

# Adaptive Reasoning Characteristics of Vocational School Students in Solving Mathematic Problems

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## ABSTRACT

The primary objective of this study was to provide a comprehensive description of the adaptive thinking attributes exhibited by students enrolled in vocational high schools when engaged in the process of solving mathematical problems. The present study is characterised as a qualitative descriptive investigation. The research employed mathematical test questions and interview guides as the primary instruments. The data collection methods employed in this study encompass both tests and interviews. Data analysis includes the processes of data reduction, data display, and the derivation of conclusions. Checking the validity of the data was carried out by triangulating the source and the adequacy of the reference data. This research was conducted on XI-grade students of SMK X in the vocational field of Motorcycle Engineering (TSM). There are three subjects in this study, they are students who can solve the problem correctly. Based on the results of data analysis, it is concluded that adaptive reasoning characteristics of TSM students in solving math problems and making plans are using different strategies as alternative answers, in providing an allegation of problem-solving, namely by assuming an example in the form of writing and pictures to solve the problem. In the completion stage, students solve problems by linking previous knowledge. In making conclusions, TSM students are simpler and get to the heart of the problem.

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## 1. INTRODUCTION

Mathematics is the basis of science and technology development, in which its influence is very important in everyday life. Through mathematics, students are trained to think logically, analytically, systematically, critically, and creatively and work together in the wider community (Maryam et al., 2018). Therefore, mathematics needs to be given to all students starting from the most basic level, namely elementary school students, to equip students with the ability to think logically, critically, systematically, analytically, and creatively and work together (Palunissa et al., 2020). One of the specific objectives of learning mathematics in schools is to train students in ways of thinking and reasoning. The National Council of Teachers of Mathematics (NCTM) states that the general objectives of students learning

mathematics are: (1) Learning about mathematical values, understanding evolution, and roles in society and science, (2) Confidence in capabilities, believe in mathematical thinking that is owned and sensitive to situations and problems, (3) Become a problem solver, become a productive and experienced citizen in solving various problems, (4) Learn to communicate mathematically, learn about symbols, symbols, and mathematical methods, (5) Learning to reason mathematically, namely making conjectures, proofs, and building arguments mathematically (Bernard, 2015). Based on the fifth objective according to NCTM, it can be concluded that reasoning is one of the important abilities needed in the process of learning mathematics.

Inductive and deductive reasoning are two distinct styles of reasoning that are closely associated with the process of solving mathematical issues. Inductive reasoning is a cognitive process that entails deriving conclusions from observed facts or evidence, whereas deductive reasoning involves deriving conclusions from a set of fundamental premises or propositions. According to the study conducted by Kilpatrick et al. (2001), There are five mathematical talents that necessitate development, the first being conceptual understanding. The five key components of mathematical proficiency are as follows: (1) conceptual understanding, (2) procedural fluency, (3) strategic competence, (4) adaptive thinking, and (5) creative disposition. Based on the provided descriptions, it is evident that the development of adaptable reasoning is a crucial competency that needs to be cultivated.

Adaptive reasoning is reasoning whose research includes inductive and deductive reasoning. Adaptive reasoning is the ability of students to make conjectures, draw conclusions logically, provide explanations about the concepts and answer procedures used, and judge their correctness mathematically (Kilpatrick et al., 2001). According to Ostler, as quoted in Rosyidi et al. (2018), adaptive reasoning is thinking logically in giving reasons and assessing why solutions are in accordance with the wider context of the problem. Students are said to be able to reason adaptively if students can think logically about existing issues, and predict problems until students are able to conclude (Haryanti et al., 2016). Based on the opinions of several experts, it can be seen that students with adaptive reasoning abilities can easily solve problems logically and know the solutions to the issues they face.

Research conducted by Kristanti (2016), who examined the analysis of students' adaptive reasoning in solving polyhedron problems in terms of learning styles and thinking styles found that students who have a visual learning style and are supported by an abstract thinking style are able to meet indicators of adaptive reasoning and have the ability excellent adaptive reasoning compared to students with other learning styles. The visual learning style is considered very effective because it exposes students to an object directly so that students can reason logically based on what has been observed. However, based on the results of another study conducted by Suindayati et al. (2019), not all students could understand the materials well. Some students can solve the problem, but others cannot give reasons for the answers they write, and some can explain the reasons for their answers. In fact, some students know how to solve a mathematical problem and apply it to other situations. This statement forms the basis that students' reasoning abilities in using logic to solve a problem for each student are not the same. There are differences, and adaptive reasoning abilities are a separate carrying capacity in learning mathematics, especially in learning mathematics and solving math problems.

