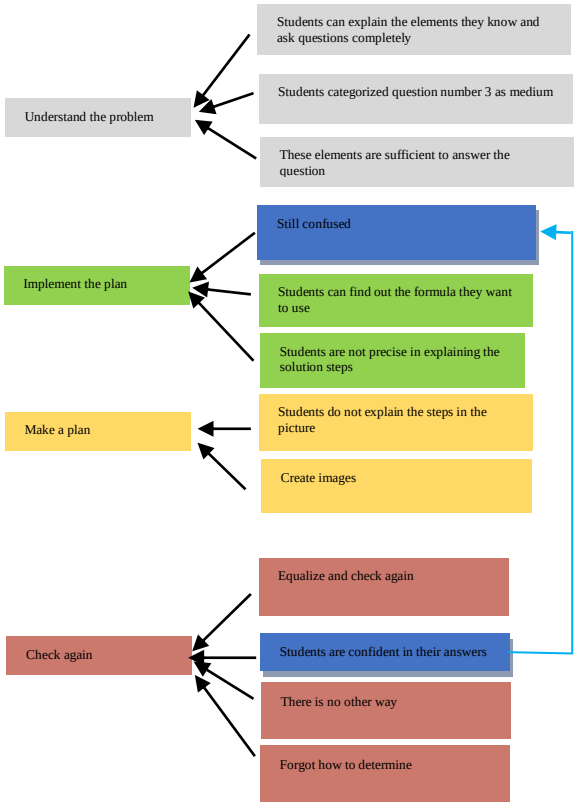
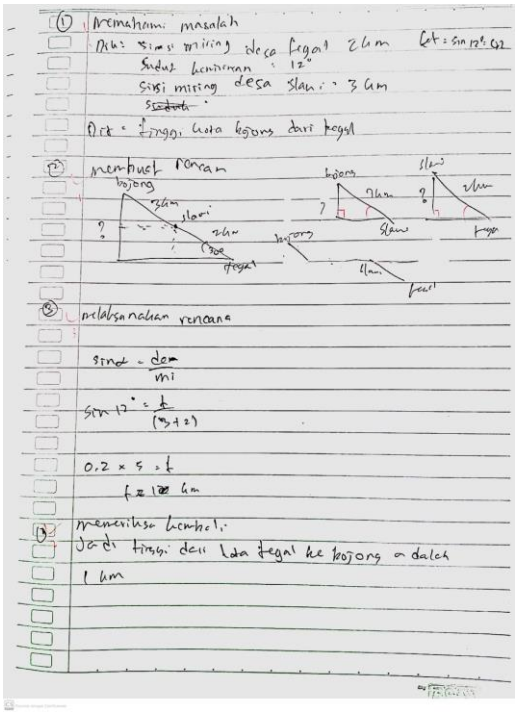
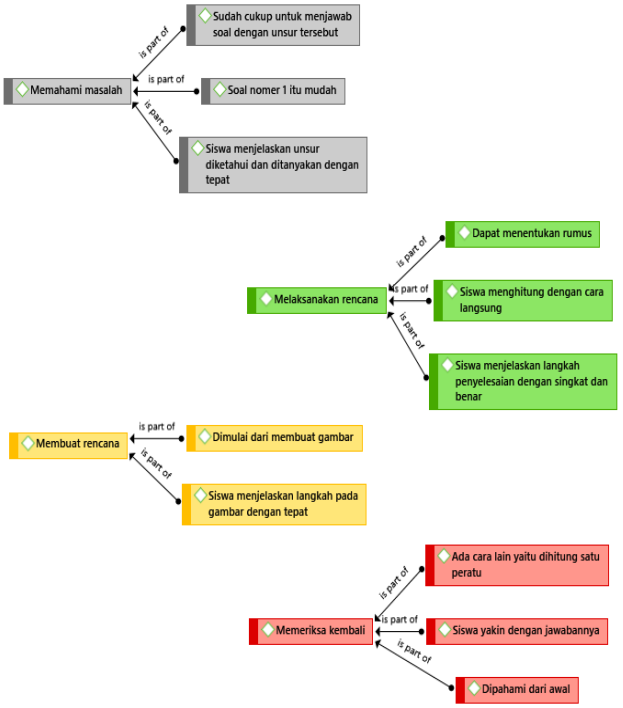


