
STUDENTS' ERROR ANALYSIS ON LINEAR PROGRAM BASED ON THE KIAT MODEL AND STUDENTS' LEARNING INTEREST

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ABSTRACT

KIAT categorizes three types of mistakes: conceptual, procedural, and technical errors. This study analyzes student errors in solving mathematical problems on linear programming material based on student learning interests. The subjects of this study were 15 Year 10 students of Taxation Vocational High School majoring in business and management taken based on learning interests. This study employed a descriptive method with tests and questionnaires as the instruments. The outcomes confirmed that students with high interest in learning made 13 mistakes, while 19 and 20 errors were for students with moderate and low interest in learning, respectively. Of all the errors, based on the student's interest in learning, conceptual and procedural errors were the most common errors (20 errors each). It can be concluded that the more positive students' attitudes, the lower the errors they make, especially on conceptual errors.

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INTRODUCTION

Mathematics is taught across all levels of education, from elementary school to college. It needs to be taught because it is used to solve problems in all aspects of life. Hence, in mathematics pedagogy, a specific material achieves the desired output. It is very important for a teacher to research and identify the difficulties of students in learning mathematics (Haryadi & Nurmaningsih, 2019).

One of the materials taught in Year 10 of Vocational High School (or known as SMK) based on the 2013 curriculum is the Linear Program. The sub-materials taught are linear inequalities of two variables, determining the maximum and minimum values, determining the set of solutions, and solving contextual problems related to linear programming. Some students have difficulty learning linear program because of students' lack of information on the concept of linear program.

Hamzah (2014) suggests that students' lack of understanding of mathematical problems will result in errors in solving the problems given. If students make mistakes in problem-solving, they will make the same mistakes in other problems, leading to low student scores in mathematics. Teachers play a crucial role in improving students' abilities. They need to pay attention to students as an individual and a whole. Hence, the teacher will certainly know the factors causing students' errors in solving math problems at school.

Students' errors can be caused by several factors, internal and external factors. Internal factors can be the lack of motivation, lack of interest of students in the materials, lack of talents in mathematics, and students' mindset of mathematics being difficult (Raharti & Yunianta, 2020) External factors include lazy friends and a lack of support from parents.

Another factor leading to students' errors in solving mathematical problems is interest in learning. Slameto (2003) mentions that "interest is a constant tendency to pay attention and remember some activities". Meanwhile, according to Djaali (2008) interest is a sense of preference and interest in a thing or activity, without anyone telling. Meanwhile, Crow & Crow (in Djaali, 2008) says that interest is related to the motion that encourages someone to stand or address humans, items, activities, reviews inspired by means of the interest itself.

Kiat (2005) classifies errors into three categories, namely: 1) Conceptual error, which refers to errors due to failure to understand the principles involved within the problem or mistakes arising from failure to appreciate the relationships involved in the

problem; 2) Procedural errors, namely errors that arise from failure to perform manipulations or algorithms even though they have understood the concept behind the problem; 3) Technical errors, which refer to errors due to lack of knowledge of mathematical content in other topics or errors due to carelessness. Students must be interested in learning or participating in ongoing learning activities because using their interest will encourage their participation in direct learning. Slameto (2003) states that interest is paying attention and remembering some activities. Interest is a feeling of pride & a sense of interest in an activity or aspect without instruction (Djaali, 2008). So, it could be concluded that interest in learning is a sense of interest and attention.

The research conducted by (Dwi Listiana & Sutriyono, 2018) found that most errors made are conceptual errors (68.9%), followed by a technical errors (20.0%), the procedural error (11.1%) So, it can be concluded that students' understanding of the concept of the set concept is relatively low. Previous research used error classification using KIAT for the topics of System of Linear Equations of Two Variables and Algebraic operations. On the other hand, this study uses error classification according to KIAT in the topic of the linear program for Year 10 students in one of the Taxation Vocational Schools in Riau.

METHOD

This study is a descriptive qualitative study. In this study, the classification of student errors is based on Kiat (2005).

1. Conceptual errors, with the indicators: a) errors due to lack of understanding of concepts related to the given problem; b) the error of not being able to determine the relationship involved in the problem.
2. Procedural errors, with the indicators: errors due to the inability to manipulate in the form of choosing the right formula to solve the problem at hand.
3. Technical errors, with the indicators: a) errors due to lack of expertise of mathematical content on other subjects; b) carelessness in fixing the given problem.

This study was done on 13 September 2021, with a sample of 15 Year 10 students randomly selected from one of the taxation vocational high schools in Riau. Data was collected using four words problems of the linear program, as presented below in table 1.

