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IDENTIFICATION OF HOTS PROBLEM SOLVING ABILITY OF HIGH SCHOOL STUDENTS USING TWO TIER DIAGNOSTIC

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Abstract: *The purpose of this study is to describe HOTS problem solving skills for high school students through the use of the 2nd Tier Diagnostic. The research is conducted using the descriptive qualitative method. SMAN Balung MIPA 4 Research subjects at Jember Regency Data Collection Techniques in the form of Written Test Questions and Semi-Structured Interviews Data on Problem Solving Skills using 5 Stages Krulick & Rudnick Stages Read and Think, Explore and plan, select a strategy, Find and Answer, Reflect and Extend. The Two Tier Diagnosis Method is composed of two stages. First, students write down how they get the answers, and second, they write down the reasons why they choose that method. The study showed that students with high mathematical problems solving skills were able to write mathematical symbols well, even write answers consistently, and write the final solution along with the question. Students with moderate abilities were unable to write the mathematical symbols well, and even wrote the stages of completion incorrectly, resulting in the majority of the final answers being wrong.*

Keyword: Problem Solving, Two Tier Diagnostic, HOTS

INTRODUCTION

Mathematics is one of the subjects that is considered difficult for students (Fatqurhohman, 2021), because they learn about formulas and symbols. Learning mathematics aims to understand concepts and use them systematically in problem solving (Dewi et al., 2020). According to (Fatqurhohman & Susetyo, 2022), problem solving abilities include the process of organizing concepts and skills using patterns. So that almost every basic competency criterion in mathematics confirms problem solving skills (Akbar et al., 2018).

Solving mathematical problems based on Krulik and Rudnick's stages includes reading and thinking (thinks and read), exploring and planning (explore and plan), choosing a strategy (select a strategy), looking for answers (find and answer), reflection and development (reflect), and extend (Lukman et al., 2023). According to (Shodiqin et al., 2020) reveals that the process of reading and exploring is carried out through a thinking process, whereas (A'yun & Retnawati, 2022) states that exploration can utilize knowledge with logical reasons to reach a conclusion.

Solving mathematical problems requires students to have high-order thinking skills (Aisyah et al., 2021; Mahendra et al., 2020). Students are said to have high-order thinking skills, if in their activities they are able to use mathematical thinking skills to determine the correct steps for solving problems (Fatqurhohman & Susetyo, 2022; Mulyani & Muhtadi, 2019), apply mathematical operations in relationships, and build reasoning abilities in identify relevant factual information (Ariati & Juandi, 2018; Fauziah et al., 2017). So that the main goal of solving HOTS problems is to improve thinking skills in receiving information in solving problems, and making decisions in complex situations (Hasyim & Andreina, 2019; Mahendra et al., 2020; Pratama & Retnawati, 2018), which involves the ability to analyze and synthesize (C4), evaluate (C5), and create or create (C6) (Mahendra et al., 2020).

One of the subjects of mathematics that is quite interesting in measuring problem solving abilities is trigonometry (Saputra et al., 2020), which discusses distances and angles. In addition, trigonometry also has an important role in various fields of science, namely astronomy (navigation), physics, engineering, computer graphics, modeling, and others (Hidayah, 2023). According to (A'yun & Retnawati, 2022), trigonometry material that is difficult to understand is related to trigonometric identities, which discuss relationships or open sentences that include trigonometric functions. Furthermore (Jamila & Natsir, 2021) reveals that solving trigonometric identity problems can be done by simplifying the left side so that it becomes the same form as the right side and vice versa, changing both sides into the same form.

The results of the research (Apino & Retnawati, 2017) and (Rismawati et al., 2022) show that in designing Higher Order Thinking Skills (HOTS) questions it is necessary to have analysis stages (C4), evaluation (C5), creation (C6). According to (Sundari et al., 2021) that the Two Tier Test instrument can be used in solving HOTS problems, and as a step to find wrong ideas or views about a concept that students understand and identify its obstacles (Noprianti & Utami, 2017). Thus the research that will be conducted aims to analyze the ability to solve trigonometry problems using the Two Tier Diagnostic instrument. The problem used in this study is the HOTS problem with reference to the Two Tier Diagnostic instrument.