Figure 12. Test Results and Reduction Results from S4 Question 3





English Version

1. Understand the problem
   Known: Tegal slant side: 2 KM, slope angle 12, Slawi slant side 3 KM
   Asked: The height of Bojong village from Tegal
2. Make a Plan
3. Implement the Plan
4. Check Back

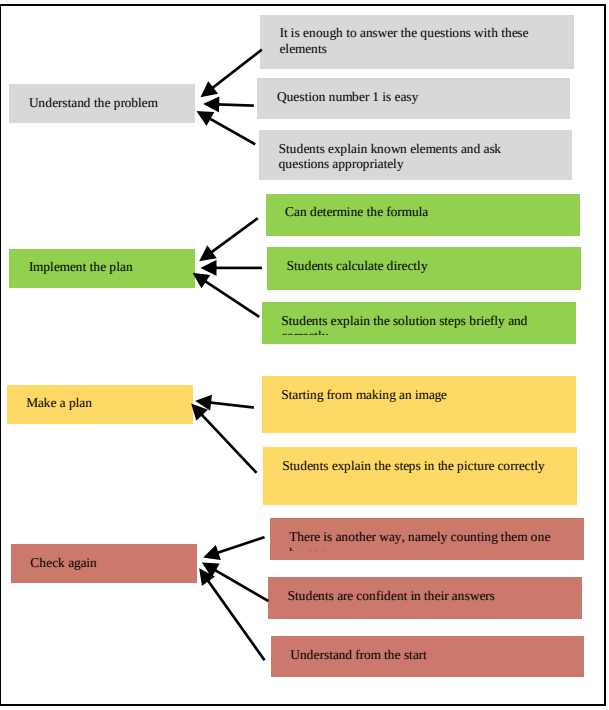
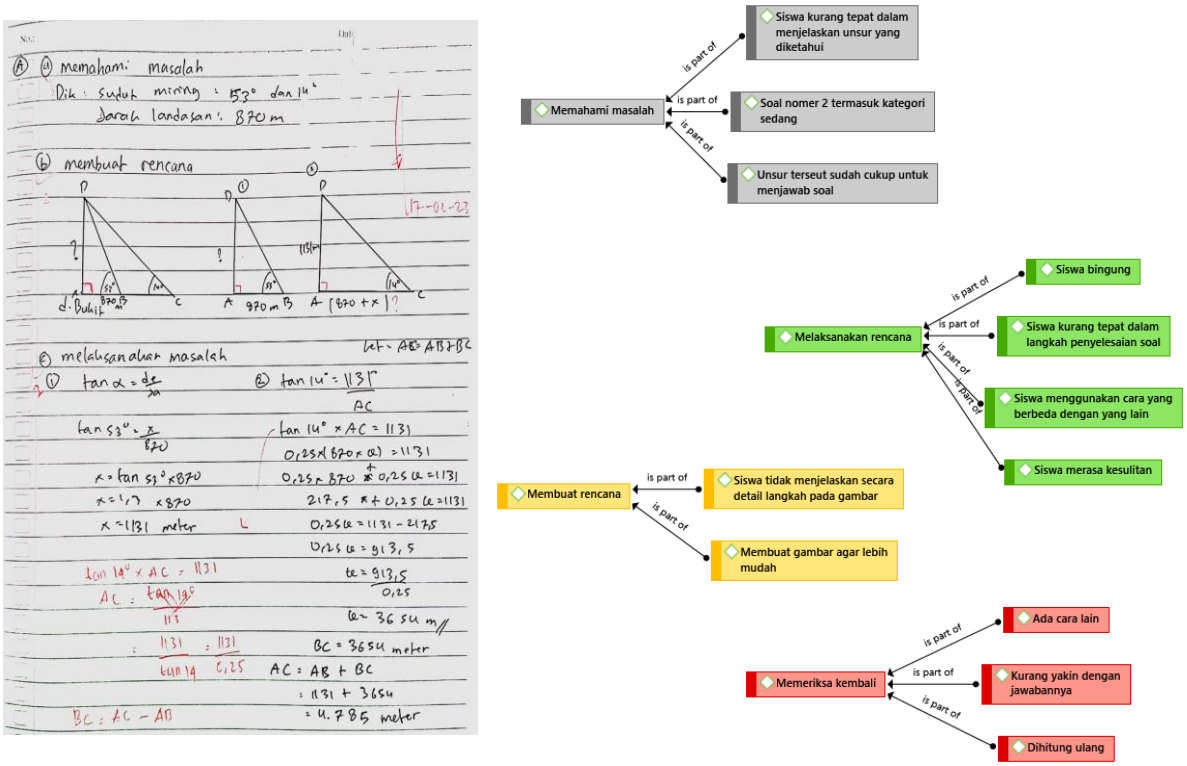