Mathematics is often regarded as a theoretical subject. Although mathematical concepts can serve as a valuable tool for problem-solving in other domains, including everyday life and other scientific disciplines. According to Inglar, as cited in Fatimah et al. (2018), certain pupils perceive concepts as just verbal expressions devoid of practical significance. In order to achieve meaningful learning, it is imperative that theory and practise are integrated, as practise without a theoretical foundation is rendered unattainable. Furthermore, it has been posited that practical knowledge can be regarded as a manifestation of both theoretical and practical aptitude.

In connection with the aforementioned issues, Vocational High School (SMK) is one of the school levels that has characteristics different from other schools. Apriyansa (2017) stated that a vocational school has an education system that directs students in several disciplines so that vocational school graduates will be more competent. The disciplines in question are vocational fields which all lead to vocational

education. In vocational schools, the learning process that is applied is more that exposes students to an object directly. Theoretical learning in class is used as an introduction to conducting learning outside the classroom, namely by exposing students to an object of study in each vocational field, SMK there is a fashion engineering department, so in learning, it exposes students more to a fashion designer, so that the ability students' adaptive reasoning to think logically without realizing it is honed by itself in every field practice lesson. However, in the learning process to support practice in vocational education, learning mathematics cannot be separated. For example, in the practice of making clothes to determine the suitability of the right and left sleeves, a mathematical theory is needed. In other fields, it is the same. For example, in the field of building engineering, determining the harmony of the height and area of a building also requires mathematical calculations. Therefore, in Vocational High Schools, learning mathematics is still needed with the aim of training students' ways of thinking and reasoning in drawing conclusions and being able to express their opinions with confidence and honesty that arise in solving problems (Bernard, 2015).

Based on the previous studies above, several researchers have studied adaptive reasoning from several parts. However, it is still rare to study further the characteristics of adaptive reasoning in vocational school students. This research focuses on the adaptive reasoning of vocational school students in solving mathematical problems. The research question for this research is what are the characteristics of adaptive reasoning of vocational school students in solving mathematical problems? The benefits obtained from this research are many, including teachers being able to understand their students' adaptive reasoning so that it will provide a basis for the teacher in designing learning for their students. Furthermore, the results of this research can be used by stakeholders as a theoretical basis for curriculum design, and other researchers can also be used as a theoretical basis for further research.

## 2. METHODS

This type of research is qualitative descriptive research. Descriptive research is research that produces descriptive data in the form of written or spoken words from people or observed behavior (Moleong, 2014). This research is intended to be able to describe events that are the center of attention (characteristics, students' adaptive reasoning, ability to solve math problems). The subjects in this study were students of class XI, namely three subjects from the TSM vocational field with the subject-taking technique using a purposive sampling technique. The subjects ranged in age from 16 to 18 years with one male and two females. Subject selection criteria are based on the subject's ability to solve problems.

There are two instruments used in this study, namely (1) written test questions and (2) interviews. The written test for solving math problems is used to collect data on students' adaptive reasoning in solving math problems. Data analysis was carried out by looking at students' answers and then analyzing them using the data reduction, data presentation and data conclusion stages. The way to analyze it is by looking at students' answers carefully and adjusting them to the interview results. The questions given are mathematical problems that require students to solve them in several stages and the problems given can also measure students' adaptive reasoning. So students' answers are not short answers that cannot measure reasoning.

The interviews in this study were used to confirm the completion of test questions that students had carried out and to dig up information about students' adaptive reasoning that had not been obtained from solving test questions. Interviews are conducted in a semi-structured manner, the researcher prepares an interview guide and then the interview can develop according to the subject's answers. The interview guide was prepared based on indicators of adaptive reasoning. Data analysis techniques using data reduction, data presentation, and drawing conclusions.

## 3. FINDINGS AND DISCUSSION

Qualitative data were obtained from the results of students' adaptive reasoning tests in solving math problems and interview results. Data were obtained from 3 students from the Motorcycle

Engineering (TSM) vocational field, with code S1 for the first and S2 for the second subjects. The following are the results of research from the two selected research subjects:

### 3.1. Findings

#### 3.1.1 Description of S1 Results in Solving Problems

The following is a snippet of the results of the written test and undergraduate interview presented in Figure 1.

