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An Analysis of Students' Errors in Solving Indefinite Integral Problems Viewed From Gender Differences

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ABSTRACT

Based on previous research, one of the gender differences between men and women in mathematics is problem solving skills. Gender differences in mathematical problem solving can be an indication of the different errors experienced by male and female students. The question of this research is what kinds of error are made by students in solving indefinite integrals viewed from gender differences? While the purpose of this research is to describe the type of errors made by students in solving indefinite integrals viewed from gender differences. This research is a qualitative research using a descriptive research methodology approach. The subjects were 3 male students male and 3 female students taken by purposive sampling. Data were collected from indefinite integral test, which are used to determine the type of the students' fault in solving problem based on indicators Newman. Indefinite integrals in this research regarding indefinite integral by substitution and integration of fractional function by partial fraction. From the result of the study, it was found that for integral substitution problem, all of the male students could solve the problems well, while female students made transformation and process skill errors. In a matter of integration of rational function by partial fractions, 1 male students encountered process skills error, while two other male students encountered comprehension error. For female students, the error that occurs is transformation error.

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INTRODUCTION

The development of science and technology requires human to improve the skills and knowledge continuously. Knowledge that can be accessed from anywhere leads to the need for the ability to obtain, choose and process information. These abilities require systematic, logical, critical, and creative thinking. Therefore we need a learning to develop critical, systematic, logical and creative thinking skills. These capabilities can develop through learn mathematics.

The purpose of learning mathematics in college by Koko is to acquire basic knowledge and mindset of mathematics in the form of: (1) well-organized scientific thinking critical, logical, and systematic, (2) trained power of reason and creativity after studying various strategies and tactics in solving problems calculus, (3) trained in designing a simple mathematical model, reasoning, formulas, and the correct method[1]. One of matter in mathematics for college that can help the achievement of learning goals is integral calculus.

Integral calculus is one of the compulsory subjects in Mathematics Education Study Program which has a weight of 3 credits. This subject aims to equip students about the concept of integral, techniques of integration, integral transcendent function, area, volume, and improper integral. In the field of integral calculus, competence which is expected to be achieved, i.e.: (1) understand the concept of indefinite integral and definite integral, and adept at applying it to the solution of the problem, (2) understand the technique of integration and proficient applying it to

the solution of the problem, (3) understand the concept of improper integral and adept at problem solving[2]. In addition, the calculus is one of the subjects that have an important role in solving problems of mathematics, physics, chemistry, biology, and engineering.

In reality based on observation and experience of researchers on the students who take integral calculus, it was found that the students are still experiencing an error in solving the problems given. This observation appropriate to the research which states that the achievement of students in calculus courses still low, because more than 50% of students got score below 70 [3].

To help overcome these problems, first, we identify errors that students do in solving of mathematic problems. By knowing the errors, lecturer can emphasize the learning on the point of the mistakes made. This is corresponding with the statement that errors or difficulties experienced by the students can be traced in order to take prevention on learning[4]. Related to this matter, lecturer should not only know the errors that students do in math. Lecturer should also be aware of other factors that could affect student errors while working on math problems, one of them is gender.

Based on these descriptions, the problem in this research is any kind of error made by students in solving indefinite integrals viewed from gender differences? While the purpose of this research is to describe the kind of mistakes made by students in solving indefinite integrals viewed from gender differences.

According to the Oxford Dictionary, the analysis is the detailed study or examination of something in order to understand more about it. While the error is a mistake, especially one that causes or affects the result of something. The error analysis is the investigation of the errors that students do in learning.

In analyzing students' errors, we need some indicators to make the process more focused. Newman procedure is one of methods for analyzing errors[5]. The indicators of errors based on Newman are reading, comprehension, transformation, process skills, and encoding.

Student errors in answering questions is influenced by various factors, one of which is gender. Some researchers believe that the effects of gender in mathematics occur because of differences in the brains of boys and girls, which are known through observation[6]. One of the gender differences between men and women in mathematics is problem solving skills[7]. Gender differences in mathematical problem solving can be an indication of the different errors experienced by male and female students.