Figure 13. Test Results and Reduction Results from S5 Question 1



English Version

1. Understand the problem
   Given: oblique angles: 53^0 and 14^0
   runway distance: 870M
2. Make a plan
3. Carry out the plan

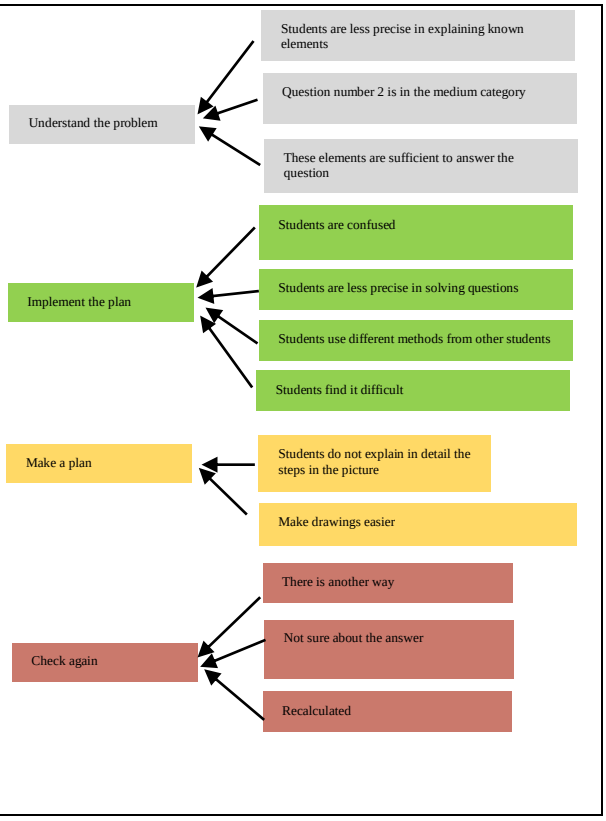
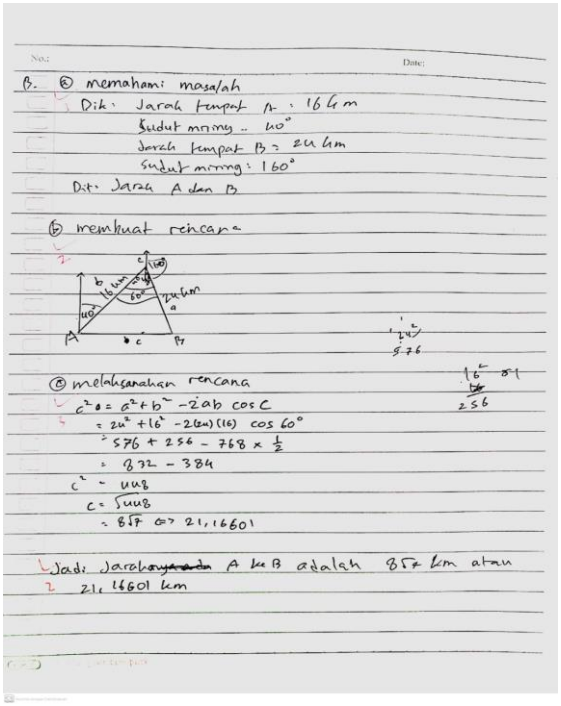