Write down information from the problem

Figure 1. Results of Subject 1's Writing Test for Question No. 1

Based on S1's answer above, it appears that S1 wrote down information from a known problem, namely the equation of a line and what was asked about the image of line AB, reflection, and rotation. However, the subject did not write down in detail what was known, namely what was asked about the rotation with centre O (0,0). In solving the subject matter using alternative answers, namely making examples in the form of writing. The following is an excerpt from the S1 interview results in solving the questions.

- Researcher : From what you know and what the problem asks, what do you plan to do to solve the problem?
- S1 : Reflect first then rotate
- Researcher : Reflecting on what?
- S1 : Line
- Researcher : Please explain again the steps you used to solve the problem!
- S1 : First look for reflection first followed by rotation.
- Researcher : What formula do you use?
- S1 : I forgot the name
- Researcher : Where did you get such a formula from?
- S1 : From the example of questions given by teacher
- Researcher : Are you sure the formula is correct?
- S1 : Yes, I'm sure because yesterday the example the teacher gave was the same
- Researcher : After doing this, what can you conclude?
- S1 : Equation of reflection and rotation result lines.

Based on the interview results it can be seen that the subject is able to explain back the answers written and it can be seen that the subject makes a settlement plan by reflecting first before rotating. As well as the subject checks the answers by looking at the suitability of the steps and what the questions are asking.

The following is an excerpt of the results of the written test and S1 interview in solving question 2 presented in Figure 2.

Diket:  $P(6\sqrt{2}, 10\sqrt{2})$  ditanyakan: koordinat baru  
 Ditanya: jika di putar  $45^\circ$  putar  $(0,0)$   
 Jawab:  $\begin{pmatrix} x \\ y \end{pmatrix} \rightarrow \begin{pmatrix} \cos 45^\circ & -\sin 45^\circ \\ \sin 45^\circ & \cos 45^\circ \end{pmatrix} \begin{pmatrix} 6\sqrt{2} \\ 10\sqrt{2} \end{pmatrix}$   
 $= \begin{pmatrix} \frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} \\ \frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} \end{pmatrix} \begin{pmatrix} 6\sqrt{2} \\ 10\sqrt{2} \end{pmatrix}$   
 $= \begin{pmatrix} 6-10 \\ 6+10 \end{pmatrix} = \begin{pmatrix} -4 \\ 16 \end{pmatrix}$   
 Jadi  $P'$  hasil rotasi  $45^\circ$  terletak pada  $(-4, 16)$

**Figure 2.** Results of the S1 written test for question no 2

Based on the results of the S1 test in doing question 2 above, it can be seen that S1 is able to solve the problem correctly. However, it can be seen that in solving the S1 problem, the calculation process was not completely written down, but the results of solving problem 2 by S1 were correct. The following is an excerpt from an interview with S1.

- Researcher : From the questions given yesterday, what can be known from the questions?  
 S1 : Knowing the point with coordinates  $6\sqrt{2}$ , and  $10\sqrt{2}$ , asked for the coordinates of the  $45^\circ$ -degree rotation  
 Researcher : From what you know and what the problem asks, what do you plan to do to solve the problem?  
 S1 : Direct rotation  
 Researcher : what steps did you use?  
 S1 : directly enter it into the formula.  
 Researcher : Please explain again the steps you used to solve the problem!  
 S1 : Write down what is known and asked and then directly enter it into the mass formula  
 Researcher : What formula do you use?  
 S1 : I forgot the name  
 Researcher : Where do you get such a formula from?  
 S1 : From the example of questions  
 Researcher : Are you sure the formula is correct?  
 S1 : Yes, I'm sure because yesterday, the example that the teacher gave was also like that  
 Researcher : After doing this, what can you conclude?  
 S1 : After rotating  $45^\circ$  degrees, the point changes to  $(-4, 16)$

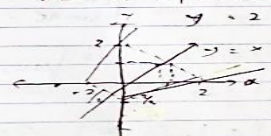
Based on the results of interviews with S1, it can be seen that S1 is able to re-explain what has been written. However, in solving problems, S1 did not memorize formulas but could explain problem-solving correctly.