Table 1. Instrument Data

No	Problems
1	A toast and grilled banana seller sells 50 servings every day. The capital for one portion of toast is IDR 4,000.00 and IDR. 3,000.00

No	Problems
	for one portion of grilled bananas. The seller only has a capital of IDR. 180,000,00. If one portion of toast is sold for IDR. 5,000.00, and the price of one portion of grilled bananas is IDR. 4,000.00. Determine the profits that the seller will get!
2	Riski and Rima work in a t-shirt factory for logo printing. Riski can print 300 t-shirts/hour, while rima 200 t-shirts/hour. The working hours of Riski and Rima are not equal. The working hours for both Riski and Rhyme is 50 hours, with 12,400 T-shirts being printed. Determine the working hours for Riski and Rima individually!
3	A small industry has two types of goods (A and B) using two machines (M1 and M2). One unit of item A is made by operating the M1 machine for 2 minutes and M2 for 4 minutes, while one unit of item B is made by operating the M1 machine for 8 minutes and M2 for 4 minutes. In one day, both machines operate for no more than 8 hours. The net profit obtained from one unit of item A is IDR. 250,000.00, and the profit of item B is IDR. 500,000. Determine the maximum profit the industry will get!
4	Determine the maximum value of the function $f(x, y) = 8x + 6y$ that satisfies the following equation! $4x + 2y \leq 60$ $2x + 4y \leq 48$ $x \geq 0$ $y \geq 0$

The first step is to administer a learning interest questionnaire to all business and management expertise program students (150 students). Data were then analyzed to find students with a high, medium, or low learning interest. Next, five students with high learning interest, five with moderate learning interest, and five with low learning interest were randomly selected as research samples. Then, four problems of the linear program were given to each student. The final step in this research was to analyze the results of students' answers based on their respective learning interests.

RESULTS AND DISCUSSION

The outcomes of the analysis of student answers in this study were based on errors according to the KIAT and learning goals based on the level of ability of each student's interest in learning, specifically high, medium, or low. The error indicators used to identify student errors can be seen in Table 2.

Table 2. Error Category by KIAT

Error Type	Error Category
Conceptual Error (CE)	Errors occur because students no longer recognize the standards concerned with the problem. Errors arise from the student's inability to decide the relationships involved in the problem.
Procedural Error (PE)	Errors due to the student's inability to perform manipulations or algorithms even though they have understood the idea behind the hassle.
Technical Error (TE)	Error due to lack of expertise in math content material in other subjects. Mistakes due to carelessness.

Table 3 Student Errors based on Learning Interest

Problem Code	Number of Errors Based on Learning Interest									Total Error
	High Interest			Medium Interest			Low Interest			
	CE	PE	TE	CE	PE	TE	CE	PE	TE	
Problem -1	0	1	2	1	2	1	2	2	1	12
Problem -2	1	2	1	3	1	1	3	2	0	14

Problem Code	Number of Errors Based on Learning Interest									Total Error
	High Interest			Medium Interest			Low Interest			
	CE	PE	TE	CE	PE	TE	CE	PE	TE	
Problem -3	0	2	1	2	2	1	3	2	0	13
Problem -4	1	1	1	2	1	2	2	2	1	13

Based on Table 3, the categorization of the types of student errors based on the interest in learning of the students who made the most mistakes were students who had low interest in learning. The following is the percentage of students' errors in answering the questions given.

High Learning Interest

Students with a high interest in learning make fewer mistakes in answering problems given, evidenced by the answers obtained, specifically for Problem 1 are shown in Figure 1. Of five students, only three students made mistakes, including one procedural error and two technical errors; the other two answered correctly.