Figure 14. Test Results and Reduction Results from S5 Question 2



English Version

1. Understand the problem
   Known: Distance to place A: 16 KM, Tilt angle: 40^0, distance to place B: 24 Km, Tilt angle: 160^0
   Asked: Distance A and B
2. Make a plan
3. Implement
4. Conclusion
   So the distance between A and B is $8\sqrt{7}$ KM atau 21,16601 Km

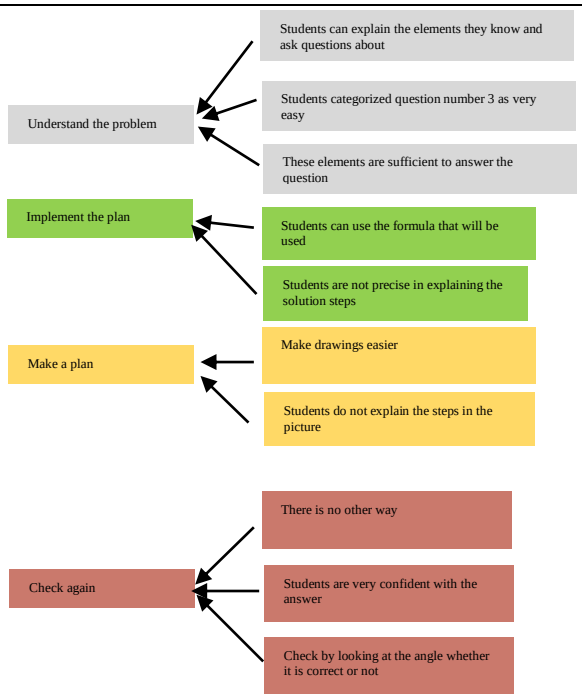
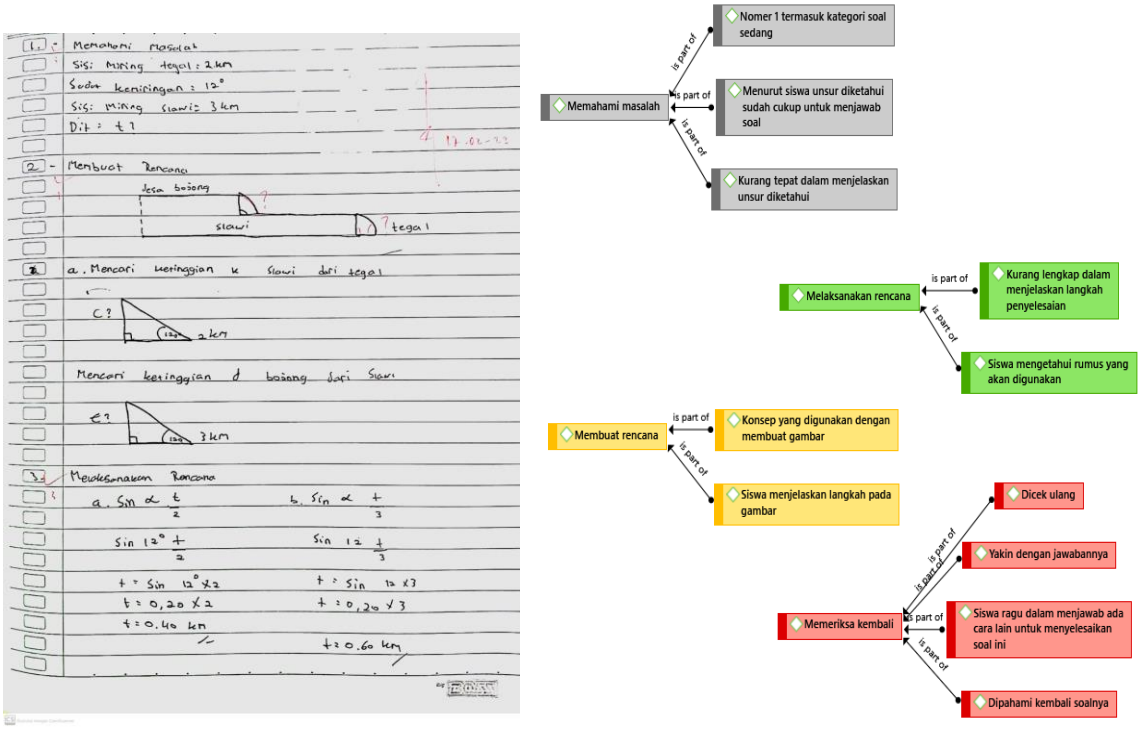