### 3.1.2 Description of S2 Results in Solving Problems

The following is an excerpt of the results of the written test and postgraduate interview in solving question 1 presented in Figure 3.

Diket: Garis AB:  $3x - y + 2 = 0$   
 ditanya: Bayangan garis AB jika dicerminkan oleh garis  $y = x$  dan dilanjutkan rotasi  $90^\circ$  dengan pusat  $(0,0)$

Jawab: Refleksi titik  $(x, y)$  oleh garis  $(y = x)$   
 $3x - y + 2 = 0$   
 $y = 0 \rightarrow 3x + 2 = 0$   
 $3x = -2$   
 $x = -\frac{2}{3}$   
 $x = 0 \rightarrow -y + 2 = 0$   
 $y = 2$   $(0, 2)$



hasil refleksi  $(-\frac{2}{3}, 2)$  dan  $(2, 0)$

$\Rightarrow$  dirotasi  $90^\circ \Rightarrow \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} -\frac{2}{3} \\ 2 \end{pmatrix} = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$   
 $\Rightarrow \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 2 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 2 \end{pmatrix}$

$\Rightarrow \frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} = \frac{y - 0}{2 - 0} = \frac{x - \frac{2}{3}}{0 - \frac{2}{3}} \Rightarrow -\frac{2}{3}y + 2 = \frac{2}{3}x - 2$   
 $\Rightarrow -\frac{2}{3}y = \frac{2}{3}x - 4$   
 $= 6x + 2y - 12 = 0$   
 Jadi persamaan garisnya adalah  $6x + 2y - 12 = 0$

S2 completed question 1 using alternative answers

Figure 3. Results of the S2 Writing Test in Solving Problem 1

Based on the test results above, it can be seen that S2 wrote down the information from the problem completely and completed question 1 using alternative answers, namely, using an example in the form of a sketch and an example in the form of writing. The following is an excerpt from the interview with S2.

- Researcher : Regarding the questions that have been given, what information can you get from the questions?
- S2 : If you know that line AB is  $3x - y + 2 = 0$ , ask the reflection of line AB on line  $Y = x$ , followed by a 90-degree rotation with center O.
- Researcher : When solving questions or answering questions, did you make a plan beforehand?
- S2 : Yes. Because specifically number 1, I plan to determine the point first from the equation of line AB
- Researcher : From the information you have and you know what you will do to answer the question?
- S2 : I plan to determine the point first then reflect and rotate.
- Researcher : How do you determine the point?
- S2 : What I know is with the example  $Y = 0$  and  $X = 0$ . then I draw it in the coordinate plane.
- Researcher : Try to explain again the steps you used to solve the problem!
- S2 : First, I write the information from the problem, then I look for the point. Then I reflect and rotate it 90 degrees
- Researcher : Please review your answer. Maybe you can explain why using steps like that?
- S2 : I think it's easy this way sir.
- Researcher : For the formula, what formula do you use?
- S2 : I don't know the name, sir. I'm just using what I know.
- Researcher : Where did you get such a formula from?
- S2 : From the examples of questions I have ever known and understand
- Researcher : After doing this, what can you conclude?
- S2 : What I know from the results of the answers, is the equation of the line changes.

Based on the results of the interview above, it can be seen that S2 is able to re-explain the answers that have been written. However, based on the answer, S2 did not memorize formulas enough. In checking the answers, S2 checks the count and steps that have been used. The following is an excerpt

of the results of the written test and postgraduate interview in solving question 2 presented in Figure 4.

Diket =  $p(6\sqrt{2}, 10\sqrt{2})$   
 Ditanya :  $p$  akan diputar berlawanan arah jarum jam  $45^\circ$   
 Pusat  $(0,0)$

Jawab =  $\begin{pmatrix} x \\ y \end{pmatrix} \rightarrow \begin{pmatrix} \cos 45^\circ - \sin 45^\circ & \\ \sin 45^\circ + \cos 45^\circ & \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$

$$= \begin{pmatrix} \frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} \\ \frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} \end{pmatrix} \begin{pmatrix} 6\sqrt{2} \\ 10\sqrt{2} \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 6-10 \\ 6+10 \end{pmatrix} = \begin{pmatrix} -4 \\ 16 \end{pmatrix}$$