Based on the description above, the problems regarding the types of errors students both male and female in solving indefinite integrals are interesting for researchers, so the researchers examined more about the types of errors experienced by male students and female students in solving indefinite integrals.

METHODS

This study is a qualitative descriptive research. According Sudjana and Ibrahim[8], qualitative research is the research that the data source is derived from the origin. The data didn't analyze statistically, so that tend descriptive analytic, in the form of words or pictures, emphasizes process rather than results, and prioritizing the meaning[8].

Descriptive research is a study that does not give special treatment to the object of study, to describe a condition which have occurred, as well as focus on the actual problems[9]. Topic

that described in this study is the fault of students in solving the indefinite integral viewed by gender differences.

In qualitative research there is no random sample, but the researcher use (purposive sample). Purposive sampling is a sampling technique based on a specific reason[10]. The subjects were 3 students male and 3 female students of the 2nd semester 2018/2019 academic year who have the same relative ability of the department of mathematics education Riau University.

Data collection research using indefinite integrals test questions, which are used to locate the fault of students in solving problems. Indefinite integrals in this research regarding indefinite integral by substitution and integration of fractional function by partial fraction. The error indicators used in this study refer to the indicators Newman i.e. comprehension, transformation, process skills, encoding. The description of each error indicator can be seen in the following table.

Table 1. Classification Code Table Error

No.	Types of Error by Newman	Error Indicator
1	Comprehension	• Do not understand the given problem correctly • Do not know what to do • Write down the exact same form from the problem but do not proceed it • Unable to find keywords in question
2	Transformation	• Do not change the information from the problem into another form that can solve the problem • Wrong in choosing the appropriate method to solve the problem • Change the information in question into another form that can solve the problem but it's not correct • Change the information on the problem, but do not write a complete description
3	Process skill	• Errors in computing • Unable to continue troubleshooting procedures • Continue the process of computing but it's not correct because there is mistake in the concept of algebra • Careless in the process of calculation
4	Encoding	• Writing down the notation (a sign, a symbol, an equal sign, and others) are not appropriate • Error in writing the final answer (None or wrong in turning into an early form)

RESULTS AND DISCUSSION

The errors analysis begin by grouping the mistakes made by 3 male and 3 female students base on the type of errors by Newman. The errors referred to a mistake made by students in solving the problem of indefinite integral by substitution and integration of rational function by

partial fraction. Summary for the mistakes of students' answer of two questions viewed from gender differences can be seen in the following table.

Table 2. Summary for the Mistakes of Students' Answer

No.	Male's Answer			Female's Answer		
	M1	M2	M3	F1	F2	F3
	Correct	Correct	Correct	Transformation error	Process skill error	Process skil error
	Process skill error	comprehension error	comprehension error	Transformation error	Transformation error	Transformation error

Explanation about each error that occurred in the male students to problem on indefinite integral by substitution, is described as follows.

