Analysis of Student Mistakes in Completing Matrix Problems in The Linear Algebra Course

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Abstract. Linear Algebra is a material that students generally get in high school, but there is no specification regarding sub-chapters in the material. Therefore, students must understand this concept well. Linear Algebra is a preliminary course, in which students will proceed to the Operations Research Engineering course. The research method used was descriptive qualitative research. The subjects of this study were the fourth-semester students of Informatics Engineering, Faculty of Computer Science at Banten Jaya University. Sampling was done purposively because there were significant differences between the other classes. The instrument in this study was a test consisting of 7 problem descriptions. The results of this study indicate that students make some mistakes in solving matrix problems, namely the results of matrix multiplication, the sum of the matrix, the writing of negative signs, and the writing of the matrix form.

1. Introduction

Mathematics is a universal science and is useful for human life, also underlies the development of modern technology, and has a very important role in various disciplines and advancing human thought power. This rapid development in the field of information and communication technology is based on the development of mathematics in the fields of number theory, algebra, analysis, probability theory, and discrete mathematics. To overcome and create technology in the future, mastery, and understanding of mathematics is needed from an early age [1].

Algebra is a very important component in mathematics [2]. Linear Algebra courses are given to students with the intention that students can think analytically, systematically and critically in developing strategies for solving a problem [3]. Although linear algebra is a basic course, algebra is still scary for students. His research concluded that the mastery of basic mathematical operations as a provision for manipulation of algebraic forms is a serious problem for students [1]. Linear algebra consists of two materials, namely matrix, and vector. Researchers only discuss the problem in solving problems in the matrix material. Because there are some significant errors in solving the problem matrix. Linear Algebra is a subject that must be taken by S1 and D3 students in the Informatics Engineering study program in semester IV. Linear Algebra is also a compulsory subject to be taught before a student contracts the Operations Research Engineering (TRO) course in semester V.

And research [4] the most mistakes made by students were 3 indicators, namely concept errors, skill errors and problem-solving errors in problem-solving. The mistakes made are generally a misconception, principle, and operation. Factors causing it to be less thorough in understanding and solving problems, ashamed to ask questions and express their opinions to lecturers in class [5]. Factors causing students to experience errors both reading questions, understanding questions, problem transformation, process skills and writing the final answers of each subject on each item [6]. Factors causing student errors include lack of mastery of concepts, not writing what is known and what is asked, not careful doing arithmetic operations, and in a hurry in working on problems [7]. In general, the location of problem-solving lies in the use of data and techniques, understanding concepts, interpreting language and data usage, and drawing conclusions [8].

Based on the results of interviews conducted by researchers with several informatics engineering students, that the matrix algebra course was very fun. It's just that students often make mistakes when calculating. Whether it's matrix multiplication, matrix addition, solving equations, and determining the shape of the matrix. Due to haste in solving problems, because often see the time that has passed. Also, do not focus on the numbers listed in the problem. Therefore, researchers are interested in analyzing several student errors in solving matrix problems in linear algebra courses. Therefore, the results of this study are expected to be able to show and describe the various errors experienced by students.

2. Research Methodology

This research was conducted in the Informatics Engineering study program, Faculty of Computer Science (FILKOM), Banten Jaya University. This research last for 1 semester in the even semester of 2019. The research procedure was 3 main stages namely preparation, implementation, and data analysis. In the preparation phase, researcher gather problems in linear algebra. There were 7 questions given to students. therefore, the researcher analyzed the students' answers to find out and describe the errors experienced by students. This study taken from the population, namely 4 classes in algebra courses and taken 1 sample class purposively with 21 students.

This type of research is a qualitative descriptive study that seeks to describe the analysis of student errors in working on linear algebra problems. [9] states that descriptive research is the most basic form of research and is shown to describe or describe existing phenomena, both natural phenomena or human engineering. According to Lofland [10], the main data sources in qualitative research are words, actions, the test is additional data such as documents and others.

The data obtained is described or describe again and then analyzed. Researchers try to describe and analyze student errors in solving linear algebra problems. Qualitative method is a research method that is based on the philosophy of post positivism, which is used to examine the natural conditions of objects (as opposed to experiments) where research is as a key instrument, sampling data sources conducted purposively [11]. Data collection techniques with triangulation (combined), data analysis is inductive/qualitative and qualitative research results emphasize the meaning rather than generalization. Qualitative research is research to answer problems that require an in-depth understanding, in the context of the time and situation concerned, conducted naturally and naturally following objective conditions in the field without any manipulation and types of data collected especially qualitative data [12]. Instrument tests include linear algebra questions and non-test instruments in the form of interviews with informatics engineering students who take Linear Algebra courses.