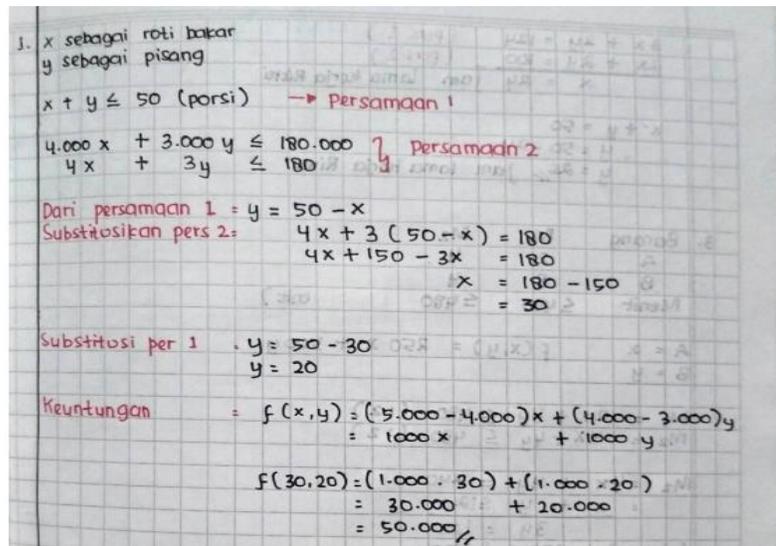


Figure.1 Answers of students with a high Learning Interest

For problem 2, students made four errors, namely one conceptual error, two procedural errors, and one technical error; one student answered correctly. For Problem 3, the number of errors made by students is three errors, namely two procedural errors and one technical error. Likewise, for Problem 4, there is one error, and two students answer correctly.

No. _____
Date _____

1. Roti Bakar = x
Pisang Bakar = y
 $x + y = 50$

Modal:
 $4000x + 3000y = 180.000$
 $4x + 3y = 180$

$F(x,y) = 5.000x + 4.000y = ?$

$4x + 3y = 180$ ($\times 1$)	$4x + 3y = 180$
$x + y = 50$ ($\times 3$)	$3x + 3y = 150$
	$x = 30$

Sub $x = 30$ ke $x + y = 50$, maka:
 $30 + y = 50$
 $y = 20$

Jadi, $F(x,y)$
 $5000(x) + 4000(y)$
 $= 5000(30) + 4000(20)$
 $= 150.000 + 80.000$
 $= 230.000$

Figure.2 Answers of students who have a high learning interest

For students with a high learning interest, the errors made by students are shown in Figure 2, that is, procedural errors that are not in accordance with the procedure in problem-solving. So, it can be concluded that students with a high interest in learning make conceptual errors of 10%, procedural errors of 30%, and technical errors of 25% of the four problems given are shown in Figure 3.

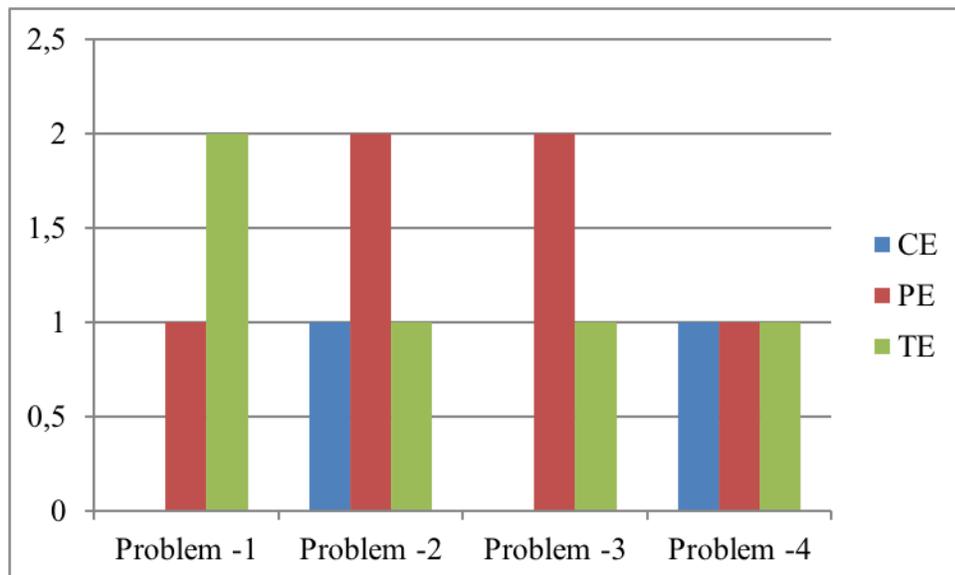


Figure.3 Mistakes of students with high learning interest

Moderate Interest in Learning

Students with a moderate learning interest make greater mistakes in answering the given problems than students with a high learning interest; their answers to Problem 1 evidence this. Of five students, four students made mistakes, including one conceptual error, two procedural errors, and one technical error, and one other student answered correctly. For Problem 2, students made five errors: three conceptual errors, one procedural error, and one technical error. For Problem 3, the number of errors made by students is five errors, namely two conceptual errors, two procedural errors, and one technical error.

