ANALYSIS OF STUDENTS' ERRORS IN MATHEMATICAL PROBLEM SOLVING BASED ON KASTOLAN ERROR ANALYSIS

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Abstract

This research is motivated by the many mistakes made by students in solving problem-solving questions. The purpose of this research was conducted to see the causes of student errors in solving problem-solving questions based on kastolan error analysis theory. The research method used is descriptive qualitative. The instrumented object in this study involved 4 students of class XI MIA 5. The sample selection technique uses purposive sampling. The instruments used in this study were tests and interviews. The test results were obtained from a problem-solving ability test through creative problem-solving learning on linear programming material. Based on the results of the many errors found in the indicator, presenting mathematical situations in various ways and knowing the differences, and developing the concepts that have been studied. The types of errors that students have made in answering the problem included conceptual error, procedural error, and technical error

Kata kunci: Analysis of student answer errors; creative problem-solving model; problem-solving ability

Abstrak

Penelitian ini dilatar belakangi oleh banyaknya kesalahan yang dilakukan siswa dalam menyelesaikan soal pemecahan masalah. Tujuan dari penelitian ini dilakukan untuk melihat penyebab kesalahan siswa dalam menyelesaikan soal pemecahan masalah berdasarkan teori analisis kesalahan kastolan. Metode penelitian yang digunakan adalah deskriptif kualitatif. Objek Instrumen pada penelitian ini melibatkan 4 orang siswa kelas XI MIA . Teknik pemilihan sampel menggunakn purposive sampling. Instrumen yang digunakan dalam penelitian ini adalah tes dan wawancara. Hasil tes diperoleh dari tes kemampuan pemecahan masalah melalui pembelajaran creative problem solving pada materi program linear. Berdasarkan hasil kesalahan yang banyak ditemukan pada indikator menyajikan situasi matematika kedalam berbagai cara serta mengetahui perbedaannya, dan mengembangkan konsep yang telah dipelajari. Jenis kesalahan yang telah dilakukan siswa dalam menjawab soal meliputi kesalahan konsep, kesalahan prosedural dan kesalahan teknik.

Keywords: Analisis kesalahan jawaban siswa; model creative problem solving; kemampuan pemecahan masalah

INTRODUCTION

Attami et al., (2020) stated that Problem-solving ability skills is considered as the heart of mathematics learning because the skills are not only to learn the subject but also emphasize the development of thinking skill methods. Problem-solving is a higher intellectual activity that isconsidered by experts to be the most difficult level of cognitive activity that supports activities at the same time (Căprioară,

2015) Although the fact that problem-solving skills of Indonesian students are still low.

Based on the TIMSS 2015 research report, Indonesia ranks 45th in the acquisition of scores from 49 other countries (IEA, 2015). The results of the TIMSS report show that the average score for Indonesian mathematics skills is 367. And this is also in line with the 2018 PISA research report which involved 600,000 students from 79 countries aged 15 years. In the PISA research report, the skills that are measured are scores on the mathematics test.

Based on research (İncebacak & Ersoy, 2016) when examining students' problem-solving papers, it was observed that they were more successful in solving problems, which they came across before or were similar to those they had solved. It can be seen that non-routine questions cause some students to experience difficulties in solving the problem.

Mistakes are a thing deviations committed by students in solving the given questions Wahyuniar & Mahdiyah (2022) Mistakes in math can be factual, procedure, or concept that happened for a number of reasons. (Sulistyaningsih & Rakhmawati (2017) states that errors happened when the completion of the problem in the question is that students are less thorough and do not understand the problem, think about the problem it is difficult, do not understand the concept questions, and want to quickly finish in do questions.

Based on Pujilestari (2018) proved that it was a mistake carried out by students as follows: 1) Conceptual errors were made by 24 students or 25.26%, 2) Concept errors were made by 41 students or 43.15%, 3)

Calculation errors were made by 21 students or 22.10%. From this, it can be said that understanding the concept is important to learn mathematics in a meaningful way, of course, the teachers expect an understanding that is not achieved by students limited to understanding that can connect (Murizal et al., 2012). This is in line with Fauziah Siregar (2019) states that based on the analysis of the results of the discussion it can be concluded that the average student who do the questions correctly by 49.518%, and the average student who did the questions wrong by 50.47%.

Student mistakes when solving problems or solving problems can become a benchmark for students' understanding of the material (Priyati & Mampouw, 2018). Errors in solving math problems often occur because, during the learning activities of mathematics, students experience a lot of difficulty with the material given. Raharti & Yunianta (2020) this research explains the importance of a teacher identifying student mistakes and making efforts to provide solutions that are appropriate for students to overcome difficulties and minimize the mistake.