3. Result and Discussion

Based on the results of data analysis, the researcher found 4 errors made by students when solving problems regarding the operation of linear algebraic forms in the matrix material. All types of mistakes made and the number of mistakes made by students can be seen in Table 1. In the table below, it has been analyzed from the number of students with a sample of 1 class that is 21 students. Also explained in the graph below

Table 1. Student error type

Error Type	The number of students
Error in matrix multiplication	17
Error in matrix addition	9
Writing error in matrix form	16
Error in the matrix equation	10

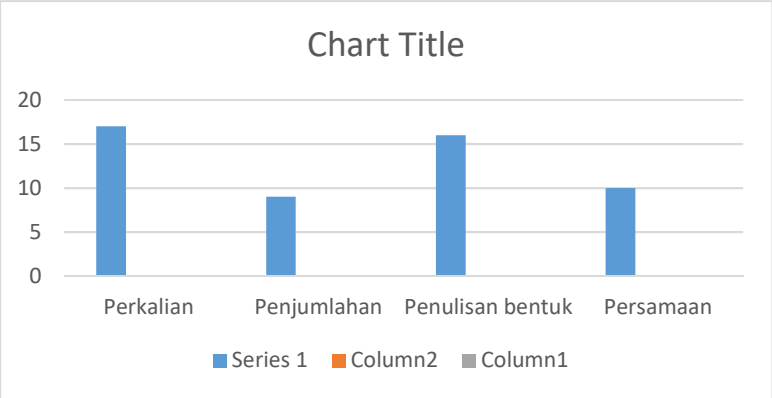


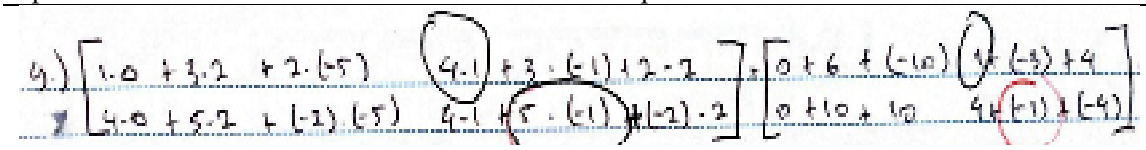
Figure 1. Recapitulation of student mistakes in solving algebra problems

From the graph above it is clear that errors in matrix multiplication are higher than in other errors. 17 students out of 21 students made a multiplication error on the matrix, 9 students out of 21 students made mistakes in the sum of the matrix, 16 students in 21 students made mistakes in writing the matrix, and 10 students in 21 students made mistakes in completing the matrix.

3.1 Error in matrix multiplication

Table 2. Error in matrix multiplication

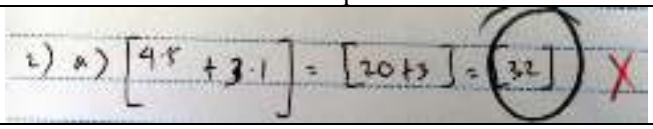
Error Type	The suspected cause of the error
The multiplication results are not relevant to the multiplication information in the first part operation.	Lack of careful seeing of numbers, lack of focus in adding together, and in a hurry in solving problems.



In table 2 there is a picture of the complete error on the multiplication 4 x 1 and 5 x (-1). Lack of accuracy of students in calculating multiplication. This is due to not understanding the matrix multiplication formula

3.2 Error in matrix addition

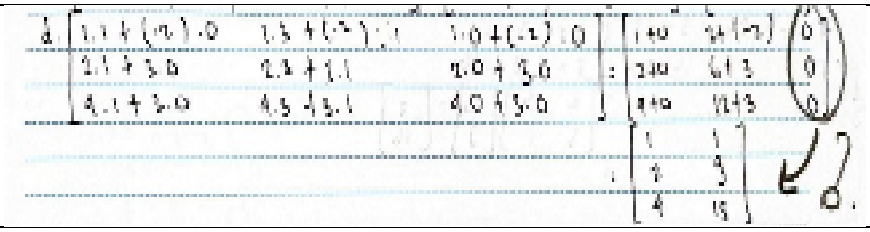
Table 3. Error in matrix addition

Error Type	The suspected cause of the error
Addition results that are not relevant to what they should be	Lack of careful seeing of numbers, lack of focus on what is done, and in a hurry in solving problems.
	