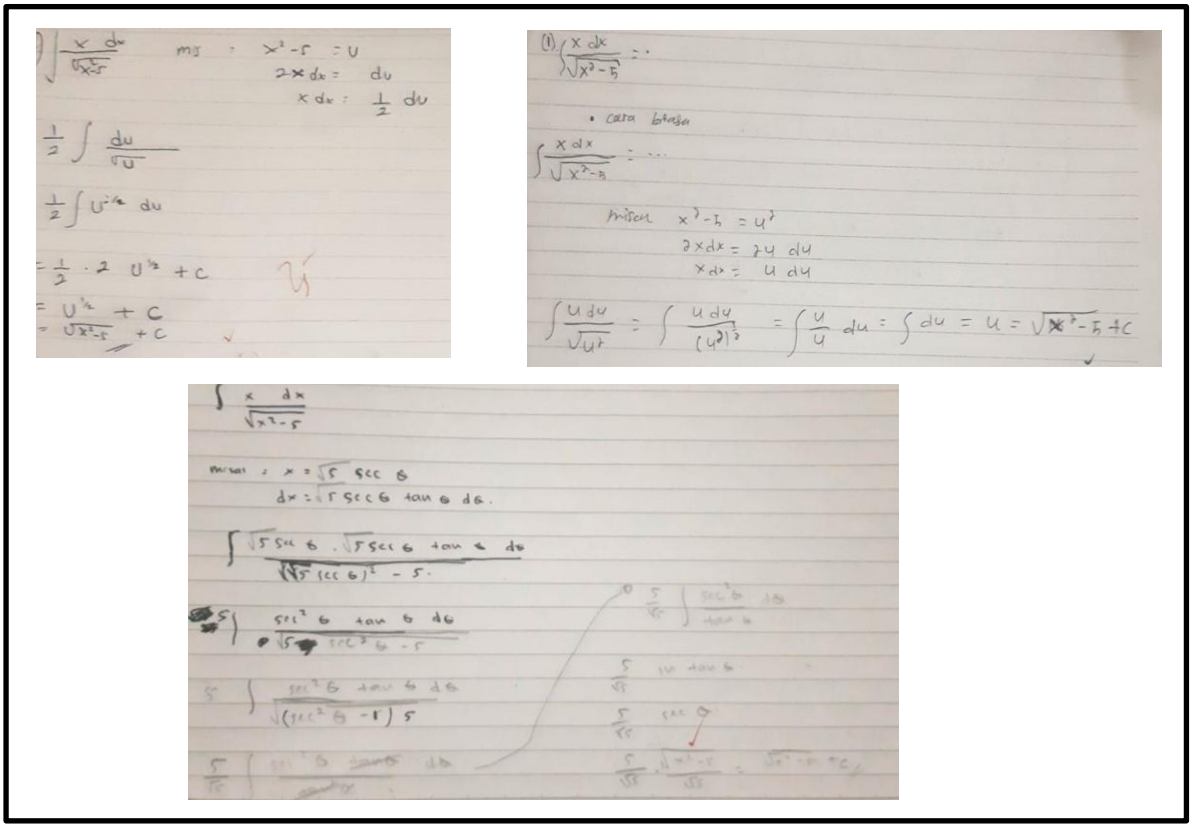
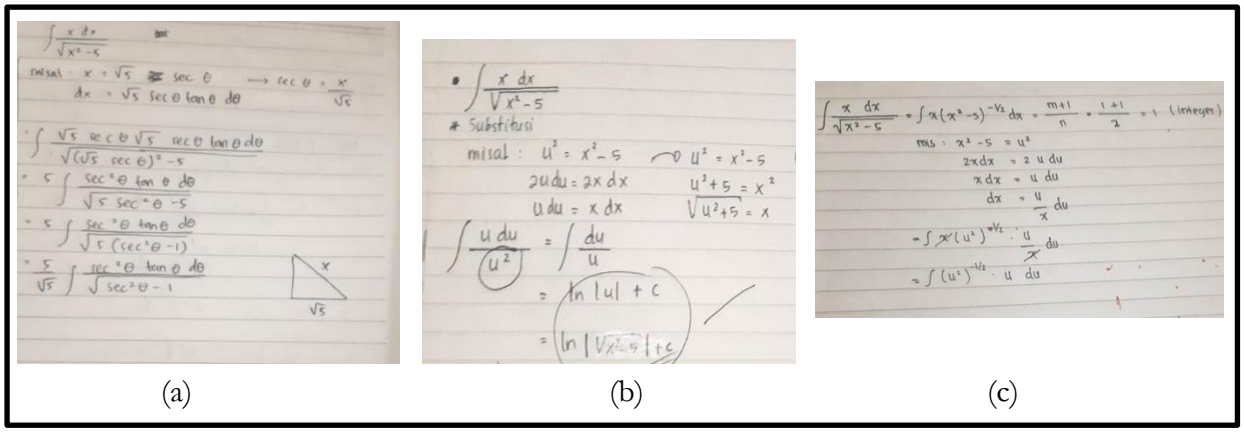


Figure 1. The Answer of Male Students (M1, M2, M3) for Problem of Integral by substitution

Figure 1 shows that the male students has already answered correctly about integral with the substitution. Means all the boys in this research understand the integral by substitution matter. Furthermore, female students' answer for integral by substitution problem can be seen in Figure 2 below.