Jadi  $p$  hasil rotasi  $45^\circ$  berlawanan pada koordinat  $(-4, 16)$

**Figure 4.** The results of the S2 test in solving problem 2

Based on the picture above it can be seen that S2 wrote down the information from the problem completely. S2 was able to solve the problem correctly, but in the completion step, S2 did not write down the calculation process completely, however, the results obtained were correct and able to draw conclusions. The following is an excerpt from the interview with S2:

- Researcher : From the questions given, what can you find out from the questions?  
 S2 : two points  $p(6\sqrt{2}, 10\sqrt{2})$ . Asked for the  $p$  coordinate if it is rotated  $45$  degrees.  
 Researcher : When solving questions or answering questions, did you make a plan beforehand?  
 S2 : Yes.  
 Researcher : From the information you have and know, what would you do to answer that question?  
 S2 : I will immediately rotate.  
 Researcher : Try to explain again the steps you used to solve the problem!  
 S2 : First, write the information from the problem, then I rotate it  $45$  degrees  
 Researcher : What formula do you use?  
 S2 : I don't know the name, sir.  
 Researcher : Where did you get such a formula from?  
 S2 : From the examples of questions that I have ever known, sir  
 Researcher : After doing this, what can you conclude?  
 S2 : What I know from the results of the answers, the coordinates have also changed.

Based on the results of interviews with S2 in solving question 2, it can be seen that S2 is able to explain back the answers that have been written. And S2 doesn't really memorize formulas. S2 rechecks the answer from the count and steps.

### 3.1.3 Description of S3 Results in Solving Problems

The following is an excerpt of the results of the written test and postgraduate interview in solving question 1 presented in Figure 5.

Diket:  $AB = 3x - y + 2 = 0$   
 dit ? Bayangan Garis AB refleksi  $y = x$   
 dan Rotasi  $90^\circ$  Pusat  $(0,0)$

Jwb :  $x = 0 \rightarrow -y + 2 = 0 \rightarrow y = 2$  titik A  
 $y = 0 \rightarrow 3x + 2 = 0 \rightarrow x = -2$  titik B

refleksi titik A =  $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 0 \\ 2 \end{pmatrix} = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$  A'  
 B =  $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} -2 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ -2 \end{pmatrix}$  B'

rotasi  $90^\circ$  Pusat  $(0,0)$   $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 2 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 2 \end{pmatrix}$   
 $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 0 \\ -2 \end{pmatrix} = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$

Garis  
 $\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$   
 $\frac{y - 0}{2 - 0} = \frac{x - 2/3}{0 - 2/3}$   
 $2/3 y = 2x - 2/3 \rightarrow 2x - 2/3 y - 2/3 = 0$   
 $6x + 2y - 9 = 0$

Jwb persamaan garis hasil adalah  $6x + 2y - 9 = 0$

Figure 5. The results of the S3 test in solving problem 1

Based on the test results above, it can be seen that S3 wrote down the information from the questions completely and completed question 1 using alternative answers, namely using an example in the form of writing. In working on S3, work coherently. The following is an excerpt from the interview with S3.

- Researcher : From the questions given, what can you find out from the questions?  
 S3 : line  $AB > 3x - y + 2 = 0$ , ask for reflection to  $y = x$  and rotate it by  $90^\circ$  with centre 0.
- Researcher : When solving questions or answering questions, did you make a plan beforehand?  
 S3 : I will look for the point first sir, I am confused about the equation.
- Researcher : From the information you have and know, what would you do to answer that question?  
 S3 : Write down what is known, and asked, look for the point first and look for the next reflection then I rotate it.
- Researcher : What formula do you use?  
 S3 : I don't know sir, Just like the matrix, sir.
- Researcher : Are you sure the formula is correct?  
 S3 : Sure, because from the examples of questions I understand like that
- Researcher : After doing this, what can you conclude?  
 S3 : The equation of the line changes sir, from to.

Based on the results of the interview above, it can be seen that the S3 in solving question 1 was able to re-explain the answers that had been written. But based on the answer that S3 doesn't memorize formulas enough. In checking the answers, S3 checked the count and steps already used. The following is an excerpt of the results of the written test and doctoral interview in solving question 2 presented in Figure 6.