Figure 15. Test Results and Reduction Results from S5 Question 3



English Version

1. Understand the problem
   Tegal's slant is 2 KM, slope angle is 12^0, Bojong's slant is 3 KM
   Asked: t?
2. Make a Plan
   Looking for the height of k, Slawi from Tegal
   Looking for the height of d, Bojong From Tegal
3. Implement the plan

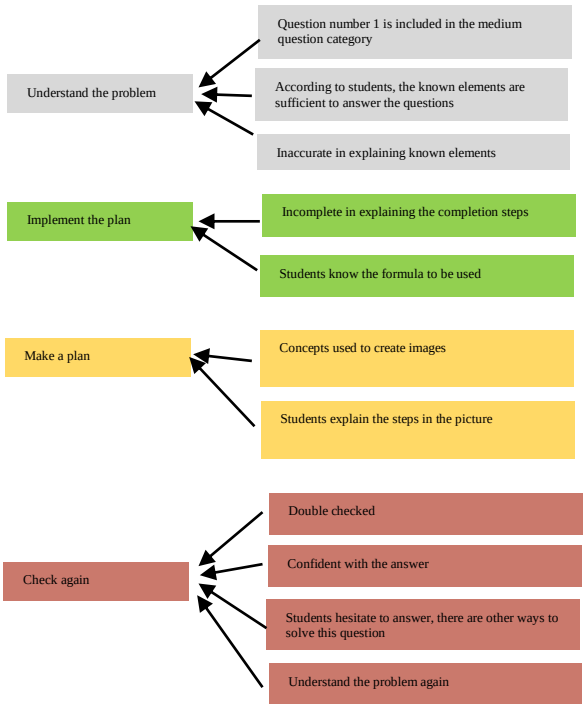
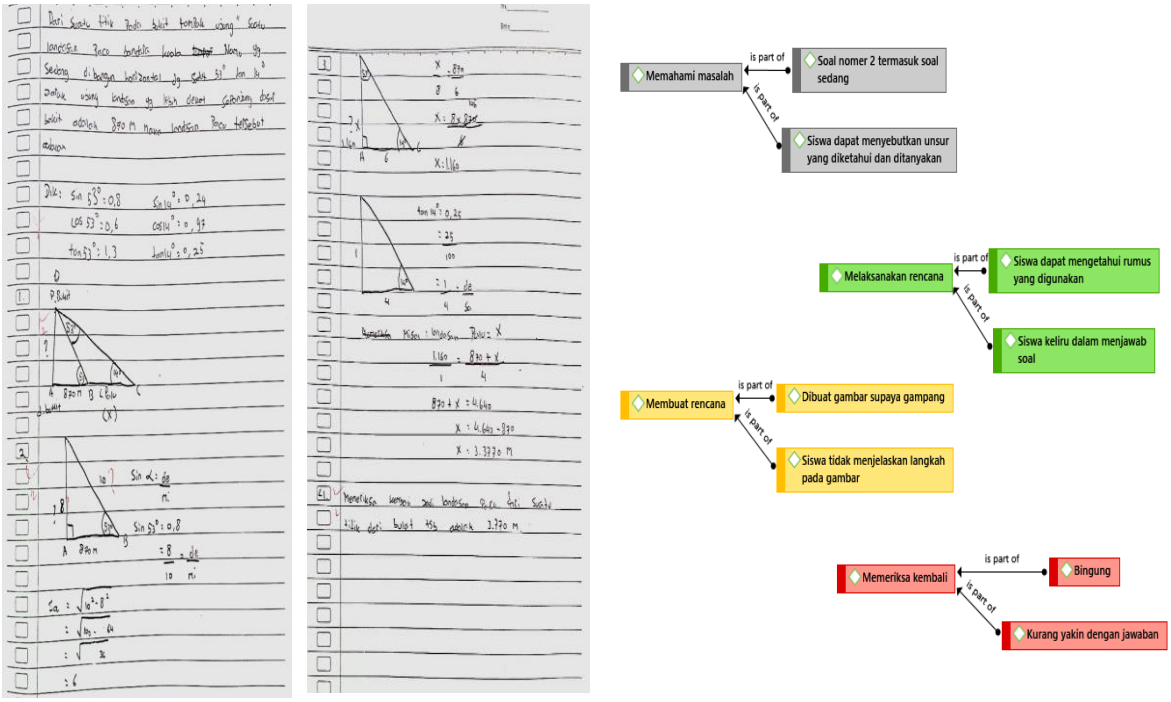