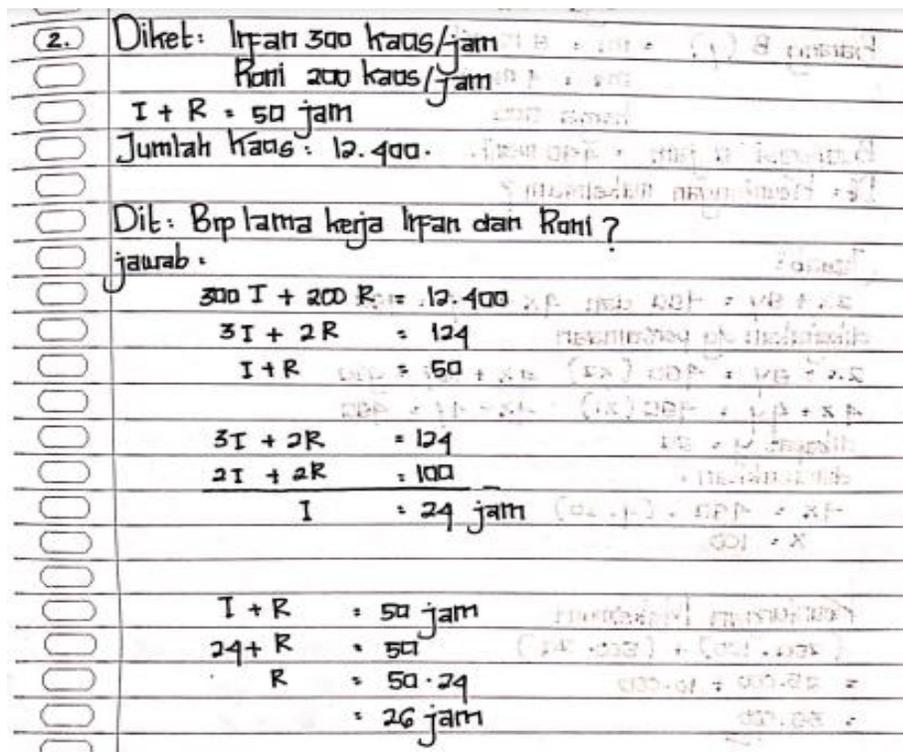


Figure.4 Answers of students who have a medium learning interest

Errors made by students in Problem 2 are shown in Figure 4. Many students do not understand the concept of the problem given, and many are still unable to interpret the problems given. Likewise, for Problem 4, there are five errors, namely two conceptual errors, one procedural, and two technical errors. So, it can be concluded that students with medium learning interest are making conceptual errors of 35%, procedural errors of 30%, and technical errors of 25% of the problems given. For more details, see Figure 5.

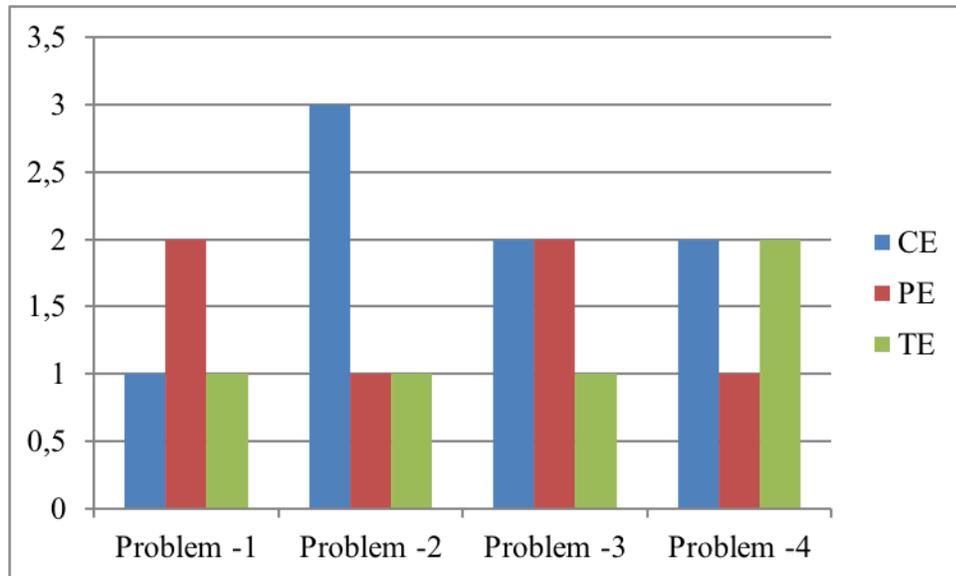


Figure. 5 Graph of mistakes of students who have moderate learning interest

Low Learning Interest

Students making maximum errors are students with low interest in learning, particularly conceptual mistakes, evidenced by the results acquired, particularly for Problem 1. Out of e students, five errors were made: two conceptual mistakes, two procedural mistakes, and one technical error. For Problem 2, students made five errors: three conceptual errors and two procedural errors. For Problem 3, students make five errors, similar to Problem 2.

