Mathematical problem-solving ability of high school/vocational school students on linear programming

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Abstract
This study was conducted to obtain the problem-solving ability of grade XI SMA/SMK students in linear programming material. The indicators that are the basis for the assessment in this study are the steps when completing mathematical problem-solving abilities, namely understanding the problem, planning the problem, implementing problem solving, and re-examining the process and results. The research method used is a qualitative method with research subjects consisting of 5 students. The results of the mathematical problem-solving ability criteria contain 2 criteria, namely high and medium criteria, From the 5 students, the researcher took 2 samples that had high and medium criteria. The samples selected were S-2 and S-3. Based on the results of the S-3 interview with high criteria, they met each indicator of problem-solving ability, while for S-2 with medium criteria, there were several indicators that were not met. Based on the results of the field research, it can be said that students with problem-solving abilities in the medium category tend to be less careful in working on the questions given so that there are several indicators that are not met, while students who have problem-solving abilities in the high category tend to be more careful in working on each question.
Keywords: mathematical problem-solving skills; linear programming; qualitative methods

Abstrak
Penelitian ini dilakukan untuk memperoleh kemampuan pemecahan masalah siswa kelas XI SMA/SMK pada materi program linier. Indikator yang menjadi dasar penilaian pada penilitian ini adalah langkah-langkah pada saat penyelesaian kemampuan pemecahan masalah matematis yaitu memahami masalah, merencanakan masalah, melaksanakan penyelesaian masalah, dan memeriksa kembali proses dan hasil. Metode penelitian yang digunakan metode kualitatif dengan subyek penelitian terdiri dari 5 orang siswa. Adapun hasil dari kriteria kemampuan pemecahan masalah matematis terdapat 2 kriteria yaitu kriteria tinggi dan sedang, dari ke-5 siswa peneliti mengambil 2 sampel yang memiliki kriteria tinggi dan sedang. Adapun sampel yang dipilih yaitu S-2 dan S-3. Berdasarkan hasil wawancara S-3 dengan kriteria tinggi memenuhi setiap indikator kemampuan pemecahan masalah sedangkan untuk S-2 dengan kriteria sedang ada beberapa indikator yang tidak terpenuhi. Berdasarkan hasil dari penelitian dilapangan maka dapat dikatakan bahwa siswa dengan kemampuan pemecahan masalah pada kategori sedang cenderung kurang teliti dalam mengerjakan soal-soal yang diberikan sehingga ada beberapa indokator yang tidak terpenuhi

sedangkan siswa yang memiliki kemampuan pemecahan masalah pada kategori tinggi cenderung lebih teliti dalam mengerjakan setiap soal.
Kata Kunci: kemampuan pemecahan masalah matematis; program linier; metode kualitatif

Introduction

Mathematics is one of the main subjects tested in the National Examination, therefore mathematics is one of the subjects that must be studied, and mathematics is a world problem so that mathematics is not only related to numbers. For this reason, there are many fields of study studied in the mathematics study program so that it can train reasoning and analytical skills, mathematics studies are also the right media to develop oneself. Mathematics is also a branch of all arithmetic, until finally mathematics is nicknamed The Queen of science (the queen of science).

In line with Zakiyah et al. (2018) who stated that mathematics is a very important science, because mathematics plays a role as a basis for the development of other disciplines in the development of science and technology. Meanwhile, according to Novferma (2016) stated that mathematics is an important part of the field of science. Because mathematics is so important, everyone should study and understand the concept of learning mathematics from an early age. In addition, there are benefits of mathematics in everyday life, for example problems related to telecommunications, insurance and banking, finance and coding, control, stabilization, optimization, and others.

Many students do not like mathematics because for most students mathematics is one of the difficult and boring subjects so that with such an assumption, students' interest and motivation to learn mathematics is very low so that it affects the students' achievements themselves. This is in line with Heriyati's statement (2017) that one of the subjects that students are less interested in is mathematics, because mathematics for most students is still seen as the most difficult subject and they consider it a scary specter. This can be seen from the students' daily attitudes when the lesson is taking place. There are students who feel afraid, anxious, pessimistic, not interested so they are not motivated to complete the mathematics given by the teacher. Other things are certainly caused by many factors so that mathematics lessons become less popular which results in low student learning outcomes in mathematics subjects, one of which is problem-solving skills.