METHOD

This research method uses descriptive qualitative. The number of subjects consisted of 33 students of class X MIPA 4 SMAN Balung. In class X the researcher took 4 research subjects, with high and medium ability student categories. The 4 subjects selected included, 2 subjects with high abilities and 2 subjects with moderate abilities. The data collection technique used a question test, by giving 2 trigonometric identity questions, using the HOTS Two Tier Diagnostic instrument. The instrument questions given to students have been validated by three validators, namely from 2 lecturers at the Muhammadiyah University of Jember, and 1 math teacher at SMAN Balung. This analysis uses problem solving according to Krulick and Rudnick. The following is an indicator of solving the Krulick and Rudnick problem.

Table 1. Krulik-Rudnick step indicator

No	Stage	Indicator
1	*Read and Think*	• Can know the problems and important information in the problem • Can restate information in own languagen
2	*Explore and plan*	• Can select and organize existing information • Can create mathematical models • Can make illustrations in the form of pictures, diagrams, tables
3	*Select a Strategy*	• Can find patterns in problems • Can simplify the settlement plan • Can write a solution plan coherently
4	*Find and Answer*	• Can perform calculations/computations • Can write solutions to problems in algebra and geometry
5	*Reflect and Extend*	• Can double check the answers obtained • Be able to review procedures that have been carried out

RESULT AND DISCUSSION

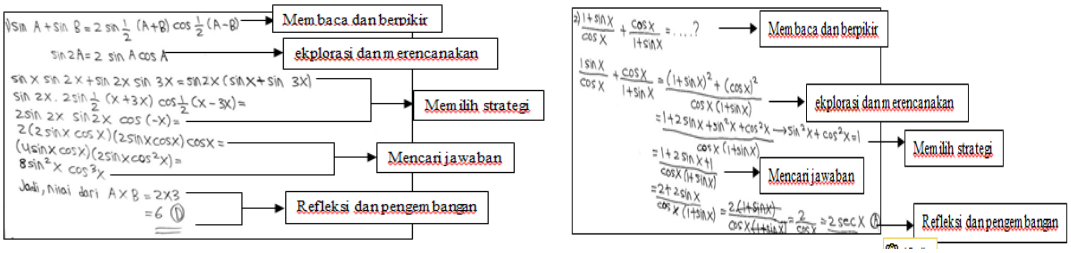
The research results were obtained after students completed the questions given by the researcher, with a total of 2 questions related to trigonometric identities. Then the

results of the students' answers were analyzed, and selected into two types of abilities including, high ability and moderate ability. Then the student scores are calculated and students are selected who meet the scores of high and medium abilities, along with students who are selected based on table 1

Table 2. Classification of Research Subjects

Subject	Ability	Code
S1	High	ST1
S2	High	ST2
S1	Medium	SD1
S2	Medium	SD2

1. High Capability

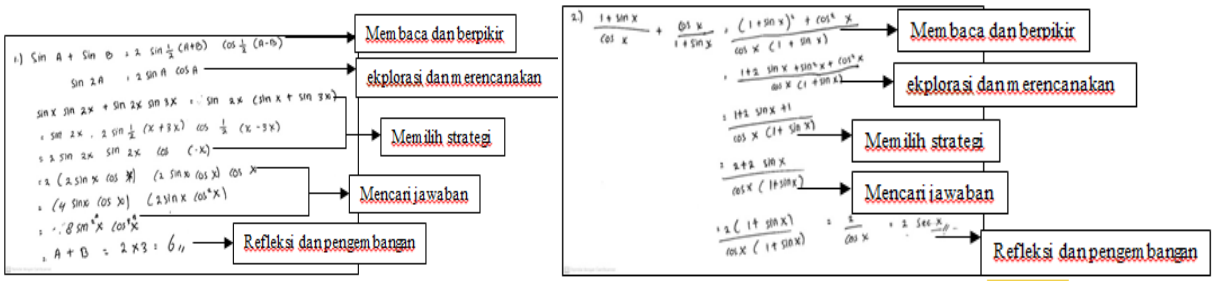


Question 1 **Question 2**

Figure 1. Jawaban Subjek 1 Kemampuan Tinggi

Based on the results of the answers to question 1 at ST1, it can be described based on indicators of problem solving ability. The researcher analyzed that ST1 knew what was asked in the questions, ST1 had fulfilled the first indicator, namely reading and thinking. In the second indicator, ST1 is also able to write down the basic formula for trigonometric identities and ST1 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, ST1 has done well to choose a strategy in solving problems but students make mistakes in putting an equal sign. The next step ST1 writes down the results from 8 sinAxsinBx to 8 sin2xsin3x, at this stage ST1 has gone through the stage of looking for answers. And the final stage of ST1 includes the values A and B multiplied by both of them to become the final answer to the question, this stage is reflection and development.