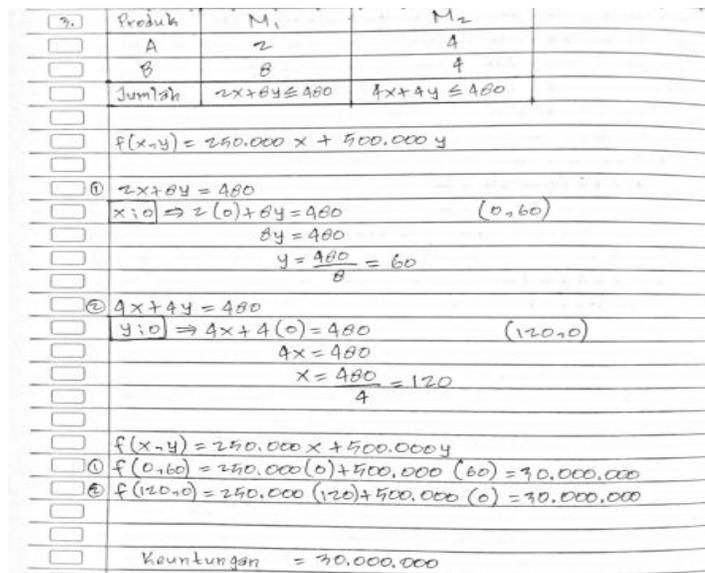


Figure.6 Answers of students with a low learning interest

For students with low interest in learning, many mistakes are made by students in answering problems, as shown in Figure 6. Students answer the problems not according to the correct concepts and procedures, resulting in the wrong solution. Likewise, for Problem 4, there are five errors, namely two conceptual errors, two procedural errors, and one technical error. So, it can be concluded that students with low interest in learning make conceptual errors by 50%, procedural errors by 40%, and technical errors by 10%. More details can be found in Figure 7.

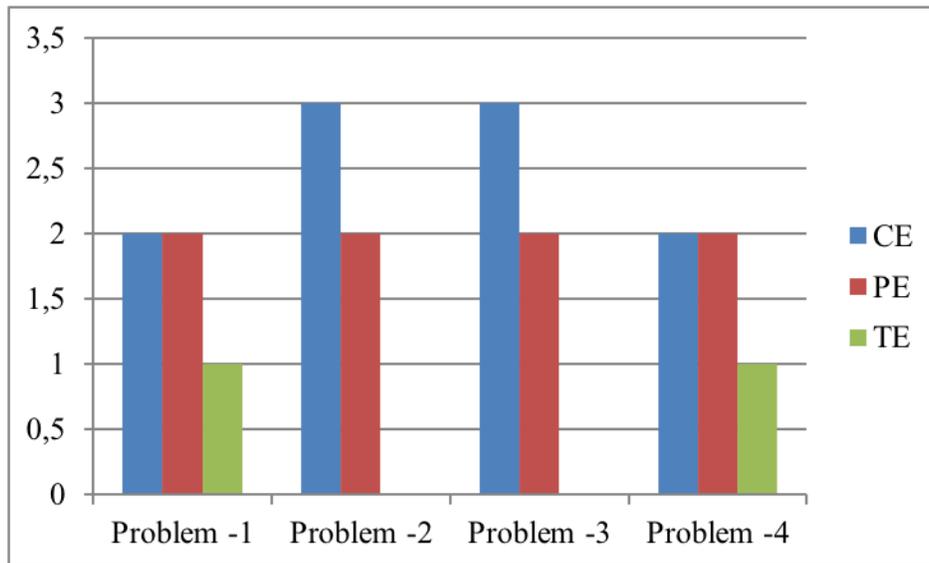


Figure. 7 Graph of Errors of Students with low learning interest

Of all the mistakes made by students, the most errors occurred based on the category of interest in learning, namely conceptual and procedural errors (20 errors in total). This is, of course, because students' learning interest impacts the learning process carried out by these students at school.

CONCLUSION

The results show various errors made by students based on the category of learning interest; it can be concluded that the higher the student's interest in learning, the errors made by students will be lower, especially on conceptual problems. Students with high learning interest made 13 mistakes, while students with moderate learning interest made 19 errors, and students with low learning interest made 20 errors. These findings strengthen the research results conducted by other researchers reporting a positive attitude toward learning interest strongly affects the mathematical abilities of each student.

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