In table 3 there is a picture of an error in solving the sum of the matrix that is 20 + 3. The lack of concentration of students in solving problems.

3.3 Writing error in matrix form

Table 4. Writing Error in Matrix Form

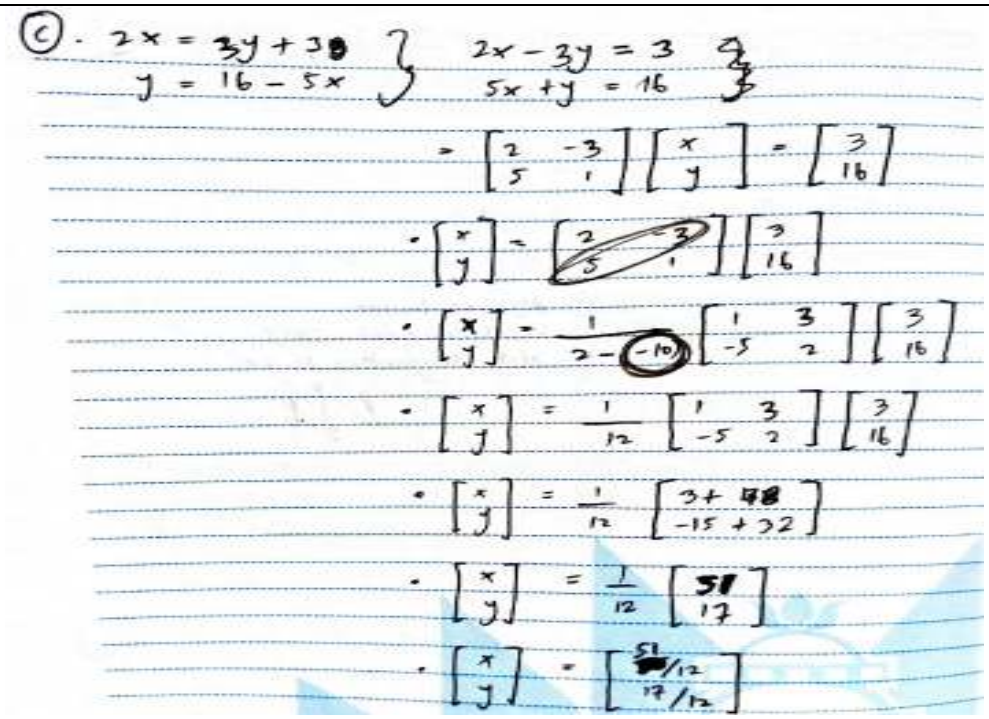
Error Type	The suspected cause of the error
The results of the matrix multiplication operation are partially omitted in one column.	Lack of student knowledge regarding matrix form
	

In table 4 there is a picture of an error in writing a matrix form. This is due to the lack of knowledge of students in the knowledge of the types of matrices. This problem is not due to exhaustion but is a mistake that requires cognitive tasks so that they are aware of the mistakes they have made [13].

3.4 Error in the matrix equation

Table 5. Error in The Matrix Equation

Error Type	**The suspected cause of the error**
The solution to linear equation problems	Not focus on the formula used, bias so students do not know the formula that must be used.



In table 5 there is a picture of the student's error in solving the linear equation system which is converted into a matrix. The error is seen in multiplication to determine the determinant. Lack of understanding of students in multiplying determinants into fatal mistakes because if at the beginning there is a misconception, then the determination of student results will not get the maximum value.

4. Conclusion

Based on the analysis above, students make 5 types of errors in solving mathematical problems related to linear algebra operations on the subject matter of the matrix. With various reasons for each error analyzed. All errors encountered in this research are calculation errors in matrix multiplication, errors, also, errors in writing matrix form and errors in solving equations in linear equation problems. The expected of this study, researcher better understand the character of students, understand the psychology of students, and find ways so that students can be more careful in solving problems, and respond to accurate instruction so that there are no misconceptions in using the formula.

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