Error analysis carried out in this study is using error analysis according to Kastolan. Kastolan Wahyuni et al., (2022) stated that three types of student errors were made in this study: conceptual, procedural, and technical. Kastolan Wahyuni et al., (2022) categorizes the types of errors based on error indicators according to Kastolan, as follows:
1. Conceptual error occurs when:
   a. Students cannot choose the formula correctly.
   b. Students are right in choosing the formula but can't implement it.

2. Procedural error occurs when:
   a. Incompatible between the completion steps ordered by the problem with the final step that students make.
   b. Students can not finish matter to the most form simple.
3. Technical error occurs when:
   a. Students make mistakes in arithmetic operations.
   b. Students make mistakes in writing constants or variables.

Based on the results of observations of students and the results of interviews done with the teacher obtained that students claim difficulties in solving problems, overcoming problems up to writing the conclusion. And on the results of an interview with students found that students don't completely understand understanding in solving problems, When students saw the question, it crossed their minds that mathematics is difficult, and often students do errors because there are many formulas was there at the time of doing the questions mathematics.

RESEARCH METHOD

This is a qualitative descriptive type of research with a qualitative approach. This study aims to determine and analyze the problem-solving ability of students in grade XI MIA 5 Senior High School 10 Palembang using two items followed by 32 students. The instruments in this study include: the main instrument in this study and the primary tool on this have a look at, particularly the researcher instruments that support the research, namely the problem-solving ability test and interviewguidelines.

Data collection techniques in this study used observation, tests, documentation, and interview. Data retrieval is accomplished by giving each research subject a problem-solving test using linear program materials. Data collection was obtained from a written test solving problems in linear program material followed by interviews based on the results of the subject's written work. Purposive Sampling is a sampling technique for data sources with certain considerations (Sugiyono, 2012). After the written test results were obtained, 4 students were selected as subjects for later interviews. This analysis study used 4 samples of student answer sheet result which is AR, EH, DR, and RA.

Based on the results of errors that are often found in indicators, presenting mathematical situations in various ways and knowing the differences, and developing the concepts that have been learned. Types of errors that have been made by students in answering questions include conceptual errors, procedural errors, and technical errors.

Data collection was carried out by giving a linear program material problem-solving test. Subjects were asked to take the test, and after the subject finished working on it, then continue with interview based on the results of the subject's written work to know students' difficulties in solving mathematical problems in linear programming material and the causes of these difficulties.

The interview was conducted based on the results of the subject's written work. After conducting the interviews, it was continued by analyzing the data using triangulation, namely conducting interviews to compare the data obtained from examining the results of the diagnostic tests and the results of interviews on the types of difficulties that the subject experienced in solving linear programming questions.

RESULT AND DISCUSSION

This study used a purposive sampling technique. Then describe the problem-solving ability of the research instrument. Students work on a linear programming mathematical problem-solving ability test. Data collection techniques used are test methods and interview methods. The test method used is in the form of non-routine questions in the form of problem-solving questions in the form of stories. Which consists of 2 questions made based on problem-solving indicators. after the test is carried out and the results are obtained, an analysis will be carried out using error analysis according to Kastolan to find out the error. The test is carried out offline and during the process, it is carried out in the classroom. The interview method was carried out after the test results were obtained and carried out based on the academic abilities represented by 6 students. Interviews are used to find out and obtain or give confirmation directly in determining the types of errors. The data analysis technique used is the analysis of test results and interview analysis. Analysis of test results in this study using the problem-solving scoring indicator will be shown in Table 1.

Table 1. Indicators scoring problem-solving abilities

Rated aspect	Reaction To Questions	Scale
Understand the problem	Does not mention what is known and what is asked	0
	Mention what is known without mentioning what is being asked	1
	Mention what is known and what is asked but not yet precise	2
	Mention what is known and state what is asked precisely	3
Plan a problem-solving solution	Not planning problem-solving at all	0
	Planning to solve the problem but not correctly	1
	Planning problem-solving properly	2
Solving problems according to the plan	Doesn't solve the problem at all	0
	Carry out the plan but wrong or right only a small part	1
	Implement the plan but there are a few mistakes or half right	2
	Carry out the plan correctly and correctly	3
Re-examining the results	Doesn't re-examining the process of checking again	0
	Re-examining the result but not right	1
	Re-examining the result correctly	2

And how to calculate the percentage of problem-solving ability by using the following equation (1):

Score presentation =
$$\frac{\text{the total score obtained}}{\text{total score}} \times 100\% \quad (1)$$

After the score is obtained, then grouped into the result criteria Table 2 problem-solving percentage mathematical.