Figure 16. Test Results and Reduction Results from S6 Question 1



English Version

1. From a point on the hill you can see the end of a Kuala Namu airport runway which is being built horizontally at an angle of 530 and 140. Rarely the end of the runway closer to the base of the hill is 870 M, then the runway is
Known: Trigonometry angles
2. Looking for syn
3. Find the distance
4. Conclusion

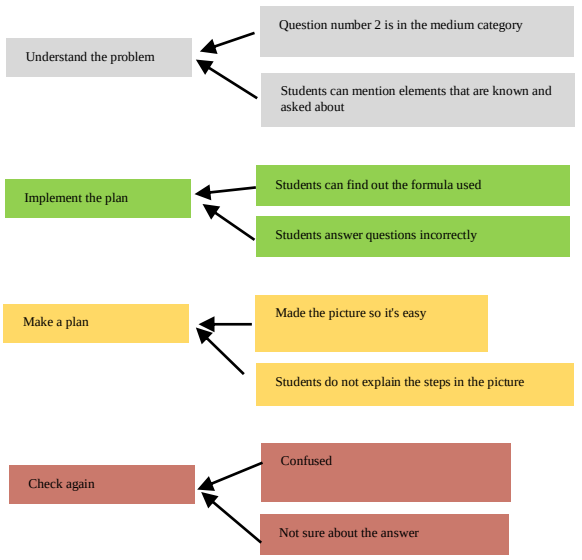
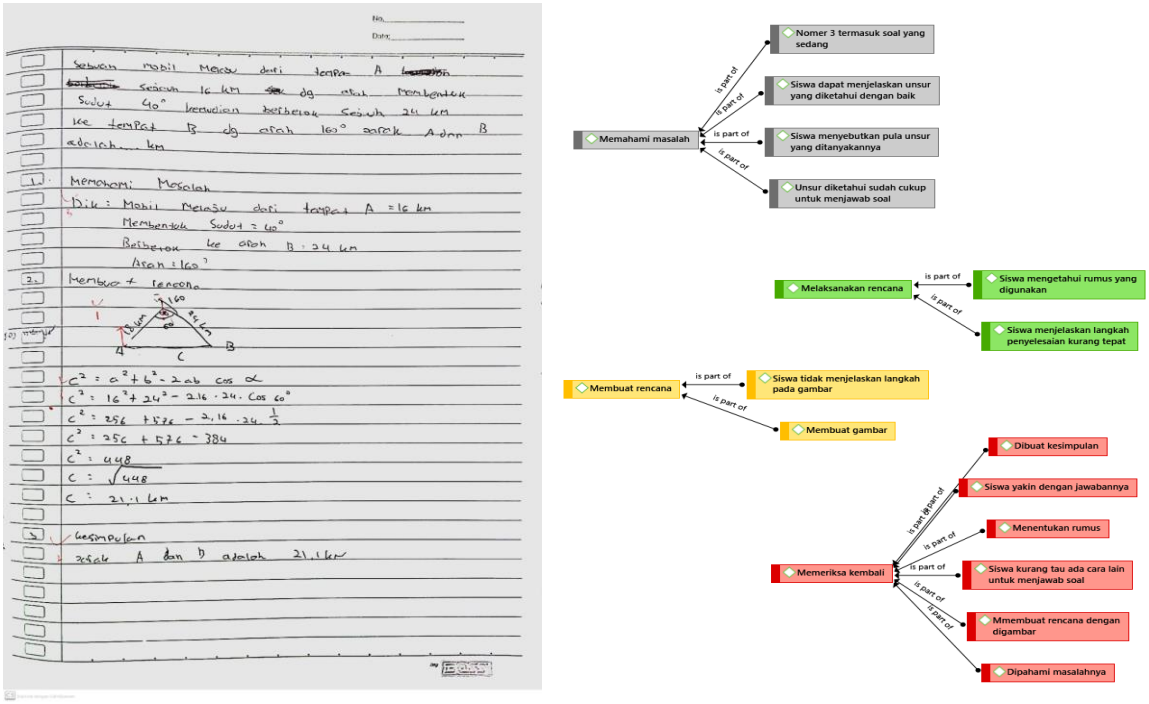