Low problem-solving skills also result in low student learning outcomes. According to Riskiningtyas & Wangid in (Rahmawati et al., 2019) that a person's low achievement is caused by the person's low self-confidence in solving mathematical problems. In line with Didi in (Jatisunda, 2017) stated that to develop a person's problem-solving ability, mathematical thinking exercises are not enough, but need to be accompanied by the development of self-confidence through the problem-solving process so that they have adequate readiness to face various challenges in real life. According to Nurjanah et al.

(2018) based on research experience, many students have difficulty when working on math problems. Students tend to have more difficulty when working on problems in the form of problem solving.

Based on the results of their observations, it turns out that there are still many students who have difficulty learning mathematics, especially linear programming material. In line with the statement of Nuryana & Rosyana (2019) stated that based on their research, students are not used to working on problem-solving problems so that it is difficult to understand the information in questions with linear programming material. While we know that in linear programming material tends to be more about story problems that need to be understood by each individual when solving them.

Method

In this study, the method used is qualitative descriptive research. According to Abdurrahman (Adni et al., 2018) descriptive research aims to accurately describe the characteristics of an individual, condition, symptoms or certain groups. Meanwhile, this study aims to analyze and describe students' mathematical problem-solving abilities in linear programming material. The subjects in this study were 5 students of grade XI SMA/SMK in the Bojongemas Village area. The data collection technique used in this study was by providing a problem-solving ability test instrument in the form of a description of 4 questions that had been tested for validity, where each question contained four indicators of mathematical problem-solving ability, namely: understanding the problem, planning problem solving, implementing problem solving, and re-checking the process and results. In addition, data collection techniques were also carried out through interviews aimed at exploring their mathematical problem-solving abilities.

To produce correct conclusions, data analysis must be carried out in this study, because this is very important. In calculating the score, the researcher used the percentage formula based on Fatmala et al. (2020):

$$Value = \frac{Students' Score}{Ideal\ Score} \times 100$$

With the assessment criteria for students' mathematical problem solving abilities based on Mulyani et al. (2020) (see Table 1):

Table 1. Assessment criteria

100% Value	Criteria
$x \geq 19$	High
$19 < x > 61$	Moderate
$x \leq 61$	Low

Result

This study was conducted to obtain the problem-solving ability of grade XI SMA/SMK students on linear programming material. The indicators that are the basis for the assessment in this study are the steps when completing mathematical problem-solving abilities, namely understanding the problem, planning the problem, implementing problem solving, and re-checking the process and results. The problem-solving ability questions consist of 4 descriptive questions.

In this study, the assessment was carried out based on problem-solving indicators where in 1 question there are four indicators, each of which has a score of 4. While in each indicator there are several scores based on the scoring rubric.

In Table 2 below are the results of students' problem-solving abilities, the results obtained are as follows:

Table 2. Problem solving ability results

No.	Name	Score				Total
		Question 1	Question 2	Question 3	Question 4	
1	S-1	0	6	7	0	13
2	S-2	7	4	6	0	17
3	S-3	12	12	12	11	47
4	S-4	10	11	0	10	31
5	S-5	3	3	9	5	20

The results of the criteria for mathematical problem solving abilities are as follows (see Table 3):

Table 3. Problem solving ability criteria results

No.	Name	Score	Value	Criteria
1	S-1	13	20.3	Moderate
2	S-2	17	26.6	Moderate
3	S-3	47	73.4	High
4	S-4	31	48.4	Moderate
5	S-5	20	31.3	Moderate

The results of the mathematical problem solving ability criteria are 2 criteria, namely high and medium criteria, from the 5 students the researcher took 2 samples that had high and medium criteria. The samples selected were S-2 and S-3.

The results of the answers to the questions worked on by the two samples are as follows:

a. Students with high criteria of mathematical problem solving ability

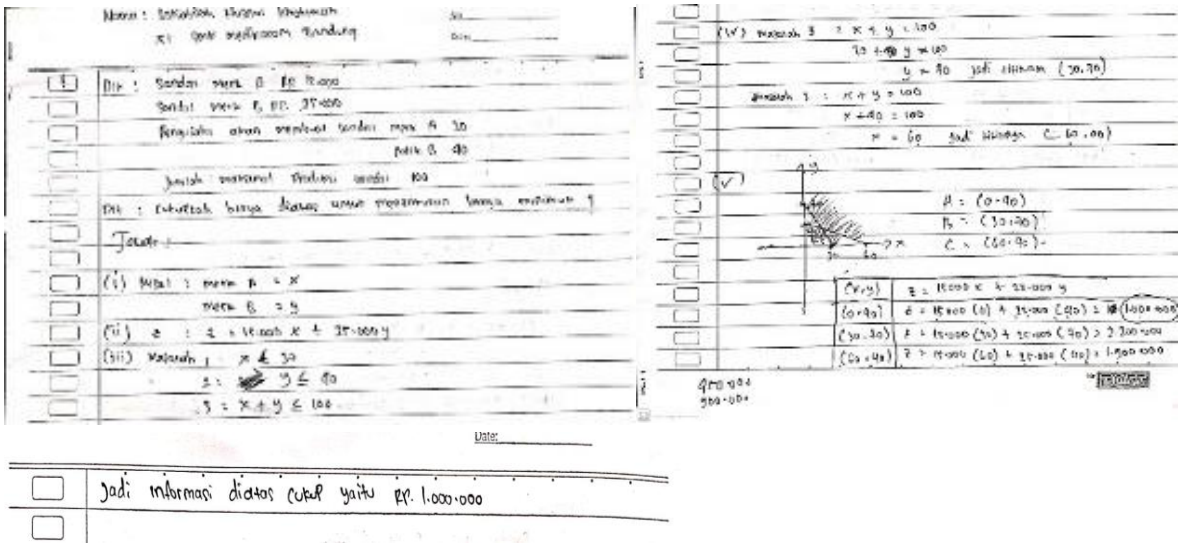

Figure 1. The results of the answers to question no. 1 for students with high criteria

Students write down the known elements completely, namely writing down each sandal brand with its price, then writing down the existing problem and the student writes down the elements asked completely and correctly. Then the student formulates the model correctly and completely according to the problem. Starting from writing down the objective function and mathematical modeling of the existing problem. Then the student completes the model correctly but produces the wrong answer, so the student writes the wrong conclusion (see Figure 1).

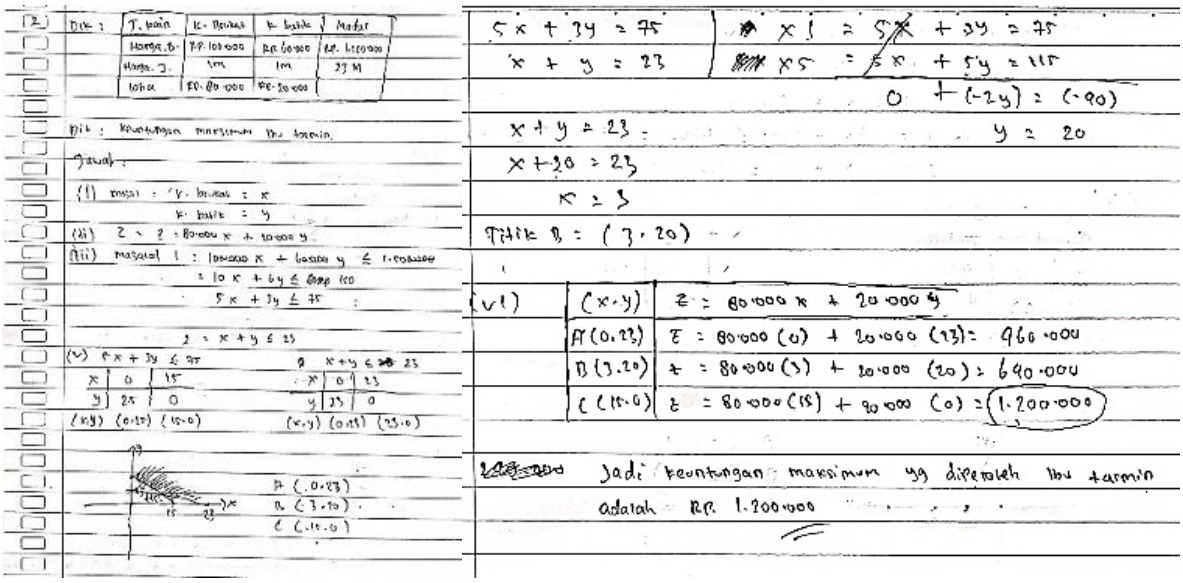

Figure 2. The results of the answers to question no. 2 for students with high criteria

Students write down the known elements in the form of a table, then students write down the elements asked completely and correctly. Next, students formulate a model correctly and completely according to the problem. Then students complete the model

correctly but produce the wrong answer, so the student writes the wrong conclusion too (see Figure 2).