Table 2. Percentage results criteria mathematical problem solving

Criteria	Percentage (%)
Tinggi	$80 \leq N < 100$
Sedang	$40 \leq N < 80$
Rendah	$0 \leq N < 40$

Interview analysis was carried out with reduced data, then the data presented and lastly withdrawn conclusion. The results of the analysis on the sheet of student answers found the type of error that students do base

on errors according to Kastolan, such as conceptual errors, procedural errors, and technical errors. Following error in solving the problem student's mathematical problem-solving, as follows:

1. Conceptual Errors
a. Subject AR

AR is a subject that is included in the low ability. Since AR subjects are less thorough in understanding the problems of the questions given. AR subject has not been able to understand question number 1. Based on the data analysis it can be concluded that the mistakes made by students are mostly on the indicator of understanding the problem (Andayani & Lathifah, 2019) the subject of AR answer sheet will be presented in Figure 1.
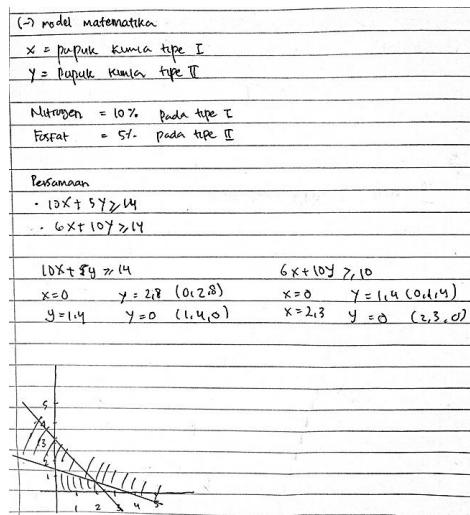
Figure 1. AR Answer Sheet Number 1

This was reinforced by the subject AR's answer when asked about the process while completing the answer. Furthermore, from the interview results obtained that AR doesn't know if the percentage of percent in the question is also used to solve the problem, He can solve the story problem, and know the method of elimination and substitution but He

didn't read carefully the meaning of question number 1. From this statement, it can be seen that subject AR don't understand the problem given correctly. So subject AR results in an incorrect answer.

b. Subject EH

EH is a subject that is included in the low ability. EH is still having trouble understanding the problem from the problem. The following is an attached image of the written answer for the subject of EH. The answers of EH will be presented in figure 2

From figure 2 showed that EH in question number 2 tried to make mathematic models of the problem but since EH doesn't understand the meaning of the problem EH can't do mathematic models correctly. This is in line with Zulfah (2018) state that problem-solving must be based on the presence of a cognitive structure student, if it is not based on cognitive structure, students have a small possibility of being able to solve the problems presented, the subject of EH answer sheet will be presented in Figure 2.
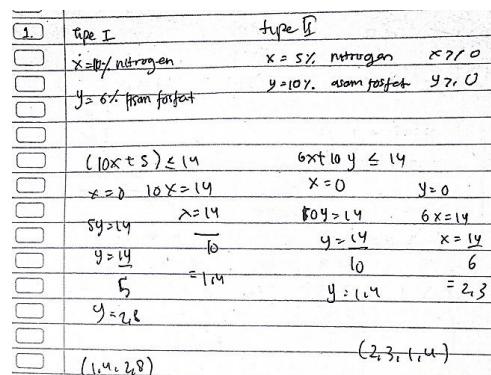

Figure 2. EH Answer Sheet Number 2

From figure 2 showed that the difficulty faced by EH is that students are not used to getting the problem in question with everyday life to practice it, the teacher and students analyze the

process of problem-solving that has been obtained, evaluate the ability to solve student problems at each meeting the teacher gives evaluation questions related to the material learned so that students are accustomed to solving the problems concerned in real life problem (Yuhani et al., 2018).

Furthermore, from the observation it can be seen that subject EH can pass the first, second, and third steps but can't fulfill the last step, it was strengthened by the results of the interview when working on the test questions. From the interview results obtained that Subject EH have difficulties to to understand the meaning of the question. Subject EH had trouble putting it into a mathematical model, And also subject EH didn't pay attention to the learning activity..

According to Jumramiatun et al., (2020) in working on problems, the factors that cause difficulty in problem-solving are that students are confused in determining the mathematical model, students do not understand the intent of the questions, causing errors during processing, students do not understand the meaning of the questions because they are lazy to read. repeat the question because the text on the question is too long while external factors are factors from outside the students including the habits of students who pay less attention to the teacher's explanation during learning.