Figure 17. Test Results and Reduction Results from S6 Question 2



English Version

A car drives from place A as far as 16 KM in a direction at an angle of 400 then turns 24 KM to place B in a direction of 1600. The distance between A and B is.... Km

1. understand the problem
   Known: The car drove from place A: 16 KM. Form an angle of 400. turn towards B: 24 KM direction: 1600
2. make a plan
3. conclusion

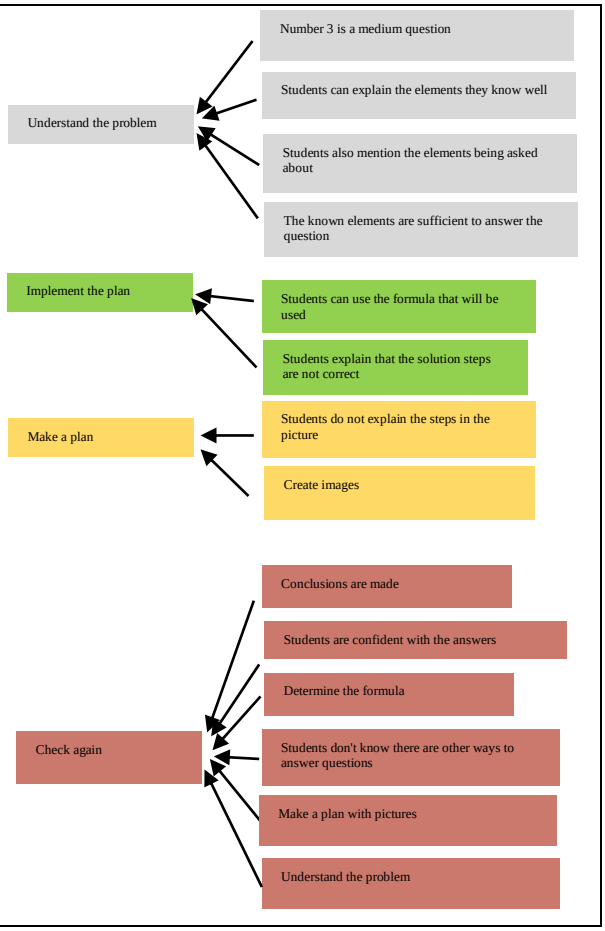


Figure 18. Test Results and Reduction Results from S6 Question 3

Based on the results of the researcher's interviews with research subjects, it shows several causes of difficulties that many students face in working on problems in solving problems according to Polya, namely that most students do not explain the steps taken in creating a concept in the second stage, where in the second stage, namely making a plan, students are too focused on the concept of making an image, but cannot explain where the concept came from. There are also difficulties in the third stage, namely carrying out the plans of most students in completing the questions in a hurry, so that the effect when explaining again what they have done is not optimal. Lack of understanding of the questions so that students feel confused in answering the questions. Students underestimate the questions so there are mistakes in solving the questions and difficulty memorizing special angles in trigonometry material.