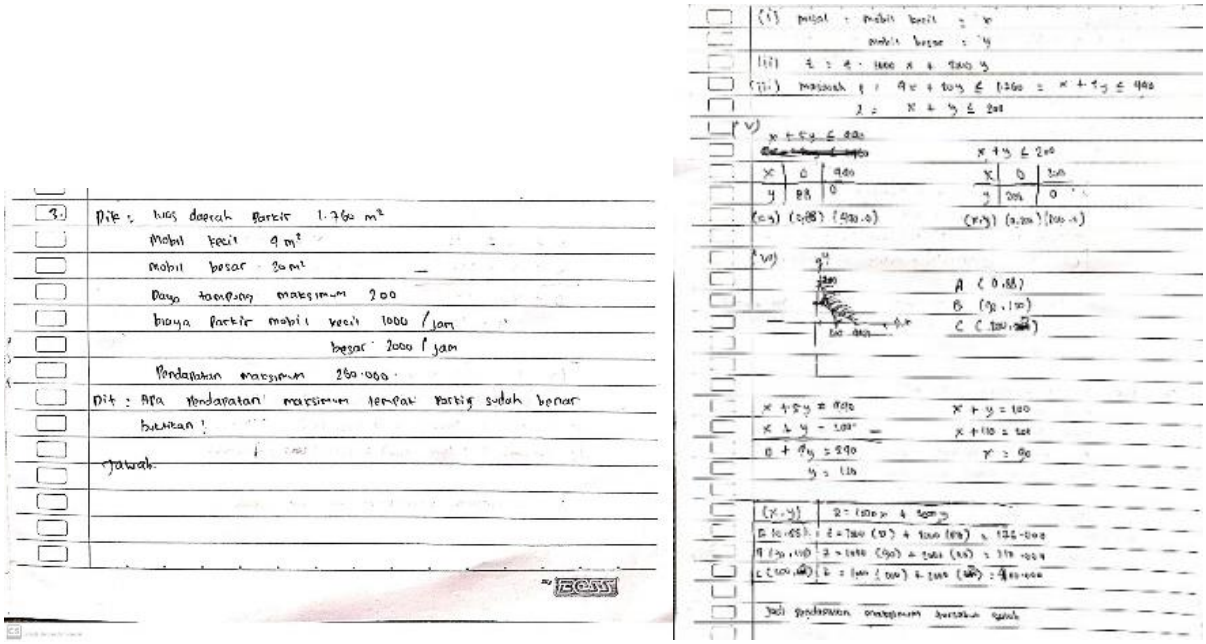

Figure 3. The results of the answers to question no. 3 for students with high criteria

Students write down the known elements completely and correctly, namely writing down the given problem and the student also writes down the elements asked completely and correctly. Then the student formulates the model correctly and completely according to the problem. Then the student completes the model correctly but produces the wrong answer, so the student writes the wrong conclusion (see Figure 3).

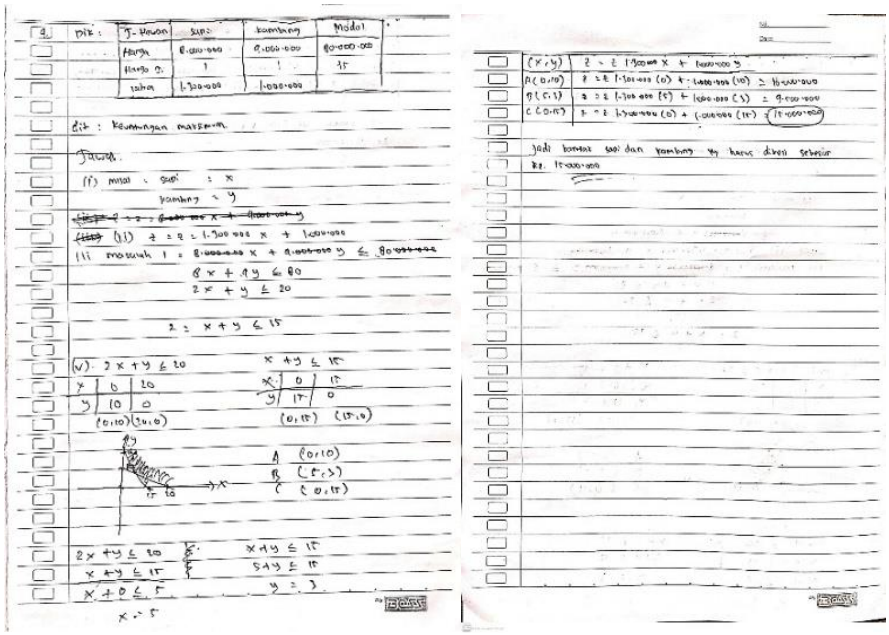

Figure 4. The results of the answers to question no. 4 for students with high criteria

Students write the known elements in the form of a table, then the student writes the elements asked completely and correctly. Next, the student formulates the model correctly and completely according to the problem. Then the student completes the model correctly but produces the wrong answer, so the student writes one of the steps of checking or explaining with the wrong result (see Figure 4).