Conceptual error Lutfia & Sylviana Zanthy (2019) is a deep error interpret or using a term. Conceptual errors in this study occur because:
a. Students cannot apply to the next stage of completion.
b. Students do not know the stage solution to be used when solving questions. This is in line with (Damayanti & Firmansyah, 2019)

that stated, which results in students often do not find out what stage of completion is should be used.

2. Procedural Errors
a. Subject DR

Subject DR students don't solve the problem according to the steps that should be there at this point to solve the problem, that is DR subject determines the corner point first then performs elimination and substitution of the constraint function even though in the end the value of each variable x and y of the constraint function will be substituted back into the objective function to get the minimum value of the problem in the given problem it is not quite right in the process, the subject of DR answer sheet will be presented in Figure 3 .

Figure 3. DR Answer Sheet Number 1

Based on Figure 3 and from the interviews conducted with DR subjects, students thought that this could be done and the most important thing was that the answers were correct. Even if you get the correct results, it is very important to pay attention to the steps in working on the problem because mathematics requires accuracy.

b. Subject RA

Subject RA did not write down the first step that should be there at the time of finishing the question. That is,

the student does not make a move early in solving the problem that is made known and inquired of question. Students just go straight to the next step, the subject of the RA answer sheet will be presented in Figure 4.

Figure 4. RA Answer Sheet Number 1

From figure 4 showed that subject RA didn't follow the subject in which subject RA did not pre-examine the problems of the questions given, namely RA subjects did not pre-examine the variables from nitrogen and asam fosfat and immediately carried out mathematical modeling of the given problems. From an interview conducted get information that students want fast finished, less conscientious students, and students confused in understanding the problem.

Procedural errors Damayanti & Firmansyah (2019) is a time error that makes efforts to compile steps for a systematic solution. procedural errors occur because:
a. Students do not fit in steps settlement.
b. Students cannot solve the problem down to the simplest form.
c. Students cannot determine the sign operation properly.

From the discussion above it is known that there are still many procedural errors in work on linear programming questions. This shows that students still have a lot of practice questions to better understand or understand and be skilled in working on questions so that you can reduce learning difficulties experienced by students procedural error that was made is in line with what was stated by Khanifah & Nusantara (2013) namely mistakes that often occur because students are not suitable when completing the completion steps ordered by the question.

3. Technical Errors
a. Subject VP

Subject VP made a mistake in writing, namely writing the constraint function that should be written as the objective function but the substituted function is correct, the subject of VP's answer sheet will be shown in Figure 5.

Figure 5. VP answer sheet number 2

Based on figure 5 and from interviews that were done give a piece of information from subject RA is accurate and didn't re-examine the answer.

b. Subject RT

Subject RT made a writing error, namely on the number line of the cartesian system of coordinates. Subject RT made a mistake in writing the numbers on the number line of the cartesian system of coordinates which

number 15000 and should be 15000 and 25000 should be 2500, the subject of RT's answer sheet will be shown in Figure 6.
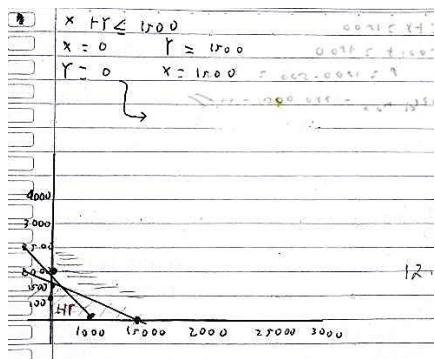

Figure 6. RT Answer Sheet Number 2

Technical error (Lutfia & Sylviana Zanthy, 2019) is the error obtained when doing calculations. The technical error occurs because:

a. Students are not careful in counting
b. Students are in moving constants or variables or coefficients from the previous step to step, furthermore. This technical error goes hand in hand with Yunia & Zanthy (2020) stated that error is obtained when students can not count correctly, students are not careful when reading the questions, and students experience difficulties during the reduction operation and summation.

CONCLUSION AND SUGESSTION

Based on research and data analysis conducted, it can be concluded that there are still many students who made a mistake in finishing mathematical problem-solving questions. There are three types of errors according to Kastolan performed by students in solving problem-solving problems mathematical problems in this study, namely conceptual errors, procedural errors, and technical errors.

There are two factors that influence student answer errors namely internal factors such as intelligence, attitude, and wrong habits in learning something, and external factors such as place of study, weather, atmosphere, etc. (Ishak and Warji in (Hananta & Ratu, 2019).

Suggestions based on these other study, this study focuses on the types of errors done by students in solving problem-solving problems in mathematics, and this study hopefully can be a reference for future researchers

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