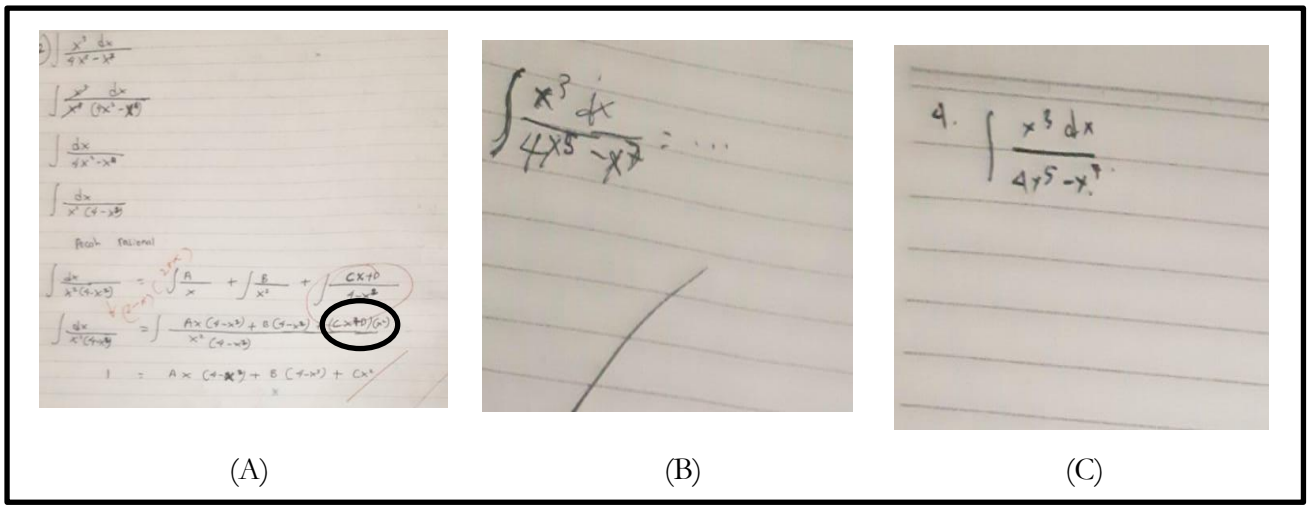
(a) (b) (c)

Figure 2. Female Students' Answer (F1, F2, F3) on Integral by Substitution Problem

From Figure 2, we can see that female students make 2 types of Newman's error. In Figure 2 (a) F1 have been working on the question well, but the student had a trouble to change $sec^2\theta - 1$ into equal form. As a result, these students can not continue the procedure to solve the problem. This student make error transformation since she is not able to change form into another correct form. Figure 2 (b) shows that F2 makes process skill error. This student forgot to put a root on u^2. She wasn't careful and didn't double check her answer. Students F3 in Figure 2 (c), is also do process skill error. She can not continue the procedure in the case of completing multiplication exponential number.

In a matter integral by substitution, the three male students answered the question correctly. Another case with female students who make two types of Newman's error, two people make the mistake of process skills, and one person made a transformation error. This means that more female students make the mistake of process skills. This is in line with the result of previous research, the percentage of errors made process skills of students in the subject of discrete mathematics by 88%, which happened for careless and hasty work on the problem [11].