Diket = P (6√2, 10√2)  
 Dit = P' jika diputar berlawanan jarumjam 45° pusat (0,0)

$$\text{Jwb} = \begin{pmatrix} x \\ y \end{pmatrix} \xrightarrow{R(0,0)} \begin{pmatrix} \cos 45^\circ & -\sin 45^\circ \\ \sin 45^\circ & \cos 45^\circ \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$= \begin{pmatrix} \frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} \\ \frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} \end{pmatrix} \begin{pmatrix} 6\sqrt{2} \\ 10\sqrt{2} \end{pmatrix}$$

$$= \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \left(\frac{1}{2}\sqrt{2}\right)(6\sqrt{2}) + \left(-\frac{1}{2}\sqrt{2}\right)(10\sqrt{2}) \\ \left(\frac{1}{2}\sqrt{2}\right)(6\sqrt{2}) + \left(\frac{1}{2}\sqrt{2}\right)(10\sqrt{2}) \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 6 - 10 \\ 6 + 10 \end{pmatrix} = \begin{pmatrix} -4 \\ 16 \end{pmatrix}$$

Jadi P' hasil rotasi 45° terletak pada koordinat (-4, 16)

**Figure 6.** The results of the S3 test in solving problem 2

Based on the picture above, it can be seen that S3 wrote down the information from the problem completely. S2 is able to solve questions correctly, and S3 writes down the steps and calculation process in a complete, coherent, and correct manner and makes brief conclusions. The following is an excerpt from the interview with S3:

- Researcher : From the questions given, what can you find out from the questions?  
 S3 : Point p (6 square root 10, 10 square root 2) is rotated 45 degrees counterclockwise to center 0.0.
- Researcher : When solving questions or answering questions, did you make a plan beforehand?  
 S3 : I immediately rotated sir because the point was already known.
- Researcher : From the information you have and know, what would you do to answer that question?  
 S3 : After writing what is known and being asked, I will rotate it, sir. Write what is known, and asked, look for the point first, and then rotate it.
- Researcher : What formula do you use?  
 S3 : I don't know sir, from the example my teacher gave me, sir.
- Researcher : Are you sure the formula is correct?  
 S3 : Sure, because from the example questions the teacher gives like that.
- Researcher : After doing this, what can you conclude?  
 S3 : The point changes to -4.16.

Based on the results of the interview above, it can be seen that the S3 in solving question 2 was able to re-explain the answers that had been written briefly and clearly. Based on the answer that S3 doesn't memorize formulas enough. In checking answers, S3 checks the count and steps already used. To get valid results, a data validity test was carried out. In this study, the data validity test was used, namely by source triangulation, namely data collection using the same technique from different sources. As table 1 follows:

**Table 1.** Source Triangulation

No	Indicator	Subject		
		S1	S2	S3
1	Arrange conjectures based on the results of the identification of the questions.	<ul style="list-style-type: none"> <li>• Write down the information from the problem in full</li> <li>• Making assumptions regarding the settlement steps.</li> <li>• Understanding the information from the problem by conveying it directly to the point in a short way</li> </ul>	<ul style="list-style-type: none"> <li>• Write down the information from the problem in full</li> <li>• Making assumptions regarding the settlement steps.</li> <li>• Understanding the information from the problem by conveying it directly to the point in a short way</li> </ul>	<ul style="list-style-type: none"> <li>• Write down the information from the problem in full</li> <li>• Making assumptions regarding the settlement steps.</li> <li>• Understanding the information from the problem by conveying it directly to the point in a short way</li> </ul>
2	Plan a solution based on reasons or evidence for a problem.	Plan a solution by making examples (pictures or words)	Plan a solution by making examples (pictures or words)	Plan a solution by making examples (pictures or words)
3	Solve the questions given based on the mathematical patterns of the questions.	Solve according to the pattern that is understood, namely by example.	Solve according to the pattern that is understood, namely by example.	Solve according to the pattern that is understood, namely by example
4	Draw conclusions from the answers.	<ul style="list-style-type: none"> <li>• Write down conclusions</li> <li>• Summarize briefly.</li> </ul>	<ul style="list-style-type: none"> <li>• Write down conclusions</li> <li>• Summarize briefly.</li> </ul>	<ul style="list-style-type: none"> <li>• Write down conclusions</li> <li>• Summarize briefly.</li> </ul>
5	Recheck answers.	<ul style="list-style-type: none"> <li>• Re-check answers by looking at the correctness of the count and steps</li> </ul>	<ul style="list-style-type: none"> <li>• Re-check answers by looking at the correctness of the count and steps</li> </ul>	<ul style="list-style-type: none"> <li>• Re-check answers by looking at the correctness of the count and steps</li> </ul>

### 3.2 Discussion

The results of the analysis of subjects in the SMK TSM field in solving math problems show that the subjects in the SMK TSM field are at the stage of understanding the problem. The subject can understand the problem by writing down the correct information and provide conjectures related to solving the problem with a plan made in the form of a solution concept that will be used in solving the problem, namely by making examples and implementing. them in the form of writing or images. Students with good adaptive reasoning can identify information related to the given problem so that it is easy to find the right solution to answer the question (Suhendra et al., 2016).