In the results of the answers to question 2, ST1 knew what was asked in the question, the subject had fulfilled the first indicator, namely reading and thinking. In the second indicator, ST1 is also able to write down the basic formula for trigonometric identities and ST1 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, ST1 has done well to choose a strategy in solving problems but students make mistakes in writing mathematical symbols. The next step ST1 writes down the results of $\frac{(2+2sinx)}{(cosx(1+sinx))}$, at this stage the subject has gone through the stage of looking for answers. And the final stage ST1 writes $\frac{(2(1+sinx))}{(cosx(1+sinx))}$ to $\frac{2}{cosx}$ the final answer to the question, this stage is reflection and development.



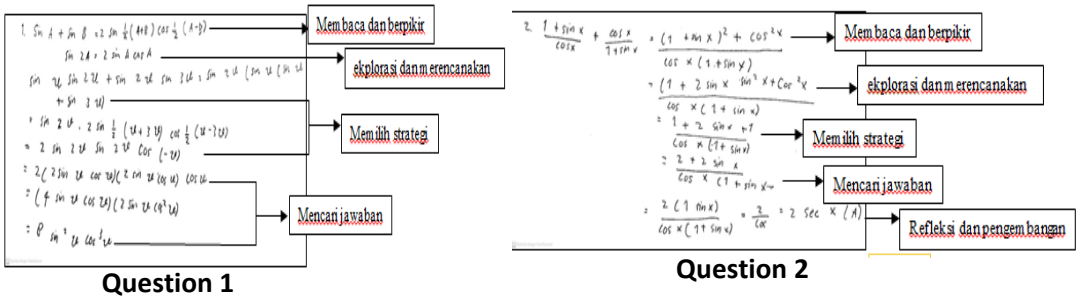
Question 1 **Question 2**

Figure 2. Subject Answers 2 High Ability

Based on the results of the answers to question 1 on ST2, it can be described based on indicators of problem solving abilities. The researcher analyzed that ST2 knew what was asked in the questions, the subject had fulfilled the first indicator, namely reading and thinking. In the second indicator, ST2 is also able to write down the basic formula for trigonometric identities and ST2 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, ST2 has done well to choose a strategy in solving problems but students have made mistakes in writing symbols. The next step ST2 writes down the results from $8 \sin A \,.\, \cos B$ to $8 \sin 2x \cos 3x$, but it is not clear enough to show the A and B values, at this stage the subject has gone through the stage of looking for answers. And the final stage of ST2 includes the values A and B multiplied by both of them to become the final answer to the question, this stage is reflection and development.

In the results of student number 2's answers, ST2 knew what was asked in the question, ST2 had fulfilled the first indicator, namely reading and thinking. In the second indicator, ST2 is also able to write down the basic formula for trigonometric identities and ST2 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, ST2 has done well to choose a strategy in solving problems but students make mistakes in putting an equal sign. The next step ST2 writes down the results $\frac{(2+2\,sinx)}{(cosx(1+sinx))}$, this stage ST2 has gone through the stage of searching for answers. And the last stage ST2 writes $\frac{(2(1+sinx))}{(cosx(1+sinx))}$ to $\frac{2}{cosx}$ the final answer to the question, this stage is reflection and development.

2. Moderate ability



Question 1 **Question 2**

Figure 3. Subject Answers 1 Moderate Ability

Based on the results of the answers to question 1 on SD1, it can be described based on indicators of problem solving ability. The researcher analyzed that SD1 knew what was asked in the questions, SD1 had fulfilled the first indicator, namely reading and thinking. In the second indicator, the subject was also able to write down the basic trigonometric identity formula and SD1 had already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, SD1 has done well to choose a strategy in solving problems but students make mistakes in writing mathematical symbols. The next step is SD1 writing 8 sin2xsin3x, at this stage SD1 has gone through the stage of searching for answers. And the last stage SD1 does not write down the final result of completion, this stage SD1 is less than the reflection and development stage.