Based on the results of the analysis of the written test data, the student has been able to mention the known elements and the elements asked in the four questions completely and correctly. So it can be concluded that the student is able to understand the problem.

Then the student was interviewed to obtain information about what the student did not understand from the questions being worked on and based on the results of the interview, the student said that he had previously worked on linear programming questions. Then according to the student, the questions given were easy but previously had to be reminded so that the student could work on the questions from being able to determine the mathematical model to using the probe line to determine the solution set. In addition, the student expressed that in the linear programming material there are benefits, namely in knowing an advantage and disadvantage.

b. Students with moderate criteria for mathematical problem solving abilities

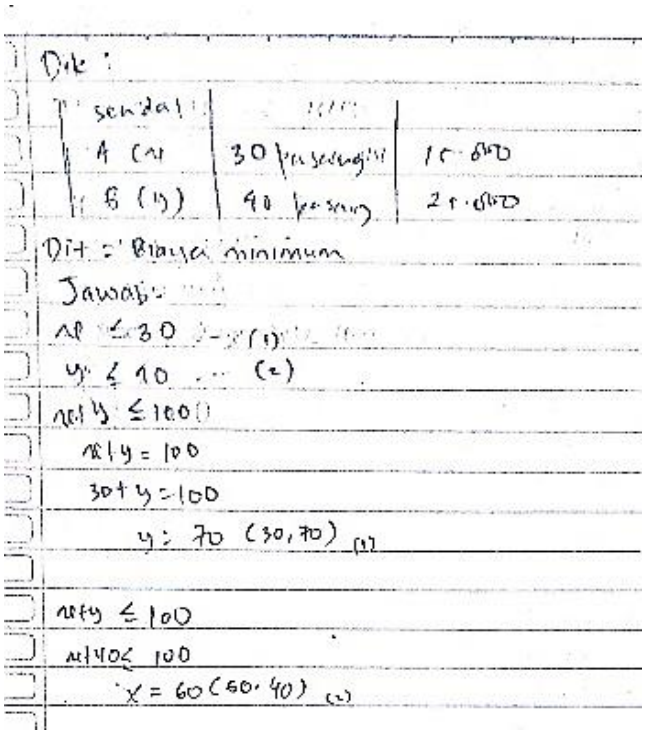

Figure 5. The results of students' answers to question no. 1 with moderate criteria

Students wrote down the known and asked elements incompletely, then students formulated the model incorrectly, besides that students also did not finish answering question number 1 where the answer was incomplete (see Figure 5).

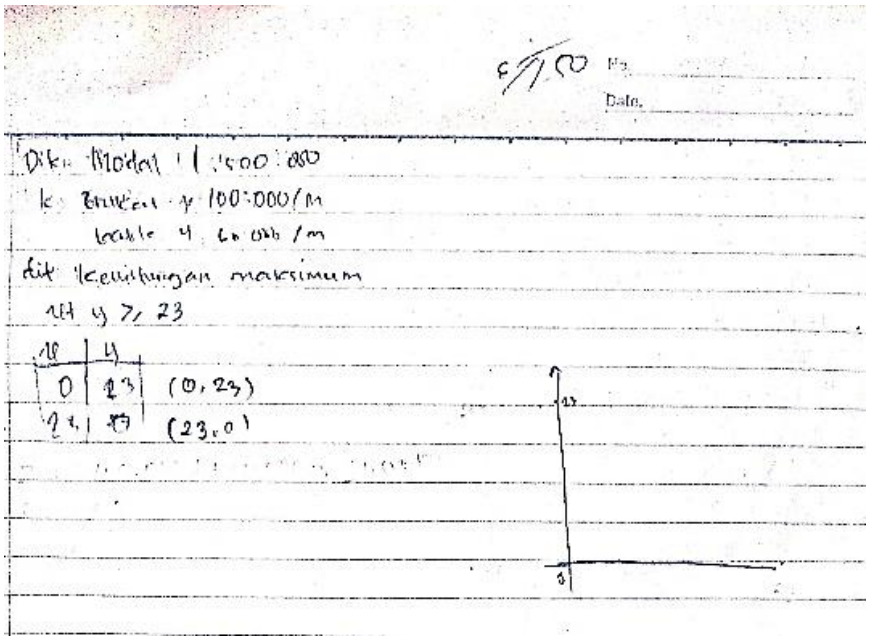

Figure 6. The results of students' answers to question no. 2 with moderate criteria

In question number 2, the student did not mention the elements known in the question, then the student did not formulate the mathematical model, in addition, the student also did not complete the answer to question number 2.