Subjects can use other solutions as alternative answers, namely by making examples in their completion. These results indicate that the subject can achieve the first indicator of adaptive reasoning with the characteristic of constructing conjectures for solving and using other solutions as alternative answers by applying them in the form of writing and pictures. This is in accordance with the opinion of Kilpatrick et al (2001), students can demonstrate their adaptive reasoning when meeting three conditions, namely: 1) Having sufficient basic knowledge. In this case students have good prerequisite skills before entering new knowledge to support the learning process; 2) Tasks that can be understood or understood and can motivate students; 3) The context presented is known and enjoyable for students.

At the settlement planning stage, the subject is able to choose strategies and steps for completion accompanied by appropriate reasons and information. Subjects make assumptions related to problem-

solving strategies by determining the points. Subjects dig up information and describe it in several pieces of information to facilitate work. The subjects of the TSM vocational field adapt to new problems by relating the information they have obtained to the previous material. Through adaptive reasoning, students are able to build their minds to master concepts (Muin et al., 2018; Rizki et al. 2018; Wasiran et al., 2019; Ansari et al., 2020). Based on this, it can be seen that the characteristics of the subject in preparing a settlement plan are connecting previous knowledge with solving or planning new problems encountered. Supported by the statement of Lestari et al. (2022) that the factors causing student errors in solving adaptive reasoning ability questions, namely conceptual errors, namely students misinterpreting the application of concepts. This is in line with Darmayanti et al. (2022) who state that when solving problems, students are expected to be able to understand the problem-solving process and be able to select and identify related conditions and concepts, seek generalizations, make plans to solve them and develop good organizational skills previously owned.

At the stage of carrying out the settlement plan, the Subject implements the strategy that has been planned to solve the given problem accompanied by logical and structured reasons or arguments for the implementation of the strategy used, which is based on proof and mathematical nature and its implementation. plan analytically and structured. Make examples in the form of writing or pictures along with logical reasons. Research conducted by Rosyidi et al. (2018) found students' adaptive reasoning with the visualizer cognitive style to determine what is known and present it in the form of equations, examples, and words or pictures. Even though they understand the questions well, there are some formulas they don't know enough about, but they are able to apply them correctly. It is possible that while following these subjects, they paid less attention to the teacher teaching so that in answering the questions given, they did not remember the names of the correct formulas to answer these questions. These results indicate that students can achieve the third indicator of adaptive reasoning in solving mathematical problems, namely solving problems based on mathematical patterns of questions with adaptive reasoning characteristics possessed by visual reasoning.

At the stage of re-checking answers, students draw conclusions based on the results of the final answers by connecting the questions from the questions and their suitability with the completion steps. Based on the results of interviews with the subjects providing conclusions, they could provide conclusions on their answers by providing logical reasons for their answers, as well as reinforcing that they had also checked the completeness, both the count and the steps. However, all of this was conveyed briefly.

#### 4. CONCLUSION

Based on the results of the research and discussion that has been described in the previous chapter, it can be concluded that in general, the adaptive reasoning characteristics of vocational students in solving math problems, in writing information from the questions students write briefly and go directly to the core of the problem. In generating plans and providing estimates for addressing problems, students make plans or conjectures by using other solutions as alternative answers, notably by making examples in the form of writing and graphics. In solving new challenges presented, students solve problems by linking past information. The capacity of students to recall formulas is quite poor, but the ability of students to insert formulas and understand the concept of addressing the questions given is very good as well as in making student conclusions simpler. The limits of this research are only on the subject of vocational students, and the adaptive reasoning explored is still generic and wide, not yet detailed in specific disciplines, for example. For further research, it can be continued to more specific subjects or it can be investigated the features of pupils with adaptable thinking.

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