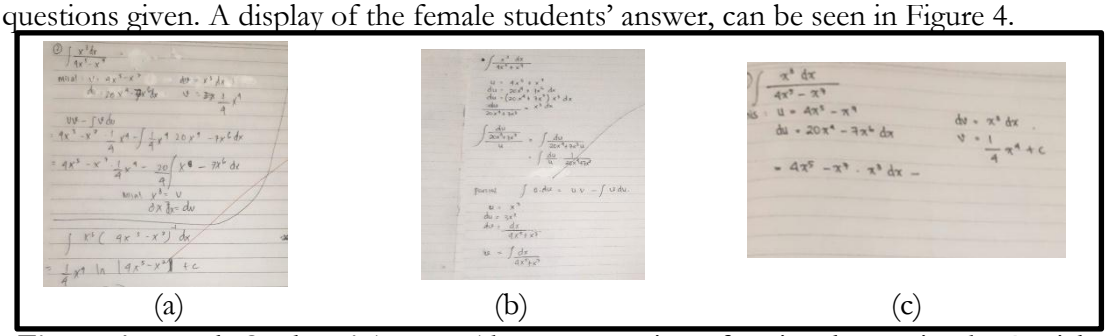
The second matter is an integration of rational function by partial fraction matter. The display of the male students' answer can be seen in Figure 3 below.



(A) (B) (C)

Figure 3. Answers of Male Student for Integration of Rational Function by Partial Fraction Problem

From Figure 3 (a), we can see that the M1 tried to solve the problem, but the students make process skill error. He is wrong when multiplied $(Cx + D)$ by x^2. As a result, the final answer obtained by students of M1 is also wrong. Unlike M1, M2 and M3 in figure 3 (b) and 3 (c) make comprehension error. They do not know what steps should be done to answer the questions given. A display of the female students' answer, can be seen in Figure 4.



(a) (b) (c)

Figure 4. Female Students' Answer About Integration of Rational Function by Partial Fraction

Students F1, F2, and F3 in Figure 4 (a), 4 (b) and 4 (c), all of them make transformation error. F1 and F3 tried to use integration by parts method for solving problems. But they aren't correctly identify the u. While students F2 in Figure 4 (b) using the substitution method first, then proceed with the partial method. However, the acquired form of the substitution method consists of two variables, so that when it was done partially integral, the student cannot continue the problem-solving procedure. F2 should change the form into one variable. In Question 2, all of female students made a transformation error. According to Prakitipong and Nakamura[11], stage of transformation is very important in solving problems. Students have reached the stage of transformation when students can choose the method that can solve the problem and can change a form to another correct form.

From the description of the students' errors, from integral substitution problem, male students can solve the problem well, while female students make transformation error and process skill error. Therefore, in the classroom, lecturer can encourage female students to recall the memory of trigonometric identities. In addition, lecturer can also remind female students o be more careful and not hasty in solving the problem.

In a matter of integration of rational function by partial fraction, only one male student who understands the questions and choose the correct method to solve the problem. However, this student less careful in doing multiplication algebra. As a result, students are experiencing process skill error. Two other male student, did not know what to do to solve the problem. For the female students, the error that occurs is transformation error. The transformation error caused the students does not understand integration by parts method. Students wrong in identify u. Besides that, the transformation error also occur because student use the method of substitution first, but student didn't change the final form into one variable. To overcome this error, lecturer can remind students to choose the easiest method in solving problems. Lecturers should make sure that students know the term and condition to apply a method. In addition, in the learning process, teachers should give a lot of exercises using various method of integration, so that students are accustomed and trained choose the easiest method of settlement for each type of problem. Lecturers should also encourage students to not be quick to give up the work on the problems. so that students are accustomed and trained to choose the easiest method of integration for each type of problem. Lecturers should also encourage students to don't give up quickly.

There are many integration methods, but in this research, the type of problem given only about substitution method and integration of fractional function by partial fractions. On the other hand, the number of male students in one class in Mathematics Education Program University of Riau, only three people. Therefore, researchers can only take three male students and three female students as a subject. It's good to do another study to see the students' errors viewed from gender differences in solving the integral use other methods with more than 6 students as a research subjects.

CONCLUSIONS AND SUGGESTIONS

The result showed that for integral substitution matter, male students can solve the problem well, while female students make transformation error and process skill error. In a matter of integration of rational function by partial fraction, 1 male student encountered error process skills, while two other male students make a comprehension error. For female students, the error that occurs is transformation error.

In this study, the matter and the research subjects are very limited. Therefore, you should be able to do another study to see the errors of students in solving the other integration method viewed from gender differences with research subjects more than 6 students. So that, we can see variations of errors that occur between the male students to female students.

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