Then the student was interviewed to obtain information about what the student did not understand in working on the given question, and the results of the interview with the student's medium criteria, the student stated that he did not understand the question given, but the student knew the benefits of linear programming, the student said that with linear programming we can calculate profit or profit (see Figure 6).

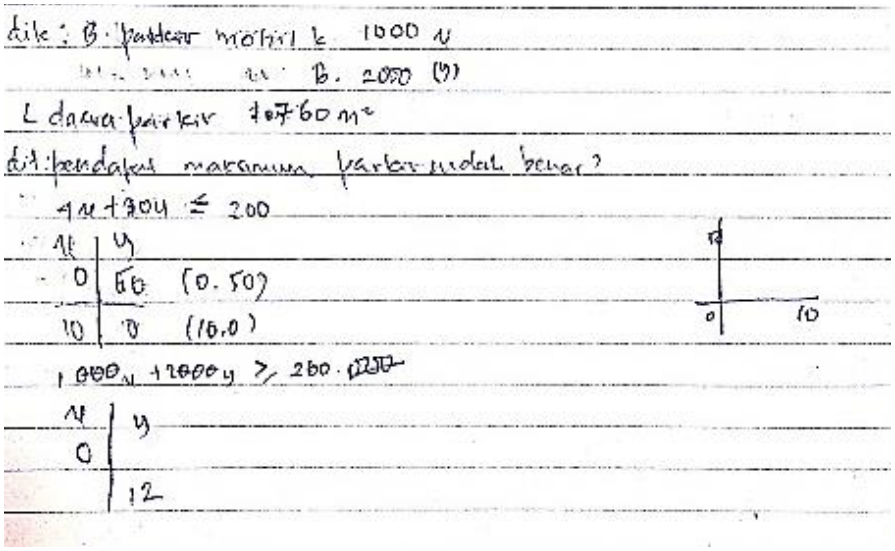

Figure 7. The results of students' answers to question no. 3 with moderate criteria

In question number 3, the student was unable to write down all the elements that were known, then the student did not formulate the mathematical model and besides that, the student was also unable to complete the answer to question number 3.

Based on the results of the analysis of the written test data, the students have not been able to write down the known elements in each question given and the students have not been able to formulate their mathematical models. So that students are not able to complete the answers to each question, even in question number 4, students are not able to work on it so it can be concluded that students are indeed less able to understand the problem.

Discussion

Based on the results of the field research, it can be seen in table 1 where the table shows the results of students' problem-solving abilities where the results are obtained based on the scores of each question worked on by the students. After getting the scores from each student, the scores are then categorized based on high, medium, and low criteria.

Based on the scores obtained by students from the five students, there are 4 students who fall into the medium criteria and one student falls into the high criteria. From the five student samples based on the results that have been categorized, two samples were taken which have two different criteria, namely high and medium. The samples selected are S-2 and S-3. then the selected samples were interviewed to explore why students were wrong in determining steps or solving problems.

The interview results from the two selected samples can be seen in tables 3 and 4 where table 3 shows the results of interviews between researchers and students who have high criteria while table 4 shows the results of interviews with students who have medium criteria. Based on the interview results, it can be seen that students with high criteria meet each indicator of problem-solving ability while for students with medium criteria there are several indicators that are not met.

Conclusion

Based on the results of the field research, it can be said that students with problem-solving abilities in the medium category tend to be less careful in working on the questions given so that there are several indicators that are not met, while students who have problem-solving abilities in the high category tend to be more careful in working on each question given so that the score obtained is greater. Based on the results of the answers to several questions given, it can be seen that students with high criteria are able to work

on the questions given well, meaning they meet the indicators of problem-solving abilities, while students with medium criteria are only able to work on 3 questions out of 4 questions given, from the three answers, none of them meet the indicators of problem-solving abilities.

Conflict of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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