Based on the results obtained from the research, students' difficulties in solving trigonometric problem solving problems according to Polya's steps owned by students of class X MIPA 8 SMA Negeri 1 Indramayu are able to solve a problem using Polya's steps. When students who have a high test score will experience little learning difficulty because the subject can explain and solve the problem well and there is no difficulty. While it is different when students who have low scores feel confused, difficult, wrong in solving a problem. Actually, in this study the highest score and the lowest score both answered the question correctly, the only difference was the diligence of the student and underestimated it too much, causing the student to get a low score.

This research is not in line with research conducted by Pratiwi & Hidayat (2020) The difficulty was by using Polya's 4 phases, namely: 1) understanding the problem, students cannot see the known and questionable elements, this happens because of the basic consideration of students who are curious about the problem at hand and basically focus on the final result; 2) making a plan, students cannot make a mathematicsematical model related to the picture because students do not know the concept; 3) completing the plan, the understudy cannot know what drives towards the use because students are not used to finding out about the problem in a detailed way; 4) checking back, students cannot see the correctness of the responses they have gotten. This happens because students are usually not asked to recheck the answers they get.

Meanwhile, this study is in line with the results of research conducted by Enlisia et al., (2020) that students' difficulties in solving problems based on Polya's steps can be seen from 4 stages, namely understanding the problem, making a plan, implementing the plan, and checking back. Based on these steps, there are student difficulties in working on

problems. Difficulties in understanding the sentences or terms contained in the problem, students have difficulty in making mathematicsematical concepts, students at this time are less careful in solving problems, and students are not accustomed to doing the method of remembering or checking back answers.

In addition, there are several studies that use Polya's steps saying that using Polya's steps can solve problems and can train students' abilities in learning mathematics. Research conducted by Hadi & Radiyatul (2014) suggests that there are 4 stages of problem solving according to Polya's steps, namely understanding the problem, making a plan, implementing the plan, and checking back. Each stage is done well from the initial meeting to the end, which means that using Polya's stages can improve students' problem solving skills and can make students' learning outcomes better.

After the results are known as described in the facts above, as a follow-up to this research, namely discussion. This is done in order to triangulate the theory against other people's hypotheses. That is, to strengthen strong and valid data.

The obstacle that the author faced during the research was the lack of optimal research time, because at the time of the research the school would hold mid-semester exams so that the research time was accelerated because the material to be studied was included in the exam material.

CONCLUSION

The difficulties faced by students in solving trigonometry problems have two factors, namely internal factors and external factors. Internal factors include subjects lacking in understanding the problem, confusion in answering questions, underestimating the responsibility given, and experiencing errors. External factors include the strategies used that have not varied, lack of time management because there are many stages that must be completed. The cause of student difficulties in trigonometry material seen from problem solving according to Polya's steps is that there are several stages that cause students to experience difficulties, namely the second stage and the third stage. The second stage, namely making a plan, most students do not explain the steps taken in making concepts in the second stage where in the second stage, namely making a plan, students are too focused on the concept of making drawings, but cannot explain where the concept is obtained. The third stage, namely implementing the plan, most students in solving the problem are in a hurry, so that it affects when explaining back what is done less optimally. Efforts made by teachers in overcoming learning difficulties experienced by students are by conducting

retests or remedials and providing additional lessons that students can access via the internet so that students can learn anywhere.

Based on the above conclusions, researchers can submit several suggestions that are expected to provide benefits. The suggestions that will be conveyed are as follows: 1) For educators, they can apply the problem solving method with Polya's steps as an option in learning mathematicsematics to develop students' problem skills. Students are also directed to be able to solve a problem by knowing the concepts to be used so that it will make it easier for students to learn. Increase practice problems related to everyday life, it will reduce the level of difficulty of students; 2) educator can also use differentiated learning to identify each student's learning difficulties in trigonometry material ; 3) For other researchers, in using Polya's problem solving method, they should pay attention to learning time because this method requires a relatively long time to improve students' abilities. It is hoped that there will be further research, given the limitations that exist in this study.

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