In the results of student number 2's answers, SD1 knew what was asked in the question, the subject had fulfilled the first indicator, namely reading and thinking. In the second indicator, SD1 is also able to write down the basic formula for trigonometric identities and SD1 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, SD1 has done well to choose a strategy in solving problems but students make mistakes in writing mathematical symbols. The next step SD1 writes (2(1+sinx))/(cosx(1+sinx)) , this stage SD1 has gone through the stage of looking for answers. And the last stage SD1 writes 2/cosx to 2 sec x the final answer to the question, this stage is reflection and development.

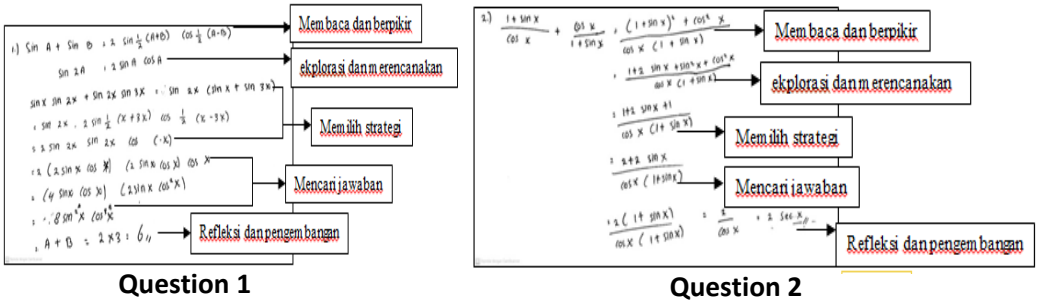


Figure 4. Subject's Answer 2 Moderate Ability

Based on the results of the answers to question 1 on SD2, it can be described based on indicators of problem solving abilities. The researcher analyzed that SD2 knew what was asked in the questions, SD2 had fulfilled the first indicator, namely reading and thinking. In the second indicator, SD2 is also able to write down the basic formula for trigonometric identities and SD2 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, SD2 has done well to choose a strategy in solving problems but students make mistakes in writing mathematical symbols. The next step is SD2 only writes $8 \sin 2x \cos 3x$, at this stage SD2 has gone through the stage of searching for answers. And the last stage of SD2 does not write down the final results, from the stages of reflection and development the subject is still lacking.

In the results of student number 2's answers, SD2 knows what was asked in the question, SD2 has fulfilled the first indicator, namely reading and thinking. In the second indicator, SD2 is also able to write down the basic formula for trigonometric identities and SD2 has already carried out the second indicator stage, namely exploration and planning. Furthermore, the third indicator is choosing a strategy, SD2 has done well to choose a

strategy in solving problems but students make mistakes in writing mathematical symbols. The next step is subject 2 to write down the results of $\frac{(2(1+sinx))}{(cosx(1+sinx))}$, this stage SD2 has gone through the stage of looking for answers. And the last stage SD2 writes $\frac{2}{cosx}$ to $2\ sec\ x$, this stage is reflection and development.

Table 3. Findings Data for Research Subjects

Question	High Ability	Moderate Ability
1	• Can place math signs/symbols correctly • Can analyze questions and make decisions • Can write down the final solution according to the question	• Wrong placement of math signs/symbols • Not yet able to analyze questions and make decisions • Unable to write down the final solution according to the question
2	• Can place math signs/symbols correctly • Can analyze questions and make decisions • Can write down the final solution according to the question	• Wrong placement of math signs/symbols • Not yet able to analyze questions and make decisions • Unable to write down the final solution according to the question

CONCLUSION

The results of the research that have been presented show that the mathematical problem solving abilities of high-achieving students can write mathematical symbols correctly, write answers coherently and the final solution is according to the question. Meanwhile, moderate abilities cannot place the mathematical symbols correctly and even the writing is wrong, the stages of completion are not correct and immediately write down the final solution so that the final answer is mostly wrong and does not match the question.

In classroom learning, it is hoped that the teacher can provide direction and guidance in solving problems according to the mathematical concepts being taught so that students can understand the correct procedures and steps in solving problems. In addition, the planting of concepts from an early age needs to be improved so that students do not misunderstand mathematical concepts. Because the abilities of students are different, it is necessary to pay more attention to each student who has low or moderate problem-solving abilities.

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